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Taxonomic Revision of the Family Psammobiidae (Bivalvia: Tellinoidea) in the Australian and New Zealand Region

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ABSTRACT. Thirty-seven species of Psammobiidae are recognised in a conchologically-based revision of taxa in the Australian and New Zealand region. Four genera are represented: *Asaphis* Modeer, 1793; *Heteroglypta* Martens, 1880; *Gari* Schumacher, 1817; *Soletellina* Blainville, 1824. The largest genus, *Gari*, is divided into nine subgenera: *Gari* sensu stricto; *Psammobia* Lamarck, 1818; *Gobraeus* Brown, 1844; *Dysmea* Dall, Bartsch & Rehder, 1936; *Kermadysmea* Powell, 1958; *Psammotaena* Dall, 1900; *Crassulobia* n.subgen.; *Psammobella* Gray, 1851; *Psammodonax* Cossmann, 1877. Subgenera are not recognised for any of the other three genera. One new species, *Gari* (*Gobraeus*) *eos*, from the Chesterfield-Bellona Plateau in the Coral Sea is described. *Asaphis nana* Powell, 1958, *Psammobia flexuosa* A. Adams & Reeve, 1850, *Psammobia brazieri* Tate, 1886 and the genus *Ascitellina* Marwick, 1928 are excluded from the Psammobiidae as presently defined and transferred to the Tellinidae because all possess lateral teeth in at least one valve. *Asaphis nana* is possibly a species of *Agnomyax* Stewart, 1930. *Psammobia flexuosa* is a junior synonym of *Cymatoica undulata* (Hanley, 1844). *Psammobia brazieri* is probably a species of *Tellina* Linné. *Ascitellina* may be synonymous with *Elliptotellina* Cossmann, 1887. *Psammobia vitrea* Quoy & Gaimard, 1835 is transferred to the Galeommatidae, probably to the genus *Scintilla* Deshayes, 1856. The region possess the highest species diversity known anywhere for the family. Biogeographically, two faunas are discernible – a considerably larger one towards the north essentially of widespread tropical Indo-west Pacific taxa (24 species), and a much smaller temperate one consisting of taxa endemic to southern Australia (5 species), and to New Zealand (5 species). Only three northern Australian species have limited distribution ranges: *Gari eos* n.sp.; *G. rasilis* (Melville & Standen, 1899); *G. gracilentia* (E.A. Smith, 1884). The wealth of taxa enabled some preliminary phylogenetic consideration of the family. No autapomorphy emerged amongst the approximately 40 shell characters described for each species. Lack of a posterior flexure is considered symplesiomorphic. Lack of lateral teeth and fusion of the lower limb of the pallial sinus with the pallial line are synapomorphies that have apparently evolved independently several times (ie, homeoplaseous characters) in the Tellinoidea. The few anatomical studies available are

equivocal in regard to relationships within the Psammobiidae and between families of the Tellinoidea. More conchological and anatomical studies are required before phylogenetic relationship within the Tellinoidea, the largest family numerically in the Bivalvia, can be assessed.

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Introduction

Psammobiids are indisputably members of the heterodont superfamily of bivalves the Tellinoidea. They are often grouped under the popular name of sunset shells. This revision grew out of my study on New Zealand *Gari* species (Willan, 1980). Like most families of bivalves, the Psammobiidae suffers from enormous taxonomic impediments at the level of species and, in consideration of relationships within and between higher constituent taxa. This revision primarily investigates taxonomy of the Recent Australian and New Zealand fauna at the species level. The confusion that exists about the identity of most species in the region, particularly the commonest ones, has two causes – insufficient original descriptions and inability of earlier workers to

comprehend intraspecific variation.

No comprehensive, critical review of the family has been published, either for Australia or New Zealand, or, for that matter, for the Indo-Pacific Ocean. And since virtually all of the species occurring in tropical Australian waters also range more or less extensively within the Indo-west Pacific Ocean, the task of reviewing literature and examining type material has been considerable.

Historically, the first significant publication affecting psammobiids in the region under consideration was that by Lamarck (1818) containing descriptions of four species of *Sanguinolaria*, 18 species of *Psammobia* and eight species of *Psammotaea*. Deshayes (1855) [publication date authenticated by Duncan, 1937] described 68 psammobiid species and varieties, but not one was figured. Reeve (1856–1857) published figures of

Soletellina, *Capsa*, *Capsella*, *Sanguinolaria*, *Psammobia* and *Psammotella* depicting many species, but never Lamarck's and often not Deshayes' type specimens. Some errors in Reeve's *Conchologia Iconica* were subsequently corrected by Bertin (1880), E.A. Smith (1885), Hedley (1904) and Dautzenberg & Fischer (1914). Descriptions of new Indo-Pacific species are contained in expedition reports by Lischke (1869), E.A. Smith (1884), Martens (1897), Hidalgo (1903), Lynge (1909), Lamy (1918), Bartsch (1929), Prashad (1932) and Powell (1958). Scarlato (1965) gave a comprehensive account of the family in Chinese waters as part of a larger monograph on the Tellinoidea. Coan (1973) reviewed the north-eastern Pacific (ie, north-western American) species. Matsukuma (1989) investigated the taxonomy of five south-western Japanese species. Very recently, Cosel (1990) has provided an account of the tropical West African psammobiid fauna.

Materials and Methods

For the purpose of this study, all available type specimens were examined, measured and photographed. A visit to Europe in 1989 concluded this work. Specimens contained in collections of major museums, institutions and private collections were examined for comparison with the type material. All available literature on the Psammobiidae has been consulted.

In this monograph higher taxa are treated in the following sequence: type species; nomenclatural comments; diagnosis; key to subgenera; key to species. Species are treated in the sequence: synonymy; nomenclatural comments on synonymy; types; material examined; description; comparative remarks; habitat; distribution. Full synonymies (ie, lists incorporating both primary synonyms and subsequent combinations) are given for 35 species. Each entry notes, in chronological order: genus name; species name; original author; subsequent reviser(s); year; page and illustrations. Only primary synonymies are given for *Asaphis violascens* (Forsskål) and *Gari maculosa* (Lamarck) because comprehensive synonymies already exist for both these very common, widespread tropical species and full synonymies would be excessively long. Explanations and nomenclatural comments follow each synonymy. Citation of type material follows the sequence: original genus name; original species name; original author; status; state of constituent material; shell length; institution; registration number; original figure; subsequent figures (termed illustrations if they are photographs); reference to illustration(s) in this work; type locality. Lectotypes have been selected from syntypic series in every case I actually had access to type material. Full descriptions, in the sequence: shape; sculpture; hinge (right valve first); muscle scars; pallial line and sinus; colouration, are deemed necessary for each species because of the brevity and/or inaccuracy of earlier descriptions (particularly those of Deshayes, 1855). Comparisons with

related species follow under remarks. Data on habitat (including bathymetric range) and distribution appear under these subheadings. Finally a complete list of material examined for each species is presented. Australian (clockwise starting from Queensland) or New Zealand (from north to south) localities are given first in a separate paragraph, then other localities are listed from east to west. Material from unknown localities is appended in a separate paragraph at the end.

Definitions, Abbreviations and Text Conventions

This revision, which is centered on Australia and New Zealand, considers all of the psammobiids occurring the south-western Pacific ocean. The northern limit is defined by New Guinea. The eastern limit is defined by the Solomon Islands, Vanuatu, Fiji, Tonga, the Kermadec Islands and the Chatham Islands (ie, it corresponds to the eastern margin of the Indo-Australian tectonic plate). Thus, the eastern Indian Ocean, Timor Sea, Arafura Sea, Gulf of Carpentaria, Solomon Sea, Coral Sea and Tasman Sea are all included. For the purposes of this revision, the area under study is hereafter called Australasia.

Repositories of specimens are indicated by the following abbreviations: AIM – Auckland Institute and Museum, New Zealand; AMS – the Australian Museum, Sydney, Australia; ANSP – Academy of Natural Sciences of Philadelphia, USA; AUZ – Department of Zoology, University of Auckland, New Zealand; BMNH – British Museum (Natural History), London, England; CAS – California Academy of Natural Sciences, San Francisco, USA; CMNZ – Canterbury Museum, Christchurch, New Zealand; HJ – Zoological Museum, the Hebrew University of Jerusalem, Israel; LACM – Los Angeles County Museum of Natural History, USA; MNCN – Museo Nacional de Ciencias Naturales, Madrid, Spain; MNHN – Muséum National d'Histoire Naturelle, Paris, France; MNHS – Museo Nacional de Historia Natural, Santiago, Chile; MUG – Marine Station, University of Guam, Agaña, Guam; MHNG – Muséum d'Histoire Naturelle, Geneva, Switzerland; NHMW – Naturhistorisches Museum, Vienna, Austria; NMNZ – National Museum of New Zealand, Wellington, New Zealand; NMSA – Natal Museum, Pietermaritzburg, Republic of South Africa; NMV – Museum of Victoria, Melbourne, Australia; NSMT – National Science Museum, Tokyo, Japan; NTM – Northern Territory Museum of Arts and Sciences, Darwin, Australia; QM – Queensland Museum, Brisbane, Australia; RMNH – Rijksmuseum van Natuurlijke Historie, Leiden, Netherlands; SAM – South Australian Museum, Adelaide, Australia; SMF – Forschungsinstitut Senckenberg, Frankfurt, Germany; UQ – University of Queensland, Brisbane, Australia; USNM – United States National Museum, Washington, USA; WAM – Western Australian Museum, Perth, Western Australia; ZMA – Zoologisch Museum, Universiteit van Amsterdam, Netherlands; ZMB – Museum für

Naturkunde, Humboldt-Universität, Berlin, Germany; ZMUC – Zoologisk Museum, Copenhagen, Denmark; ZSI – Zoological Survey of India, Calcutta, India.

All specimens in the author's collection, other than those from New Zealand, are held in NTM, Darwin. The New Zealand specimens remain in that country.

Other abbreviations used in this work, particularly in the lists of material examined, are as follows: c – complete specimen (ie, both right and left valves contained together in lot); coll. – specimen presently housed in the private collection of the individual named; h – half valve (either right or left) only contained in lot.

Terminology related to shell morphology follows Cox in Moore (1969:N39-N58) for an equivalve, inequilateral bivalve except I have substituted umbo (plural umbones) for beak. Terms specifically related to orientation of a psammobiid shell are illustrated in Figure 1 below.

In the case of complete specimens, measurements relate to the length of the right valve only, and this valve is the one consistently chosen for illustration. In cases where a lot contains only half valve(s), the measurements relate to those available specimen(s).

Family Diagnosis and Affinities

History. Early conchologists used the all-encompassing genera *Solen* or *Tellina* to accommodate elongate, fragile tellinoideans (Chemnitz, 1782; Linné, 1758, 1767; Gmelin, 1791; Wood, 1815). Lamarck (1818) amalgamated ten heterodont bivalves with two cardinal teeth in each valve into his family “Les Nymphacées”, distinguishing the cylindrical forms “Les Nymphacées solénares” (ie, *Sanguinolaria*, *Psammobia*, *Galeomma* and *Psammotaea*) from the compressed ones “Les Nymphacées tellinaires” (ie, *Tellina*, *Tellinida*, *Corbicula*, *Lucina*, *Donax*, *Capsa*, *Crassina*). Deshayes & Milne-Edwards (1835:184,185) recognised the artificiality of Lamarck's latter category and the concept of the family Psammobiidae as it is presently understood was formulated by Deshayes (1844). [Actually Fleming (1828) proposed the name as Psammobiadae and Fischer (1887) later corrected it to Psammobiidae.] Subsequent major reviewers (Bertin, 1880; E.A. Smith, 1885; Dall, 1900; Prashad, 1932) and

compilers Thiele, 1935; Keen, 1969; Boss, 1982) adhered to Deshayes' concept of the family even though they have called it by other names: Garidae (or Gariidae) Stoliczka, 1871; Asaphidae Winkworth, 1932; Sanguinolariidae M. Smith, 1937 [Sanguinolariidae Grant & Gale, 1932 is unavailable because it does not meet the conditions of ICZN Article 13 (P. Bouchet, personal communication, 1991)]. Psammobiidae Fleming, 1828 has been selected by the ICZN (1970:16, Opinion 910) as the valid family-group name.

Shell characters. Presently the characters diagnosing the Psammobiidae are entirely conchological. They are the following: shell fragile, elongate, equivalve, compressed; anterior end rounded; margins smooth; umbones approximately central; valves with slight gapes (especially at the posterior end), but no posterior flexure; sculpture of concentric or radial cords and growth striae; lateral teeth absent; two cardinal teeth in each valve (posterior one can be greatly reduced in left valve); long, external ligament seated on elevated nymph; deep pallial sinus (Keen, 1969; Powell, 1979; Boss, 1982). Many general texts incorrectly state that the left valve has three cardinal teeth, but that mistake is due to the previous inclusion of unrelated taxa (ie, Solecurtidae, Glauconomidae, Petricolidae, *Orbicularia*) in the Psammobiidae. Therefore, membership of the family is really determined by the absence of lateral teeth and lack of a posterior flexure rather than the presence of any unique characters. It is possible to find psammobiids showing exceptions to almost all the above defining characters: *Nuttallia* species are round, not elongate; *Gari radiata*, *G. rasilis* and *G. gracilentia* are markedly inequilateral; *Asaphis violascens* and *G. crassula* are thick-shelled; *Soletellina tumens* is inflated; *G. inflata* has a short ligament; adult *G. convexa* is inequivalve and it has a posterior flexure; *G. anomala*, *G. occidens* and others have a projection on the anterodorsal margin of the left valve immediately in front of the hinge. These exceptions blur the distinction between this family and its enormous, undoubtedly heterogeneous, sister the Tellinidae. The only invariable characters within the Psammobiidae are those of smooth shell margins, dentition and ligament situation.

The treatment of the Psammobiinae and

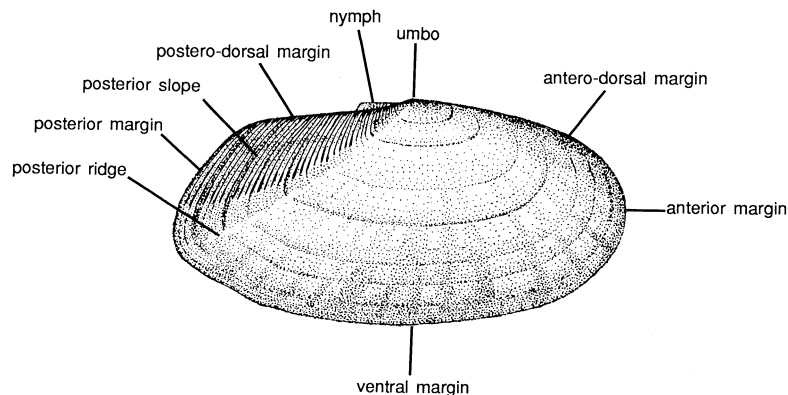


Fig.1. *Gari convexa* (Reeve): exterior of right valve indicating terminology.

Sanguinolariinae as separate subfamilies of the Psammobiidae is certainly unjustified. Although recent authors have taken the latter name to cover one group of genera, it was initially conceived to embrace the whole family. Basically, members of the first group are supposed to have thicker, sculptured shells that are truncated posteriorly, to have shallower pallial sinuses and to have relatively greater separation of the lower limb of the pallial sinus from the pallial line. It is my contention that this arbitrary separation has created an unnatural division. For example, there are species in the two largest genera (*Gari* and *Soletellina*) that show combinations of, and gradations between, these characters. The genera *Gari*, *Sanguinolaria*, *Soletellina* and *Nuttallia* form a coherent group for which distinction at the level of subfamily is unwarranted. Rather, they ought to be contrasted with *Asaphis* and *Heteroglypta*.

I must dwell on one character upon which the division of the Psammobiinae and Sanguinolariinae has largely been based, that is the relative degree of separation of the lower limb of the pallial sinus from the pallial line. In reviewing the Australasian Psammobiidae, I found extensive separation between the sinus and pallial line in the following species: *Asaphis violascens*; *Heteroglypta contraria*; *Gari anomala*; *G. rasilis*; *G. gracilentia*; *G. galathea*; *G. elongata* (juveniles only); *G. togata*; *G. inflata*; *Soletellina burnupi*. These ten species do not share other characters that might indicate a close phylogenetic relationship. In all the other 27 species, the lower limb of the pallial sinus is fused with the pallial line for most of its length. The genus *Heterodonax* is an example of an exotic (ie, non-Australasian) taxon that also shows separation. The patchy occurrence of pallial fusion/separation between genera, and (particularly) within the genus *Gari*, indicates to me that the ancestral condition (plesiomorphy) is one of separation as in other heterodont lineages, and that in the Psammobiidae fusion has occurred in most (of the advanced) species only in the *Gari-Sanguinolaria-Soletellina-Nuttallia* lineage. The Tellinidae also displays fusion in an equally patchy way so Afshar's (1969) failure to grasp the homeoplaseous nature of this character in this family resulted in numerous internal contradictions in his attempt at superspecific classification.

Anatomy. The few accounts that are available provide essential information on the structure of the animal. No species of *Heteroglypta*, *Sanguinolaria* sensu stricto, *Heterodonax*, or subgenus of *Gari* (other than *Gobraeus*, *Psammobia*, *Psammobella* or *Psammotaena*) has been examined anatomically and no investigations have been conducted on any Australasian species. Bloomer (1911) investigated the anatomy of all four British species – *Gari (Gobraeus) depressa* (Pennant) (in detail); *G. (Psammobia) fervensis* (Gmelin); *G. (Psammobella) costulata* (Turton); *G. (Psammobella) tellinella* (Lamarck). The musculature of the latter species was described by Graham (1934). White (1942) described the pericardial cavity of *Asaphis violascens* (Forsskål) as like that of *Solecirtus scopula* (Turton). Purchon (1960) studied the

stomach of *Asaphis violascens* and *G. (Psammotaena) togata* (Deshayes); that of *G. togata* being fundamentally similar to that of *Soletellina (Soletellina) diphos* (Linné) (Dinamani, 1967). Pohlo (1972) gave an account of the anatomy of *Nuttallia nuttalli* (Conrad). The most recent anatomical work is that by Narchi (1980) on *Asaphis violascens*. In some cases, these data lead to conflicting interpretations of function (eg, Yonge, 1949; Pohlo, 1969).

Purchon (1987:239) believed there was a similarity in stomach structure between the Psammobiidae and Donacidae, even though the principal synapomorphy, the transverse fold, was lacking in *Soletellina* yet present in the tellinid *Macoma*.

The comment by Coan (1971:8) that the Psammobiidae have rows of sensory cells in their siphons in contrast to the Tellinidae where these receptors are lacking needs substantiation.

Summary. It seems impossible to find a set of unique, derived conchological characters (apomorphies) or even a few exclusive characters that unequivocally delineate the Psammobiidae. On the other hand, there are numerous characters possessed jointly by the Psammobiidae and Tellinidae that seem too important to deny their kinship: smooth shell margins; details of heterodont dentition; opisthodontic and parivincular ligament; dimyarian musculature; separate and elongate siphons; similar gills and stomachs. Consideration of the inter-relationships of psammobiids and tellins must involve a detailed cladistic survey with emphasis on anatomy across all genera in both families. Presently I do not have the material to make this evaluation. Therefore, reluctantly, I continue to use the existing family diagnoses.

Taxonomy

Asaphis Modeer, 1793

Type species. *Venus deflorata* Linné, 1758, by monotypy (see Winkworth, 1935:322). Recent, Indo-Pacific.

Comments. In an introduction to a study of the Vermes published in the Proceedings of the Royal Academy of Stockholm, Modeer (1793) established the genus *Asaphis* in which he included only one species, *Venus deflorata* Linné. Thus, unlike many other early molluscan genera, the type species was fixed unambiguously. *Asaphis* has been in general use (Dall, 1900; Winkworth, 1935) for over a century. However, the important literature of the early nineteenth century was confused through synonymy because Modeer's work was so obscure. Synonyms of *Asaphis* include: *Corbula* Röding, 1798; *Capsa* Lamarck, 1801; *Capsula* Schumacher, 1817; *Psammocola* Blainville, 1824 (in part); *Sanguinolaria* Deshayes, 1835; *Pliorhytis* Conrad, 1863. *Capsa* (of Bruguière, 1792) is ambiguous, not

being the same as *Capsa* Bruguière, 1797, or *Capsa* Lamarck, 1799, or *Capsa* Lamarck, 1818 (Dall, 1900). *Corbula* (of Röding, 1798) is preoccupied by *Corbula* Bruguière, 1797, for which the type species is *Corbula sulcata* Lamarck, 1801. *Sanguinolaria* (of Deshayes, 1835) is preoccupied by *Sanguinolaria* Lamarck, 1799, for which the single included species (hence type by monotypy) is *Sanguinolaria sanguinolenta* Gmelin, 1791. The history of *Asaphis* has been discussed further by Mörch (1858), Bertin (1880) and Dall (1900).

Diagnosis. Moderate-sized psammobiids. Shell ovate to elliptical, thick, with truncate posterior end, inequilateral, inflated, with only a small posterior gape. Sculpture of well-developed radial ribs over entire outer surface, ribs rounded in section. Hinge plate well developed; right valve with 2 cardinal teeth, rear one somewhat stronger and deeply bifid; left valve with 2 unequal cardinal teeth, anterior one considerably stronger and deeply bifid; no lunular projection on hinge plate in front of anterior cardinal. Pallial sinus moderately deep, lower limb free from pallial line for its entire length. Colour uniform or faintly rayed.

Discussion. *Asaphis* is a genus containing only two (weakly separable) Recent species – *A. violascens* (Forsskål) in the Indo-Pacific Ocean and *A. deflorata* (Linné) in the Caribbean Sea. *Asaphis* shares many characters with the closely related genus *Heteroglypta* Martens, but as explained under the diagnosis of *Heteroglypta*, they do not merit amalgamation into a single genus.

Powell's (1958) *Asaphis nana* (Fig.372), originally from Kermadec Islands, is a tellinid possibly belonging to the genus *Agnomyax* Stewart.

Ivanova (1985) recently described a small heterodont bivalve from Moneron Island, north-east Vladivostok, northern Sea of Japan, in the genus *Asaphis*, ie, *A. kussakini*. Judging from the description of the exterior (with fine radial divarications), hinge (3 cardinal teeth are illustrated, not 2 as stated in the text), lack of nymph, pallial impressions (short pallial line and very extensive sinus), and muscle impressions (dorsally situated adductor scar), this species belongs in the veneroid genus *Petricola* (Petricolidae).

Asaphis violascens (Forsskål, 1775)

Figs 13-26, 381

Listed below are just the primary synonyms in the combinations they were originally published. Oostingh (1925:311,315) and Prasad (1932:305,306) have already produced comprehensive synonymies.

Tellina arenosa Rumphius, 1705: 145, 146, pl.95 fig.C (pre-Linnean).

Venus violascens Forsskål, 1775: 31, no.28.

Tellina anomala Born, 1778: 20 and vars α , β , τ and σ .

Tellina anomala Indiae orientalis Chemnitz, 1782: 93, 94, pl.9

fig.83 (non binomial).

Tellina anomala Schröter, 1788: 103.

Venus deflorata var. β Gmelin, 1791: 3274, no.24.

Sanguinolaria rugosa Lamarck, 1818: 411, *Sanguinolaria* species 4 and var. (b).

Sanguinolaria dichotoma Anton, 1838: 4, no.123.

Capsa deflorata (Linné).–Reeve, 1856: *Capsa* pl.1, species 1 (non *Venus deflorata* Linné, 1758).

Capsa tahitensis Reeve, 1856: *Capsa* pl.1, species 2.

Comments on synonymy. This Indo-Pacific species was generally known as *Asaphis dichotoma* (Anton, 1838) until Cernohorsky (1972) altered its name, without explanation, to *A. violascens* (Forsskål, 1775). A large series of Forsskål's type material is in ZMUC and, although the shells are smoother than usual for Indo-Pacific specimens, I consider them conspecific with *A. dichotoma* and, therefore, vindicate Cernohorsky's alteration. I follow Lemche (1965:9), Wolff (1968:585), Yaron *et al.* (1986) and Schiøtte (1992:353) in the spelling of Forsskål's surname.

Born (1778) recognised four colour varieties of his *Tellina anomala*. Brauer (1878:8) located only two original specimens of this species in the Born collection, NHMW, belonging to Born's var. α and var. τ . Since specimens of Born's var. β (white with violet umbones and violet interior) and var. τ (violet with white rays, and blue and white spotted interior) are not present in NHMW, it is probable Born based these colour varieties on Knorr's (1772) illustrations.

The species has not attracted any additional synonyms since 1856.

Despite the opinions of Lyngé (1909), Oostingh (1925) and Abbott (1950) that only a single, cosmopolitan-tropical species of *Asaphis* exists, the consensus among malacologists is that *Asaphis violascens* and *A. deflorata* (Linné) are closely-related but distinct species, the former occurring throughout the Indo-Pacific Ocean and the latter in the Caribbean Sea (Mörch, 1863; Bertin, 1880; Prasad, 1932; Cernohorsky, 1972; Abbott & Dance, 1982; Oliver, 1992). I concur with this opinion.

Types. *Venus violascens* Forsskål: lectotype selected by Yaron *et al.*, 1986: 196 (complete specimen - 68.2 mm) in ZMUC (not registered); figured by Yaron *et al.*, 1986: fig.46 (Figs 13,14). Paralectotypic series comprising 19 complete specimens and 212 half valves in ZMUC. Type locality Red Sea.

Tellina anomala Born: lectotype, here designated (Born's var. = pale yellow exterior and darker interior, complete specimen - 48.7 mm) in NHMW (3051 = E.31. β) (Fig.15). Paralectotype (Born's var. = white with red umbones and red interior, complete specimen - 65.9 mm) in NHMW (3049 = E.31). Type locality unknown.

Tellina anomala Born var. β and var. τ : material not found by Brauer (1878) in NHMW; not found during personal search in NHMW in 1989. Type locality unknown.

Sanguinolaria rugosa Lamarck: lectotype, here designated (complete specimen - 80.0 mm) in MNHN (Fig.16). Paralectotypes (complete specimens - 77.7, 67.2, 47.8, 38.8, 37.5 mm) in MHNG (1083/8). Type locality "les mers de l'Inde et celles de l'Amérique." Herein restricted to Indian Ocean.

Sanguinolaria rugosa Lamarck var. (b): syntypes (complete specimens - 49.1, 45.1, 44.0 mm) in MHNG (1083/9); figured by Chenu, 1862: fig.256. Type locality as for *Sanguinolaria rugosa* Lamarck above.

Sanguinolaria dichotoma Anton: type material ought to be in ZMUC, but it cannot be found there and is presumed lost (T. Schitte, personal communication, 1985; personal search, 1989). Type locality East Indies.

Capsa tahitensis Reeve: lectotype, here designated (figured syntype, complete specimen - 62.4 mm) in BMNH (1989121/1); figured by Reeve, 1856: *Capsa* pl.1, species 2 (Fig.17). Paralectotype (complete specimen - 36.7 mm) in BMNH (1989121/2). Type locality Tahiti.

Specimen figured as *Capsa deflorata* (Linné) by Reeve, 1856: *Capsa* pl.1, species 1a (complete specimen - 32.5 mm) in BMNH (1989122/1) (Fig.18).

Material examined. AUSTRALIA – QUEENSLAND: 1c, West Island, Torres Strait (BMNH 1883.1.8.1); 2c, Busy Island, Cape York (BMNH 1845.8.15.13,17); 1c,1h, Coconut Beach, Lizard Island (Willan coll.); 1h, Watsons Beach, Lizard Island (Willan coll.); 1h, Casuarina Beach, Lizard Island (Willan coll.); 2c,1h, Low Isles (QM); 4c,1h, Port Douglas (QM); 1c, Half Moon Bay, Cairns (Whitehead coll.); 1c,4h, Little Pioneer Bay, Orpheus Island (Willan coll.); 3c, Palm Island (AIM AM17633); 2c, Palm Island (AIM); 1c, Townsville (AIM AM34242); 3c, Dunk Island (QM); 11c, Eliot River, near Bowen (QM); 2c, Bowen (AIM); 1c, Nellie Bay spit, Dingo Beach, Gloucester Passage (Whitehead coll.); 2c, Dingo Beach, Gloucester Passage (Lamprell coll.); 2c, Yeppoon (Lamprell coll.); 1c, Keppel Island (QM); 23c, Lammermoor Beach, Keppel Bay (Willan coll.); 4c, Halfway Island, Keppel Bay (Coles coll.); 2c, Keppel Bay (AIM AM17630); 1c, Round Hill Heads, Buzzard Bay (QM); 8c,2h, Cable House Creek, north Mon Repos Beach, near Bundaberg, Hervey Bay (Willan coll.); 1c, Mon Repos Beach, near Bundaberg, Hervey Bay (Willan coll.). WESTERN AUSTRALIA: 1h, creek 1.6 km north Wapet, North West Cape (WAM 1732-68); 1h, near old cannery jetty, Exmouth Gulf (WAM 1732-68); 1c, Nickol Bay, Dampier (Willan coll.); 1h, on beach, Rosemary Island, Dampier Archipelago (WAM 1751-68); 7c, Broome (AIM AM17647, AM32083; Lamprell coll.); 2c, Quondong Point, north Broome (Whitehead coll.); 3c, James Price Point, north Broome (Hansen coll.); 1h, Descartes Island, Kimberley (WAM); 1c, West Island, Ashmore Reef (NTM P16186). NORTHERN TERRITORY: 3c, Darwin (Coles coll.; Lamprell coll.); 4h, East Point, Darwin Harbour (NTM); 1h, Bullocky Point, Darwin (NTM); 1c, Smith Point, Darwin (NTM P1037); 1c, Nightcliff Reef, Darwin (NTM P16172); 1c,1h, Casuarina Beach, Darwin (NTM; Whitehead coll.); 3c, Sunday Island, Cobourg Peninsula (Whitehead coll.).

SOCIETY ISLANDS: 1c, Moorea Island (MHNG); 3c, Tahiti (AIM AM17648; BMNH 1989121/1, 1989121/2 - lectotype & paralectotype of *Capsa tahitensis* Reeve). COOK ISLANDS: 3c, 1h (AIM AM17622); 4c, Ootu, Aitutaki Island, Rarotonga (AIM); 6c, Aitutaki Island, Rarotonga (Hole coll.). SAMOA: 1c, Vaialele Bay, Upolu Island (AIM AM2658) WESTERN SAMOA: 3c (AIM); 1c, Sogi, Apia (AIM); 2c, Apia Harbour (AIM); 30c, Moatoa Beach, Apia (AIM AM17693). TONGA: 6c, Vava'u Island (Willan coll.). FIJI ISLANDS: 4c, Nananui-Ra, Viti Levu Island (Willan coll.); 1c, Suva Harbour, Viti Levu Island (Willan coll.); 2c, Senewai Island, Viti Levu Island (Douglas coll.); 2c,1h, north coast, Viti Levu Island (AIM AM17637); 1c, Munia Island, Exploring Island (Douglas coll.); 1c, Matuku Island (BMNH 1856.11.3.43). LORD HOWE ISLAND: 1c (Whitehead coll.). LOYALTY ISLANDS: 2c, Lekin Lagoon, Ouvea Island (Hole coll.); 3c, Ouvea Island (Coles coll.). VANUATU: 16c,5h, Mele Bay, south-west Efate Island (Coles coll.; Willan coll.); 2c,1h, Siviri, Undine Bay, Efate Island (Willan coll.); 1c, Forari, Efate Island (Willan coll.); 1c, Rowa River mouth,

east Néafou, Espiritu Santo Island (Willan coll.); 5c, South West Bay, Malekula Island (AIM AM17692); 4c, Banks Island (AIM AM30740). SOLOMON ISLANDS: 4c (AIM AM17623); 3c,1h, Malaita (AIM AM17680); 1c, Tikopia (Whitehead coll.); 1c, Guadalcanal (Lamprell coll.); 3c,1h, Port Moresby (MHNG 985.129; Willan coll.). PAPUA NEW GUINEA: 1c (AIM). MARIANA ISLANDS: 2c,1h, Bile Bay, south-west Guam Island (Willan coll.). RYUKYU ISLANDS: 2c, Okinawa Island (Whitehead coll.). PHILIPPINE ISLANDS: 1c (Whitehead coll.); 10c,1h, Cacaben, south-east Batan, Luzon Island (AIM AM31146); 1h, Batangas Island (MHNG 983.193); 7c, Bangao channel, Saga Saga Island, Sulu Archipelago (AIM AM31145). INDONESIA: 2c,1h, Mios Woendi Atoll, Padaido Island, West Irian (AIM AM17706); 1c, Java (AIM AM17625). THAILAND: 2c, 1h, rocky point at south-east corner Hi Island, 8 km south of Chalong Bay, Phuket Island (Willan coll.). ANDAMAN ISLANDS: 1c, east shore Stewart Island (Willan coll.); 1c, Tamalu Beach, Car Nicobar (Willan coll.). GULF OF OMAN: 1h, Muscat (BMNH). PERSIAN GULF: 1c, Doha, Qatar (Whitehead coll.). GULF OF ADEN: 1h, on beach, Layada, 30 km south of Djibouti (MNHN); 4c,4h, East Aden Protectorate (WAM 1736-68). RED SEA: 20c,212h (ZMUC - lectotype & paralectotypes of *Venus violascens* Forsskål); 1c, Coral Beach, Elat (HUJ); 1c, Gulf of Aqaba (BMNH); 5c, Devil's Head, Gulf of Aqaba (Willan coll.). SEYCHELLES: 15c, Beau Vallon (BMNH); 5c, North-west Bay, Mahé Island (BMNH 1952.12.23.231-235); 1c, La Digue (MHNG 988.297); 1c, Poirue Island, Amirante Island (BMNH 1882.12.6.272). MAURITIUS: 6c (AIM AM17649; WAM 1135-70); 1h, Chaland Beach (WAM 1742-68). TANZANIA: 2c, Mtwara (WAM 1766-68). MADAGASCAR: 1c (Whitehead coll.); 4c,2h, west Pointe de Tafondo, south-east Nossi Bé (AIM AM34134). MOZAMBIQUE: 1c, south-east Conducia Bay, south-west Cháca Island (NMSA H309). SOUTH AFRICA: 1c, intertidal zone on east shore of estuary, Kosi Bay, Zululand (NMSA D9760).

INDIAN OCEAN: 9c, (MNHN; MNHG 1083/8, 1083/9 - lectotype & paralectotypes of *Sanguinolaria rugosa* Lamarck).

LOCALITY UNKNOWN: 2c (NHMW 3051, 3049 - lectotype & paralectotype of *Tellina anomala* Born respectively).

Description. Maximum length 109 mm, but seldom exceeding 75 mm. Shell heavy, ovate; greatest width at level of umbones; somewhat equilateral, umbones displaced a little forward of centre (equally so in adults and juveniles); considerably inflated; anterior end broadly rounded; ventral margin straight or slightly convex posteriorly; posterior end truncate, broader than anterior end; equivalve; commissure at junction of ventral margins straight; tiny anterior gape, small posterior gape; shell lacking a distinct posterior ridge and no discernable posterior slope. Surface of both valves with strong, rounded, often forked, radial ribs; ribs flatter and further apart anteriorly; posteriorly, ribs stronger, sharper, and often scabrous or scaly; shell crossed with weak, concentric growth lines that do not interrupt radial ribs. Exterior surface dull, covered with a very thin, dehiscent periostracum.

Hinge plate broad, strong; nymph broad, moderately elongate; ligament very tough, high, stout, elongate. Right valve with 2 cardinal teeth, diverging by 60° from each other; anterior one triangular, directed very slightly anteriorly; rear one stronger, elongate, deeply bifid, directed backward, and, in adults, projecting a

considerable distance below hinge plate. Left valve with 2 cardinal teeth, diverging by 60° from each other; anterior one stronger, triangular, deeply bifid, directed vertically downward; rear one narrow, elongate, directed backward. Muscle scars and pallial line strongly impressed on shell's interior. Anterior adductor scar elongate, elliptical; posterior adductor scar almost circular; 2 separate pedal retractor scars immediately behind hinge plate. Pallial sinus moderately deep (reaches level with rear of hinge plate, ie, not attaining level of umbones), broad; upper limb straight; anterior margin broadly rounded; lower limb descending obliquely to rear extremity of pallial line (ie, lower limb free for its entire length); ventral extremity directed obliquely downward (rarely straight back), reaches level with middle of posterior adductor scar.

Exterior usually uniform creamish white, less commonly orange, peach, pinkish red or violet, sometimes marked with faint, narrow, purplish brown rays that extend from umbones; rays discordant on each valve (Fig.20); interior whitish, never clear-glazed, with a yellow or orange hue centrally and large dark violet blotch posteriorly (covering nymph and entire posterior section, usually including posterior adductor scar) and often a second, smaller, violet streak at front end of anterior dorsal margin). Hinge plate and teeth white.

Remarks. *Asaphis violascens* is easily distinguishable from all other Australasian, and in fact Indo-Pacific, bivalves. Its unique characters are its solid, ovate, equivalve shell, truncate posterior end, sculpture of numerous, narrow radial ribs that become scaly posteriorly, broad hinge plate with two distinct cardinal teeth in each valve, tongue-shaped pallial sinus which is relatively shallow for the family, separation of the lower limb of the pallial sinus for its entire length, and exterior and interior colouration, particularly the violet-stained areas within.

Asaphis violascens displays intraspecific variation in ribbing and colour. Some specimens have many (approximately 60), relatively fine ribs that rarely bifurcate (Figs 15-17), whereas others possess few (approximately 40), strong ribs that fork often (Fig.18). However, all intergrades exist within populations. The degree of development of scales on the posterior ribs varies greatly too, but usually juveniles are scaly and adults are scabrous or nodulose. The extent of colour polymorphism is considerable, but the commonest morph is creamish white. Again, colour varies continuously within populations, but always the white morph predominates.

The closest relation to *Asaphis violascens* is *A. deflorata* (Linné) from the Caribbean Sea, and undoubtedly both species share a common ancestor from which divergence has occurred relatively recently. Separation between the two species is based on sculpture alone; in *A. deflorata* the ribs are finer, more even, significantly greater in number (ranging from 60 to about 90), and have less tendency to fork.

Habitat. *Asaphis violascens* inhabits the lower shore

where it prefers substrates of muddy sand with incorporated gravel or coral rubble. Substrates of uniform mud or sand appear inimical to habitation. It buries to a maximum depth of 25 cm, although specimens commonly live closer to, or even on top of, the surface when forced to do so by impenetrable substrates. Soemodihardjo & Matsukuma (1989:208) found maximum density at 13 and 20 cm on a sheltered coral sand beach at Pari Island, Indonesia. Narchi (1980) found no horizontal separation according to size in Hong Kong populations. *Asaphis violascens* favours protected habitats (ie, fringes of coastal mangrove forests), but it can also tolerate moderate wave exposure as on semi-sheltered reef platforms.

Asaphis violascens attains sufficiently high densities in lagoons of Pacific islands to support sustained collection for human consumption. For example, in Kiribati this species, along with *Anadara maculata* and *Gafrarium tumidum*, are dietary staples (Yamaguchi, 1989). In New Caledonia, *A. violascens* is considered plentiful enough to cultivate for aquaculture (Glude, 1972).

Asaphis violascens is strictly intertidal.

Distribution. This species is widespread throughout the (central and western) Pacific and Indian Oceans as well as the Gulf of Oman and the Red Sea. It extends as far east as the Tuamotu Island in the Pacific Ocean (Salvat & Rives, 1975). In the Indian Ocean, *A. violascens* extends northward to the Persian Gulf (Bosch & Bosch, 1982; Smythe, 1982; Glayzer *et al.*, 1984) and Red Sea (Forsskål, 1775; Lamy, 1918). Slack-Smith (1990) listed it from Shark Bay, Western Australia. Melvill & Sykes (1898) recorded it from the Andaman Islands. Recently Drivas & Jay (1988) recorded it from Réunion Island and Mauritius Island. Dr R.N. Kilburn (personal communication, 1989) informs me that it is abundant in Mozambique and there is only a single shell (Fig.26) known from South African limits. In summary, it appears that *A. violascens* occurs throughout the tropical Indo-Pacific Ocean wherever there are suitable habitats and, in many locations, it reaches warm temperate waters as well. However, it does not extend as far south as New Zealand, so Bertin's (1880), Oostingh's (1925) and Ray's (1977) incorporation of that country into this species' geographical range are definitely incorrect.

Heteroglypta Martens, 1880

Type species. *Psammobia contraria* Deshayes, 1863, by monotypy.

There are no synonyms. Recent, Indo-Pacific.

Diagnosis. Moderately small psammobiids; subrectangular, with truncate posterior end; inequilateral; inflated; no gapes. Sculpture elaborate, anterior area and posterior slope with oblique ribs (coarser on posterior slope) that intersect radial ribs of central area. Small,

external lunular ligament present; right valve with 2 equally developed cardinal teeth; left valve with 2 unequal cardinals, the anterior much stronger, deeply bifid. Pallial sinus deep, moderately broad, lower limb free from pallial line for almost its entire length. Colour uniform cream.

Heteroglypta is a monotypic genus that is distinguished from other psammobiid genera by its sculpture, shape, dentition and pallial sinus. On account of the radial sculptural component, inequilateral shape and lack of gape (similarity of hinge plates' development being erroneous), Keen in Moore (1969) made *Heteroglypta* a subgenus of *Asaphis* Modeer. I acknowledge the two are sister groups, but placing one as a subgenus of the other is not warranted because there are major differences: *Asaphis* has only radial sculpture whereas *Heteroglypta* has oblique components as well; *Heteroglypta* has a relatively narrower hinge plate than *Asaphis*; *Asaphis* lacks a lunular ligament; in *Heteroglypta*, the posterior cardinal in the left valve is weaker than in *Asaphis*; in *Heteroglypta*, the anterior cardinal is not strongly bifid nor is it as strongly sloping as in *Asaphis*, and the posterior cardinal tooth is relatively stronger in *Asaphis*; there is a broader and deeper pallial sinus in *Heteroglypta*; in *Asaphis* the pallial sinus does not reach level with the umbones, but in *Heteroglypta* it reaches level with them. Differences also exist in the relative size and position of the pedal retractor scars, particularly the posterior one.

Heteroglypta contraria (Deshayes, 1863)

Figs 27-37, 382

- Psammobia contraria* Deshayes, 1863: 11, pl.28 figs 20,21.–Paeltel, 1890: 39.–Shopland, 1902: 177.
Gari contraria (Deshayes).–Tryon, 1868: 74.–Bertin, 1880: 111, no.38.
Psammobia (section *Heteroglypta*) *contraria* Deshayes.–Martens, 1880: 331.
Asaphis (*Heteroglypta*) *contraria* (Deshayes).–Dall, 1898: 59.–Dall, 1900: 981.–Keen in Moore, 1969: N633, fig.E116, nos 10a,10b.–Lamprell & Whitehead, 1992: 60, pl.54 fig.406.
Asaphis contraria (Deshayes).–Hedley, 1901: 731, pl.48 figs 4-8.–Hedley, 1910: 350.–Hedley, 1918: M28, no.286.
Gari (*Heteroglypta*) *contraria* (Deshayes).–Lamy, 1918: 247, 248.–Oliver, 1992: 163, pl.36 fig.8a,b.
Heteroglypta hedleyi Iredale, 1929 n.syn.: 265.–Iredale & McMichael, 1962: 25, no.424.
Heteroglypta avecta Iredale, 1929 n.syn.: 266.
Heteroglypta pansa Iredale, 1929 n.syn.: 266.
Heteroglypta saltatrix Iredale, 1929 n.syn.: 266, pl.30 figs 5,6.
Heteroglypta nipponica Kuroda, 1934 n.syn.: ii, fig.inside front cover.–Kuroda, 1941: 168, no.1383.–Habe, 1951: 202, fig.485.–Kuroda & Habe, 1952: 21.–Azuma, 1960: 88, no.1482.–Habe, 1961: 135, pl.61 fig.7.–Habe, 1964: 197, pl.61 fig.7.–Shikama, 1964: 85, fig.157.–Scarlatto, 1965: 96.–Higo, 1973: 369, no.1161.–Koyama, 1983: 200.
Heteroglypta contraria (Deshayes).–Habe, 1977: 221, pl.46 fig.8.–Habe, 1981: 140.

Comments on synonymy. Iredale (1929) created four of the five synonyms. His *Heteroglypta hedleyi* (Fig.27) and *H. avecta* (Fig.28) are based on slight differences in shape and sculpture from Deshayes' illustration of *Psammobia contraria*. *Heteroglypta pansa* (Fig.29) and *H. saltatrix* (Fig.30) are both based on deformed shells with particularly narrow anterior ends. Such deformation, probably resulting from the semi-nestling habit, is not uncommon in shells of this species. The fifth synonym, *H. nipponica* Kuroda, was created for coarsely-sculptured Japanese shells.

Types. *Heteroglypta contraria* Deshayes: type material ought to be in MNHN, but it cannot be found there and is presumed lost (P. Bouchet, personal communication, 1985; personal search, 1989); not found in BMNH (S. Morris, personal communication, 1985; personal search, 1989). Type locality Bourbon (= Réunion Island).

Heteroglypta hedleyi Iredale: holotype (single right valve 9.0 mm) in AMS (C8974) (Fig.27). Type locality Nambucca River, NSW.

Heteroglypta avecta Iredale: lectotype, here designated (single right valve - 11.5 mm) in AMS (C149155) (Fig.28). Paralectotypes (all single left valves - 14.0, 14.0, 12.0 mm) in AMS (C147438). Type locality Michaelmas Cay, Qld.

Heteroglypta pansa Iredale: holotype (single right valve - 9.0 mm) in AMS (C28799) (Fig.29). Type locality New Caledonia.

Heteroglypta saltatrix Iredale: holotype (single left valve - 18.0 mm) in AMS (C57816); figured by Iredale, 1929: pl.30 figs 5,6 (Fig.30). Type locality Michaelmas Cay, Qld.

Heteroglypta nipponica Kuroda: holotype (12.2 mm) ought to be in Kuroda coll., NSMT, but it cannot be found there and is presumed lost (T. Okutani, personal communication, 1991); figured by Kuroda, 1934, on title page of *Venus* 4(6). Type locality Okinoshima Islet, Kochi Prefecture, Japan.

Material examined. AUSTRALIA – QUEENSLAND: 1c,2h, 6-8 m, North Point, Lizard Island (Willan coll.); 1h, 9-12 m, base of reef face, south-west end South Island, near Lizard Island (AMS C149148); 1h, 15-20 m, south-west end No Name Reef, 14°40'S 145°39'E (AMS); 1h, 6 m, No. 5 Ribbon Reef, east-north-east Cape Flattery, 15°21'S 145°46'E (AMS); 5h, Michaelmas Reef, north-east off Cairns (AMS C57816 - holotype of *Heteroglypta saltatrix* Iredale, C149155 - lectotype of *H. avecta* Iredale, C147438 paralectotypes of *H. avecta* Iredale); 1h, 10-11 m, reef no. 21-184, Swain Reefs - 21°23'S 151°42'E (AMS); 3c, 37 m, Gillett Cay, Swain Reefs (AMS C149139); 1h, 13 m, north side Heron Island, Capricorn Group (Willan coll.); 1c,4h, 10 m, Mudjimba Island, north-east of Mooloolaba (Willan coll.); 2h, 18 m, Murphy's Shoal, Mooloolaba (Willan coll.); 3h, 17-20 m, outer Gneering Shoals, east of Mooloolaba (Willan coll.); 3c, Caloundra (AMS; Willan coll.); 2c,9h, 7-24 m, north of Cape Moreton, Moreton Island (Willan coll.); 8c,2h, 7-20 m, Shag Rocks, north-west of Point Lookout, North Stradbroke Island (Willan coll.); 1h, Burleigh (QM). NEW SOUTH WALES: 2c,1h, 10-15 m, Julian Rocks, east of Cape Byron (Willan coll.); 1c, 23m, South Solitary Island, north-east of Coffs Harbour (AMS C108839); 3c,2h, 7 m, North West Solitary Island, north-east of Coffs Harbour (Willan coll.); 1c, Nambucca Heads (AMS C8974 - holotype of *H. hedleyi* Iredale); 2c, Long Reef, Collaroy (AMS); 2c, Middle Harbour, Sydney (AMS); 1c, Kurnell, Botany Bay (AMS). WESTERN AUSTRALIA: 1c, west end Rottneest Island, west off Perth (WAM); 2c,7h, south of Vlaming Head, North West Cape (WAM); 1c,1h, reef tract

near Tantabiddi, North West Cape (WAM); 1h, 7.5 m, 19 km north of Tantabiddi Well, North West Cape (WAM 325-86); 5c, series of h, Lighthouse Beach, North West Cape (AMS); 1c, 1h, Citadel Rock, Kendrew Island, Dampier Archipelago (WAM 323-86, 324-86).

KERMADEC ISLANDS: 1c, 15 m, west coast Meyer Island (Brook coll.). NEW CALEDONIA: 1c (AMS C28799 - holotype of *H. pansa* Iredale); 1c, 16 m, north of Hienghène, 20°14'S 164°25'E (MNHN). CORAL SEA: 1c, 50 m, Chesterfield Plateau, 19°28'S 158°23'E (MNHN). LOYALTY ISLANDS: 1c, Lifu Island (AMS). VANUATU: 1c, 9 m, north-east side Pango Peninsula, south-west Efaté Island (Willan coll.). PAPUA NEW GUINEA: 1h, 9-15m, Murray Island, north-east Torres Strait (AMS C30287). JAPAN: 1c, Amami-oshima, Amami Island, Kagoshima Prefecture (Sakurai coll.); 1c, Hachijo Island (NSMT). RÉUNION ISLAND: 1c, 20 m, St Giles (MNHN). GULF OF ADEN: 7c, 1h, Djibouti (MNHN). RED SEA: 1c, Dahlak Archipelago (NHMW 39931). MADAGASCAR: 7c, 1h, 25 m, Tuléar (MNHN). MOZAMBIQUE: 2h, Conducia Bay (NMSA H5564). SOUTH AFRICA: 1c, 10-15 m, 2-Mile Reef, Sodwana Bay, Zululand (NMSA E704); 1c, Landers Reef, off Park Rynie, Natal (NMSA E1554).

Description. Maximum length 20 mm. Shell light but thickened; ovate - oblong, juveniles squarish, adults tending to be subrectangular; greatest width at level of umbones, inequilateral, umbones displaced anteriorly (less so in juveniles); inflated; anterior end rounded, narrower than posterior end; ventral margin straight or slightly convex; posterior end abruptly truncated; equivalve, commissure straight; without anterior or posterior gapes. Sculpture very elaborate, that on exterior divisible into 4 components - essentially divarications anteriorly and posteriorly and an abrupt junction between them centrally (Fig.34); sculpture on anterior half much weaker than that on posterior half; posterior half with (in adults) 14-16, strong, sharp radial cords, each of which divaricates on posterior ridge to a rounded cord that bends obliquely toward ventral margin posteriorly; new cords are added at extreme posteroventral corner; whole surface covered with microscopic, concentric growth striae that do not affect radial sculpture; microscopic, evenly-spaced pores present over entire outer surface of shell (Fig.35). Periostacrum light, very thin, readily lost.

Hinge plate narrow; nymph relatively narrow and short; ligament moderately thin; slender ligamental extension present anteriorly in lunular region. Right valve with 2, equally-developed cardinals, diverging by about 70° from each other; anterior one not bifid, directed obliquely forward; rear one sometimes weakly bifid, directed a little behind vertical. Left valve also with 2 cardinal teeth; anterior one well developed, solid and much the stronger, triangular, deeply bifid, directed vertically downward; rear one much the weaker, merely a ridge, directed obliquely backward and diverging at 40° behind anterior one. Pallial sinus deep (extends level with umbones), broad; upper limb short, passes straight across shell; anterior margin broadly convex; lower limb runs, with some concavity, obliquely posteriorly; lower limb free from pallial line for almost its entire length; ventral extremity of pallial line downturned, reaches level with

front of posterior adductor scar. Pedal retractor scars 2, very weak, one at either end of hinge plate dorsally, ie, posterior one displaced to below nymph.

Colour usually uniform cream, somewhat darker posteriorly (see remarks for comments on colour variation); interior white, thinly glazed. Teeth white; escutcheonal area on rear of hinge plate and nymph with a short, brown, lilac or violet streak.

Remarks. The complicated sculpture on the exterior of *Heteroglypta contraria* shells is the species' single most distinctive feature. Yet there are several less obvious, additional characters, notably the subrectangular shape of adults, truncated posterior end, equivalve condition, lack of gape, presence of lunular ligament, hinge details, almost entire separation of the lower limb of the pallial sinus from the pallial line, relatively early termination of ventral extremity of pallial line and uniform colouration always without radial markings.

The predominant colour morph (with a frequency of approximately 90% is uniform cream, but two shells (from northern NSW) have a pale lilac flush around the umbones and are weakly maculated with light brown, and two others (from Lifu, Loyalty Islands, and north of Cape Moreton, southern Qld) are vivid yellow. These unusually coloured specimens demonstrate colour variation is discontinuous within, and not geographically clinal between, populations of *Heteroglypta contraria*.

The only psammobiid that resembles *Heteroglypta contraria* is *Gari pennata* (Deshayes) because both species have divaricating sculpture centred on the posterior ridge and radially oblique ridges on the posterior slope that intersect the posterodorsal margin. However, *G. pennata* differs in shape (in being less inflated), in hinge, pallial sinus and colour.

Habitat. *Heteroglypta contraria* burrows shallowly in clean, coarse substrates (sand or coral rubble), sometimes inhabiting sandy spaces between depressions in corals. Considering the species' semi-nestling habit, it is not surprising to find some deformation in outline as is the case with other bivalves that occupy this niche (for example, species of *Venerupis*, *Petricola*, *Kellia* and *Hiatella*). *Heteroglypta contraria* apparently lives most often on the seaward slopes of coral reefs where three other psammobiid species also occur - *Gari occidens* (Gmelin), *G. maculosa* (Lamarck) and *G. pulcherrima* (Deshayes).

Heteroglypta contraria is a subtidal psammobiid with a known bathymetric range of 6 to 30 m, and it probably does extend into deeper water. *Heteroglypta contraria* is commonest below 10 m.

Distribution. The presently known range is patchy because of incomplete collecting, but *Heteroglypta contraria* probably has a continuous distribution throughout the tropical western Pacific and Indian Oceans. Literature records are as follows: New Caledonia (Iredale, 1929); Queensland (Hedley, 1910; Iredale, 1929); New South Wales (Hedley, 1901, 1918; Iredale,

1929; Iredale & McMichael, 1962); Sagami Bay, Japan to Taiwan (Habe, 1964, 1981), Mauritius (Martens, 1880); Réunion Island (Deshayes, 1863); Djibouti and Aden (Lamy, 1918); Red Sea (Oliver, 1992).

Gari Schumacher, 1817

Type species. *Gari vulgaris* Schumacher, 1817 (by designation under ICZN plenary powers, ICZN, 1970: 16 Opinion 910) (= *Tellina truncata* Linné, 1767). Recent, Indo-Pacific.

Comments. Psammobiid bivalves belonging to this genus, the largest in the family, were placed in *Psammobia* Lamarck almost without exception until the end of the nineteenth century. The reasons for the alteration to *Gari*, which does have precedence by one year but had two species as contenders for type, are explained later in this work under the synonymy for *Gari truncata*. The decision in favour of *Gari* was obtained by use of the plenary powers of the International Commission on Zoological Nomenclature. This decision had one unfortunate consequence. Now the family name stems from a subgenus (or possibly even synonym) instead of a currently recognised genus level taxon.

The type species of *Gari* was incorrectly cited in my earlier work on the Psammobiidae (Willan, 1980). There, I followed Keen in Moore (1969) and Coan (1973) in citing *Solen amethystus* Wood, 1815 as type species. That citation is wrong in the light of the ICZN ruling of 1970 (which must have been published too late for emendation by Keen in her section of Moore's *Treatise on Invertebrate Paleontology*). Although it is not explicitly stated anywhere in the ICZN ruling of 1970, *Gari vulgaris* Schumacher is a junior synonym of *Tellina truncata* Linné, so *T. truncata* must be cited as the type species.

Diagnosis. Small to large psammobiids; elongate to

ovate; posterior end usually wider than anterior end, rounded or truncate; inequilateral; compressed; with a posterior gape; posterior ridge usually distinct, separating shells into anterior and central areas in front of, and posterior slope behind, ridge. Valves either smooth or with low, concentric cords; sculpture on posterior slope often strengthened and different from rest of shell, often discordant between valves (in which case, always stronger on right valve). Right valve with 2, approximately equal cardinals. Left valve with only anterior cardinal tooth developed; rear cardinal tooth reduced to a lamella. Pallial sinus deep, moderately broad. Shell surface glossy beneath periostracum; often vividly rayed with red or violet lines that emanate from umbones and are discordant between valves.

Gari is a monophyletic genus, but one that has apparently speciated into numerous, diverse subunits. I rank these subunits at the level of subgenera using Hennigan principles, ie, the possession of a set of unique derived characters (apomorphies) by all species of a particular group. Consequently, I recognise nine subgenera in all: *Gari sensu stricto*, *Psammobia* Lamarck; *Gobraeus* Brown; *Psammobella* Gray; *Psammodonax* Cossmann; *Psammotaena* Dall, *Crassulobia* n.subgen.; *Dysmea* Dall, Bartsch & Rehder; *Kermadysmea* Powell. These are, in fact, all the subgenera containing Recent species recognised by Keen in Moore (1969), plus *Crassulobia*. The only remaining subgenera recognised by Keen in Moore (1969) contain species from the lower Tertiary of Europe and North America with no Recent derivatives: *Amphipsammus* Cossmann; *Azor* Sowerby; *Garum* Dall; *Psammoica* Dall.

The psammobiid genera apparently closest to *Gari* on conchological grounds are *Soletellina* Blainville and *Sanguinolaria* Lamarck despite their previous location in another subfamily. The subfamily Sanguinolariinae M. Smith is quite unnecessary. *Soletellina* and *Sanguinolaria* possess deeper pallial sinuses than *Gari*. Features that separate *Soletellina* and *Sanguinolaria* are given later in this work under the definition of *Soletellina*.

Key to the Subgenera of *Gari* in Australasia

[The number in square brackets after the subgeneric name indicates the number of species in Australasia.]

1. Shell with oblique cords anteriorly and centrally.....*Gari* [10]
 - Anterior and central areas of shell smooth or with concentric cords or lamellae2
2. Shell elongate; posterior end of valves somewhat pointed; inequilateral when fully grown (umbones displaced anteriorly)*Psammobia* [5]
 - Shell quadrate or rounded; posterior end of valves evenly rounded or truncate; equilateral3

3. Shell large (ie, greater than 100 mm long when adult), flaring posteriorly, hinge plate of left valve with prominent lunular projection in front of anterior cardinal tooth *Dysmea* [1]
- Shell small or moderate in size (ie, less than 100 mm long when adult), rounded or subtruncate posteriorly; hinge plate of left valve without prominent lunular projection 4
4. Lower limb of pallial sinus of adult confluent with pallial line for less than half its length 5
- Lower limb of pallial sinus of adult confluent with pallial line for equal to, or greater than, half its length 6
5. Shell laterally compressed; umbones displaced posteriorly (ie, anterior end enlarged); exterior predominantly smooth *Psammodonax* [2]
- Shell moderately inflated; umbones displaced anteriorly (ie, posterior end somewhat enlarged in adults); exterior sculptured with prominent, concentric lamellate cords consisting of microscopic, recurved riblets *Kermadysmea* [1]
6. Shell less than 15 mm long; posterior slope bearing (sometimes scaly) radial ridges *Psammobella* [1]
- Shell greater than 15 mm long; posterior slope smooth or with concentric lamellae 7
7. Umbones displaced anteriorly (ie, posterior end elongate); large posterior gape *Psammotaena* [3]
- Umbones approximately central on dorsal margin; small posterior gape or none at all 8
8. Adult shell moderately heavy; red rayed; without a thick periostracum *Gobraeus* [3]
- Adult shell extremely heavy; covered with a thick, persistent periostracum *Crassulobia* n.subgen. [1]

***Gari (Gari)* Schumacher, 1817**

One of the most significant outcomes of this revision has been the realisation that there is a natural group of *Gari* species linked by the presence of oblique cords on the anterior and central areas of both valves (an apomorphy). Other conchological characteristics shared by all members of this group, the subgenus *Gari*, are the equivalve condition with straight commissure at the junction of the shells' margins ventrally, very thin periostracum, presence of a distinct – albeit delicate – posterior cardinal tooth in the left valve, absence of a process on the hinge plate (= lunular projection) in advance of the anterior cardinal tooth in the left valve, and purple streaks along the hinge plate and nymph internally. Hitherto, the closeness of these species had

not been appreciated because taxonomists had classified them only according to external sculpture, and in particular that on the posterior slope. *Grammatomya* Dall was erected solely on these sculptural grounds. Thus the constituent species were dispersed amongst several poorly defined categories.

It appears that species of *Gari* belonging to this subgenus are evolving rapidly. A major part of the evolutionary divergence is expressed in plasticity of sculpture over the posterior slope of the shell. Indeed, several new higher taxa will probably evolve in the future, but at present, while the species all possess all the uniting characteristics mentioned above, they should not be allocated to different subgenera. As an example of what I mean regarding the plasticity of sculpture on the posterior slope, it seems profligate to attempt to distinguish those species with oblique radial

ribs on the posterior slope (*G. pennata* (Deshayes), *G. pulcherrima* (Deshayes) and *G. squamosa* (Lamarck)) from others with smooth or concentrically striate posterior slopes. The nature of this single character (radial ornamentation) differs between the three species just mentioned so greatly that it appears probable it has been acquired independently on (at least two) separate occasions. Therefore this particular group of three species does not represent a natural evolutionary subunit.

Not one of the ten species constituting the subgenus

Gari occurs outside the Indo-Pacific Ocean. Actually all ten species occur in northern Australia and South-east Asia. Five species range into warm temperate waters and only *G. modesta* Deshayes extends into cool temperate waters in southern Australia. No species lives in New Zealand or the Kermadec Islands.

Two other subgenera, *Psammobia* Lamarck and *Gobraeus* Leach, are closely related to *Gari sensu stricto* and I have emphasised these comparisons under the diagnosis for each subgenus. Table 1 also contrasts these three subgenera.

Key to the Species of Subgenus *Gari* in Australasia

1. Posterior slope smooth or ornamented with concentric lamellae (very weak, fine radial ribs also occasionally present) 2
 - Posterior slope ornamented with strong radial ribs 8
2. Shell with strongly maculated colour pattern *G. maculosa*
 - Shell uniform in colour, or with faint and continuous rays 3
3. Posterior slope of right valve with reticulate sculpture *G. sibogai*
 - Posterior slope of right valve smooth, or sculpture other than reticulate 4
4. Shell with concentric striae (sometimes weak) on posterior slope; uniform lilac or violet in colour 5
 - Shell with smooth posterior slope; rose, reddish, orange or cream in colour 7
5. Shell with a distinct break or interruption like a ridge posteriorly at intersection of oblique and concentric cords *G. truncata*
 - Shell without distinct interruption between oblique and concentric cords 6
6. Posterior slope smooth; shell without radial colour markings; larger than 30 mm when adult *G. lessoni*
 - Shell ornamented with concentric striae on posterior slope (particularly on right valve); often coloured with vague, reddish rays; smaller than 30 mm when adult *G. modesta*
7. Posterior end much broader than anterior end, moderately sharply truncate or rounded-truncate; without a distinct posterior ridge; umbones white; lower limb of pallial sinus confluent with pallial line for most of its length *G. pallida*
 - Posterior end little broader than anterior end, very acutely truncate; with a distinct posterior ridge; umbones red, orange, lilac or violet; lower limb of pallial sinus separated from pallial line for most of its length *G. anomala*

8. Ribs divaricating on posterior ridge, curving towards dorsal margin on posterior slope *G. pennata*
- Ribs not divaricating posteriorly; radiating directly from umbo 9
9. Shell with an abrupt discontinuity posteriorly between oblique cords and radial ribs *G. pulcherrima*
- Oblique cords gradually merge into radial ribs over posterior ridge *G. squamosa*

***Gari (Gari) truncata* (Linné, 1767)**

Figs 1, 2, 38-48

- Tellina truncata* Linné, 1767: 1118.—ICZN, 1970: 16 (name no. 2371).
- Tellina Gari* Linnaei...Chemnitz, 1782: 100 (in part), pl.10 fig.92 only (not binomial). [See ICZN, 1944 Opinion 184.]
- Tellina gari* var. b Spengler, 1798: 72.
- Gari vulgaris* Schumacher, 1817: 44, 131 (in part).—Lemche, 1970: 18.
- Psammobia pulchella* Lamarck, 1818 (n.syn.): 515.—Deshayes & Milne-Edwards, 1835: 177 (*Psammobia* species 14).—Hanley, 1843: 58 (*Psammobia* species 14).—Bertin, 1880: 114.—Hidalgo, 1903: 83, no.166.—Dautzenberg & Fischer, 1913: 485.—Dautzenberg & Fischer, 1914: 220-223, pl.7 figs 1-3.—Lamy, 1914: 60.
- Psammobia bipartita* Philippi, 1849 (n.syn.): 166, no.38.
- Psammobia truncata*.—Hanley, 1855: 40.—Martens, 1897: 245, no.9.
- Psammobia caerulescens*.—Reeve, 1857: *Psammobia* pl.8, species 60.—Crosse, 1864: 18.—Odner, 1917: 9.—Cotton, 1964: 13, pl.3, no.4 (misidentification, not *Psammobia caerulescens* Lamarck, 1818).
- Gari bipartita*.—Tryon, 1868: 73, no.6.
- Gari gari*.—Bertin, 1880: 112.—Cox, 1960: 94-96, figs 1,2.—Cox, 1961b: 304.—Kira, 1962: 170, pl.60, no.1.
- Psammobia pallida*.—E.A. Smith, 1885: 93 (misidentification, not *Psammobia pallida* Deshayes, 1855).
- Psammobia (Gari) pulchella*.—Paetel, 1890: 40.
- Psammobia arakanensis* E.A. Smith, 1904 (n.syn.): 10, 1907, pl.18, fig.1,1a.
- Gari pulchella*.—Melville & Standen, 1906: 842.
- Gari arakanensis*.—Winkworth, 1940: 27.
- Gari truncata*.—Kuroda, 1941: 168, no.1389.—Habe, 1951: 203.—Kuroda & Habe, 1952: 20.—Kira, 1959: 59, fig.1.—Azuma, 1960: 88, no.1483.—Kuroda *et al.*, 1971: 441 (English part), pl.98 fig.4.—Higo, 1973: 368, no.1144.—Habe, 1977: 219, pl.46, figs 4,5.—Habe, 1981: 138.—Habe *et al.*, 1986: 33.
- Gari (Gari) truncata*.—Scarlatto, 1965: 49, pl.2 fig.4.—Matsumoto, 1979: 109, no.1840.—Lamprell & Whitehead, 1992: 56, pl.52 fig.390.

Comments on synonymy. The correct identity of the type species of the genus *Gari* was the subject of a protracted debate between Dr L.R. Cox in London (Cox, 1960, 1961a, 1963, 1965) and Dr H. Lemche in Copenhagen (Lemche & Parker, 1962; Lemche, 1964, 1970). At the centre of the controversy was the fact that the first adequate illustration of "*Tellina Gari* Linnaei" by Chemnitz (and hence type of the genus *Gari* Schumacher by monotypy) depicted two shells

(Chemnitz, 1782:figs 92,93) belonging to different species (Bertin, 1880). Chemnitz gave no indication of any preference for one figure above the other. Fortunately the shells on which both Chemnitz' illustrations are based are still in existence, figure 92 being the species now called *Gari truncata* (Linné) and figure 93 being *G. amethysta* (Wood). However, the debate centered on deciding which particular shell should best take the name "*Tellina Gari* Linnaei". Cox (1960) initially proposed a neotype for the shell in Chemnitz' figure 92, but that action was unnecessary because Lemche (1964, 1970) later claimed the illustration was a composite of two shells in ZMUC. Lemche & Parker (1962) proposed a neotype for the shell in Chemnitz' figure 93, and in doing so wisely advocated suppression of the name "*Tellina Gari*" because of the confusion it had caused, a suggestion first mooted by Dautzenberg & Fischer in 1914. A ruling by ICZN in 1970 ended the debate and the two hundred years of confusion. The ICZN ruled in favour of suppression of *Tellina gari* and in addition, the ICZN voted in support of Cox's amended proposals (Cox, 1965:144,145) ie, that *Tellina truncata* Linné was the oldest available name for *Gari vulgaris* Schumacher.

This particular debate was clarified, in large part, through the existence of the actual type specimens. Cox (1960:pl.1 fig.2a-d) illustrated the holotype of *Tellina truncata* Linné in BMNH. Cox's neotype for *Tellina gari*, though eventually unnecessary, was based on the shell in BMNH that Reeve (1857) had illustrated in *Conchologia Iconica*. Thus Cox confirmed Reeve's unintentional misidentification of *Gari truncata* as *G. caerulescens* (Lamarck) (= *G. amethysta* (Wood)). Although Lemche (1964, 1970) mentioned the type specimens of *G. vulgaris* Schumacher, he never actually illustrated them and I have done so here for completeness (Figs 39,40).

Lamarck (1818) was apparently unaware of pre-existing descriptions or illustrations when he described *Psammobia pulchella* as new; that name was based on juvenile specimens.

There is a complete specimen of this species in the Lamarck collection, MHNG (1083/16), labelled *P. caerulescens* Lamarck. Although this shell undoubtedly represents one of the three in Lamarck's own collection (as indicated by Rosalie Lamarck's annotation "3" besides "*P. caerulescens* ... Mon cabinet" in the copy of *Histoire Naturelle* ... belonging to Lamarck in MHNG), it does not match Lamarck's description of *P. caerulescens* and cannot, therefore, be part of the original type material. *Psammobia caerulescens* Lamarck is, in fact, a junior synonym of *Gari amethysta* (Wood).

Psammobia bipartita Philippi is most probably another synonym of *Gari truncata*. Philippi cited Chemnitz' figure (1782: pl.10 fig.92), but ignored all other relevant literature (Cox, 1960:95,96). *Psammobia arakanensis* E.A. Smith is

unquestionably a third junior synonym of *G. truncata*, being based merely on minor differences of the oblique cords.

Types. *Tellina truncata* Linné: holotype (complete specimen - 34.0 mm) in Linné coll., Linnean Society of London (not registered); isolated by Hanley, 1855; figured by Cox, 1960: fig.2a-d (Fig.38). Type locality unknown.

Gari vulgaris Schumacher: lectotype selected by Lemche, 1970: 18 (complete specimen - 40.0 mm) in ZMUC (Fig.39). Paralectotype (complete specimen - 37.5 mm) in ZMUC (Fig.40). (Type locality unknown.) [Lemche (1970:18) argued it is impossible to specify a type locality.]

Psammobia pulchella Lamarck: lectotype here designated (smaller syntype, complete specimen - 22.6 mm) in MNHN (M4 R1113); figured by Dautzenberg & Fischer, 1914: pl.7 figs 2,3 (Fig.41). Paralectotype (complete specimen - 25.3 mm) in MNHN (M4 R1113); figured by Dautzenberg & Fischer, 1914: pl.7 fig.1. Type locality unknown; Lamarck said only "Du voyage de Peron".

Psammobia bipartita Philippi: type material originally in Largilliert coll., Natural History Museum of Rouen, France, but it cannot be located there and is presumed lost (P. Bouchet, personal communication, 1985). Not found in ZMB (E.A. Kay, personal communication, 1989). Type locality Manila, Philippine Islands.

Specimen figured as *Psammobia caerulea* Lamarck by Reeve, 1857, *Psammobia* pl.8, species 60 (complete specimen - 57.8 mm) in BMNH (1960963); illustrated and (unnecessarily) designated as neotype of *Tellina gari* Linné by Cox, 1960: 95, pl.1 fig.1a-e (Fig.42).

Psammobia arakanensis E.A. Smith: holotype (complete specimen - 30.8 mm) in ZSI (M3063/1); figured by E.A. Smith, 1907: pl.18 fig.1,1a (Fig.43). Type locality off Cheduba, Arakan coast.

Material examined. AUSTRALIA – NORTHERN TERRITORY: 1h, Lee Point, Darwin (AMS C77157); 4c, Tree Point, Darwin (Willan coll.); 2c,4h, Darwin (AMS; AMS C124402; WAM); 1c, Melville Island (AMS); 1c,3h, Boucaut Bay, Arnhem Land

(AMS C125621); 1c, Yirrakala Beach, Gove Peninsula (Lamprell coll.); 1c, Gove Peninsula (Whitehead coll.).

PAPUA NEW GUINEA: 1c, 13-22 m, Lolorua Island, southwest of Port Moresby (AMS). JAPAN: 13c (CAS 37000; MNHN; NHMW 343); 3c, Mikawa, Honshū Island (WAM 1068-70; ZMUC). HONG KONG: 2c, Cheng Chau (AMS C94421). PHILIPPINE ISLANDS: 15c,1h, Manila, Luzon Island (AMS C38769; BMNH 1936.1.8.219-220; CAS 421; MNCN; MNHN; NMNZ M15182); 1c, Catanauan Bay, Bondoc Peninsula, Quezon Island (WAM); 4c, Daptan, Mindanao Island (MNCN). INDONESIA: 2c, Ambon Island (NHMN); 1c, 35 m, Makassar, Celebes Island, 00°54'S 119°31'E (MNHN); 1c, Santubong and Buntal, Sarawak (BMNH 1894.7.14.49); 3c, Borneo (NMV). MALAYSIA: 1c, 38.6 km north of Kuala, Dungun (AMS). INDIA: 1c, 37-55 m, off Cheduba, Arakan Coast (ZSI M3063/1 - holotype of *Psammobia arakanensis* E.A. Smith); 1c, Madras (BMNH 1953.1.7.196); 1c, Tranquebar (ZMUC); 1c, Tuticorin (BMNH 1953.1.7.174). SRI LANKA: 6c (BMNH 1964063, 1964064; MNCN).

LOCALITY UNKNOWN: 1c (Linné coll., Linnean Society of London - holotype of *Tellina truncata* Linné); 2c (ZMUC - lectotype & paralectotype of *Gari vulgaris* Schumacher); 2c (MNHN M4 R113 - lectotype & paralectotype of *P. pulchella* Lamarck).

Description. Maximum length 60 mm. Shell moderately solid, elongate-ovate; maximum width at level of umbones; equilateral, umbones approximately central on dorsal margin in both juveniles and adults; anterior end broadly rounded; ventral margin straight (occasionally weakly convex or concave centrally); posterior end broadly subtruncate, subangulate, about equal in width to anterior end; equivalve, both valves moderately inflated; commissure at junction of shells' ventral margins usually straight (very slightly bowed in some juveniles); small anterior and moderate posterior gapes. Surface of both valves sculptured all over; on anterior and central areas are numerous, broad, flat-topped,

Table 1. Distribution of character states within the three most closely related subgenera of *Gari*.

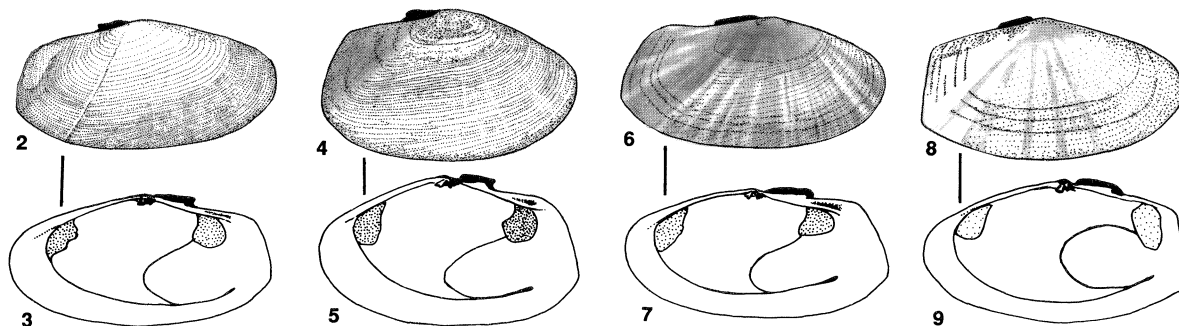
Character	<i>Psammobia</i>	<i>Gobraeus</i>	<i>Gari</i>
Shape	elongate	quadrate	elongate
Exterior surface	with concentric striae (always on posterior slope)	smooth (growth lines only)	with oblique cords on anterior and central areas
Posterior ridge	present	absent	absent
Posterior gape	small	moderate	moderate
Valve symmetry (as determined by relative position of umbo)	inequilateral	equilateral	inequilateral
Relationship of valves to each other	inequivalve	equivalve	equivalve
Lunular projection on left valve	present	present or absent	absent

oblique cords that override finer concentric growth striae; cords number 23 per cm counting in from ventral margin transversely towards umbo of a 53 mm adult shell; posteriorly, oblique cords terminate abruptly at a sharp line (which is stronger on right valve, and whose actual position is discordant between valves, being higher on right valve) (Fig.45); behind are numerous, flat-topped, evenly spaced, concentric cords; cords become narrower and raised near posterodorsal margin but never lamellose; surface glossy. Periostacum thin, light brown, usually completely dehiscent or present only as vestiges close to ventral margin.

Hinge plate narrow; nymph narrow, moderately elongate. Right valve with 2 cardinal teeth, equally developed, deeply bifid (rear one especially so), directed obliquely, diverging by 70° from each other. Left valve with a strong, triangular, deeply bifid, slightly anteriorly directed anterior cardinal tooth and a minute rear cardinal, a short, high lamella diverging by 65° behind anterior cardinal. Pallial sinus moderately deep (extends level with umbones), moderately broad; upper limb straight, descending; anterior margin narrowly rounded, sometimes subacute in right valve; lower limb straight, pointing rearwards, free from pallial line for about half its length; ventral extremity of pallial line directed straight backward, extends level with rear end of posterior adductor scar. Pedal retractor scar present in front of hinge plate.

Colour of exterior livid purple or violet, darker towards umbones which are white. Interior shining, uniformly purple, with 2, narrow, pale rays (corresponding to successive positions of cruciform muscles posteriorly; especially visible when valve is held to light); secondary calcification never present. Teeth white; hinge plate and nymphs purple.

Remarks. *Gari truncata* is the type species of both the genus and subgenus *Gari* Schumacher, and accordingly many of its characters are shared by other species belonging to those taxa. However, its sculpture is unique, particularly the abrupt discontinuity between the oblique and concentric cords on the posterior slope. Only *G. pulcherrima* (Deshayes) has such an abrupt discontinuity between the sculptural components posteriorly, but that species has strong radial ribs behind the discontinuity.



Figs 2-9. Four closely related species of *Gari* (*Gari*), representations of right valves to illustrate differentiating characters: 2, 3, *G. (G.) truncata* (Linné); 4, 5, *G. (G.) lessoni* (Blainville); 6, 7, *G. (G.) pallida* (Deshayes); 8, 9, *G. (G.) anomala* (Deshayes).

Gari truncata is most closely related to *G. lessoni* (Blainville) with which it has been confused on several occasions (Angas, 1867; E.A. Smith, 1885; Kuroda *et al.*, 1971; Cernohorsky, 1978) on account of similarities of size, sculpture, colour, habitat and distribution. However, *G. lessoni* has a broader squatter and more inflated shell, the oblique cords extend across the central area to the posterior ridge instead of terminating at an abrupt line in front of the ridge, and the concentric cords are weaker and more irregular over the steeper posterior slope.

Historically *Gari truncata* has been confused with *G. (Psammobia) amethysta* (Wood) because both were mistakenly figured under the same name by Chemnitz (1782) (see earlier discussion), but the two species are unlike. *Gari amethysta* has a more elongate, narrower, decidedly inequilateral shell, the posterior end of which is noticeably pointed, its valves are more compressed and the commissure is sinuous, the sculpture (which is discordant between the two valves) is completely different and finally, *G. amethysta* always has radial lines featuring in its colour pattern. Philippi (1849) distinguished these two species most succinctly on sculpture alone; he called one *Psammobia bipartita* and kept the name *P. tripartita* Deshayes for the other.

Habitat. *Gari truncata* inhabits fine sandy substrates and it can tolerate mud. The only locality in Australia at which it is common is Tree Point, Darwin (V. Kessner, personal communication, 1985).

Gari truncata is essentially a subtidal psammobiid with a bathymetric range of 0 to 50 m.

Distribution. *Gari truncata* occurs in the western Pacific Ocean, ranging widely from central Honshû Island (Boso Peninsula), Japan (Kuroda *et al.*, 1971), through the Philippines (Philippi, 1849; Hidalgo, 1903) and Indonesia (Reeve, 1857) to northern Australia (E.A. Smith, 1885; Odhner, 1917; Cotton, 1964). *Gari truncata* also occurs in the Indian Ocean, although there are few records, from Chah Bahar, Gulf of Oman (Melville & Standen, 1906), Sri Lanka (Linné, 1767; Cox, 1960) and Cheduba, Bay of Bengal (E.A. Smith, 1904).

Gari truncata occurs only around Australia's northernmost coasts; E.A. Smith (1885) recorded it from Cape York, Odhner (1917) recorded it from Broome, and

Cotton (1964) recorded it from Yirrakalla, Arnhem Land. The wider Australian distribution given for this species by Lamprell & Whitehead (1992) is incorrect.

Gari (Gari) lessoni (Blainville, 1826)

Figs 4, 5, 49-54

- Psammobia lessoni* Blainville, 1826: 480, 481.—Reeve, 1856: *Psammobia* pl.2, species 8.—Fischer, 1858: 336.—Hidalgo, 1903: 75, 101, no.7.—Hedley, 1904: 1976.—Hedley, 1910: 350.
- Psammobia striatella* Philippi, 1849: 166, no.30.—Martens, 1897: 246, no.10.—Hidalgo, 1903: 101.
- Psammobia malaccana* Reeve, 1857 n.syn., *Psammobia* pl.6, species 42.—Crosse, 1864: 18.—Paetel, 1890: 40.
- Gari malaccana*.—Angas, 1867: 917, no.37.—Whitelegge, 1889: 237, no.54.
- Gari lessonii* (sic = error pro. *lessoni*).—Tryon, 1868: 74, no.20.
- Gari lessoni*.—Bertin, 1880: 104, no.2.—Hedley, 1904: 196.—Hedley, 1918a: M27, no.280.
- Psammobia pallida*.—E.A. Smith, 1885: 93, 94 (misidentification, not *Psammobia pallida* Deshayes, 1855).
- Psammobia (Gari) lessoni*.—Paetel, 1890: 40.
- Gari schepmani* Prashad, 1932 n.syn.: 302, 303, pl.7 figs 1,2.
- Milligaretta venta*.—Allan, 1950: 342, fig.80, no.3.—Allan, 1962: 342, fig.80, no.3 (misidentification, not *Milligaretta venta* Iredale, 1936).
- Gari (Gari) schepmani* Prashad.—Scarlatto, 1965: 48, pl.5 fig.1.
- Gari truncata* (Linné).—Cernohorsky, 1978: 185, 186, pl.67 fig.5 (misidentification, not *Tellina truncata* Linné, 1767).
- Gari (Gari) lessoni* (Linné).—Lamprell & Whitehead, 1992: 56, pl.52 fig.391.

Comments on synonymy. Blainville's (1826) original description of *Psammobia lessoni* is very exact, especially when matched against the holotype. That particular shell (Fig.49) was mentioned specifically by Blainville in his description; he gave its length as "près de soixant millimètres", and its length is actually 58.4 mm.

I agree with Martens' (1897:246) supposition that *Psammobia lessoni* Blainville and *P. striatella* Philippi are synonymous, but cannot confirm it as fact through lack of type material of *P. striatella*. *Psammobia malaccana* Deshayes is based on fully grown, but thin shelled, white specimens.

Gari lessoni is similar to both *G. truncata* Linné and *G. pallida* (Deshayes), so it is not surprising the three species have been confused in the past (E.A. Smith, 1885, Kuroda *et al.*, 1971; Cernohorsky, 1978). E.A. Smith (1885:93,94) erred, not only in synonymising *P. pallida* Deshayes with *P. malaccana* Reeve and *P. suffusa* Reeve, but also in saying "there is in each valve a more less distinct lateral tooth rather remote from the cardinals".

Apparently the first record of this species from Australia was that by Angas (1867) as *Gari malaccana* (Reeve). That name was subsequently altered to *G. lessoni* by Hedley (1904), and later Hedley (1918) repeated it as such in his checklist of marine molluscs of New South Wales. In his first note, Hedley (1904) mentioned the smaller size and less bright colouration of specimens from Sydney, but he made it clear they were identical with specimens of *G. lessoni* from the tropics. Iredale (1936) misinterpreted Hedley's comments, and in doing so confused *G. lessoni* with *G. modesta* (Deshayes); the outcome being a new genus and species name

(*Milligaretta venta*) for *G. modesta*. Allan (1950) mistakenly assumed Iredale had intended *M. venta* should entirely replace *G. lessoni*.

Prashad (1932) distinguished pale, juvenile shells under the name of *Gari schepmani*.

In my opinion, the best illustrations of *Gari lessoni* are those by Reeve (1856) and Cernohorsky (1978).

Types. *Psammobia lessoni* Blainville: holotype (complete specimen - 58.4 mm) in MNHN (Fig.49). Type locality Bourou Island, Moluccas Islands. Specimen of *Psammobia lessoni* Blainville figured by Reeve, 1856: *Psammobia* pl.2, species 8 (complete specimen - 59.2 mm) in BMNH (196420) (Fig.50).

Psammobia striatella Philippi: type material not found in ZMB (E.A. Kay, personal communication, 1989) and definitely not in SMF (R. Jansen, personal communication, 1989). Enquiries regarding its present location to the Director, MNHS, were not answered. Type locality unknown.

Psammobia malaccana Reeve: lectotype, here designated (figured syntype, complete specimen apart from broken right valve - 34.8 mm) in BMNH (1964049); figured by Reeve, 1857: *Psammobia* pl.6, species 42 (Fig.59). Paralectotypes (complete specimens - 37.3, 32.7 mm) in BMNH (1964050/1, 1964050/2 respectively). Type locality Malacca.

Gari schepmani Prashad: holotype (complete specimen - 24.0 mm) in ZMA (3.32.054) (Fig.52). Paratypes (complete specimens - 16.2, 15.0 mm) in ZMA (3.32.002, 3.32.004 respectively). Additional paratypes (single right valve - 16.0 mm and 2 single left valves - 20.3, 19.2 mm) in ZMA (3.32.003). Type locality Sapeh Bay, east coast Sumbawa Island, Indonesia.

Material examined. AUSTRALIA - QUEENSLAND: 1h, Boigu Island, Torres Strait (WAM); 34h, Karumba Point, Gulf of Carpentaria (WAM); 1h, 51 m, north Cape York (BMNH 1887.2.9.2542); 10c, Cape York (NMV; WAM 1074-70); 4c, Port Douglas (QM); 2c, Yorke's Knob, north of Cairns (Whitehead coll.); 1c, Machan's Beach, Cairns (WAM 1073-70); 1c, Dunk Island (QM); 1c, Cardwell (Whitehead coll.); 1c, off Palm Island (Lamprell coll.); 1h, Magnetic Island (NMV); 1c, Townsville (QM); 3c, Sinclair Bay, Gloucester Passage, Bowen (Whitehead coll.); 3c,6h, Dingo Beach, Gloucester Passage, Bowen (Lamprell coll.; Willan coll.); 1c, Bowen (WAM 1072-70); 2c, Armstrong Beach, Shoal Point, Mackay (Willan coll.); 2c, Sarina Inlet, south of Mackay (NMSA G862; Whitehead coll.); 1c, Flock Pigeon Island, Clairview (Kroll coll.); 1c, Long Beach, Yeppoon (Whitehead coll.); 4c, Yeppoon (WAM1071-70); 4c, Boyne Island, Gladstone (QM; Willan coll.); 2c, Hummock Island, Rodds Bay, south of Gladstone (NMV F17230); 2h, Port Curtis (WAM 999-68); 1c, Outer Harbour, Port Curtis (Trevor coll.); 6c, Tin Can Bay (NMV); 2c, Fraser Island (Lamprell coll.) 2c, Urangan, Hervey Bay (WAM 1070-70); 3c,2h, Toorbul Point, Deception Bay, Moreton Bay (Willan coll.); 1c, Woody Point, Bramble Bay, Moreton Bay (Lamprell coll.); 4c, Dohles Rocks, Pine River mouth, Bramble Bay, Moreton Bay (Willan coll.); 1h, Sandgate, Moreton Bay (WAM 1069-70); 2c,2h, 4 m, east Nudgee Beach, Moreton Bay (Willan coll.); 2c,1h, 12 m, east Green Island, Moreton Bay (Willan coll.); 1h, 12-14 m, Rainbow Channel, Moreton Bay (Willan coll.); 2h, 7 m, Myora, North Stradbroke Island, Moreton Bay (Willan coll.); 2h, Lota, Moreton Bay (Willan coll.); 1h, Wellington Point, Moreton Bay (Willan coll.); 2h, Raby Bay, Moreton Bay (Willan coll.). NEW SOUTH WALES: 2c, Clarence River (AMS C15995); 1c,3h, 4-7 m, off Challenger Head, Broken Bay (AMS); 1h, 75-150

m, east off Sydney (AMS); 1h, off Garden Island, Port Jackson (AMS); 1c, Lane Cove River, Port Jackson (BMNH 1873.5.2.41). WESTERN AUSTRALIA: 1c, Gales Bay, Exmouth Gulf (WAM); 1c, Exmouth Gulf (WAM); 1c, Giralia Bay, Exmouth Gulf (WAM); 1c, 3h, north-east Dampier (WAM); 1c, Lewis Island, Dampier Archipelago, (WAM); 3c, Karratha (WAM); 1c, Nooreas, Roebourne (Whitehead coll.); 1c, Six Mile Point, Port Hedland (WAM 1812-68); 2c, Condon, Eighty Mile Beach (Hansen coll.); 1c, Buccaneer Rocks, Broome (WAM 1729-68); 2c, Condon, Eighty Mile Beach (Hansen coll.); 1c, Buccaneer Rocks, Broome (WAM 1729-68); 1h, Crab Creek, approximately 22.5 km from Broome (WAM 1845-68); 15c, Broome (AIM; Lamprell coll.; NMV; QM; WAM 1075-70; Whitehead coll.); 1c, Roebuck Bay, Broome (AMS; Hansen coll.; NMV; WAM 11956/7); 2c, Sunday Island, near Derby (WAM 1277-68); 1c, Beagle Bay (AIM AM17629); 1c, Sam's Creek, Port Sampson (WAM 1730-68); 2c, Port Sampson (WAM 1786-68); 2c, Antonni Mia, Port Sampson (WAM 1758-68); 2c, north-western Australia (AIM AM17628); 2c, Yampi Sound, Buccaneer Archipelago (NMV); 1c, Port Warrender, Admiralty Gulf (WAM); 1c, 5.5 m, Second Bay, south of Warrender Hill, Port Warrender, Admiralty Gulf (WAM 1828-68). NORTHERN TERRITORY: 1c, Darwin (Turnbulle coll.); 2c, Vashon Head, north-west Cobourg Peninsula (Whitehead coll.); 2c, Croker Island, Cobourg Peninsula (Whitehead coll.); 2c, South Goulburn Island (Kessner coll.); 1c, Sandy Creek Reach, west Arnhem Land (Kessner coll.).

TUVALU: 1h, Funafuti Atoll (NMV). HONG KONG: 2c (QM). PHILIPPINE ISLANDS: 3c (NMV); 2c, Samar Island (BMNH 196420, 196421); 15c, Manila, Luzon Island (BMNH 1936.1.8.210-211; MNCN; MNHN; NHMW 35649; ZMUC). INDO-MALAYSIA: 1h, 100 m - 05°37'S 132°56'E (ZMUC). INDONESIA: 1c, Bourou Island, Moluccas Islands (MNHN - holotype of *Psammobia lessoni* Blainville); 1c, 36 m, Sapeh Bay, east coast Sumbawa Island (ZMA 3.32.054 holotype of *Gari schepmani* Prasad); 1c, off west coast Wasir Island, West Wokam, Moluccas Islands (WAM 1022-68); 1c, Java (AMUC). MALACCA: 5c (BMNH 1964049, 1964050/1,2 - lectotype & paralectotypes of *P. malaccana* Deshayes; MNHN; NHMW 35650). INDIA: 1c, off delta of Ganges River (BMNH 1900.7.9.10); 1c, dredged, Madras (BMNH 1953.1.7.169).

Description. Maximum length 55 mm. Shell moderately solid, elongate-ovate; maximum width at level of umbones; adults equilateral, juveniles inequilateral (umbones displaced forward of centre on dorsal margin); anterior end broadly rounded; ventral margin evenly convex; posterior end blunt, truncate, approximately equal in width to anterior end; subequivalve, both valves moderately inflated, the left a little more so; commissure at junction of shells' ventral margins straight; small anterior and posterior gapes. Sculpture consisting of numerous, fine, broad, flat-topped, oblique cords that override finer concentric growth striae on anterior and central areas; cords number 33 per cm counting inwards from ventral margin transversely toward umbo of a 53.8 mm adult shell; posteriorly, oblique cords extend to weak posterior ridge; posterior slope of both valves smooth or with irregular, narrow, concentric growth striae; no abrupt line at termination of oblique cords; surface glossy. Periostracum brownish, moderately heavy, dehiscent but usually persisting close to ventral margin.

Hinge plate, nymphs, dentition, pallial sinus, adductor and pedal retractor scars identical to those of *Gari truncata*.

Colour of exterior livid purple, violet, blue or cream, always darker towards umbones which are white. Interior shining, uniformly purple, with 2, narrow, pale rays (corresponding to successive positions of cruciform muscles posteriorly; especially visible when valve is held to light); some secondary calcification in adults. Teeth white; hinge plate and nymphs pale purple.

Remarks. *Gari lessoni* possesses the following distinctive features: moderately solid shell which is inequilateral in juveniles and subadults; truncated posterior end; moderately inflated valves (left a little more so); straight commissure; weak posterior ridge; external sculpture of oblique cords anteriorly and centrally, and smooth posterior slope; moderately deep pallial sinus and uniform purple or violet colour without any hint of radial lines.

Gari lessoni shows negligible variation in outline but some shells are more inflated than others. Sculpture too shows no intraspecific variation. However, some variation is apparent regarding thickness and colour; specimens from particularly silty, subtidal situations (form *malaccana*) have thinner shells that are uniformly cream externally and internally (Figs 52,54), and their size (both full adult and population mean) is significantly smaller. Examination of museum collections indicates that shells from Western Australian populations (Fig.56) are paler and attain a larger adult size that those from Queensland.

There are three, largely sympatric, obliquely corded *Gari* species with smooth posterior slopes that *G. lessoni* resembles and with which it could be confused - *G. truncata* (Linné), *G. pallida* Deshayes and *G. anomala* (Deshayes). These differences are summarised in Figures 2 to 9. The characteristics that enable discrimination between *G. lessoni* and *G. truncata* have already been outlined in the remarks section under *G. truncata*. By contrast to *G. lessoni*, *G. pallida* is relatively more elongate, the posterior end is more flaring, it lacks an abrupt termination to the oblique cords, it bears pale radial colour lines externally, and its interior is flushed with orange. *Gari anomala* is smaller, thinner, more inequilateral, very truncate posteriorly, it has a stronger posterior ridge, a completely different pallial sinus (the lower limb is free from the pallial line for most of its length), and it is usually orange, pinkish, or reddish with darker rays. The other Australian species of the subgenus *Gari* have either lamellae, reticulate sculpture, or radial ribs on the posterior slope of the right valve instead of being smooth.

Habitat. *Gari lessoni* inhabits fine sandy substrates, often muds. It can occur in the same habitat as *G. truncata* but where this happens, as in the Northern Territory, *G. lessoni* is usually rarer.

Gari lessoni has a bathymetric range of 0 to 150 m and it is apparently most abundant in 0 to 15 m.

Distribution. The distribution of *Gari lessoni* is apparently determined by its preference for sheltered sites. All the locality records (except that of Funafuti Island which is probably incorrect) indicate a restriction to the coasts of continents and continental islands. For example, *G. lessoni* definitely does not occur on the Great Barrier Reef islands. *Gari lessoni* extends throughout the southwestern Pacific and south-eastern Indian Ocean but it does not reach the western Indian Ocean. It is widespread in tropical waters and extends well into warm temperate waters, ie, *G. lessoni* is more wide ranging than *G. truncata*. Literature records are as follows: New Caledonia (Fischer, 1858); Philippine Islands (Reeve, 1856; Hidalgo, 1903); Bourou Island, Moluccas Islands (Blainville, 1826); Indonesia (Martens, 1897); whole coast of Queensland (Hedley, 1904, 1910). Oddly there are neither records nor specimens in museum collections from southern Japan. In Australia, *G. lessoni* extends as far south as Sydney Harbour (Angas, 1867) but it is relatively rare there, whereas further north, in Moreton Bay it is not uncommon (personal observation).

Gari (Gari) pallida (Deshayes, 1855)

Figs 6, 7, 57-75

- Unnamed figure by Savigny, 1818.
Psammobia pallida Deshayes, 1855: 323, no.29.—E.A. Smith, 1885: 93, 94.—Macandrew, 1870: 446.—Cooke, 1886: 104.—Shopland, 1902: 177.—E.A. Smith, 1903: 398, no.365.—Tomlin, 1927: 307.—Barnard, 1964: 533.
Psammobia pulchella (Lamarck)—Reeve, 1856: *Psammobia* pl.4, species 23 (misidentification, not *Psammobia pulchella* Lamarck, 1818).
Psammobia tenuis Deshayes.—Reeve, 1857: *Psammobia* pl.6, species 37a only (misidentification, not *Psammobia tenuis* Deshayes, 1855).
Psammobia suffusa Reeve, 1857 n.syn.: *Psammobia* pl.7, species 54.—Paetel, 1890: 40.
Psammobia rosea (Deshayes)—Vaillant, 1865: 120.—Issel, 1869: 56, no.25 (misidentification, not *Sanguinolaria rosea* Lamarck, 1818 or *Psammobia rosacea* Deshayes, 1855 see Bertin, 1880: 114, 115).
Psammobia weinkauffi Crosse, 1864 n.syn.: 17, pl.2 fig.4.—Mörch, 1876: 373.—Paetel, 1890: 41.—Shopland, 1902: 177.—Warén, 1980, pl.8 figs 11-13.
Gari (Gari) suffusa (Reeve)—Tryon, 1868: 75, no.36.—Bertin, 1880: 110, no.32.
Gari (Gari) weinkauffi (Crosse)—Tryon, 1868: 76, no.41.—Prashad, 1932: 301, 302.—Lamprell & Whitehead, 1992: 58, pl.53 fig.394.
Gari weinkauffi (Crosse)—Bertin, 1880: 114, no.47, Lamy, 1918: 246, 247, 1938: 36.—Parenzan, 1976: 324, pl.58 fig.281.—Nordsieck, 1969: 124, no.71.01.—Nicolay, 1979: 20, 21.—Cosel, 1990: 701.—Oliver, 1992: 162, pl.36 figs 7a, 7b.
Gari (Psammobia) pallida (Deshayes)—Bertin, 1880: 119, no.55.
Psammobia sp. E.A. Smith, 1885: 92.
Psammobia (Heteroglypta) reevei Martens, 1897 n.syn.: 247, 248, no.11 (replacement name for *Psammobia pulchella* of Reeve, 1856).
Psammobia (Gari) pallida Deshayes.—Paetel, 1890: 40.

- Psammobia bertini* Hidalgo, 1903 n.syn.: 86, 87, 102, no.168 (replacement name for *Psammobia pulchella* of Reeve, 1856).
Psammobia anomala (Deshayes)—Lyngge, 1909: 212 (misidentification, not *Psammobia anomala* Deshayes, 1855).
Gari pallida (Deshayes)—Tomlin, 1927: 307.
Psammobia valdiviae Jaekel & Thiele, 1931 n.syn.: 239, pl.4 fig.115.
Gari anomala (Deshayes)—Habe, 1964: 197, pl.61 fig.4.—Kuroda *et al.*, 1971: 442 (English part), pl.97 fig.13.—Higo, 1973: 368, no.1145.—Habe *et al.*, 1986: 33.—Okutani *et al.*, 1989: 135, no.115 (misidentification, not *Psammobia anomala* Deshayes, 1855).
Gari hosoyai Habe, 1958 n.syn.: 40, no.213, 1964: 197, pl.61 fig.1.—Azuma, 1960: 88, no.1484a.—Kuroda *et al.*, 1971: 442 (English part), pl.97 fig.14.—Higo, 1973: 368, no.1146.—Inaba & Oyama, 1977: 50.
Gari (Gari) reevei (Martens)—Scarlatto, 1965: 49, pl.3 fig.2.
Gari (Gari) hosoyai Habe.—Matsumoto, 1979: 109, no.1483.

Comments on synonymy. Although it is a distinctive species, *Gari pallida* has presented taxonomic difficulties because of its similarity to *G. truncata*, *G. lessoni* and *G. anomala*, and its widespread distribution. The first accounts of this species in the literature are from the Red Sea by way of Savigny's (1818) illustration of a specimen from Egypt and Deshayes' (1855) original description of *Psammobia pallida*. Reeve (1856-1857) gave no mention of *P. pallida* as such in his monograph on *Psammobia* in *Conchologia Iconica*. This is noteworthy because Reeve had access to the Cuming collection for illustrative material (Dance, 1966:159) and upon which Deshayes' psammobiid descriptions were largely based. Yet unknowingly Reeve did illustrate three shells belonging to this species. The first was under the erroneous name of *P. pulchella* Lamarck. Reeve's error was detected independently by Martens (1897) and Hidalgo (1903), and the new names *P. reevei* and *P. bertini* were created by these respective authors as replacements. [Incidentally Hidalgo (1903:102) came across Martens' earlier name as he was checking the page proofs for his *Obras Malacologicas* and he added a note synonymising his *P. bertini*]. The second was under the wrong name of *Psammobia tenuis* Deshayes. Reeve's third illustration of a well-coloured juvenile shell from Malacca was accompanied by a new name *P. suffusa*.

Crosse (1864) created another synonym by introducing the new name *Psammobia weinkauffi* based on a single adult shell supposedly from Algeria, Mediterranean Sea. He compared it with *Gari truncata* (Linné) (as *P. caeruleus* Lamarck) and *G. lessoni* (Blainville) (as *P. malaccana* Reeve) from the Indian Ocean, but curiously not with *P. pallida* Deshayes or Reeve's *P. pulchella* or *P. suffusa* from the Pacific Ocean. Several workers have subsequently raised doubts over the locality of Algeria (Jeffreys in Bertin, 1880:115; R. von Cosel, personal communication, 1989). [See later section on distribution of this species for further comments.]

Bertin (1880:115) intended to employ the name *Psammobia savignyi* for Red Sea material which he thought was different to *P. weinkauffi*, but that name was never validly published because Bertin received advice to the contrary from J.G. Jeffreys (who held the holotype of *P. weinkauffi*). Therefore Oliver (1992:162) is incorrect in treating *P. savignyi* Bertin as either an available name or a contender for synonymy under *P. weinkauffi*.

The confusion associated with this species really stems from E.A. Smith's writings in the *Challenger Expedition Report* (1885:92). Smith had one valve belonging to this species from

Ambon Island and he remarked on its great resemblance to *P. weinkauffi* which he had not seen. Yet, because of the distance between Ambon Island and Algeria, he refused to accept the two as the same. Furthermore, he failed to relate this valve to Reeve's *P. pulchella*. Had he done so, he would have noticed Reeve gave the Philippine Islands for this species and he [Smith] would surely have realised the full distribution of this species. This error was exacerbated by Smith's (1885:93) incorrect synonymy of *Gari lessoni* (as *P. malaccana*) with *P. pallida* and *P. suffusa*. Prasad (1932:301,302) partly righted the confusion, but he retained *P.* (as *Gari*) *pallida* as distinct. Lynge (1909) erroneously identified his specimens as *P. anomala* Deshayes. Lamprell & Whitehead (1992) wrongly incorporated *P. pallida* into the synonymy of *G. lessoni*.

Psammobia valdiviae Jaekel & Theile is a synonym based on dead juvenile shells taken in deep water off the east African coast.

Gari hosoyai Habe is the most recent synonym; that name is based on Japanese specimens that are relatively narrow posteriorly (ie, the *weinkauffi* form) resulting in an outline very like that of *Gari anomala* Deshayes). Dr A. Matsukuma (NSMT) has been particularly helpful in sorting out the confusion regarding the status of the type material of *G. hosoyai*. This confusion had stemmed from the facts that the holotype and one paratype were stated to be the same length, neither was figured by Habe (1958), and no registration numbers were cited in the original description. Consequently, Inaba & Oyama's (1977:50) indication that the holotype is the valve figured by Habe (1961:pl.61 fig.1) is erroneous.

Types. *Psammobia pallida* Deshayes: lectotype, here designated (complete specimen - 39.6 mm) in BMNH (1964046/1) (Fig.57). Paralectotypes (complete specimens - 45.7, 28.1 mm) in BMNH (1844.6.3.594, 1964046/2 respectively). Type locality Red Sea.

Specimen figured as *Psammobia pulchella* Lamarck by Reeve, 1856: *Psammobia* pl.4, species 23 (complete specimen - 46.2 mm) in BMNH (196444) (Fig.58).

Psammobia suffusa Reeve: type material ought to be in BMNH, but it cannot be found there (S. Morris, personal communication, 1986; personal search, 1989); not found in MNHN (R. von Cosel, personal communication, 1987; personal search, 1989). Type locality Malacca.

Psammobia weinkauffi Crosse: holotype (complete specimen - 45.5 mm) in USNM (178599); figured by Warén, 1980: pl.8 figs 11-13 (Fig.59). [Warén (1980) explains how the Jeffreys coll. (which contained the holotype in the Weinkauff coll.) came into USNM.] Type locality Algeria.

Psammobia reevei Martens: holotype (complete specimen - 31.3 mm) in ZMB (Fig.60). Type locality Flores Island, Indonesia.

Psammobia bertini Hidalgo: lectotype, here designated (complete specimen - 47.2 mm) in MNCN (15.07/0308) (Fig.61). Paralectotypes (complete specimens - 54.0, 47.5, 46.4, 42.0, 41.0, 40.9 mm) in MNCN (15.07/0308). Type locality Philippine Islands.

Psammobia valdiviae Jaekel & Thiele: lectotype, here designated (figured syntype, right valve with broken ventral margin and red letter T on exterior - 21.0 mm) in ZMB (69972); figured by Thiele & Jaekel, 1931: pl.4 fig.115 (Fig.62). Paralectotypic series (1 complete specimen, 11 right valves and 5 left valves) in ZMB (69972) (largest paralectotype Fig.63). Type locality off Dar es Salaam, Tanzania.

Gari hosoyai Habe: holotype (complete specimen - 29.5 mm - not 29.7 mm as stated by Habe, 1958) in NSMT (Mo39913a-

1) (Fig.64). Paratype (complete specimen - 29.7 mm) in NSMT (Mo39913). [The single right valve (30.6 mm) in NSMT (Mo39913a-2) is that figured by Habe, 1961: pl.61 fig.1, but it does not constitute part of the type material.] Type locality Sagami Bay, Honshû Island, Japan.

Material examined. AUSTRALIA - QUEENSLAND: 1c, 36.5 m, off Watsons Bay, north-west side Lizard Island (Willan coll.); 3h, 24 m, south Townsville - 19°17'S 147°32'E (AMS C149144); 3h, 24 m, east Sarina - 21°27.5'S 150°08'E (AMS); 1h, 53 m, off Broad Sound - 22°06'S 150°49'E (AMS C149141). WESTERN AUSTRALIA: 1h, 112 m, 157 km north-north-west of Port Hedland - 19°08'S 118°01.3'E (AMS).

NEW CALEDONIA: 1c (AMS); 1c, 30-35 m, north-east Hienghène - 20°30'S 164°47'E (MNHN); 1h, 33 m, Grand Récif Mengalia, north Koua - 20°41'S 165°07'E (MNHN); 7h, 48 m, north Poindimié - 21°01'S 165°28'E (MNHN). SOLOMON ISLANDS: 1h, New Britain (AMS C45579). PAPUA NEW GUINEA: 5h, 27 m, off Cape Procection, near Yule Island, Gulf of Papua (AMS); 2c, 22-33 m, 2.4 km south-west of Yule Island, Gulf of Papua (AMS C74807); 1h, 37-48 m, 2.4 km south-west of York Island (AMS C74806); 8h, 23 m, north-west side of Manubada Island (AMS); 7h, 13-18 m, off west side of Loloria Island, south-west Port Moresby (AMS C149163).

JAPAN: 2c (NHMW 75.J.345); 2c, Sagami Bay, Honshû Island (NSMT Mo39913a-1, 39913 - holotype and paratype respectively of *Gari hosoyai* Habe); 2c, Sagami Bay, Honshû Island (NSMT Mo63220); 2c, Mikawa Bay, Honshû Island (NSMT Mo63131); 1c, 9-18 m, Mikawa Bay, Honshû Island (MNHN); 1c, Rikuzen, Tokada City, Honshû Island (NSMT Mo63221); 2c, Wakayama, Honshû Island (AMS C74209).

PHILIPPINE ISLANDS: 7c (MNCN 15.07/0308 - lectotype & paralectotypes of *Psammobia bertini* Hidalgo); 1c (CAS 31846); 4c (BMNH 1931.1.8.205-206; CAS 31846; NHMW); 3c, Manila, Luzon Island (CAS 1745; MNCN) 3c, Bay of Manila, Luzon Island (BMNH 1964044, 1964045/1,2); large series h, 93-99 m - 11°43'N 122°34'E (MNHN). INDONESIA: 1h, 27-37 m, Ambon Island (BMNH 1887.2.9.2538); 1c,1h, 45.5-62 m, off Teluk Dodinga, near Ternate, Halmahera, Moluccas Islands - 00°49'N 127°E (WAM 900-85); 1c, 33-36.5 m, between Du Rowa and Kai Dulah Island, Kai, Moluccas Islands - 05°32'S 132°46'E (WAM 903-85); 1h, 51-58 m, approximately 8 km north of Labuan Olendir, Selaru, Tanimbar, Moluccas Islands - 08°03'S 130°56'E (WAM 901-85); 1c, 33-40 m, off west coast of Wasir Island, West Wokam, Aru, Moluccas Islands - 05°30'S 134°12'E (WAM 902-85); 1c, Flores Island (ZMB - holotype of *P. reevei* Martens); 1h, Borneo (MNHN). JAVA: 35h, Java Sea (ZMUC). MALAYSIA: 2c, Malacca Strait (AMS C38773). THAILAND: 1c,1h, 13-18 m, Bugten and Rayong (ZMUC). ANDAMAN ISLANDS: 1c, dredged, Port Blair (BMNH). INDIA: 1c, dredged, North-west Bay, Madras (BMNH); 4c, Tranquebar (ZMUC). GULF OF OMAN: 2c, Muscat, Oman (MNHN). PERSIAN GULF: 2c, Kuwait (BMNH); 1c, Charbar, Mekram Coast, south Persia (BMNH 1904.1.22.12). GULF OF ADEN: 3c (AMS C34119; BMNH 1902.12.30.518). RED SEA: 3c (BMNH 1844.6.3.594, 1964046/1,2 - lectotype & paralectotypes of *P. pallida* Deshayes); 1c (Lamprell coll.); 1c, near Suakim (BMNH 1885.2.19.6); 1c, Ras Turfa (NHMW 37999); 3h, Gulf of Suez (MNHN); 1c, 19 m, Suez Harbour (MNHN). SEYCHELLES: 2c, dredged, NW Bay, Mahé Island (BMNH 1953.1.7.184-185). KENYA: 1c,1h, 10 m, Wasin Channel, Shimoni (BMNH). TANZANIA: 3c, Mtwara (WAM 996-68); 2c, 2-10 m, Dar es Salaam Harbour entrance (AMS C149150); 1c,16h, off Dar es Salaam (ZMB 69972 - lectotype & paralectotypes of *P. valdiviae* Jaekel & Thiele). ZANZIBAR: 3c,2h (MNHN); 1h, 18-20 m, 2.4 km south-

west of Ras Shangani, west Zanzibar Island (MNHN). MADAGASCAR: 1c (MNHN); 1c,3h, south-east principal harbour, Tuléar (MNHN); 2c,7h, Tuléar (MNHN). MOZAMBIQUE: 1c, Lumbo (BMNH 1920.6.15.49); 1c, Inhaca Island (MHNG 981.877); 1c, north-west Nacala Bay, north Chalau (NMSA H1309); 3c, Macoque (NMSA J5125); 3c, south-west Conducia Bay (NMSA H1314). SOUTH AFRICA: 1c, 42-50 m, north-east Leven Point, Zululand - 27°54.7'S 32°36.7'E (NMSA E4441); 1c,1h, Durban, Natal (BMNH 1902.10.14.2; NMSA 1752).

“ALGERIA”: 1c (USNM 178599 - holotype of *P. weinkauffi* Crosse).

UNKNOWN LOCALITY: 1c (NHMW G9388).

Description. Maximum length 50 mm, seldom exceeding 35 mm. Shell thin, elongate to elongate-ovate; maximum width at level of umbones; approximately equilateral at all stages of growth; anterior end relatively narrow; ventral margin evenly convex; posterior end very broad (same width maintained from level of umbo to posterior margin), broader than anterior end, subtruncate, rounded at intersection with dorsal margin, sharply right angled at intersection with posterodorsal margin; equivalve, both valves moderately inflated; commissure at junction of shells' ventral margins straight; small anterior and posterior gapes. Surface of both valves glossy; anterior and central areas sculptured with numerous, broad, flat-topped, oblique cords; oblique cords number 21 per cm counting in from ventral margin transversely towards umbo of a 33 mm adult shell; cords discernable to ventral margin; cords terminate on rounded posterior ridge; posterior slope of both valves smooth, with indistinct growth striae. Periostracum very thin, pale brown.

Hinge plate narrow; nymph moderately long, narrow. Right valve with 2 cardinal teeth, diverging by 70° from each other; anterior one stronger, bifid, directed obliquely forward; rear one somewhat weaker, very deeply bifid, directed obliquely backward. Left valve with a strong, deeply bifid, ventrally-directed anterior cardinal tooth and a weak posterior cardinal tooth - merely a short, narrow lamella diverging by 65° behind anterior one. Muscle scars and pallial line weakly impressed, hence often difficult to observe. Pallial sinus deep (extends level with umbo), broad; upper limb descending obliquely from posterior adductor scar; anterior margin rounded, subtruncate; lower limb descending to pallial line immediately so the two are confluent for most of their length; ventral extremity of pallial line directed straight back (or flexed upwards very slightly), extends level with middle of posterior adductor scar. Single, relatively small, elongate pedal retractor scar a short distance in front of hinge plate.

Colour always pale - juveniles nearly translucent; exterior white, yellow, pink or rose, always patterned with numerous, narrow, reddish rays that emanate from white umbones, flushed with purple in front of, and behind, umbones. Interior showing colouration of exterior, whitish below umbones and clear-glazed over central and marginal sections. Hinge plate and teeth white; nymphs pale purple.

Remarks. The combination of broad posterior end with truncate margin, relatively weak oblique cords, smooth posterior slope, extensive fusion of lower limb of pallial sinus with pallial line, narrow reddish rays, purple flush in front of and behind white umbones, and clear internal glaze serve to distinguish *Gari pallida*. I could find very little variation in sculpture. Some specimens, particularly those from the Red Sea (form *weinkauffi*) (Figs 59,73), are narrower than those from east Africa or Asia (form *reevei*) (Figs 60,61,64,65). Colour varies between, but apparently not within, populations. Some specimens are richly coloured with red rays (form *reevei*) whereas others are very pale (form *pallida*).

In possessing coloured rays, *Gari pallida* is most like *G. anomala* Deshayes; indeed the two species have been confused by Lynge (1909), Habe (1958, 1964) and Okutani *et al.* (1989). As a juvenile, *G. anomala* is thicker and it has more numerous and coarser cords. As an adult, it is smaller, narrower posteriorly (however its posterior margin is more sharply truncate), it is more inflated, it has many more and finer oblique cords and dark-coloured umbones, and finally, at all stages of growth its pallial sinus is free from the pallial line for the greater part of its length. *Gari truncata* (Linné) is larger, thicker shelled, possesses a sharp ridge between the sculptural components, and it has strong concentric cords posteriorly. *Gari lessoni* Blainville, which was confused with *G. pallida* by E.A. Smith (1885), is larger, more ovate, thicker shelled, stronger toothed, never rayed, and there is a more distinct ridge marking off the posterior slope.

Habitat. Information accompanying museum specimens indicates *Gari pallida* inhabits a variety of sediment types: coarse sand; sand-shell-seagrass; mudflats. In Mozambique it is common on sandflats near *Thalassodendron* (R. Kilburn, personal communication, 1989). Judging by the large series in MNHN, ZMUC and WAM, *G. pallida* can attain high population densities.

Gari pallida is essentially a subtidal psammobiid with a depth range of 10 to 150 m and greatest abundance between 30 and 60 m.

Distribution. Despite doubts by earlier workers, it is now apparent that *Gari pallida* ranges from the tropical western Pacific (not east of New Caledonia) to the Indian Ocean and Red Sea. Literature records are as follows: New Guinea and Indonesia (Prashad, 1932); Japan (Habe, 1964); Philippine Islands (Reeve, 1856; Hidalgo, 1903); Ambon Island (E.A. Smith, 1885); Flores Island. (Martens, 1897); Kuwait, Persian Gulf (Glazyer *et al.*, 1984); Aden (Lamy, 1918); Suez (Bertin, 1880; Lamy, 1918); Red Sea (Deshayes, 1855; Bertin, 1880; Oliver, 1992); Zanzibar Island (Bertin, 1880); Madagascar (Bertin, 1880); South Africa (E.A. Smith, 1903; Barnard, 1964). Crosse's (1864) locality of Algeria has been accepted uncritically by several European authors recently (Nordsieck, 1969; Parenzan, 1976; Nicolay, 1979) despite

Bertin's (1880:115) refutation of its occurrence in the Mediterranean Sea. I found no authentic Mediterranean specimens in any of the European museums I visited in 1989, and R. von Cosel (personal communication, 1989) is strongly of the opinion the Algerian locality is incorrect. Therefore I firmly reject Crosse's locality. It is necessary to establish with certainty that *G. pallida* does not occur in the Mediterranean Sea at this time, because it could enter the eastern Mediterranean via the Suez canal in the future.

***Gari (Gari) anomala* (Deshayes, 1855)**

Figs 7, 8, 76-81

Psammobia anomala Deshayes, 1855: 320, no.15.—Reeve, 1857: *Psammobia* pl.1, species 5.—E.A. Smith, 1885: 95.—Hidalgo, 1903: 87, no.170.—Lynge, 1909: 116.—Hedley, 1910: 350.

Psammobia tenuis Deshayes, 1855 n.syn.: 320, no.16 and var. β .—Reeve, 1857: *Psammobia* pl.6, species 37b only.—Paetel, 1890: 41.—Hidalgo, 1903: 82, no.164.—Lynge, 1909: 211.

Gari anomala (Deshayes).—Tryon, 1868: 73, no.4.—Bertin, 1880: 110, no.37.—Whitelegge, 1889: 237, no.56.—Hedley, 1918a: M27, no.279.—Allan 1950: 342.—Habe, 1951: 203, 1958: 40, no.212.—Kuroda & Habe, 1952: 20.—Azuma, 1960: 88, no.1484.—Habe, 1961: 135, pl.5 fig.4.—Kuroda *et al.*: 1971: 442 (English part), pl.97 fig.13.—Habe, 1977: 219.—1981: 138, 139.—Slack-Smith, 1990: 137.

Gari tenuis (Deshayes).—Bertin, 1880: 110, no 30.

Psammobia (Gari) anomala Deshayes.—Paetel, 1890: 39.—Melvill & Standen, 1899: 198.

Gari (Gari) anomala (Deshayes).—Matsumoto, 1979: 109, no.1842.—Lamprell & Whitehead, 1992: 56, pl.52 fig.393.

Comments on synonymy. There appears to be nothing in Deshayes' original account or Reeve's (1857) subsequent illustration that might account for this species being deemed anomalous (ie, irregular or unusual) amongst psammobiids. Perhaps it is the sharply truncated posterior end? As noted later, the single most atypical conchological character possessed by this species is the separation of the lower limb of the pallial sinus from the pallial line for most of its length.

Deshayes (1855) gave the type locality for *Psammobia anomala* as Zebu (now Cebu), Philippine Islands, and therefore Reeve (1857) made a mistake only two years later in citing the type locality as "Brisbane Water, east of New Holland". Tryon (1868) repeated Reeve's incorrect Australian citation.

Psammobia tenuis Deshayes is a name based on juvenile shells that are so thin both Deshayes (1855) and Reeve (1857) overlooked their characteristic, oblique sculpture. Acting as first reviser, I select *P. anomala* Deshayes as the valid name for this species in preference to *P. tenuis* Deshayes because the former has numerical precedence on page 320 of Deshayes' (1855) original publication and because *P. tenuis* could be easily mistaken for *P. lessoni* Blainville.

Types. *Psammobia anomala* Deshayes: lectotype, here designated (figured syntype, complete specimen - 28.7 mm) in BMNH (1984290/1); figured by Reeve, 1857: *Psammobia* pl.1, species 5 (Fig.76). Paralectotypes (complete specimens - 23.9, 23.7, 21.0, 15.4 mm) in BMNH (1984290/2-5). Type

locality Zebu, Philippine Islands.

Psammobia tenuis Deshayes: lectotype, here designated (figured syntype, complete specimen apart from broken right valve - 23.8 mm plus broken fragment of left valve - 7.7 mm) in BMNH (1984291/1); figured by Reeve, 1857: pl.6, species 37b (Fig.77). Paralectotype (complete specimen - 25.0 mm) in BMNH (1984291/2). Type locality Philippine Islands.

Material examined. AUSTRALIA - QUEENSLAND: 1h, on beach near mangroves, west of Saibai Village, Saibai Island, Torres Strait (AMS C121653); 1c, 5-22 m, Cape York (BMNH 1887.2.9.2544); 6c, Cape York (WAM 1067-70); 1h, Wonga Beach, Trinity Bay (NTM); 3c, 1h, Dunk Island, east of Tully (QM); 2c, Cockle Bay, south-west coast Magnetic Island, Townsville (Willan coll.); 8c, Bowen (WAM 1066-70); 10c, Gloucester Island, Bowen (Whitehead coll.); 11c, Dingo Beach, Gloucester Passage, Bowen (Kessner coll.; Lamprell coll.; Whitehead coll.; Willan coll.); 5h, Shoal Point, north of Mackay (Willan coll.); 1h, Kinka Beach, Yeppoon (Willan coll.); 1c, off Gladstone (WAM 1064-70); 1c, mouth Boyne River, Gladstone (Whitehead coll.); 2c, Turkey Beach, Rodds Bay, south of Gladstone (Lamprell coll.; Willan coll.); 2h, 9 m, Platypus Bay, north-west Fraser Island (Willan coll.); 10c, 1.5-2 m, 1.2 km north of Newport Waterways, Deception Bay, Moreton Bay (Willan coll.); 3c, 9h, south-east Hope Banks, Moreton Bay (Willan coll.); 3h, 8 m, off north-eastern tip St Helena Island, Moreton Bay (coll. Willan); 6c, 10h, 6 m, Banana Bank, south-east Cleveland, Moreton Bay (Willan coll.); 5h, 6 m, south-east Peel Island, Moreton Bay (Willan coll.); 2c, 0.8 km south of Peel Island, Moreton Bay (QM Mo4974; Whitehead coll.); 2c, 9-11 m, near Dunwich, North Stradbroke Island, Moreton Bay (AMS C143433). WESTERN AUSTRALIA: 1c, Monkey Mia, Shark Bay (WAM N4657); 1c, 2h, North West Cape (WAM); 1h, "Onslow area" (AMS C90848); 1c, Back Beach, Dampier (WAM); 1h, north Maitland River, Dampier (WAM); 1c, Karratha, Nickol Bay (Trevor coll.); 2c, Pretty Pool, Port Hedland (Hansen coll.); 3c, 1h, 36-37 m, 96 km north-north-east of Port Hedland - 19°30.9'S 118°49.2'E (AMS C145718); 1h, Malcolm Island, Admiralty Gulf (WAM); 1c, Vansittart Bay, east of Cape Bougainville (AMS C77895). NORTHERN TERRITORY: 2c, Darwin (Lamprell coll.); 2c, Dudley Point, Darwin (AMS C143435); 1c, East Arm, Darwin (Kessner coll.); 1c, Lee Point, Darwin (Whitehead coll.); 1c, Tree Point, Darwin (Kessner coll.); 1h, Casuarina Beach, Darwin (NTM); 1c, Vashon Head, north-west of Cobourg Peninsula (WAM); 1h, 17 m, Orontes Reef, Port Essington, Cobourg Peninsula (Willan coll.); 1h, 4-5 m, upper reaches Coral Bay, Port Essington, Cobourg Peninsula (Willan coll.).

FIJI ISLANDS: 1c, 9-35 m, Nadi Bay - 16°57'S 178°47'E (AMS C149152). NEW CALEDONIA: 2c, Plum (MNHN). PHILIPPINE ISLANDS: 2c (BMNH 1984291/1,2 - lectotype & paralectotype of *Psammobia tenuis* Deshayes); 5c, Cebu Island (BMNH 1984290/1-5 - lectotype & paralectotypes of *P. anomala* Deshayes); 1h, Sulu Archipelago (WAM 1029-68).

Description. Maximum length 30 mm. Shell thin; elongate-ovate; maximum width at level of umbones; approximately equilateral, but large adult shells inequilateral as umbones become progressively displaced posteriorly; anterior end relatively narrowly rounded; ventral margin evenly convex, almost straight; posterior margin markedly truncate, perfectly straight, broader than anterior end; equivalve, both valves inflated; commissure at junction of ventral margins straight; very

small anterior and posterior gapes. Surface of both valves dull or weakly glossy; anterior and central areas sculptured with numerous, weak and microscopic, flat-topped, oblique cords, some concentric growth furrows present but no concentric growth striae; oblique cords number 48 per cm counting in from ventral margin transversely towards umbo of a 29 mm adult shell; towards ventral margin, cords become obscured by concentric furrows on adult shells; oblique cords stop in front of distinct posterior ridge; posterior slope of both valves smooth. Periostracum very thin, pale straw-brown.

Hinge plate narrow; nymph moderately long, very narrow, barely raised above dorsal margin behind umbo. Right valve with 2 cardinal teeth, diverging by 60° from each other; anterior one stronger, shaped like an isosceles triangle, apex weakly bifid, directed obliquely forward; rear one weaker, very deeply bifid, directed obliquely backward. Left valve with a strong, deeply bifid, vertically-directed anterior cardinal tooth and a weak rear one - merely a low lamella that diverges by 60° behind anterior cardinal. Muscle scars and pallial line weakly impressed, difficult to observe; pallial sinus deep (extends level with umbo), broad; upper limb and anterior margin evenly curved; lower limb long, runs obliquely to pallial line, joins pallial line near its termination (ie, lower limb free from pallial line for most of its length); ventral extremity of pallial line directed straight back, extends level with middle of posterior adductor scar. Pedal retractor scar present a short distance in front of hinge plate.

Colour of exterior variable - orange, peach, pinkish red or livid purple, always darker near umbones, often patterned with indistinct, narrow rays that emanate from, and are the same colour as, umbones. Interior reflects colouration of exterior, often clear-glazed. Teeth white; hinge plate and (especially) nymphs with brownish purple streaks.

Remarks. *Gari anomala* is a distinctive psammobiid on account of the posterior displacement of the umbones in large adults, the sharply truncate posterior margin appearing as though the shell had been cut with a knife, the inflation of the valves, small gapes, sculpture of weak, flat, oblique cords anteriorly and centrally, smooth posterior slope, distinct posterior ridge, narrow nymphs, weak right rear cardinal, separation of the lower limb of the pallial sinus from the pallial line for most of its length (Fig.8), and colouration.

The only anomalous character is that of the pallial sinus just mentioned. No other member of the subgenus *Gari* has the lower limb free for most of its length. The significance of this plesiomorphy has been discussed in the introductory section to this monograph under shell characters.

Gari anomala is closest to *G. pallida* and features distinguishing them have already been given. *Gari anomala* could be mistaken for *G. modesta* (Deshayes) and both do occur sympatrically in southern Queensland, but *G. modesta* is more elongate, its posterior margin is rounded, the posterior slope bears concentric lamellae and it is less inflated. Another species like *G. anomala*

is *G. lessoni* (Blainville), but that species is larger, flatter, not so truncate posteriorly, more coarsely corded and never rayed. Some specimens of *G. maculosa* (Lamarck) are reminiscent of *G. anomala*, especially those with suppressed oblique cords and obsolete lamellae on the posterior slope; however *G. maculosa* is consistently heavier, broader, less acute at the posterior end, it is never completely smooth on the posterior slope, and it always has some pale maculations on the exterior.

Habitat. *Gari anomala* inhabits fine sandy substrates, often muds. Throughout Queensland *G. anomala* occurs sympatrically with, but is rarer than, *G. lessoni*.

Although *Gari anomala* has a bathymetric range of 0 to 35 m, it is commonest within the uppermost 10 m.

Distribution. Relatively restricted for a tropical psammobiid. Like *Gari lessoni*, *G. anomala* is confined to continental coasts, and also like that species it does not reach the western Indian Ocean. *Gari anomala* extends throughout the western Pacific and eastern Indian Oceans, ranging from the Philippine Islands (Deshayes, 1855), to Papua New Guinea and Queensland (E.A. Smith, 1885; Hedley, 1910) in the Pacific, and in the Indian Ocean from Thailand (Lyngge, 1909), through the Sumbawa and Flores Island (Prashad, 1932) to northern Western Australia. I have not examined any authentic specimens from Japan or Hong Kong and conclude all references to this species from those locations (eg, Kuroda *et al.*, 1971) are based on misidentified *G. pallida* Deshayes.

Gari (Gari) modesta (Deshayes, 1855)

Figs 82-93, 383

- Psammobia modesta* Deshayes, 1855: 319, no.10.—Reeve, 1856: *Psammobia* pl.1, species 3.—E.A. Smith, 1884: 98, 1885 : 95.—Hedley, 1910 : 350.
- Psammobia menkeana* Deshayes, 1855: 319, no.12.—Reeve, 1857: *Psammobia* pl.6, species 43.—Macpherson & Chapple, 1951: 153.
- Psammobia angusta* Deshayes, 1855: 320, no.13.—Reeve, 1857: *Psammobia* pl.6, species 44.
- Psammobia (Psammobella) modesta* Deshayes.—Chenu, 1862: 64 fig.264.—Paetel, 1890 : 40.
- Gari (Amphichaena) angusta* (Deshayes).—Tryon, 1868: 77, no.62.
- Gari (Amphichaena) menkeana* (Deshayes).—Tryon, 1868: 77, no.66.—Angas, 1867: 918, no.39.
- Gari (Amphichaena) modesta* (Deshayes).—Tryon, 1868: 77, no.67.
- Gari menkeana* (Deshayes).—Bertin, 1880: 127, no.83.—Hedley, 1918a: M28, no.282.—Macpherson & Gabriel, 1962: 373.
- Gari modesta* (Deshayes).—Bertin, 1880: 127, no.84.—Whitelegge, 1889: 237, no.57.—Allan, 1950 : 342, fig.80, no.6.
- Psammobia aequalis* Tate, 1885 n.syn.: 4, 1887b: 168, pl.16 fig.10.
- Psammobia (Psammobella) menkeana* Deshayes.—Paetel, 1890: 40.
- Milligaretta venta* Iredale, 1936 n.syn.: 282, pl.21 fig.8.—Iredale

& McMichael, 1962: 25, no.417.

Psammobia temperata Cotton & Godfrey, 1938 n.syn.: 263 fig.298.

Gari temperata (Cotton & Godfrey).—Cotton, 1961: 279, fig.307.

Milligaretta menkeana (Deshayes).—Iredale & McMichael, 1962: 25, no.418.

Milligaretta modesta (Deshayes).—Iredale & McMichael, 1962: 25, no.419.

Gari aequalis (Tate).—Darragh, 1970: 129.

Gari (Gari) modesta (Deshayes).—Lamprell & Whitehead, 1992: 56, pl.52 fig.392.

Comments on synonymy. E.A. Smith (1885) was the first to synonymise *Psammobia modesta*, *P. menkeana* and *P. angusta* (all of Deshayes, 1855), his decision being based on Deshayes' original material and Reeve's illustrations in *Conchologia Iconica*. Smith realised the broadness of the figured syntype of *P. modesta* was an artist's error and the narrowness of the figured syntype of *P. angusta* was, in fact, due to the specimen's ventral margin being broken (verified by my own observations). Clearly, Smith (1885:95) acted as first reviser, and selected *P. modesta* in preference to *P. menkeana* or *P. angusta* as the name for this particular species. Although Whitelegge (1889) followed Smith, Australian authors have been more reluctant to do so. Several Australian authors have intimated *P. modesta* and *P. menkeana* might be the same species, but maintained them as distinct (Cotton & Godfrey, 1938; Allan, 1950; Cotton, 1961). Iredale's (1936) new genus and species were, as explained earlier under *Gari lessoni*, unwarranted. Cotton & Godfrey's (1938) *Psammobia temperata* was only separated from *P. modesta* and *P. menkeana* because it came from South Australia. Having examined much material, I have no doubt that all five names (*P. modesta* Deshayes, *P. menkeana* Deshayes, *P. angusta* Deshayes, *Milligaretta venta* Iredale and *P. temperata* Cotton & Godfrey) relate to the same species.

Psammobia aequalis Tate is a junior synonym based on fossil shells from the upper beds of the Grange Burn Formation at Muddy Creek, Victoria. Tate (1885, 1887b) distinguished *P. aequalis* solely from the sympatric *P. livida* (as *P. hamiltonensis* Tate) only by the absence of a posterior ridge. Tate's illustration (1887b:pl.16 fig.10) is inaccurate as regards the figured syntype because it shows too marked an angle at the intersection of the posterodorsal and ventral margins. I have designated this shell (Fig.85) as lectotype in order to fix *P. aequalis* as an objective synonym of *P. modesta* because two of the other syntypes (T1189D,G) are juvenile *Gari kenyoniana* Pritchard & Gatliff. Although the tablet supporting the syntypes of *P. aequalis* has Eocene written on it, the upper strata of the Grange Burn formation are now known to be Middle Pliocene (Kalimnan) in age (Spencer-Jones, 1971:247; Abele *et al.*, 1988:289; B. McHenry, personal communication, 1990).

Types. *Psammobia modesta* Deshayes: lectotype, here designated (figured syntype, complete specimen - 27.8 mm) in BMNH (1984285/1); figured by Reeve, 1857: *Psammobia* pl.1, species 3 (Fig.82). Paralectotype (complete specimen - 22.9 mm) in BMNH (1984285/2). Type locality Moreton Bay, Queensland.

Psammobia menkeana Deshayes: lectotype, here designated (figured syntype, complete specimen - 21.2 mm) in BMNH (1984287/1); figured by Reeve, 1857: *Psammobia* pl.6, species 43 (Fig.83). Paralectotypes (complete specimens - 21.0, 20.3 mm) in BMNH (1984287/2, 1984287/3 respectively). Type

locality east coast of Australia.

Psammobia angusta Deshayes: lectotype, here designated (figured syntype, single left valve - 19.6 mm) in BMNH (1984288/1); figured by Reeve, 1857: *Psammobia* pl.6, species 44 (Fig.84). Paralectotype (complete specimen - 19.5 mm) in BMNH (1984288/2). Type locality Senegal.

Psammobia aequalis Tate: lectotype, here designated (probable figured syntype, single right valve - 19.6 mm) in SAM (T1189B); figured (as a left valve) by Tate, 1887b, pl.16 fig.10 (Fig.85). Paralectotypic series (1 complete specimen, 4 right valves and 5 left valves) in SAM (T1189A,C,D,F,H,J,K,L,M). Additional paralectotypes (single valves of *Psammobia kenyoniana* Pritchard & Gatliff - 23.5, 17.0 mm in SAM (T1189D,G respectively)). Type locality Muddy Creek, Hamilton, Victoria.

Milligaretta venta Iredale: holotype (complete specimen - 28.6 mm) in AMS (C60624) (Fig.86). Type locality Sydney Harbour, New South Wales.

Psammobia temperata Cotton & Godfrey: holotype (19.9 mm) in SAM (D12857) (Fig.87). Type locality Black Point, Yorke Peninsula, South Australia.

Material examined. "EAST COAST OF AUSTRALIA": 3c (BMNH 1984287/1-3 - lectotype & paralectotypes of *Psammobia menkeana* Deshayes). "SENEGAL" (= error pro. eastern Australia): 2c (BMNH 1984288/1,2 - lectotype & paralectotype of *P. angusta* Deshayes).

AUSTRALIA - QUEENSLAND: 19h, 46-73 m, 3 km north-east off the west side of Gillett Cay, Swain Reefs - 21°41'S 152°24'E (AMS C149138 in part); 1c,36h, 31-37 m, off Masthead Island, Capricorn Group - 23°32'S 151°45'E (AMS C19103); 2h, dredged, Lady Musgrave Island, Bunker Group (AMS C116320); 1h, Burnett Heads, Hervey Bay (Willan coll.); 2c, off Woody Island, Hervey Bay (Lamprell coll.); 1h, 9 m, Platypus Bay, north-west coast Fraser Island (Willan coll.); 1h, 47.5 m, east Fraser Island - 25°27'S 153°17'E (Willan coll.); 1h, 73 m, south Fraser Island - 25°48'S 153°46'E (AMS C143434); 3h, 56 m, off Tin Can Bay - 26°09.5'S 153°18.5'E (AMS C149142); 1h, 37 m, Beaumont Bank, east-south-east Noosa Heads - 26°32'S 152°32'E (AMS C92144); 1h, 24 m, Outer Gneering Shoals, east of Mooloolaba (Willan coll.); 1h, Kings Beach, Caloundra (Willan coll.); 3h, Caloundra (AMS C12837); 1h, east side Bribie Island (Willan coll.); 1h, 12-15 m, Flinders Reef, north of Cape Moreton (Willan coll.); 2c, Moreton Bay (BMNH 1984285/1,2 - lectotype & paralectotype of *P. modesta* Deshayes); 5c,9h, 4-10 m, off Tangalooma, Moreton Bay (Willan coll.); 1c,4h, 4.5-6 m, off Amity Point, Moreton Bay (Willan coll.); 1h, 4.5-6 m, Rous Channel, Moreton Bay (Willan coll.); 16c,10h, 6 m, south-east Peel Island, Moreton Bay (Willan coll.); 2h, 7 m, off Myora, North Stradbroke Island, Moreton Bay (Willan coll.); 1c,1h, 9-12 m, Shag Rocks, north-west Point Lookout, North Stradbroke Island (Willan coll.); 1h, beach at south end The Esplanade, Burleigh Heads (Willan coll.); 1h, beach on south side of Tallebudgera Creek, Burleigh Heads (Willan coll.); 93h, 19-28 m, approximately 2 km off Tugun Beach (Willan coll.). NEW SOUTH WALES: 31c,27h, 8-18 m, Fly Point, Port Stephens (Willan coll.); 74c,100h, 9-14 m, west end Nelson Bay, Port Stephens (Willan coll.); 4h, Palm Beach, Broken Bay (WAM 1060-70); 1h, Collaroy Beach, north of Sydney (WAM 1059-70); 8h, Manly Beach, north of Sydney (AIM AM24431; AMS C143436); 6c,3h, Port Jackson (BMNH 1881.11.10.179, 1887.2.9.2551; MNHN; NHMW 35651; QM); 8c, 4-18 m, Port Jackson (BMNH 1887.2.9.2545-50); 1c, Sydney Harbour, Port Jackson (AMS C60624 - holotype of *Milligaretta venta* Iredale); 2h, Sydney Harbour, Port Jackson (ZMUC); 7h, off

Chinamans Beach, Port Jackson (WAM 1058-70); series, off Sow and Pigs Reef, Port Jackson (QM); 1c, 73 m, off Botany Bay (AMS C143431); 2h, Cronulla Beach (Willan coll.); 1c, 21h, 12-14 m, Ship Rock, north side Port Hacking (Willan coll.); 15h, Bundeena, Port Hacking (WAM 1057-70); 1h, 205 m, Port Hacking - 34°09.6'S 151°26.3'E (AMS); 2c, Shellharbour (NHMW 56.288); series, 13-18 m, off Montague Island (AMS C40716). VICTORIA: series, off Lakes Entrance (MNV); 4c, 59 m, south Waratah Bay, east Bass Strait - 39°00'S 146°10.1'E (NMV); 2h, 64 m, south Waratah Bay, east Bass Strait - 38°59.9'S 146°00'E (NMV); series, 91 m, south Point Hicks, east Bass Strait - 37°52'S 149°18.4'E (NMV); 1c, Western Port (NMV); series, Portsea, Port Phillip Bay (NMV); series, 14.5 m, Point Cook, Port Phillip Bay (NMV); 1c, 10h, upper beds, Grange Burn Formation, Muddy Creek, west of Hamilton (SAM T1189A,B,C,E,F,H,J,K,L,M - lectotype & paralectotypes of *P. aequalis* Tate). TASMANIA: 2c, George Bay (BMNH 1893.3.2.232-3). SOUTH AUSTRALIA: 1c, Gulf St Vincent (NMV 5795); 1h, Aldinga Bay, north coast Fleurieu Peninsula (NMV); 1c, 7.5 m, off Black Point, Whyalla, Spencer Gulf (SAM D12857 - holotype of *P. temperata* Cotton & Godfrey). WESTERN AUSTRALIA: 1h, Dunsborough, Geographe Bay (WAM N1195); 2h, off Leighton Beach, north of Fremantle (WAM N1961); 1h, 146-156 m, south-west Rottnest Island (WAM 1153-68); 4h, 137 m, off west end Rottnest Island (WAM N4811; 1323-68); 3h, 146-164 m, west-north-west Rottnest Island (WAM N4380); 2h, 119 m, north-north-west Rottnest Island (WAM N4444); 5h, 146 m, west Guilderton (WAM); 1h, 128-132 m, south-west Dongara (WAM 1305-68); 1h, 128 m, north-west Bluff Point, Geraldton (WAM 1293-68).

Description. Maximum length 27 mm, but 18-24 mm is more usual for adults. Shell moderately solid; elongate or elongate-ovate; maximum width at level of umbones; umbones approximately central on dorsal margin in both juveniles and adults; anterior end rounded; ventral margin straight or weakly convex; posterior end usually broadly rounded (broader than anterior end), rarely truncate or subtruncate, never subacute; equivalve, both valves moderately inflated; commissure at junction of shells' ventral margins straight; small anterior and posterior gapes. Surface of both valves glossy when fresh, but usually dull; anterior and central areas of both valves bear numerous, weak, flat-topped, oblique cords about equal in strength to the concentric growth striae they intersect, cords number 42 per cm counting in from ventral margin transversely towards umbo of a 20.3 mm adult shell; cords become obsolete in vicinity of posterior ridge on both valves, and there on right valve concentric striae usually strengthen to become raised and lamellate; concentric lamellae occupying entire posterior slope of right valve; posterior slope of left valve with occasional, weak, concentric raised lamellae, but never as numerous nor as strong as on right valve; region anterior to posterior slope (ie, between there and end of oblique cords) on left valve always smooth. Periostracum thin, rusty brown, almost always lost (even in live specimens).

Hinge plate narrow; nymph narrow, relatively short. Right valve with 2 equally strong cardinal teeth, diverging by 70° from each other; anterior one weakly bifid, directed obliquely forward; rear one triangular, deeply bifid, directed obliquely backward. Left valve with a strong, triangular, deeply bifid, ventrally directed anterior

cardinal tooth and a small, sharp, rear cardinal that diverges at 60° behind anterior one. Pallial sinus relatively deep (extends almost level with rear end of anterior adductor scar well in front of umbones), moderately narrow; upper limb descends obliquely straight across middle of shell; anterior margin narrowly rounded, almost acute; lower limb joins pallial line almost immediately, (ie, lower limb is confluent with pallial line for most of its length); ventral extremity of pallial line directed straight backward, extends level with rear end of posterior adductor scar. Pedal retractor scar present immediately in front of, sometimes just beneath, anterior end of hinge plate.

Colour of exterior pale livid pinkish purple or bluish violet, occasionally creamish or pale orange; usually with narrow, reddish brown rays emanating from white umbones. Interior pinkish, purplish or violet, usually uniformly coloured, sometimes with rays visible near margins; clear-glazed. Teeth white; hinge plate and nymphs purple.

Remarks. *Gari modesta* could be mistaken for a juvenile of some other Australian *Gari* species because of its small adult size, but it does possess several distinctive characters that always allow its identification, these are: its equivalve and moderately solid shell; moderate inflation; typical sculpture (of weak, flat, oblique cords anteriorly (Figs 82,86,88,89), strongly raised lamellae on the posterior slope of the right valve (Figs 87-89), and smooth zone between the termination of the oblique cords and posterior slope on the left valve (Figs 84,90,93); distinctive deep, rather narrow pallial sinus; pale purplish colouration with narrow, darker rays.

Gari modesta varies intraspecifically in shape, sculpture and colouration. In part, this variation is clinal with all three characters concordant, ie, populations in Western Australia, South Australia and Victoria tend to have thinner, paler, less sculptured shells with subtruncate or truncate posterior ends and weak rays or none at all (Figs 87,91); whereas populations from southern Queensland tend to have thicker and more sculptured shells (especially as regards the lamellae on the posterior slope) with rounded posterior ends and distinct radial markings (Fig.93). However, shells from New South Wales (Figs 86,92) clearly show an intergradation of characters. Specimens from all deep water (ie, greater than 20 m) populations always possess the characteristics of southern forms.

Gari modesta could be confused most easily with immature *G. livida* (Lamarck), however juveniles of that species are much more fragile, longer, narrower, inequivalve, without oblique cords anteriorly, and the lamellae on the right valve terminate very abruptly at the posterior ridge. In southern Australia, *G. modesta* occurs sympatrically with *G. kenyoniana* (Pritchard & Gatliff). Juveniles of that species are longer, narrower, inequivalve, and possess more numerous and finer concentric cords that continue onto the posterior slope as raised lamellae. In eastern Australia, *G. modesta*

occurs sympatrically with *G. lessoni* from the tropic of Capricorn to Sydney; however, juveniles of *G. lessoni* are thinner, flatter, broader (especially posteriorly), more glossy, have a thicker periostracum and much stronger oblique cords, a relatively shallower yet broader pallial sinus, and they are never rayed.

Habitat. *Gari modesta* inhabits areas where there is considerable water flow such as scour channels and harbour mouths. The substrate is usually well-sorted coarse sand or grit, sometimes with mud. The localities at which I have observed most specimens were in the entrance channels to Port Stephens and Port Hacking in New South Wales. Other bivalves that occur in the same habitat, at least in eastern Australia, are *Solen intermedius* Koch, *Chlamys livida* (Lamarck) and *Limatula strangei* (G.B. Sowerby II). *G. sibogai* Prasad was taken with *G. modesta* at the Swain Reefs.

Gari modesta is strictly a subtidal psammobiid, with a known depth range from 4 to 205 m, ie, across the entire continental shelf.

Distribution. *Gari modesta* is endemic to Australia and also the only temperate water species of the subgenus *Gari* in Australasia. It extends from the southern Great Barrier Reef (Swain Reefs and Capricorn Group), around the eastern and southern coasts of the Australian continent to at least Geraldton in Western Australia. Several other Australian molluscs are also long-ranging endemics: *Donax deltooides* Lamarck; *Eumarcia fumigata* (G.B. Sowerby II); *Tyrodina corticalis* (Tate); *Cellana tramoserica* (Holten); *Cancellaria undulata* G.B. Sowerby I.

The record of *Gari modesta* from the Persian Gulf by Melvill & Standen (1906:841) is clearly erroneous, being based on a misidentification.

Gari (Gari) maculosa (Lamarck, 1818)

Figs 10, 94-112, 384

Gari maculosa is common and widespread throughout the tropical Indo-Pacific Ocean, and it has appeared very often in the literature. Therefore I list below only the names of the primary synonyms in the combinations in which they were first published instead of giving a full synonymy.

Tellina scabra striis divergentibus, var *Tellina Gari* Chemnitz, 1782: 102, pl.10 fig.94 (not binomial) [See ICZN, 1944 Opinion 184.]

Tellina scabra Schröter, 1788: 103 (work not binomial).

Tellina gari var. β Gmelin, 1791: 3230.

Unnamed figure by Bruguière, 1797, pl.228 fig.2.

Tellina gari vars c and d Spengler, 1798: 72,73.

Psammobia maculosa Lamarck, 1818: 513, *Psammobia* species 5 and var. (b).

Psammobia maculata (sic = error pro. *maculosa*) Lamarck.—Blainville, 1826: 478.

Psammobia tongana Quoy & Gaimard, 1835 n.syn.: 539, pl.83 figs 13, 14.

Psammobia praestans Deshayes, 1855 n.syn.: 323, no.25 and vars β and τ .

Psammobia layardi Deshayes, 1855 n.syn.: 323, no.26.

Psammobia ornata Deshayes, 1855: 323, no.27 and var. β .

Psammobia rubicunda Deshayes, 1855: 324, no.30 and var. β .

Psammobia corrugata Deshayes, 1855: 324, no.31 and var. β .

Psammobia marmorea Deshayes, 1855: 324, no.32 and vars β and τ .

Psammobia scabra ["Chemnitz"] Martens, 1897: 248-250.

Psammobia obtusa Preston, 1908 n.syn.: 208, pl.16 fig.41.

Psammobia scabra ["Chemnitz"] Lynge, 1909: 210.

Comments on synonymy. Chemnitz (1782:102) initially used the Latin sentence *Tellina scabra striis divergentibus*, var *Tellina Gari* to diagnose this species. Later however, Chemnitz (1795:208) used only the first two words of this sentence, *Tellina scabra*, as a binomen for an entirely different species (a member of the Lucinidae). Chemnitz' (1782) *Conchylien Cabinet* has been ruled as not binomial (ICZN, 1944: Opinion 184), and Schröter's (1788:103) subsequent listing of the binomen *Tellina scabra* according to Chemnitz' first usage is therefore also unavailable for the same reason (Prasad, 1932:3; Willan *et al.*, in press). By attributing *Tellina scabra* to Chemnitz, Martens (1897:248) and Lynge (1909:114) validated the name with themselves as authors. *Psammobia* (or *Gari*) *scabra* auctt., however, has not been employed for this species by any other author.

Prasad (1932) has already presented a comprehensive synonymy for *Gari maculosa* containing a total of 80 entries and encompassing all but four of the names listed above. Essentially his was an expanded version of that suggested by Dautzenberg & Fischer in 1914 and containing four junior synonyms of *Psammobia maculosa*. Three of these synonyms, *P. ornata* Deshayes, *P. rubicunda* Deshayes and *P. marmorea* Deshayes, were based simply on different coloured shells and the fourth, *P. corrugata* Deshayes, was based on an unusual, strongly corded shell.

The four new primary synonyms added by me are *Psammobia tongana* Quoy & Gaimard, *P. praestans* Deshayes, *P. layardi* Deshayes and *P. obtusa* Preston. Examination of the two syntypes of *P. tongana* leaves me in no doubt that species is conspecific with *P. maculosa*. Matsukuma (1989:110) has foreshadowed this synonymy. [Incidentally, the date of publication of *P. tongana* was 1835, since that name was introduced in the second part (consisting of pages 369 to 954) of Quoy & Gaimard's third volume.] *Psammobia praestans* was briefly described by Deshayes and two varieties (β and τ) were distinguished on colour, the former being violet-black and the latter rose-purple. Reeve (1856: *Psammobia* pl.3, species 16) repeated the bulk of Deshayes' description and gave a fine figure. I have examined one specimen from the Solomon Islands (Fig.111) that is a perfect match with the figured syntype; *P. praestans* is therefore undoubtedly a dark violet colour form of *P. maculosa*. An illustration of (the holotype of) *P. layardi* was given by Reeve (1857); that figure depicts an elongate shell with posterior truncation, colour pattern of maculated dark rays, fine oblique cords anteriorly and decussate sculpture on the posterior slope. All these characters are possessed by *P. maculosa* and, in fact, I have found specimens in the AMS (C11417, C14322, C143430) that match Deshayes' holotype and Reeve's figure closely. Therefore I have no hesitation in relegating *P. layardi* into synonymy with *P. maculosa* on the basis that *P. layardi* is only based on a finely sculptured shell. *Psammobia obtusa* Preston is based on a mauve specimen from the Andaman Islands.

Barnard (1964) tentatively listed *Psammobia albanyana*

Turton as a synonym of *P. maculosa*, but I agree with Kilburn (1971; personal communication, 1989) that *P. albanyana* is based on a juvenile *Gari depressa* (Pennant).

Types. *Tellina scabra* ... Chemnitz (= *Tellina gari* var. c Spengler): type material originally in Chemnitz' own collection; probable specimen figured by Chemnitz, 1782: pl.10 fig.94 (complete specimen - 35.3 mm) in ZMUC (Fig.94). Type locality Nicobar Islands.

Tellina gari, var. d Spengler: two complete specimens (26.9, 26.4 mm) in Spengler coll., ZMUC. Type locality Nicobar Islands.

Psammobia maculosa Lamarck: lectotype, here designated (smallest syntype, complete specimen - 45.0 mm) in MNHN (M4 R1077); illustrated by Dautzenberg & Fischer, 1914: pl.6 fig.3 (Fig.95). Paralectotype (complete specimen - 48.7 mm) in MNHN (M4 R1077); illustrated by Dautzenberg & Fischer, 1914: pl.6 figs 1,2. Additional paralectotype (complete specimen - 46.5 mm) in MHNG (1083/15/2); figured by Bruguière, 1797: pl.228 fig.2 (Fig.96). Type locality Indian Ocean.

Psammobia maculosa Lamarck var. (b): complete specimen - 50 mm in MHNG (1083/15/1). Type locality Indian Ocean.

Psammobia tongana Quoy & Gaimard: lectotype, here designated (figured syntype, complete specimen - 45.8 mm) in MNHN; figured by Quoy & Gaimard, 1835: pl.83 figs 13, 14 (Fig.97). Paralectotype (complete specimen - 43.5 mm) in MNHN. Type locality Tonga-Tabou Island.

Psammobia praestans Deshayes: lectotype, here designated (figured syntype, complete specimen - 50.5 mm) in BMNH (196416); figured by Reeve, 1856: *Psammobia* pl.3, species 16 (Fig.98). Type locality Moluccas Islands.

Psammobia praestans Deshayes var. β: material not found during personal search in BMNH in 1989. Type locality Moluccas Islands.

Psammobia praestans Deshayes var. τ: material not found during personal search in BMNH in 1989. Type locality Moluccas Islands.

Psammobia layardi Deshayes: holotype (complete specimen - 31.0 mm) in BMNH (196422); figured by Reeve, 1857: *Psammobia* pl.6, species 45 (Fig.99). Type locality Philippine Islands.

Psammobia ornata Deshayes: lectotype, here designated (figured syntype, complete specimen - 46.8 mm) in BMNH (196423); figured by Reeve, 1856: *Psammobia* pl.4, species 26a (Fig.100). Paralectotypes (complete specimens - 42.2, 38.8 mm) in BMNH (196424/1,2). Type locality Ticao Island, Philippine Islands.

Psammobia ornata Deshayes: var. β: complete specimen - 47.9 mm in BMNH (196425); figured by Reeve, 1856: *Psammobia* pl.4, species 26b. Type locality Ticao Island, Philippine Islands.

Psammobia rubicunda Deshayes: lectotype, here designated (figured syntype, complete specimen - 46.3 mm) in BMNH (1964299/1); figured by Reeve, 1856: *Psammobia* pl.5, species 34 (Fig.101). Paralectotype (complete specimen - 44.5 mm) in BMNH (1984299/2). Type locality Ticao Island, Philippine Islands.

Psammobia rubicunda Deshayes var. β: two complete specimens - 50.1, 47.0 mm in BMNH (1984299/3,4). Type locality Ticao Island, Philippine Islands.

Psammobia corrugata Deshayes: holotype (complete specimen - 46.5 mm) in BMNH (1964013); figured by Reeve, 1856: *Psammobia* pl.2, species 9 (Fig.102). Type locality Zebu Island, Philippine Islands.

Psammobia corrugata Deshayes var. β: material not found

during personal search in BMNH in 1989. Type locality Zebu Island, Philippine Islands.

Psammobia marmorea Deshayes: holotype (complete specimen - 39.1 mm) in BMNH (1846.9.16.112) (Fig.103). Type locality Moluccas Islands.

Psammobia marmorea Deshayes var. β: material mentioned from Moluccas (complete specimens - 53.6, 41.7, 40.8 mm) in BMNH (196447, 196448/1,2); largest specimen figured by Reeve, 1856: *Psammobia* pl.4, species 27. Type locality Darnley Island, New Holland and Moluccas Islands.

Psammobia obtusa Preston: holotype (complete specimen - 42.2 mm) in ZSI (M22856/4); figured by Preston, 1908: pl.16 fig.41 (Fig.104). Type locality Andaman Islands.

Material examined. AUSTRALIA – QUEENSLAND: 2h, 18 m, 16 km, south-west Mapoon, Gulf of Carpentaria (AMS C11417); 3h, 4.5 m, Watsons Beach, north-west side Lizard Island (Willan coll.); 1h, 9-10.5 m, off north-west coast Lizard Island (Willan coll.); 1h, 4-5.5 m, Palfrey Island, off Lizard Island (Willan coll.); 1c, Mackay Reef, off Cape Tribulation (Whitehead coll.); 1c, off Batt Reef, north of Cairns (WAM 1077-70); 1h, Wonga Beach, Trinity Bay (NTM); 3c, Great Barrier Reef, off Cairns (Lamprell coll.; Whitehead coll.); 1c, Dunk Island, east of Tully (QM); 2c, Dingo Beach, Gloucester Passage, Bowen (Lamprell coll.); 1c, Gloucester Island, Bowen (Whitehead coll.); 3c, Hayman Island, Whitsunday Group (MNHN; Whitehead coll.); 2c, Black Island, Whitsunday Group (NMV); 1c, Langford Island, Whitsunday Group (Kessner coll.); 1c, off Palm Island, Palm Isles Group (Lamprell coll.); 1h, 10 m, reef no.21-128, Swain Reefs - 21°22'S 151°41'E (AMS); 1c, 3-8 m, Mystery Reef, Swain Reefs - 21°23'S 152°01'E (AMS); 1c, 1h, Swain Reefs (Lamprell coll.; Hansen coll.); 4c, 4h, 6-13.5 m, north side Heron Island, Capricorn Group (Willan coll.); 2h, 15 m, south side Heron Island, Capricorn Group (Willan coll.); 12c, 24h, 26-35 m, north-east side Wistari Reef, Capricorn Group (Willan coll.); 1h, North West Island, Capricorn Group (WAM 1078-70); 2c, off Pancake Creek, Bustard Bay, south Gladstone (Lamprell coll.); WAM 1076-70); 1c, 3h, 17-20 m, north-east Outer Gneering Shoals, east of Mooloolaba (Willan coll.); 1c, 8-10 m, Inner Gneering Shoals, north-east of Mooloolaba (Willan coll.); 1c, 20-24 m, Smith Reef, north Cape Moreton (Willan coll.); 2h, 27 m, Hutchinson Shoal, north Cape Moreton (Willan coll.); 1c, 2h, 10-12 m, north-west side Flinders Reef, Cape Moreton (Willan coll.); 7c, 11h, 6-12 m, Shag Rocks, north-west Point Lookout, North Stradbroke Island (Willan coll.); 1c, 1h, 6 m, south-east Peel Island, Moreton Bay (Willan coll.). NEW SOUTH WALES: 1c, 18 m, North Solitary Island, north off Coffs Harbour (Tarrant coll.). WESTERN AUSTRALIA: 1c, Pelican Island, Shark Bay (AMS C143430); 1h, 3.5-7.5 m, off south-east end Dirk Hartog Island, Shark Bay (WAM); 3c, 4h, 18.5 m, off west and south-west sides Peak Island, near Onslow (WAM); 1h, 51 m, 11.3 km, north Long Island, Onslow (WAM); 1h, 2-3 m, off Hermite Island, Monte Bello Islands (WAM); 1c, on beach, Rosemary Island, Dampier Archipelago (WAM 1727-68); 1c, 9.5 m, Rosemary Island, Dampier Archipelago (WAM 1793-68); 1c, 42 m, 32.2 km north of Delambre Island, Dampier Archipelago (WAM); 2h, 38-40 m, 80 km north-north-east off Port Hedland - 19°30'S 118°52'E (AMS); 1h, 40 m, 83 km north-west off Port Hedland - 19°55.2'S 118°55'E (AMS). NORTHERN TERRITORY: 4h, 17 m, Orontes Reef, Port Essington, Cobourge Peninsula (Willan coll.); 2h, Smith Point, Cobourge Peninsula (AMS C143432).

WESTERN SAMOA: 1c, 2 m, Sogi, Apia (AIM). TONGA: 2c, "Ile-de Tonga-Tabou" (MNHN - lectotype & paralectotype of *Psammobia tongana* Quoy & Gaimard); 1h, 9 m, Lifuka Island

(NMNZ MF23117). Niue Island: 1h (NMNZ MF22383). Fiji Islands: 1c, Nananu-i-Ra Island, north off Viti Levu Island (AIM). NEW CALEDONIA: 8c, 1h (WAM 3686-67); 1c, Anse Vata Beach, Nouméa (WAM 1836-68); 1c, Ilot Cesar, near Anse Vata Beach, Nouméa (AMS C143437); 2c, Baie des Citrons, Nouméa (WAM 1835-68); 1c, Touho (WAM 1079-70); 1c, 42 m, north-east Pam - 20°13'S 164°18'E (MNHN); 1h, 80 m, south New Caledonia - 22°17'S 167°05'E (MNHN). CORAL SEA: 1h, 52 m, Chesterfield Plateau - 19°25'S 158°32'E (MNHN); 4h, 50 m, Chesterfield Plateau - 19°28'S 158°23'E (MNHN); 1h, 32 m, Chesterfield Plateau - 19°34'S 158°15'E (MNHN). SOLOMON ISLANDS: 1c (Lamprell coll.); 1c, Guadalcanal Island (Whitehead coll.); 1c, Marau Sound, Maraunibina Island (Coles coll.); PAPUA NEW GUINEA: 1c, Biliau Island, near Madang (WAM); 1h, 6 m, "Cement Mixer Reef", south end Ruo Island, Madang (Willan coll.). Japan: 3c, off Kashiwajima, Tosa Province (NMNZ MF19056; Whitehead coll.); 1c, 49 m, Skalburd - 33°51'N 130°03'W (ZMUC). HONG KONG: 3c (MNHN; NMNZ MF15571; QM). PHILIPPINE ISLANDS: 1c (BMNH 196422 - holotype of *Psammobia layardi* Deshayes); 2c, Ticao Island (NMNZ MF15288); 3c, Ticao Island (BMNH 196423, 196424/1,2 - lectotype & paralectotypes of *P. ornata* Deshayes); 2c, Ticao Island (BMNH 1984299/1,2 - lectotype & paralectotype of *P. rubicunda* Deshayes); 1c, Cebu Island (BMNH 1964013 - holotype of *P. corrugata* Deshayes); 1c, Cebu Island (NMNZ MF15542); 1h, 45.5 m, off Cabulan, Mactan Island, Cebu Island (WAM 1384-68); 1h, 16.5-24 m, 14.5 km off Bongao light, Tawitawi Bay, Sulu Archipelago (WAM 1823-68). INDONESIA: 2c, Moluccas Islands (BMNH 196416, 196417 - lectotype & paralectotype of *P. praestans* Deshayes); 3c, Moluccas Islands (BMNH 1846.9.16.112 - holotype of *P. marmorea* Deshayes); 2c, 16h, 25.5-55 m, off Tutuhuhur, Piru Bay, Ceram Island, Moluccas Islands (WAM); 3h, 36.6 m, north Du Rowa, north Nuhu Rowa Kai Island, Moluccas Islands (WAM); 1c, 0-18.5 m, Babi Island, West Wokam, Aru Island, Moluccas Islands (WAM). SINGAPORE: 1c, Kg Loyang (WAM). MALAYSIA: 6c, Port Lembu, west coast Malaysia (WAM). THAILAND: 1h, 55 m, 24 km, south Koh Chien (ZMUC). ANDAMAN ISLANDS: 1c (ZSI M22856/4 - holotype of *P. obtusa* Preston). SRI LANKA: 1c (QM); 1h, between Colombo and Mambantota (MNHN). Gulf of Oman: 1c (BMNH 1899.12.27.12). PERSIAN GULF: 1c, Dhabran, near Bahrain (ZMUC); 1h, 33 m, Stiffe's Bank - 26°27'N 53°08'E (ZMUC). GULF OF ADEN: 2c (BMNH 1888.4.9.421-422); 3c, 1h, Djibouti (MNHN). KENYA: 10 m, Wasin Channel, Shimoni (BMNH). ZANZIBAR: 1h (MNHN); 1h, 13 m, 2 km west-north-west off Ras Mbweni (BMNH). MADAGASCAR: 14c, 20h, Tuléar (MNHN). MOZAMBIQUE: 3c, 1h, Mucoque Beach, near Vilanculos (MNHN), 5c, 1h, West Bay, Santa Carolina Island, Bazarubio Archipelago (NMSA J5124). SOUTH AFRICA: 1c, Durban, Natal (NMSA 1749). "INDIAN OCEAN": 3c (MNHN M4 R1007 - lectotype & paralectotype of *P. maculosa* Lamarck; MHNG 1083/15/2 - paralectotype of *P. maculosa* Lamarck).

Description. Maximum length 60 mm. Shell solid, elongate-ovate; maximum width at level of umbones; inequilateral, umbones displaced towards anterior end - moderately so in juveniles, markedly so in adults; anterior end broadly rounded, always narrower than posterior end; ventral margin straight; posterior end truncate (occasionally smoothly rounded and subtruncate); equivalve, both valves moderately inflated; commissure at junction of shells' ventral margins straight;

small anterior gape; moderately large, twisted posterior gape. Surface of both valves sculptured all over; on anterior and central areas are numerous, coarse, flat-topped, oblique cords that completely dominate finer concentric growth striae, cords number between 18 and 26 per cm counting in from ventral margin transversely towards umbo of adult shells; cords merge with concentric striae just in front of posterior ridge; on posterior slope striae strengthen into irregular, close, sharp lamellae that are microscopically crenulate or sometimes decussate on right valve. Periostracum thin, yellowish brown.

Hinge plate and nymphs moderately strong, the latter elongate. Right valve with 2 equally strong cardinal teeth, diverging by 60° from each other; anterior one weakly bifid, directed obliquely forward; rear one triangular, deeply bifid, directed obliquely backward. Left valve with a strong, elongate, deeply bifid, ventrally-directed anterior cardinal tooth and a delicate, short rear cardinal tooth that diverges by 60° from anterior one; weak lunular projection present on hinge plate just in front of anterior cardinal tooth. Pallial sinus moderately deep (extends just in front of level of hinge plate), broad; upper limb runs anteriorly with ample convexity to rounded anterior margin; lower limb short, oblique, confluent with pallial line for most of its length; ventral extremity of pallial line directed straight backward, extends level with hind end of posterior adductor scar. Small, circular pedal retractor scar present in front of hinge plate.

Colour of exterior exceedingly variable, ground colour usually cream but occasionally pink, peach, orange, yellow, red, lilac or violet; ground overlain with darker rays and maculated with white; white maculations independent of rays in their occurrence - sometimes they interrupt rays; rays not symmetrical on right and left valves (Fig.107). Interior shows colouration of exterior, with dark markings most obvious at ventral margin; often clear-glazed; adults possess thin, white, secondary calcification; teeth white; hinge plate and nymphs often purple streaked.

Remarks. The distinctive features of *Gari maculosa* are its solid and moderately inflated shell that is markedly inequilateral in adults, relatively large and twisted posterior gape, oblique cords on anterior and central areas, concentric lamellae on the posterior slope (weak on left valve, strongly developed on right valve), moderately deep and broad pallial sinus, and complicated colour pattern of dark rays and white maculations.

Gari maculosa is justly renowned for its variability of colouration. No two shells are identical and any one population appears to exhibit all morphs. Polymorphism is undoubtedly continuous from cream to yellow, to pink and red, to lilac and violet. The morph with a yellow ground colour is rarest with only two shells out of all those I examined being like that. The second element constituting the colouration, the darker rays, need not necessarily always be present (see for example Fig.109). The third element, the white maculations, are invariably present, yet their particular position on the shell is

independent of that of the rays. *Gari maculosa* would seem pre-eminently suited for studies on the nature and significance of polymorphism because of the species' great variability, abundance and thin periostracum that does not obscure the colouration in life.

Not only does colouration vary, but sculpture does too. A minority of shells bear strong, corrugated, oblique cords (Figs 102, 110) and in others, the cords barely etch the surface (Figs 99, 106). However, these are the extremes and all intermediates do occur.

Gari maculosa and *G. modesta* (Deshayes) are the only members of the subgenus *Gari* that possess a combination of oblique cords anteriorly and centrally, and concentric lamellae posteriorly. However, *G. modesta* is smaller, narrower, more finely sculptured, its oblique cords are flatter and less distinct, its lamellae are never crenulate or decussate, it is never white spotted and the upper limb of the pallial sinus is different in shape (Fig. 383). *Gari sibogai* Prashad has strong, scaly, decussate sculpture regularly developed on the posterior slope of the right valve and its colour pattern, although generally rayed, is never maculated. *G. pulcherrima* (Deshayes), *G. pennata* (Deshayes) and *G. squamosa* (Lamarck) all possess maculated colour patterns to some degree, but they all possess radial ribs posteriorly in place of the concentric lamellae of *G. maculosa*.

Habitat. *Gari maculosa* inhabits clean substrates in open locations, and the substrate can be sand or comminuted coral. *Gari maculosa* is intolerant of mud. It appears to prefer finer grades of clean sediments where several other tellinoideans regularly occur, especially *G. occidentis* (Gmelin). In my experience, *G. maculosa* is most prolific on the steep seaward reef slopes of coral isles.

Gari maculosa occurs subtidally, the known depth range for live specimens being 6 to 80 m.

Distribution. *Gari maculosa* is very widespread throughout the (central and western) Pacific and Indian Oceans. It ranges through tropical seas and extends, along continental coasts, into warm temperate waters. Hedley (1918a) noted Deshayes' (1855) record of this species (as *Psammobia marmorea* var. β) from Sydney

was incorrect. Hedley's rejection was probably justified as the southernmost authentic record known to me from eastern Australia is North Solitary Island in northern New South Wales (Phipps & Tarrant, 1988; Tarrant, personal communication 1990). Nevertheless there remains a remote possibility that *G. maculosa* might have turned up at Sydney last century as other tropical molluscs are known to do today (eg, *Glossodoris atromarginata* - Willan & Coleman, 1984). Perhaps the situation is like that in southern Africa, where a few specimens of *G. maculosa* were collected at Durban a hundred years ago (G.B. Sowerby III, 1897), but none has been found there subsequently (R. Kilburn, personal communication, 1989).

Literature records are too numerous to cite in full, so I give only those that indicate the probable limits of distribution: Tonga (Quoy & Gaimard, 1835); Boso Peninsula, Japan (Kuroda *et al.*, 1971); Shark Bay, Western Australia (Slack-Smith, 1990); Andaman Islands (Melvill & Sykes, 1898); Angrias Bank, India (Melvill & Standen, 1906); Gulf of Oman (Melvill & Standen, 1906); Persian Gulf (Smythe, 1982; Glayzer *et al.*, 1984); Red Sea (Oliver, 1992); Mauritius and Réunion Island (Drivas & Jay, 1988); Madagascar (Rost & Soot-Ryen, 1955); South Africa (G.B. Sowerby III, 1897). Barnard's (1964:533) records of this species from the Cape of Good Hope are based on misidentified *Gari depressa* (R. Kilburn, personal communication, 1989).

Gari (Gari) sibogai Prashad, 1932

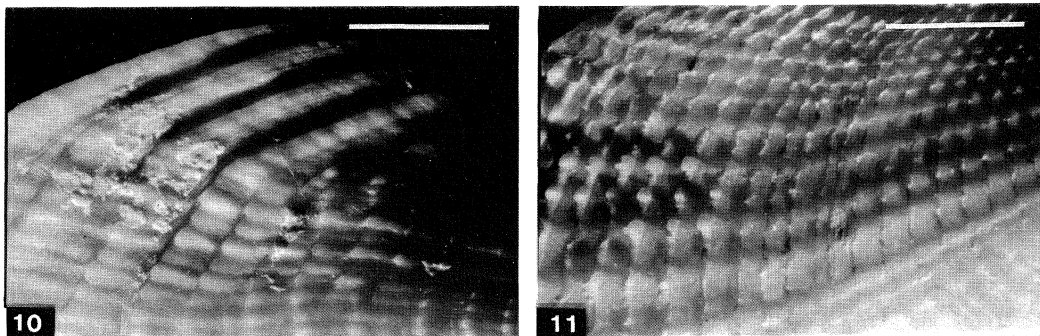
Figs 11, 113-118, 385

Gari (Gari) sibogai Prashad, 1932: 303, pl.7 figs 3,4.-Matsumoto, 1979: 109, no.1844.

Gari sibogai Prashad.-Kuroda & Habe, 1952: 20.-Habe, 1964: 197, pl.61 fig.8.-Kuroda *et al.*, 1971: 442 (English part), pl.97 figs 15, 16.-Higo 1973: 368, no.1147.-Habe, 1981: 139.

Types

Gari sibogai Prashad: holotype (complete specimen - 20.2



Figs 10, 11. Comparison of sculpture on posterior slope of right valves of: 10, *Gari maculosa* (Lamarck), 18.8 mm, 4-5.5 m, Palfrey Island, off Lizard Island, Qld, Willan coll., scale = 2.0 mm; 11, *G. sibogai* Prashad, 15.4 mm, 55-91 m, east Agana Bay, Guam Island, Marianas Islands, Willan coll., scale = 1.0 mm.

mm) in ZMA (3.32.058); illustrated by Prashad, 1932: pl.7 figs 3,4 (Fig.113). Paratype (complete specimen - 13.6 mm) in ZMA (3.32.006). Second paratype mentioned by Prashad not found in ZMA (R. Moolenbeek, personal communication, 1990). Type locality Ceram Island, Banda Sea, Indonesia.

Material examined. AUSTRALIA – QUEENSLAND: 3c,5h, 62-67 m, Chesterfield-Bellona Plateau - 20°34'S-21°29'S 158°30'E - 159°16'E (MNHN); 11h, 64-73 m, 3 km north-east off west side Gillett Cay, Swain Reefs - 21°41'S 152°24'E (AMS C149138 - in part).

NEW CALEDONIA: 2c, 78-80 m, east Yaté - 22°16'S 167°05'E (MNHN); 1h, 75 m, east Yaté - 22°34'S 167°10'E (MNHN); 1c, 65 m, Grand Récif Sud - 22°52'S 167°00'E (MNHN). PAPUA NEW GUINEA: 4h, 13-18 m, off west side Lolorua Island, south-east Port Moresby (AMS C149163). MARIANAS ISLANDS: 1h, 55-91 m, east Agana Bay, Guam Island (Willan coll.); 1c, 183 m, off Alupat Island, Agana Bay, Guam Island (MUG); 1h, 73-128 m, Tumon Bay, Guam Island (MUG). INDONESIA: 3c, 9-45 m, south Ceram Island, Banda Sea (ZMA 3.32.058, 3.32.006 - holotype & paratypes respectively of *Gari sibogai* Prashad); 1h, 75-90 m, Holtor Kombir, Banda Sea (ZMUC); 1c, 7-27 m, South lagoon, Sibutu, Sulu Archipelago (WAM).

Description. Maximum length 21 mm. Shell thin, transversely elongate, rather narrow; maximum width at level of umbones; umbones almost central in both juveniles and adults; anterior end moderately rounded, narrower than posterior end; ventral margin straight; posterior end sharply truncate, bluntly rounded in juveniles, perfectly straight in adults; equivalve, both valves moderately inflated; commissure at junction of shells' ventral margins straight; negligible anterior gape; small posterior gape. Exterior of both valves glossy, finely sculptured. On anterior and central areas are numerous, flat-topped, oblique cords; cords sharpen to lamellae in region of posterior slope on right valve; lamellae form scales on posterior slope where they intersect broad radial ribs (Fig.11). On left valve oblique cords terminate abruptly at an oblique line parallel to, and in front of, posterior ridge and sculpture on posterior slope consists only of minute, close, concentric growth striae. Periostacrum undetectable in living specimens.

Hinge plate and nymphs weak; nymph short, low. Dentition like that of *Gari maculosa*, but no lunular projection in front of anterior cardinal tooth on left hinge plate. Muscle scars and pallial line weakly impressed, difficult to observe. Pallial sinus moderately deep (extends midway between level of hinge plate and rear of anterior adductor scar), lower limb confluent with pallial line for most of its length; ventral extremity of pallial line directed straight back, extending level with hind end of posterior adductor scar.

Shell translucent, white or (rarely) yellow or pale lilac, generally with several orange-red rays emanating from umbones; rays either wide or narrow, stronger towards margins; not symmetrical on right and left valves; shell never with white maculations; umbones white. Interior shows colouration of exterior because of thinness of valves, rays most obvious at ventral margins; clear glazed, never with secondary calcification. Teeth white;

nymphs often flushed with pale purple, more intense in juveniles.

Remarks. *Gari sibogai* is a relatively small species with distinctive features of thin, elongate and narrow shell, cancellate sculpture with scales on the posterior slope of the right valve (Fig.11), smooth posterior slope of the left valve, and red rayed colour pattern. Although Prashad (1932:303) had three specimens before him, his description is essentially that of the holotype, obviously a mature adult shell. My examination of 30 additional specimens (6 complete and 24 halves) indicates that this species is more variable than the original description would indicate. For instance, most specimens are thin-shelled; the holotype is stronger but still not "thick" in comparison to other species of *Gari*. The number of oblique cords varies intraspecifically; the holotype has 45 cords per cm counting transversely from the ventral margin towards the umbo, whereas a finely sculptured shell from the Chesterfield-Bellona Plateau (Figs 117,118) has approximately 60 cords per cm. The transition from flat-topped oblique cords to sharp lamellae over the posterior ridge on the right valve produces a clearly defined zone of raised, concentric lamellae (see for example Figs 113,115,116). Generally each oblique cord develops into a single lamella, and the union of two cords to produce a single lamella only occurs irregularly. By stating "a number of ridges unite in pairs and similarly to ridges", Prashad implied the opposite condition was more normal. The scales on the posterior slope of the right valve (Fig.11) are most prominent in fresh specimens. In dead specimens, they become abraded to knobs, and eventually only cancellate ridges remain (Fig.114). Colouration is not greatly variable; most specimens have translucent to opaque white backgrounds. The holotype is the only lilac specimen known to me, and similarly a juvenile from off New Caledonia is the only yellow specimen I have encountered. The rays are very faint in juveniles and rarely adults too, especially if the adult shells are faded.

Gari sibogai is most similar to juvenile *G. maculosa* (Lamarck). Differences pertaining to sculpture and colour have been given briefly in the remarks section for *G. maculosa*. *Gari sibogai* possesses cancellate sculpture and scales on the posterior slope of the right valve (Fig.11), whereas *G. maculosa* possesses concentric lamellae (Fig.10). In *G. sibogai*, there is a relatively broad zone of concentric lamellae across the area of the posterior ridge of the right valve, whereas in *G. maculosa* the oblique cords become concentric lamellae along a straight line corresponding to the summit of the posterior ridge. *Gari sibogai* has uninterrupted dark rays and it never has white spots. *Gari sibogai* has a thinner and relatively narrower shell.

Gari anomala (Deshayes) also possesses a sharply truncate posterior margin and orange-red rays, but the posterior slope of the right valve is always smooth, its umbones are orange, its rays are relatively broad, and, most important of all, the lower limb of its pallial sinus is separated from the pallial line for most of its length.

Gari pusilla Bertin is a superficially similar but smaller species that possesses a white shell and scales on the posterior slope. Further, *G. pusilla* has more numerous concentric (instead of oblique) cords over the central area of the shell and the scales, which are present on both valves, are more regular, thicker, and more erect, and the scale-bearing ridges are separated by much deeper grooves (Fig.201).

Habitat. Although few specimens have been taken alive, *Gari sibogai* apparently inhabits fine, clean substrates in open locations. It probably has similar requirements to *G. modesta* (together with which it has been taken off the Swain Reefs - AMS C149138) and *G. pallida* (together with which it has been taken off Port Moresby - AMS C149163).

The bathymetric range for *Gari sibogai* is between 9 and 183 m. By far the majority of specimens come from depths of 40 to 80 m, and live specimens have only been taken in this part of the bathymetric range.

Distribution. The existing literature records, from Indonesia (Prashad, 1932) and Japan (Kuroda & Habe, 1952; Kuroda *et al.*, 1971; Habe, 1981), plus the additional localities reported herein, from Queensland, New Caledonia and the Mariana Islands, indicate *Gari sibogai* occurs throughout the tropical western Pacific Ocean. The absence of specimens from the Philippine Islands probably only reflects a lack of collecting in suitable locations.

***Gari (Gari) pennata* (Deshayes, 1855)**

Figs 119-130, 386

- Psammobia pennata* Deshayes, 1855: 325, no.35.—Reeve, 1857: *Psammobia* pl.7, species 52.—Hidalgo, 1903: 79, no.158.
Psammobia dispar Deshayes, 1855 n.syn.: 325, no.36.—Reeve, 1857: *Psammobia* pl.7, species 48.—Cooke, 1886: 104.—Paetel, 1890: 39.—Hidalgo, 1903: 80, no.159.
Gari dispar (Deshayes).—Tryon, 1868: 74, no.18.—Bertin, 1880: 107, no.17.
Gari pennata (Deshayes).—Tryon, 1868: 75, no.27.—Bertin, 1880: 107, no.16.—Wells *et al.*, 1990: 87, pl.79 fig.375.
Psammobia (Gari) pennata Deshayes.—Paetel, 1890: 40.
Heteroglypta kanaka Pilsbry, 1921 n.syn.: 380, fig.16.
Gari (Gari) dispar (Deshayes).—Prashad, 1932: 302.
Grammatomya kanaka (Pilsbry).—Dall, Bartsch & Rehder, 1938: 175, pl.45 figs 3-8.—Kay, 1979: 564, fig.183G.
Gari (Grammatomya) pennata (Deshayes).—Lamprell & Whitehead, 1992: 58, pl.53 fig.399.
Gari (Heteroglypta) dispar (Deshayes).—Oliver, 1992: 164, pl.36 fig.6a,b.

Comments on synonymy. Contrary to Prashad (1932), I find *Psammobia pennata* Deshayes and *P. dispar* Deshayes to be synonymous. The divaricating sculpture on the posterior slope is distinctive and unique to *Gari pennata*. The specific name *pennata* relates to the more finely sculptured form and *dispar* to the coarser form. Consequently, acting as first reviser,

I select *pennata* as the name for this species because, even though *pennata* and *dispar* appear on the same page in Deshayes' original publication, *pennata* was described ahead of *dispar*. The species is relatively uncommon and it has appeared seldom in the literature under either name, so no taxonomic upheaval will result.

This species has also been named as *Heteroglypta kanaka* Pilsbry. That name is based on dead, discoloured, juvenile shells in which the coarse sculpture (particularly posteriorly) and rounded posterior end are obvious. An Australian specimen of *G. pennata* that matches the holotype of *H. kanaka* is illustrated for comparison in Figure 122.

Types. *Psammobia pennata* Deshayes: holotype (single left valve - 19.1 mm) in BMNH (1985169) (Fig.119). Type locality unknown.

Psammobia dispar Deshayes: lectotype, here designated (figured syntype, complete specimen - 18.9 mm) in BMNH (1985170/1); figured by Reeve, 1857: *Psammobia* pl.7, species 48 (Fig.120). Paralectotype (complete specimen - 15.6 mm) in BMNH (1985170/2). Type locality Philippine Islands.

Heteroglypta kanaka Pilsbry: holotype (complete specimen - 11.5 mm) in ANSP (47033); figured by Pilsbry, 1921: 381, fig.16 (Fig.121). Type locality off Waikiki, Oahu Island, Hawaii.

Material examined. AUSTRALIA – QUEENSLAND: 1c, off Darnley Island, Torres Strait (AMS C51522); 1h, 9-15 m, off Murray Island, Torres Strait (AMS C30269); 1h, 20 m, drop off on south-east side Bird Islet, off Lizard Island (AMS C149147); 1h, 12-15 m, north-west end No.10 Ribbon Reef - 14°40'S 145°39.5'E (AMS); 1h, 4.5-18 m, south-west end No.10 Ribbon Reef - 14°55'S 142°42'E (AMS); 1c,1h, 21 m, south-west side Euston Reef, off Cairns (AMS C143438); 1c, Cairns area (AMS C143439); 1c, 18 m, Cobham Reef, off Townsville (Lamprell coll.); 1c, 0.5 m, Barnett Shoals, off Townsville (Whitehead coll.); 1h, Heron Island, Capricorn Group (AMS); 1c, 7 m, north-west side Wistari Reef, Capricorn Group (Willan coll.); 1h, 17-20 m, north-east Outer Gneering Shoals, east Mooloolaba (Willan coll.); 1c,1h, 10.5-12 m, Shag Rocks, north-west Point Lookout, North Stradbroke Island (Willan coll.). WESTERN AUSTRALIA: 1c, intertidal, north-east side Sholl Island, Passage Islands (WAM); 1c,1h, 15 m, Hibernia Reef (NTM).

HAWAII: 1c, 64-91 m, off Waikiki, Oahu Island (ANSP 47033 - holotype of *Heteroglypta kanaka* Pilsbry); 1h, 11-15 m, entrance to Honolulu Harbour, Oahu Island (USNM 337367); 3h, 36.5 m, off Keehi, Oahu Island (WAM 1775-68); 1c, 7-15 m, off Launiupoko Camp, Maui Island (USNM 337368). NEW CALEDONIA: 1c, 37 m, Grand Récif Sud - 22°52'S 166°50'E (MNHN). VANUATU: 1h, 7.5 m, north-east side Pango Peninsula, Mele Bay, Efate Island (Willan coll.). SOLOMON ISLANDS: 1h, Florida Group (NMV); 1c, New Britain (AMS C45582). PAPUA NEW GUINEA: 1h, 7.6 m, "Anemone Reef", north Nagada Harbour, Madang (Willan coll.). PHILIPPINE ISLANDS: 2c (BMNH 1985170/1,2 - lectotype & paralectotype of *Psammobia dispar* Deshayes); 1c, 7-30 m, off Buyong Beach, Mactan Island (AMS); 1h, 35 m, off Jolo Island (ZMUC); 1c, 55 m, south-west Doc Can Island, Sulu Archipelago (WAM); 1c, 23.4, 14.5 km from Bongao light, Tawitawi Bay, Sulu Archipelago (WAM); 1c, 36.5-40 m, north Siasi Island, Sulu Archipelago (WAM). RED SEA: 1c, Elat, Gulf of Aqaba (HUI 32.252); 1c, Aqaba (HUI 35.251). SEYCHELLES: 1c, dredged, Ternay, Mahé Island (BMNH). RÉUNION ISLAND: 1h, 58-70 m - 21°00'S 55°15'E

(MNHN); 2h, 75 m - 21°21'S 55°27'E (MNHN). KENYA: 1c, 10 m, Wasin Channel, Shimoni (BMNH). MADAGASCAR: 2c, Tuléar (MNHN). SOUTH AFRICA: 1h, 50 m, off Boteler Point, north Zululand - 27°01.2'S 32°54.2'E (NMSA D7753); 1h, 50 m, north-east Leifeldt's Rocks, Zululand - 27°43.2'S 32°39.7'E (NMSA E4401); 1h, 18-24 m, main reef, 1-2 km south estuary, Kosi Bay; Zululand (NMSA D9368).

LOCALITY UNKNOWN: 1h (BMNH 1985169 - holotype of *P. pennata* Deshayes).

Description. Maximum length 24 mm. Shell thin and fragile, elongate-ovate; maximum width at level of umbones; umbones approximately central on dorsal margin in both juveniles and adults; anterior end broadly rounded; ventral margin evenly convex but little expanded; posterior end usually truncate in adults (occasionally subtruncate, with that of the left valve being rounded), there being an angle of 130° at the intersection of the posterodorsal and posteroventral margins; equivalve, both valves moderately inflated; commissure at junction of ventral margins straight; small anterior and posterior gapes. Surface of both valves sculptured all over; anterior and central areas with numerous, fine, broad, flat-topped, oblique cords that override finer concentric growth striae; cords number 32 per cm counting in from ventral margin transversely towards umbo of a 22.2 mm adult shell; cords interrupted in front of posterior slope by stronger oblique radial ribs and on the posterior ridge itself radials diverge at an angle of approximately 60° so that on posterior slope in adults, there are, on average, 17.5, well-spaced, moderately strong, rounded or A-shaped ribs running obliquely to posterodorsal margin where they terminate; ribs slightly stronger on right valve where they project beyond edge on posterodorsal margin, never lamellate or nodulose even on intersection with concentric growth striae; some shells possess fine, irregular striae that override ribs. Periostracum thin, pale yellow brown, most often lost.

Hinge plate narrow; nymph moderately long, particularly narrow. Right valve with 2 cardinal teeth, diverging by 60° from each other; anterior one stronger, triangular, directed obliquely forward; rear one shallowly bifid, directed obliquely backward. Left valve with a strong, deeply bifid, triangular, ventrally directed anterior cardinal tooth and a very weak (almost obsolete) rear one being a low ridge that diverges by 70° behind anterior one. Muscle scars and pallial line weakly impressed, difficult to observe. Pallial sinus moderately deep (extends level with umbones), broad; upper limb short; anterior margin very broadly convex, almost truncate; lower limb short; oblique, joins pallial line almost immediately (ie, lower limb is confluent with pallial line for most of its length); ventral extremity of pallial line directed straight backward, reaches level with rear end of posterior adductor scar. Pedal retractor scar present in front of hinge plate.

Colour of exterior variable, ground creamish white, yellow, rose or lilac, overlaid (everywhere but on posterior slope) with close maculations of purple, pale brown or creamish yellow to give a cloud-like, speckled appearance;

sometimes maculations are arranged into 2 or 3 darker rays emanating from umbones. Interior showing colouration of exterior, often clear-glazed. Teeth white; short purple streaks always present in front of, and behind, teeth internally; anterior streak shorter, posterior streak immediately below nymph and always longer than it.

Remarks. The distinctive features of *Gari pennata* are its relatively small size, fragile shell, equivalve condition, truncate posterior end (especially in the right valve), external sculpture, particularly the oblique radial ribs on the posterior slope, relatively narrow (for a *Gari*) pallial sinus with its truncate anterior margin, confluence of lower limb of pallial sinus with pallial line for most of its length and complicated, closely maculated colouration. Some of these characters are possessed by other psammobiids, but no other species resembles *G. pennata* closely.

This species is moderately variable in sculpture, and finely (Figs 119,123-128) or strongly (Figs 120-122,129,130) ornamented forms coexist with each other and with intermediates. It appears that finely sculptured individuals predominate in most populations. As an example of the variation in sculpture, the number of oblique radial ribs on the posterior slope of adult shells can vary from 13 to 25 (mean = 17.5; n = 11). The colouration of *Gari pennata* consists, most typically, of dark maculations overlying a pale cream ground (Fig.123). One specimen from Cobham Reef, north Queensland, has a rich, violet purple ground on which the pale maculations contrast vividly (Fig.125). Yet other shells are uniform cream with very few maculations, or none at all (Figs 121, 122, 129, 130).

The maculated pattern and shape cause *Gari pennata* to resemble (particularly juveniles of) *G. maculosa* (Lamarck). However, that species is larger, stronger, lacks both divarications on the posterior ridge and oblique ribs on the posterior slope, and it is coloured with fewer yet bolder maculations. By possessing divaricating sculpture centred on the posterior ridge, *G. pennata* recalls *Heteroglypta contraria* (Deshayes), but that species differs in many ways, notably inflation, sculptural detail, dentition and colouration. The only other *Gari* species that *G. pennata* could be mistaken for is *G. squamosa* (Lamarck), but that species is more elongate and narrower, its oblique cords are stronger, it has no posterior divergence because the oblique cords are continuous with the posterior ribs, its ribs slope in the opposite direction to those of *G. pennata* and, although it is also maculated, the spots on *G. squamosa* are never as fine nor as close.

Habitat. *Gari pennata* is confined, probably because of a requirement for clean substrates, to offshore islands, atolls and coastal locations well away from harbours. The preferred sediment is clean, fine to medium grained sand. *Gari pennata* occurs with, but is always less common than, *G. maculosa* and *G. occidens*.

Gari pennata ranges from the immediate subtidal (where specimens are rarest) to 75 m, although most specimens have been found in 10 to 30 m.

Distribution. Widespread in tropical waters throughout the (central and western) Pacific and Indian Oceans. *Gari pennata* is, together with *G. occidentis*, the most wide ranging of Recent psammobiids. Furthermore, these are the only two Indo-Pacific psammobiid species whose distributions extend eastwards as far as the Hawaiian Islands. Paucity of records probably reflects this species' relatively small adult size. Literature records are as follows: Hawaii (Pilsbry, 1921; Dall, Bartsch & Rehder, 1938; Kay, 1979); Philippine Islands (Deshayes, 1855; Reeve, 1857); Indonesia (Prashad, 1932); Christmas Island (Wells *et al.*, 1990); Gulf of Suez (Cooke, 1886). *Gari pennata* is uncommon in Australia. Occasional specimens occur as far south as southern Queensland on the continent's east coast.

Gari (Gari) squamosa (Lamarck, 1818)

Figs 131-139, 387

- Psammobia squamosa* Lamarck, 1818: 514, *Psammobia* species 9.—Deshayes & Milne-Edwards, 1835: 176, *Psammobia* species 9.—Delessert, 1841: pl.6 figs a-c.—Hanley, 1843: 57, pl.11 fig.47.—Reeve, 1857: *Psammobia* pl.7, species 50.—Martens, 1897: 251, no.15.—Hidalgo, 1903: 78, no.56.—Woodward, 1913, pl.19 fig.8.—Lamy, 1914: 58.
- Psammobia denticulata* A. Adams & Reeve, 1850: 80, pl.24 fig.2.—Reeve, 1857: *Psammobia* pl.7, species 49.—Hidalgo, 1903: 79, no.57.—Scarlatto, 1965: 96.
- Psammobia rugulosa* A. Adams & Reeve, 1850: 81, pl.24 fig.4a,b.—Reeve, 1857: *Psammobia* pl.7, species 51.—Scarlatto, 1965: 96.
- Psammobia palmula* Deshayes, 1855 n.syn.: 325, no.37 and var. β .—Reeve, 1857: *Psammobia* pl.7, species 47.—Hedley, 1918a: M28.
- Gari denticulata* (A. Adams & Reeve).—Tryon, 1868: 74, no.12.—Bertin, 1880: 107, no.13.
- Gari palmula* (Deshayes).—Tryon, 1868: 75, no.25.—Bertin, 1880: 107, no.15.
- Gari rugulosa* (A. Adams & Reeve).—Tryon, 1868: 75, no.33.—Bertin, 1880: 106, no.12.
- Gari squamosa* (Lamarck).—Tryon, 1868: 75, no.34.—Bertin, 1880: 106, no.11.—Kuroda & Habe, 1952: 20.—Allan, 1950: 343, fig.80, no.5.
- Psammobia (Gari) squamosa* Lamarck.—Fischer, 1887: 1104, pl.21 fig.10.—Paetel, 1890: 40.
- Psammobia (Gari) denticulata* A. Adams & Reeve.—Paetel, 1890: 36.
- Psammobia (Gari) palmula* Deshayes.—Paetel, 1890: 40.
- Psammobia (Gari) rugulosa* A. Adams & Reeve.—Paetel, 1890: 40.
- Psammobia (Grammatomya) squamosa* Lamarck.—Dall, 1898: 57, 1900: 975.
- Gari (Grammatomya) squamosa* (Lamarck).—Prashad, 1932: 304, 305.—Habe, 1964: 197, pl.61 fig.2.—Shikama, 1964: 85, pl.50 fig.5.—Scarlatto, 1965: 50, pl.2 fig.3.—Keen in Moore, 1969: N631, fig.E115, no.5.—Matsukuma, 1989: 99-101, pl.1 figs 1-3.—Lamprell & Whitehead, 1992: 58, pl.53 fig.398.

Grammatomya squamosa (Lamarck).—Habe, 1951: 202, 1977: 219.—Higo, 1973: 368, no.1151.

Comments on synonymy. Reeve (1857) uncritically accepted as valid all the earlier, similar-looking species (ie, *Psammobia squamosa* Lamarck, *P. denticulata* A. Adams & Reeve, *P. rugulosa* A. Adams & Reeve and *P. palmula* Deshayes), although no differences apart from colour are apparent between any of them in his illustrations. Bertin (1880) treated each species separately, probably because of their different type localities, but he did say that *P. rugulosa* might be the same as *P. squamosa*. Martens (1897:251,252) realised the species was capable of considerable colour variation, but he still treated *P. denticulata*, *P. rugulosa* and *P. palmula* as “apparently different” (translated from the German) from *P. squamosa*. Furthermore, he listed *P. caledonica* Crosse as another different species; I have been unable to trace that name and it must be considered a *nomen nudum*. Dall (1898) made *P. squamosa* the type species of his new section (ie, subgenus) of *Psammobia*, *Grammatomya*. The primary differentiating character of *Grammatomya* was the continuity of the oblique cords from the central area onto the posterior slope of the shell (Dall, 1900:975). As stated in my introduction to this subgenus, the sculpture on the posterior slope of species of *Gari* is interspecifically variable but unsuitable for classification at levels higher than that of species.

Credit for the realisation of colour polymorphism in *P. squamosa* must go to Hidalgo (1903:78), even though he continued to separate *P. denticulata* on sculptural grounds. Prashad (1932:304,305) formalised the synonymy of *P. denticulata* and *P. rugulosa* under *P. squamosa*, but evidently he left *P. palmula* as a valid species because that name does not appear in his synonymy. Cernohorsky (1972) illustrated a specimen of *Gari pulcherrima* (Deshayes) under the name of *P. squamosa*.

Types. *Psammobia squamosa* Lamarck: lectotype, here designated (larger syntype, complete specimen 31.3 mm) in MHNG (1083/19/1); probably that figured by Delessert, 1841: pl.6 figs a-c but 2 mm smaller (Fig.131). Paralectotype (single left valve - 30.5 mm) in MHNG (1083/19/2). Type locality unknown. Specimens figured as *Psammobia squamosa* Lamarck by Reeve, 1857: *Psammobia* pl.7, species 50a,b (complete specimens - 29.2, 26.5 mm) in BMNH (1985183/1,2 respectively).

Psammobia denticulata A. Adams & Reeve: type material ought to be in BMNH, but not found there (S. Morris, personal communication, 1987; personal search, 1989). Type locality China Sea. Specimen figured as *Psammobia denticulata* A. Adams & Reeve by Reeve, 1857: *Psammobia* pl.7, species 49 ought to be in BMNH, but not found during personal search in 1989.

Psammobia rugulosa A. Adams & Reeve: type material ought to be in BMNH; but not found during personal search in 1989. Type locality China Sea. Specimen figured as *Psammobia rugulosa* A. Adams & Reeve by Reeve, 1857: *Psammobia* pl.7 species 51 (complete specimen - 31.2 mm) in BMNH (1985184/1) (Fig.132).

Psammobia palmula Deshayes: holotype (complete specimen - 21.5 mm) in BMNH (1985171); figured by Reeve, 1857: *Psammobia* pl.7, species 47 (Fig.133). Type locality Sydney, New Holland.

Material examined. “SYDNEY, NEW HOLLAND” (= error, see above): 1c (BMNH 1985171 - specimen described as

Psammobia palmula var. *β* by Deshayes).

AUSTRALIA – QUEENSLAND: 1h, Murray Island, Torres Strait (AMS C29808); 1h, Watsons Beach, north-west coast Lizard Island (Willan coll.); 1c, 9 m, off Rocky Point, Lizard Island (AMS); 1h, 20 m, off east face Lizard Island (AMS C149149); 1c, intertidal, Cairns Reef, south-east Cooktown (AMS); 1c, 14 m, south-east side Wheeler Reef, north-east Townsville (AMS C112049); 1c, 0.5 m, Langford Reef, near Hayman Island, Whitsunday Group (Lamprell coll.); 5c, Black Island, Whitsunday Group (NMV; Lamprell coll.; Whitehead coll.); 1c, 13–18 m, reef no.14–151, Swain Reefs (AMS); 1c, Swain Reefs (AMS C74214). WESTERN AUSTRALIA: 1h, on beach, West Islet, Ashmore Island (WAM); 1h, 2 m, Cartier Island (NTM).

TONGA: 3h, 9 m, Lifuka Island (NMNZ MF23118). FIJI ISLANDS: 2c,1h (MNHN); 1c,22h, 9–34.5 m, Nadi Bay, Viti Levu Island (AMS C69063); 1c, intertidal, Nukubuco Reef, Laucala Bay, Suva, Viti Levu Island (Willan coll.); 2c, Viti Levu Island (CAS 24205). TUVALU: 1c,1h, Funafuti Atoll (AMS C6182; NMV). NEW CALEDONIA: 11c (AMS C15985, C80495; BMNH 1852.3.20.62, 1870.12.31.328; NMNZ MF15181; WAM 1045–68, 1069–68); 1h, Hienghène (AMS C4000); 1c, 11 m, Ile Ouen, Baie du Prony (MNHN); 1c, Ilot Mette, Nouméa (AMS C87973); 3c, Ile St Marie, Nouméa (AMS C83686); 2c, 0.8 m, north-west and west sides Ile St Marie, Nouméa (AMS C83708); 1c,1h, Ile des Pines (AMS C15986; MNHN). LOYALTY ISLANDS: 1h, Lekin lagoon, Ouvea Island (Hole coll.). CORAL SEA: 1c, 37 m, Chesterfield Plateau - 19°09'S 158°26'E (MNHN); 1h, 44 m, Chesterfield-Bellona Plateau - 19°11'S 158°55'E (MNHN); 4h, 9 m, Anchorage Cay, Chesterfield Reef (AMS); 2h, 45 m, Chesterfield Plateau - 19°15'S 158°57'E (MNHN); 1c, 21 m, Chesterfield Plateau - 19°19'S. 158°20'E (MNHN). VANUATU: 2c,4h, 1 m, Malapoa Peninsula, Mele Bay, Efate Island (Willan coll.); 1h, 10 m, off Irikeri Island, Mele Bay, Efate Island (Willan coll.); 3c,2h, 1.5–3 m, Erakor lagoon, south-west side Efate Island (Hole coll.; Willan coll.); 1c,2h, 0.5 m, Luganville foreshore, Espiritu Santo Island (Hole coll.). SOLOMON ISLANDS: 3c, New Britain (AMS C45580, C45581); 1c, Buka Island (AMS C45876); 3c, Florida Group (NMV). PAPUA NEW GUINEA: 6h, 18–22 m, Buriwadi Island, Lusancay Island, Trobriand Group (AMS); 1c, 6 m, "Cement Mixer Reef", south Ruo Island, Madang (Willan coll.); 3h, 13–18 m, west side Lolorua Island, south-west Port Moresby (AMS). CHINA: 2c (MNHN; NMV). PHILIPPINE ISLANDS: 12c (AMS C33505; BMNH 1931.1.8.208–209; NHMW 9089, 35652; NMV); 1c, Naujan, north-east Mindoro Island (MNCN); 1c, Port Galara, Mindoro Island (BMNH 1914.6.17.8.); 3c, Masbate Island (BMNH 1985183/1–3); 1h, 16.5–27.5 m, Tawitawi Bay, Tawitawi Island, Sulu Archipelago (WAM 1788–68); 2c, 23.7 m, off Bongao light, Tawitawi Bay, Tawitawi Island, Sulu Archipelago (WAM 1066–68, 1792–68); 1h, Sulu Archipelago (WAM 1789–68); 1h, 36.5–49 m, 14.5 km west Cape Melville light, Balbac Island, Sulu Archipelago (WAM 1790–68); 3c, south lagoon, Sibutu Island, Sulu Archipelago (WAM 1791–68). INDONESIA: 1c, south end Kajoa Island, Moluccas Islands - 00°05'S 127°27'E (WAM). BORNEO: 3c (NMV). JAVA: 1c (ZMUC). ANDAMAN ISLANDS: 1c (NHMW G9737); 2c,1h, dredged, Port Blair (BMNH). MAURITIUS: 1c (NMV). KENYA: 2c, 10 m, Wasin channel, Shimoni (BMNH). MADAGASCAR: 1h, 1 m, Grand Ricif, Tuléar (MNHN); 38c,26h, Tuléar (MNHN).

LOCALITY UNKNOWN: 1c,1h (MHNG 1083/19/1,2 - lectotype & paralectotype of *Psammobia squamosa* Lamarck).

Description. Maximum length 38 mm. Shell thin and fragile, transversely elongate, curved along anteroposterior

axis (particularly in adults); maximum width at level of umbones; umbones displaced towards anterior end (particularly in adults); anterior end rounded; ventral margin deeply concave (straighter in juveniles); posterior end truncate, there being a right angle at intersection of posterodorsal and ventral margins; equivalve, both valves compressed; commissure at junction of shells' ventral margins straight; small anterior gape, larger posterior gape (though still relatively small). Surface of both valves sculptured with raised cords. On anterior and central areas, cords run obliquely from dorsal margin (where they arch steeply) toward ventral margin; cords steep on side facing umbo and more gently sloping on side facing ventral margin; cords intersect finer concentric growth striae obliquely; 30 cords per cm counting in from ventral margin transversely towards umbo of a 28.8 mm adult shell; shell without a posterior ridge. On posterior slope cords, now strengthened into rounded ribs, radiate toward posterior margin, thus some terminate on ventral margin and others on posterodorsal margin; some posterior ribs weakly nodulose, but never scaly; grooves between posterior ribs flat-bottomed, much broader than ribs themselves; in this region, fine growth striae become microscopically reticulate. Periostracum apparently lacking or very thin.

Hinge plate very narrow; nymph long and narrow, its posterior end merging into posterodorsal ridge; ligament relatively short, thin, low. Dentition identical to that of *G. pulcherrima*, although all teeth more delicate. Muscle scars and pallial line weakly impressed, difficult to observe; pallial sinus moderately deep (extends level with rear of nymph), broad; upper limb short, directed obliquely downward; anterior margin convex; lower limb directed obliquely backward to pallial sinus and separated from pallial line for half its length; ventral extremity of pallial line directed straight backwards, reaches level with rear end of posterior adductor scar. Small pedal retractor scar present close beneath dorsal margin just in front of hinge plate.

Colour of exterior variable – dark violet, purple, violet brown, orange, peach-pink or (most often) cream; exterior always sparsely maculated with white; occasional, broad white rays present (Fig.138), but darker rays never present; interior reflects colouration and sculpture of exterior because of shells' thinness, often clear-glazed. Teeth white; short, purple streaks always present on dorsal margin internally, anteriorly at umbo and posteriorly below nymph (streak always longer than nymph).

Remarks. *Gari squamosa* possesses many distinctive characteristics, notably its fragility, compression, curving anteroposterior axis, external sculpture, even – yet deeply convex – ventral margin, crenulate and sharply truncate posterior margin, relatively shallow (for a *Gari*) pallial sinus, separation of the lower limb of the pallial sinus from pallial line for half its length, and white spots on a uniform, darker background. The length of the pallial sinus merits extra comment. Because of its thin shell, one would expect *G. squamosa* to live deeply buried and

consequently one would predict the species to possess a relatively deep pallial sinus to accommodate the long siphons when they are retracted. However, this species possesses a relatively shallow sinus (that does not even reach level with the umbones or middle of the shell), so its siphons must be shorter than expected.

The above characters readily separate *Gari squamosa* from all other congeners save *G. pulcherrima*, with which it has been confused at least once (Cernohorsky, 1972). However, as indicated in the remarks section for *G. pulcherrima*, discrimination between these two species is not difficult.

Intraspecific variation in colour appears to be continuous between morphs with a predominance of violet shades in Queensland populations. Much more extensive series need to be examined before the mechanisms (genetic, biochemical and ecological) that determine the expression of colour in *G. squamosa* can be explained.

Habitat. Habitats in which *Gari squamosa* occurs range from partially protected to moderately open. *Gari squamosa* inhabits clean substrates, especially comminuted coral sand. Several species of tellin, but apparently no other psammobiid, regularly occupy this same habitat.

Gari squamosa extends from the immediate subtidal to about 30 m depth, indicating a relatively shallow bathymetric range.

Distribution. *Gari squamosa* is widespread throughout the tropical (western) Pacific and Indian Oceans, but it is apparently absent from the Arabian and Red Seas. *Gari squamosa* never extends into warm temperate waters. It has been reported from the Philippine Islands repeatedly in the literature (Reeve, 1857; Tryon, 1868; Hidalgo, 1903). Other locations are Japan (Habe, 1964, 1977; Matsukuma, 1989), China (A. Adams & Reeve, 1850), Indonesia (Prashad, 1932), and India (Lamarck, 1818; Hanley, 1843).

Records of *G. squamosa* from the western Atlantic Ocean (ie, Virgin Islands by Dall, 1898) are erroneous.

I completely concur with Hedley's (1918a) rejection of Deshayes' record of this species (as *Psammobia palmula* var. β) from Sydney.

Gari (Gari) pulcherrima (Deshayes, 1855)

Figs 140-148, 388

Psammobia abrupta Deshayes, 1855 n.syn.: 324, no.33.—Reeve, 1857: *Psammobia* pl.6, species 39.—Hidalgo, 1903: 81, no.161.

Psammobia pulcherrima Deshayes, 1855: 325, no.34.—Reeve, 1857: *Psammobia* pl.7, species 46.—E.A. Smith, 1885: 91.—Melvill & Sykes, 1898: 48, no.207.—Melvill & Standen, 1899: 198, no.402.—Hidalgo, 1903: 81, no.162.—Hedley, 1910: 350.

Psammobia pazi Hidalgo, 1867 n.syn.: 306, pl.8 fig.4.—Paetel,

1890: 40.—Hidalgo, 1903: 80, no.160.

Gari abrupta (Deshayes).—Tryon, 1868: 73, no.1.—Bertin, 1880: 103, no.19.

Gari pulcherrima (Deshayes).—Tryon, 1868: 75, no.30.—Bertin, 1880: 108, no.20.—Kuroda & Habe, 1952: 20.—Slack-Smith, 1990: 137

Gari pazi (Hidalgo).—Bertin, 1880: 107, no.18.—Lamy, 1938: 36; Oliver, 1992: 163, pl.36 fig.4.

Psammobia (Gari) abrupta Deshayes.—Paetel, 1890: 39.

Psammobia (Gari) pulcherrima Deshayes.—Paetel, 1890: 40.

Psammobia elegans Deshayes.—Hidalgo, 1903: 82, no.163 (misidentification, not *Psammobia elegans* Deshayes, 1855).

Grammatomya pulcherrima (Deshayes).—Habe, 1951: 202.—Cox, 1969: N66, fig.56, no.2.—Higo, 1973: 368, no.1152.—Habe, 1977: 220.

Gari (Grammatomya) squamosa (Lamarck).—Cernohorsky, 1972: 231, pl.66 fig.4 (misidentification, not *Psammobia squamosa* Lamarck, 1818)

Gari (Grammatomya) pulcherrima (Deshayes).—Matsumoto, 1979: 109, no.1846, pl.D fig.10.—Matsukuma, 1989: 101, 102, pl.2 figs 1-7.—Lamprell & Whitehead, 1992: 58, pl.53 fig.400.

Grammatomya kurodai Habe, 1981 n.syn.: 139-140, pl.3 fig.5.

Gari (Grammatomya) pulcherrima kurodai (Habe).—Matsukuma, 1989: 103-105, pl.2 figs 8-13.

Comments on synonymy. Both *Psammobia abrupta* Deshayes and *P. pulcherrima* Deshayes were described from juvenile shells. There is nothing in the original descriptions, subsequent literature or available specimens that might warrant their separation. Acting as first reviser, I select *P. pulcherrima* for this species because, although described on the page after *abrupta* by Deshayes, it has now gained general acceptance. The name *P. abrupta* has never been employed since 1903. *Psammobia pazi* Hidalgo is also undoubtedly this same species, the name being based on a single shell from unknown locality. When he identified a single valve from Tonga, E.A. Smith (1885:91) realised that the holotype of *P. pulcherrima* was a juvenile specimen; Smith's specimen is illustrated here in Figure 147. Hidalgo (1903) recorded specimens from the Philippine Islands under the erroneous name of *P. elegans* Deshayes.

Grammatomya kurodai Habe was based on Japanese material and described without reference to either of Deshayes' or Hidalgo's species. Matsukuma (1989) treated *G. kurodai* as a subspecies of *G. pulcherrima* restricted to western Japan. However, the characters advanced as exclusive of *kurodai* ("longer and narrower shell with a longer and narrowly rounded posterior end, slightly weaker shell ornamentations and wider posterior slope in the right valve") are variable, and specimens exhibiting some or all of them occur in all populations of *G. pulcherrima*. Actually Matsukuma's own data and illustrations disprove his claim of *kurodai* being narrower than *pulcherrima*.

Photographs of *Gari pulcherrima* shells appear in recent works by Cox (1969), Cernohorsky (1972) and Matsukuma (1989); that by Cox depicts the sculpture on the exterior of a left valve particularly well.

Types. *Psammobia abrupta* Deshayes: holotype (right valve - 10.5 mm; left valve broken) in BMNH (1984300); figured by Reeve, 1857: *Psammobia* pl.6, species 39 (Fig.141). Type locality Philippine Islands.

Psammobia pulcherrima Deshayes: holotype (complete specimen - 17.9 mm) in BMNH (1985168); figured by Reeve, 1857: *Psammobia* pl.7, species 46 (Fig.140). Type locality

unknown.

Psammobia pazi Hidalgo: holotype (complete specimen - 33.8 mm) in MNCN (15.07/0307); figured by Hidalgo, 1867: pl.8 fig.4 (Fig.142). Type locality unknown.

Grammatomya kurodai Habe: holotype (complete specimen - 26.8 mm) in NSMT (Mo58965); illustrated by Habe, 1981: pl.3 fig.5 (Fig.143). Paratypes (single left valve - 31.0 mm and single right valve - 26.8 mm) in NSMT (Mo58966 and Mo58967 respectively). Type locality off Cape Ashizuri, Kochi Prefecture, Japan.

Material examined. AUSTRALIA - QUEENSLAND: 1h, 24.5 m, east Snake Reef (AMS); 1h, 9-18 m, Hope Island (AMS C29675); 1c, 8h, 27 m, Lizard Island (Willan coll.). WESTERN AUSTRALIA: 1h, 4-7 m, south-east corner Dirk Hartog Island, Shark Bay (WAM 1307-68); 3c, 51 m, 11.3 km north of Long Island, Onslow (WAM); 1h, 97-117 m, north-east Monte Bello Islands (WAM); 2h, 82 m, 144 km north-north-east Port Hedland - 19°04'S 119°04.4'E (AMS); 1h, 80 m, 137 km north-north-east Port Hedland - 19°05.4'S 118°53.9'E (AMS); 1h, 90 m, west Broome (WAM); 2h, 70 m, east-north-east Troughton Island, Timor Sea (WAM 1776-68). NORTHERN TERRITORY: 1h, 132 m, approximately 338 km north-east Croker Island - 8°18'S 133°58'E (AMS C149151).

TONGA: 1c, 33 m, Nukualofa, Tongatabu Island (BMNH 1887.2.9.2537). FIJI ISLANDS: 9c, 9-35 m, Nadi Bay, Viti Levu Island (AMS C69063). NEW CALEDONIA: 1c, 43 m, Ile Ouen, Baie du Prony (MNHN); 1c (MNHN); 1h, 27 m, Grand Récif Mengalia, north Koua - 20°41'S 165°07'E (MNHN); 4c, 4h, 80 m, south New Caledonia - 22°17'S 176°05'E (MNHN); 1c, 65 m, Grand Récif Sud - 22°52'S 167°00'E (MNHN). SOLOMON ISLANDS: 1h, New Britain (AMS C45580). PAPUA NEW GUINEA: 2c, Rabaul, East New Britain (Hansen coll.; Hewitt coll.). JAPAN: 1c, 1h, off Cape Ashizuri, Kochi Prefecture (NSMT Mo58965, Mo58966 - holotype & paratype of *Grammatomya kurodai* Habe). PHILIPPINE ISLANDS: 1c (BMNH 1984300 - holotype of *Psammobia abrupta* Deshayes); 1c, 100-113 m, off Lady Island, near Bohol Island (WAM 1779-68); 1h, 141 m, off Pangalao Island, off Bohol Island (WAM 1028-68). INDONESIA: 1h, 49-64 m, off Elat Bay, west coast Nuhu Tjuk, Kai Island, Moluccas Islands (WAM); 1c, 2h, 5 fragments, 40-57 m, off west coast Wasir Island, West Wokam, Aru Island (WAM). MALAYSIA: 2c, Point Lembu, west coast (WAM 896-84). ANDAMAN ISLANDS: 1c (NHMW 45594); 2h, 13-18 m (AMS C34085); 4c, 2h, dredged, Port Blair (BMNH 1953.1.7.176, 1953.1.7.180, 1953.1.7.187-188). INDIA: 1h, dredged, North West Bay, Madras (BMNH). MALDIVES: 1c, north Mahé Atoll (BMNH 1903.4.23.62). SEYCHELLES: 1h, dredged, Cerf Passage, Mahé Island (BMNH). KENYA: 1h, Watamu (BMNH); 1c, 3h, 10 m, Wasin Channel, Shimoni (BMNH). MADAGASCAR: 2c (MNHN); 2c, 13h, Tuléar (MNHN). SOUTH AFRICA: 1c, 75 m, off Kosi River mouth, north Zululand - 26°54.6'S 32°56.6'E (NMSA D8994); 2c, 2h, 70 m, off Jesser Point, north Zululand - 27°35.5'S 32°41.8'E (NMSA D8452); 2h, 50 m, north-east Liefeldt's Rocks, Zululand - 27°42.7'S 32°39.9'E (NMSA E4328); 1c, 50 m, north-east Liefeldt's Rocks, Zululand - 27°43.2'S 32°39.7'E (NMSA E4409).

LOCALITY UNKNOWN: 1c (BMNH 1985168 - holotype of *P. pulcherrima* Deshayes); 1c (MNHN 15.07/0307 - holotype of *P. pazi* Hidalgo).

Description. Maximum length 40 mm. Shell moderately solid, elongate, elliptical; maximum width at level of umbones; umbones nearly central in both adults

and juveniles; dorsal margin straight anteriorly; anterior end rounded, a little narrower than posterior end; ventral margin slightly convex; posterior end usually pointed-truncate, occasionally rounded; nearly equivalve; commissure at junction of shells' ventral margins slightly curved; no gape, either anteriorly or posteriorly. Surface of both valves strongly sculptured; anterior and central areas with oblique, raised cords that are steep on side facing umbo and gently sloping on side facing ventral margin; cords intersect finer concentric growth striae obliquely; 11 cords per cm counting in from ventral margin transversely towards umbo of a 28 mm long adult shell; cords extend to posterior slope; behind posterior slope is an abrupt change in sculpture to strong radial ribs that are rounded in section with flat grooves separating them; radial ribs number 9-11 on right valve; ribs nodulose (never scaly) near umbones so they are particularly evident on juvenile shells. Periostracum apparently lacking or very thin.

Hinge plate moderately narrow; nymph quite short, narrow; ligament rather short, reddish brown, low. Right valve with 2 oblique cardinal teeth, diverging by 60° from each other; anterior one slightly stronger; rear one bifid. Left valve with 2 cardinal teeth, diverging by 50° from each other; anterior one strong, triangular, bifid, directed vertically downward; rear one slender, represented by a short, high lamella, pointing obliquely backward. Pallial sinus deep (reaches level with anterior end of hinge plate), rather broad; upper limb convex, curves evenly downward; anterior margin sharply angled at lower corner; lower limb confluent with pallial line for most of its length; ventral extremity of pallial line points slightly upward, reaches level with rear end of posterior adductor scar. Small pedal retractor scar present dorsally in front of hinge plate.

Colour of exterior cream or pale pink-orange, maculated with pinkish red or brownish flecks near white umbones; irregular magenta or reddish rays emanate from middle of shell towards ventral margin; interior creamish or pale pink-orange with exterior rays visible especially near margins. Teeth white; hinge plate and nymphs pink or violet.

Remarks. The most distinctive attributes of *Gari pulcherrima* are sculpture and colouration. The posterior radial ribs are possessed by *G. pulcherrima* and *G. squamosa* alone (and explain why Habe (1981), on this one character, placed *G. kurodai* in the same genus as *G. squamosa*), but *G. squamosa* is lighter and flatter, it has more numerous oblique cords and radial ribs, and it does not show the abrupt intersection between the oblique cords and radial ribs posteriorly as *G. pulcherrima* does. In *G. squamosa* the oblique cords gradually merge into the radial ribs on the posterior slope. *Gari maculosa* has a maculated/rayed colour pattern reminiscent of *G. pulcherrima*, but in *G. maculosa* there are no posterior radiating ribs and neither are the oblique cords as strong.

Habitat. *Gari pulcherrima* inhabits clean sand substrates and specimens are obtained from coarse shell

rubble as would indicate environments of current scour.

The bathymetric range is 4 to 150 m with greatest abundance from 30 to 100 m. This preferred depth is noteworthy because most other *Gari* species attain greatest densities in shallower waters.

Distribution. Apparently identical to *Gari squamosa*. Lack of records and/or specimens from the Arabian Sea probably reflect a genuine absence in the north-west Indian Ocean. *Gari pulcherrima* never extends into warm temperate waters.

Gari (Psammobia) Lamarck, 1818

Type species. *Psammobia fervensis* Gmelin, 1791 by subsequent designation (Children, 1823), (as *Psammobia feroensis* (sic)). Recent, eastern Atlantic.

Diagnosis. Moderate-sized psammobiids with thin to moderately thick shells; inequilateral (umbones displaced anteriorly); inequivalve (right valve more convex); posterior ridge usually distinct (on right valve at least). Valves with weak concentric cords across anterior and central areas; strong concentric striae over posterior slope (of right valve at least). Right valve with 2, approximately equal, oblique, diverging cardinals, the rear one deeply bifid. Left valve with a (weak) lunular projection in front of teeth; dentition consisting of a single, vertically directed, deeply bifid anterior cardinal tooth and a short, oblique lamella representing posterior cardinal tooth. Pallial sinus moderately deep, relatively broad, lower limb confluent with pallial line for its entire length. Interior with purplish glaze.

Species of the subgenus *Psammobia* are united by their elongate shape, compression, weak concentric (never oblique) sculpture on the central area, presence of a posterior ridge, inequilateral condition and inequivalve state. The lunular projection on the left valve is not unique to *Psammobia* because it is also possessed by the

subgenera *Gobraeus* (some species) and *Dysmea* (all species). Species of *Psammobia* share many characters with those of the subgenus *Gobraeus*, and the two are possibly sister groups or they may be more distantly related, with relationships complicated by parallel and convergent evolution. Rehder's (1961) conviction that *Psammobia* is subgenerically distinct from *Gari* is upheld even though some of the characters he used (surface of pallial sinus, extent of pallial fusion and pedal retractor muscle scars) have proven inconsistent across all species in this region. The characters that distinguish *Psammobia* from *Gobraeus* (and also *Gari sensu stricto*) are given in Table 1.

Within Australasia, the two most closely related species, *Gari convexa* (Reeve) and *G. livida* (Lamarck), share numerous characters which are probably symplesiomorphies of the subgenus *Psammobia*. The remaining three species all possess apomorphies that indicate considerable evolutionary divergence from the supposed *Psammobia* ancestor. In fact, as regards sculpture, *G. kenyoniana* and *G. lineolata* represent two divergent extremes, with the former being sculptured all over and the latter completely smooth.

Members of this subgenus are cosmopolitan, attesting a long evolutionary history. Unlike species belonging to the subgenus *Gari* however, most species of *Psammobia* do not have a wide Indo-Pacific distribution. Instead, their ranges are restricted, sometimes being limited to relatively small area within temperate waters. In Australasia, two species are endemic to southern Australia (*G. livida* (Lamarck) and *G. kenyoniana* (Pritchard & Gatliff)) and two are endemic to New Zealand (*G. convexa* (Reeve) and *G. lineolata* (Gray in Yate)). Besides the five species that occur in Australasia, I include the following five exotic species in this subgenus: *G. fervensis* (Gmelin) (= *P. feroensis* Lamarck), *G. jousseaumeana* Bertin; *G. insignis* (Deshayes) (= *G. bicarinata* (Deshayes) and *G. elegans* (Deshayes)); *G. pseudoweinkauffi* Cosel; *G. radiata* (Dunker in Philippi). I have covered the latter species elsewhere (Willan, 1992).

Key to Species of Subgenus *Psammobia* in Australasia

1. Shell completely smooth *G. lineolata*
- Shell sculptured with (strong and weak) concentric cords and/or striae on posterior slope 2
2. Posterior slope of left valve sculptured with raised striae (ie, lamellae) *G. kenyoniana*
- Posterior slope of left valve smooth 3
3. Shell with broad, concentric cords on anterior section of both valves; central section of right valve compressed; patterned with brownish purple rays *G. amethysta*
- Anterior sections of both valves smooth or at most with fine, close cords; right valve evenly inflated; rayed but other than with brownish purple 4

4. Anterodorsal margin sloping 15°-20° from horizontal,
larger than 45 mm when adult; New Zealand only *G. convexa*
- Anterodorsal margin sloping 25°-30° from horizontal,
smaller than 45 mm when adult; southern Australia only *G. livida*

***Gari (Psammobia) amethysta* (Wood, 1815)**

Figs 11, 12, 149-157, 389

- Blaue goldene Zungenmuschel, ober blaues Zungendublet ...
Knorr, 1772: 22, pl.12 fig.2 (not binomial)
- Tellina Gari* Linnæi...Chemnitz, 1782: 100 (in part), pl.10
fig.93 only (not binomial) [See ICZN, 1944 Opinion 184.]
- ? *Tellina gari* Gmelin, 1791: 3229, species 5.
- Tellina gari* var a. Spengler, 1798: 70.
- Solen amethystus* Wood, 1815: 138, no.31, pl.34 fig.1.—Dillwyn,
1817: 68, *Solen* species 27.—Wood, 1818: 16, no.31.—ICZN,
1970: 16 (name no.2872).
- Psammobia caerulescens* Lamarck, 1818: 513, *Psammobia*
species 6 (in part) and var (b).—Deshayes & Milne-Edwards,
1835: 174, *Psammobia* species 6 (in part).—Crouch, 1826:
10, pl.5 figs 7a, 7b.—Martens, 1897: 244, no.8.—Lamy, 1914:
6.
- Gari vulgaris* Schumacher, 1817: 131 (in part), pl.9 fig.2.
- Psammobia cerulescens* (sic = error pro. *caerulescens*) Lamarck.—
Hanley, 1843: 57, pl.3 fig.36
- Psammobia tripartita* Deshayes, 1855: 321, no.21 and var. β.—
Reeve, 1856: *Psammobia* pl.3, species 20.—Paetel, 1890: 39.
- Psammobia amoena* Deshayes, 1855 n.syn.: 323, no.28.—Reeve,
1856: *Psammobia* pl.5, species 36.—Paetel 1890: 39.
- Gari tripartita* (Deshayes).—Tryon, 1868: 76, no.39.—Smythe,
1979: 72, 78, 1982: 109.—Bosch & Bosch, 1982: 182.—Abbott
& Dance, 1982: 346.—Smythe, 1982: 109.
- Gari amoena* (Deshayes).—Bertin, 1880: 111, no.36.
- Gari caerulescens* (Lamarck).—Bertin, 1880: 114, no.45.
- Gari amethysta* (Wood).—Bertin, 1880: 114, no.46.—Willan,
1992: 231, figs 18,22.
- Gari mirabilis* Bertin, 1880 n.syn.: 117, no.51, pl.4 fig.2a,b.
- Psammobia (Gari) amoena* Deshayes.—Paetel, 1890: 39.
- Psammobia (Gari) tripartita* Deshayes.—Paetel, 1890: 41.
- Psammobia amethystus* (sic = error pro. *amethysta*) (Wood).—
Hidalgo, 1903: 84, no.167.
- Gari (Heteroglypta) amethystus* (sic = error pro. *amethysta*)
(Wood).—Lamy, 1918: 248-250.
- Gari (Gobraeus) amethystus* (sic = error pro. *amethysta*)
(Wood).—Prashad, 1932: 303, 304.
- Gari gari* (Linné).—Lemche & Parker, 1962: 375-377, figs 1-
4.
- Gari (Gari) sp. aff. amethystus* (sic = error pro. *amethysta*)
(Reeve) (sic = error pro. Wood).—Shikama, 1964: 84, pl.50
fig.7.
- Gari (Gari) amethystus* (sic = error pro. *amethysta*) (Wood).—
Keen in Moore, 1969: N631, fig.E115, no.11.—Springsteen
& Leobrera, 1986: 300, pl.85 fig.15.—Lamprell & Whitehead,
1992: 58, pl.53 fig.395.
- Gari amethystus* (sic = error pro. *amethysta*) (Wood).—Slack-
Smith, 1990: 137.—Oliver, 1992: 162, pl.36 fig.9a,b.

Comments on synonymy. Historically, the name of this species has been confused with that of the species now known as *Gari truncata* (Linné) because Chemnitz (1782) illustrated shells of both species under the same name and indicated no preference for one above the other. A decision by ICZN has

now clarified the taxonomy of both species (ICZN, 1970: 16 Opinion 910). Reeve (1856: *Psammobia* pl.3, species 19) exacerbated the situation by figuring a shell of *Gari radiata* (Dunker in Philippi, 1845) under the name of *Psammobia amethystus* (Willan, 1992).

Prashad (1932) has already presented a synonymy for this species in which he recognised *Solen amethystus* Wood and *Psammobia tripartita* Deshayes as synonymous. *P. amoena* Deshayes is another synonym, being based on an almost completely white shell; actually the holotype's right valve does possess brown mottlings externally, but these are much fainter than those depicted for this shell by Reeve (1856). Bertin (1880:114) wrongly incorporated *P. bipartita* Philippi into the synonymy of this species. *Gari mirabilis* Bertin is a name based on two particularly compressed and elongate specimens from Madagascar; the sculptural differences advanced by Bertin to support this species are part of the variation of *G. amethysta*.

Besides the formal synonyms given above, there are at least two manuscript names for this species. Bertin (1880) and Lamy (1914) both suggested that Lamarck intended to call it *Psammobia furcellata*, and indeed there is a 69.3 mm complete specimen in MNHN (Fig.150) accompanied by a Lamarckian label to that effect, but that name was never published. Neither was *Gari bardwelli*, a name that Iredale intended to bestow on shells from northern Western Australia [according to a note with two shells in AMS (C81321 presented by Beresford E. Bardwell)].

Smythe (1979:78) separated *G. tripartita* from *G. amethysta* on sculpture, but she seems to have relied on Woods' (1815) original figure of *Solen amethystus* as the only comparative material of that species. In fact shells referable to the two taxa show no significant sculptural differences. Besides that, the type locality of *G. tripartita* is the Philippine Islands, so Smythe's apparent attempt to localise it from the Arabian (= Persian) Gulf is wrong.

The specific name is obviously adjectival, and therefore it must be spelt *amethysta* to agree with the feminine gender of the genus *Gari*.

The best illustrations of this species are those by Chemnitz (1782: pl.10 fig.93), Reeve (1856: *Psammobia* pl.3, species 20) and Bertin (1880: pl.4 fig.2a,b). Both the specimens illustrated as *Gari amethystus* by Dharma (1992:pl.25 fig.3,3a) are *G. maculosa* (Lamarck).

Types. *Gari vulgaris* Schumacher: paralectotype (= specimen figured by Schumacher, 1826: pl.9 fig.2) (complete specimen - 51.3 mm) in ZMUC; illustrated by Lemche & Parker, 1962: pl.6 figs 1-4 (Fig.149). [I do not consider this shell is the one figured by Chemnitz (1782: pl.10 fig.93) because that shell is larger (58.3 mm - measured from figure) and it was in Chemnitz' own collection.]

Solen amethystus Wood: type material ought to be in BMNH, but not found there (S. Morris, personal communication, 1987; personal search, 1989). Type locality India.

Psammobia caerulescens Lamarck: type material ought to be in MNHN, but it cannot be found there and is presumed lost (Bertin, 1880; Lamy, 1914); not found in MNHN during

personal search in 1989. [See remarks above regarding the 69.3 mm complete specimen in Lamarck coll., MNHN]. Not found during personal search in MHNG in 1989. Type locality "les mers de l'Inde".

Psammobia tripartita Deshayes: lectotype, here designated (figured syntype, complete specimen - 66.9 mm) in BMNH (196414); figured by Reeve, 1856: *Psammobia* pl.3, species 20 (Fig.151). Paralectotypes (complete specimens - 62.5, 58.2 mm) in BMNH (196415/1,2 respectively). Type locality Philippine Islands.

Psammobia amoena Deshayes: holotype (complete specimen - 47.9 mm) in BMNH (1964010); figured by Reeve, 1856: *Psammobia* pl.4, species 36 (Fig.152). Type locality unknown.

Gari mirabilis Bertin: holotype (complete specimen, but right valve badly damaged - 50 mm, left valve - 55.0 mm) in MNHN; figured by Bertin, 1880: pl.4 fig.2a,b (left valve Fig.153). Paratype (complete specimen, right valve - 48.3 mm, left valve badly damaged in central area - 48.5 mm) in MNHN. Type locality Madagascar.

Material examined. AUSTRALIA – WESTERN AUSTRALIA: 1h, South Passage, Shark Bay (WAM 1091-68); 1h, 5.5 m, mainland side South Passage, Shark Bay (WAM 1317-68); 3c, 1h, 3.5-7.5 m, south-east corner Dirk Hartog Island (WAM 1716-68); 1c, 73 m, 16 km west of Bernier Island (WAM); 1c, Bay of Rest, Exmouth Gulf (WAM); 1h, Learmouth, Exmouth Gulf (WAM 1721-68); 3c, Exmouth Gulf (AMS C69351; WAM; Willan coll.); 1h, 11-18 m, west Flat Island, Onslow (WAM); 3h, south-east Sholl Island, Passage Islands (WAM); 2c, east side Pascoe Island (WAM); 3c, Nickol Bay, Dampier (Hodge coll., AUZ); 3c Regnard Bay, Dampier (Turnbulle coll.); 4c, Dampier (WAM; Lamprell coll.); 1c, 1h, 0 m, north-east Rosemary Island, Dampier Archipelago (WAM); 1c, 9 m south-east Rosemary Island, Dampier Archipelago (WAM 1719-68); 1c, Norbil Bay, Rosemary Island, Dampier Archipelago (WAM); 1c, 23.5-33 m, between Gidley Island and Rosemary Island, Dampier Archipelago (WAM); 1h, approximately 23.5 km west of Eaglehawk Island, Dampier Archipelago (WAM); 1c, 2h, Point Samson, north Roebourne (WAM 1715-68, 1720-68); 21c, Broome (AIM AM17627, AM17636; AMS C72065, C81321, C124397, C124398; NMU, QM; WAM 1714-68); 1c, Goldwires Well, south-east Roebuck Bay (NMU F428); 4c, Roebuck Bay (AMS C121364; NMU).

SOLOMON ISLANDS: 2c (Lamprell coll.; Whitehead coll.); 1h, Alligator Creek, east Honiara (WAM 890-85); 2h, Duke of York Island, New Britain (AMS C68227). PAPUA NEW GUINEA: 3c, 3h, Cape Studest (CAS 35446); 1c, Buna and Gona Beaches, Popondetta (NMU); 1c, Cape Killerton (NMU). PHILIPPINE ISLANDS: 5c (AMS C38722; NHMW G6795, 35653; NMU F24790); 1h, 4 m, off Tabangao, Luzon Island (AMS C104739); 1c, trawled, off Manila, Luzon Island (MNHN); 2c, 2-5.5 m, Bauan, Batangas Bay, Luzon Island (WAM); 1h, Villa Carmen, Cabcaben (WAM 1702-68); 1c, Cebu Island (NHMW G1769); 3c, San Nicholas Island, off Cebu Island (BMNH 196414, 196415/1,2 - lectotype & paralectotypes of *Psammobia tripartita* Deshayes); 1c, Sulu Archipelago (WAM 1717-68); 3c, south lagoon, Sibutu Island, Sulu Archipelago (WAM 1718-68). INDONESIA: 1c, Ambon Island (BMNH); 1c, 1.5 m, Matih Island, north side Outer Bay, Ambon Island (WAM); 1c, Mobukken, Ambon Island (NHMW E36058); 2c, Celebes Island (NMV); 1h, 24 m, Corindon, Celebes Island - 01°56'S 119°17'E (MNHN); 3h, 70 m, Java - 08°23'S 114°29'E (ZMUC). INDIA: 1c, 1h (WAM 11435); 4c, Malabar (NMU). SRI LANKA: 3c (AIM AM17638; AMS C38110; BMNH). PERSIAN GULF: 2h, Ras-al-Khaimah (BMNH); 1h, 65 m, 40 km north-north-east Cape Mussandam (BMNH).

MADAGASCAR: 2c (MNHN - holotype & paratype of *Gari mirabilis* Bertin).

LOCALITY UNKNOWN: 1c (BMNH 1964010 - holotype of *P. amoena* Deshayes).

Description. Maximum length 70 mm. Shell light to moderate in weight; transversely elongate; greatest width at level of umbones; slightly inequilateral, umbones displaced a little towards anterior end (equally so in juveniles); valves decidedly compressed, inequivalve, left relatively flatter; commissure at junction of shells' ventral margins sinuous; anterior end rounded; ventral margin straight or a little convex midcentrally; posterior end slightly broader than anterior end and rather more blunt, pointed-truncate at posterior extremity, particularly so on right valve of adults (never subrostrate); shells gape anteriorly and posteriorly. Surface of both valves polished, with prominent sculpture. Both valves with 3 distinct sculptured sections, anterior area with relatively few, broad, flat-topped, concentric cords, central area with numerous, fine, rounded, concentric cords that terminate at different positions on the 2 valves; on the right valve they run over one weak posterior ridge to a second ridge that terminates at posterior extremity, but on left valve cords cease at position corresponding to the first weak ridge on right valve and remaining area is smooth except for growth striae; posterior area (= posterior slope) of right valve with relatively narrow, concentric growth striae that are stronger and lamellate and also fine radial striae that produce microscopic scales or nodules where they intersect concentric striae (especially noticeable at posterodorsal margin near nymph); radials become obsolete near posterior end as do scales; posterior area of left valve smooth except for growth striae, occasionally with obsolete radials. Exterior covered with a thin, pale brown periostracum that readily wears off.

Hinge plate narrow; nymph elongate, moderately developed; shell with narrow, thickened ridges running parallel to both anterior and posterior dorsal margins, ridge next to posterodorsal margin on right valve with a small knob (= ? posterior lateral tooth) mid-way along its length (ie, immediately above posterior adductor scar) in adults. Right valve with 2 cardinals, each oblique, of approximately equal strength, anterior one weakly bifid, rear one strongly so, diverging by 60° from each other. Left valve with 2 cardinal teeth; anterior one much stronger, deeply bifid; rear one merely a lamella on hinge plate, sloping obliquely at 60° behind anterior cardinal; short lunular projection on hinge plate in front of anterior cardinal, stronger than rear cardinal. Pallial sinus moderately deep (reaches level with umbones), not particularly broad; upper limb short, runs obliquely downward to convex anterior margin; lower limb confluent with pallial line for most of its length; ventral extremity of pallial line upturned, reaches level with rear of posterior adductor scar. Single pedal retractor scar present dorsally in front of hinge plate.

Colour of exterior creamish white or lilac, closely mottled, rayed with interrupted, brownish purple lines

that emanate from umbones, rays in some shells consist of close maculations, some shells possess broad purplish concentric zones; interior of shell white, faintly purple-rayed near margins. Teeth, hinge plate and nymph white.

Remarks. *Gari amethysta* has a number of distinctive features, these being: its elongate shape; compressed valves; inequivalve condition and consequent sinuous commissure; pointed-truncate posterior extremity; anterior and posterior gapes; sculpture that is discordant between the 2 valves; obsolete right posterior lateral tooth; presumptive left anterior lateral tooth (better developed than in any other species of the subgenus *Psammobia*).

Colouration varies intraspecifically. The description of colour given above – cream to fawn ground with pale brownish purple rays (the fawn morph) – relates to shells from Australian populations (Figs 154, 155). It is also possessed by shells from (some localities in) the Philippine Islands, Java and Gulfs of Oman and Aden. However, populations elsewhere have a darker colour overall, the ground being lilac or amethyst, and the superimposed rays violet or purple (the violet morph) (Figs 151, 157). Apparently both morphs occur in the Philippine Islands, but never together in the same locality. No other character varies concordantly, so both colour morphs obviously constitute part of the genome of the same biological species. Since both morphs overlap

within the distribution range (Fig.12), separation as subspecies purely on the basis of colour variation is unwarranted.

In shape and colouration, *Gari amethysta* resembles the Asian *G. radiata* (Dunker in Philippi) and the New Zealand *G. convexa* (Reeve) and *G. lineolata* (Gray in Yate). Actually, Reeve (1856: *Psammobia* pl.3, species 19) did illustrate a shell of *G. radiata* under the name of *Psammobia amethystus*. However, the sculpture of *G. amethysta*, which shows negligible intraspecific variation, always enables separation of that species and *G. radiata* (Willan, 1992). A further resemblance between *G. lineolata* and *G. amethysta* is seen in the shape of the pallial sinus with its similar extent and obliquely sloping upper limb, however the anterior margin of the sinus is more acute in *G. lineolata*.

Gari amethysta could be confused with some individuals of *G. maculosa* (Lamarck) on the basis of similarity of colouration, particularly the dark violet morph of *G. maculosa* (form *praestans*). But there are always strong white and/or brown maculations on the outside of the valves of *G. maculosa*, and in addition *G. maculosa* has a more solid and inflated shell with a truncate (never pointed-truncate) posterior end, it has stronger obliquely-directed cords on the anterior and central areas, and there are well-developed (irregularly lamellate) striae on the posterior slope of the left valve.

Gari sibogai Prashad has cancellate sculpture and scales on the posterior slope of the right valve (Fig.11),

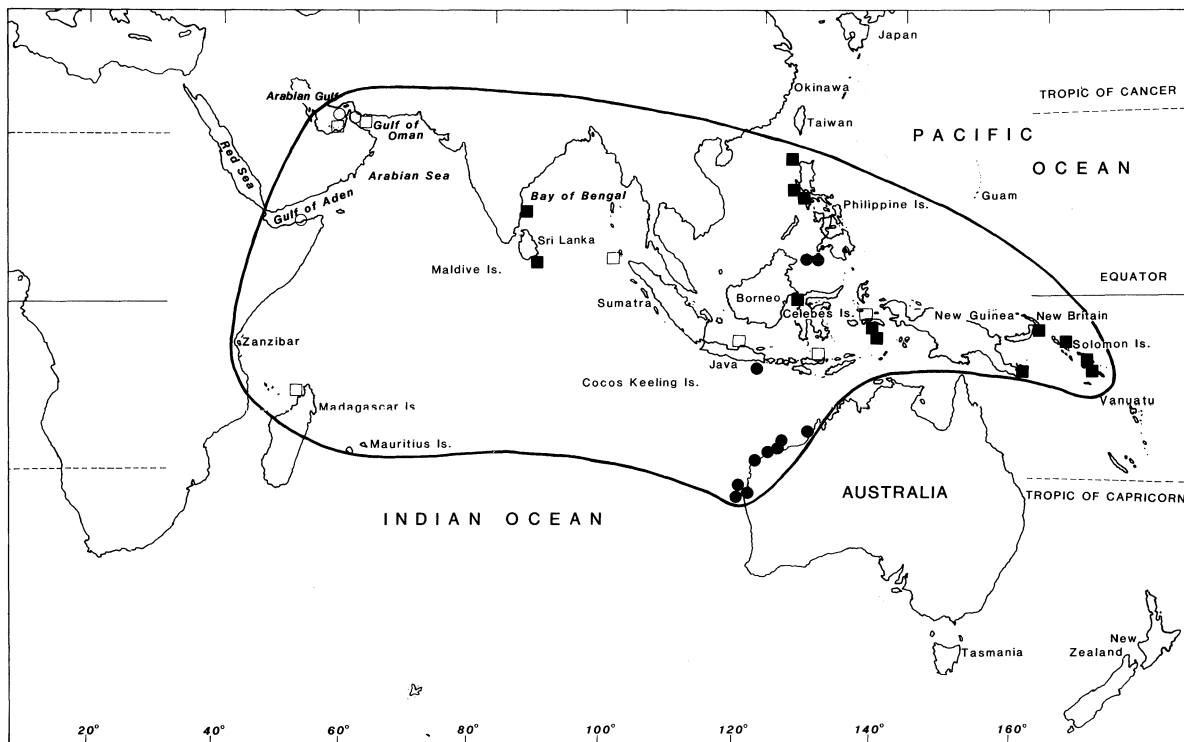


Fig.12. Distribution of *Gari amethysta* (Wood): closed circles represent localities from which specimens of pale fawn colour morph were examined; closed squares represent localities from which specimens of violet colour morph were examined; open circles and open squares represent literature records for the two morphs respectively.

but this sculpture is stronger than in *G. amethysta* and the remainder of both valves (except the posterior slope of the left valve) has oblique cords as is typical of members of the subgenus *Gari*.

Habitat. *Gari amethysta* is apparently only inhabits clean sands. Dead yet still complete shells wash ashore occasionally on open beaches.

Based on available specimens, the depth range for living specimens is 1.5 to 73 m. Most records are between 5 and 20 m. The absence of any records from depths between 33 and 66 m probably indicates a lack of sampling rather than a bimodal bathymetric distribution.

Distribution. *Gari amethysta* is restricted to the tropical Indian Ocean (Fig.12). Literature records are as follows: Western Australia (Slack-Smith, 1990); Philippine Islands (Deshayes, 1855; Reeve, 1856; Hidalgo, 1903); Moluccas Islands (Hanley, 1843); Java and Flores Island (Martens 1897); Ambon Island, (Prashad, 1932); Nicobar Islands (Chemnitz, 1782); India (Wood, 1815; Lamarck, 1818); Gulf of Oman (Bosch & Bosch, 1982); Persian Gulf (Smythe, 1979, 1982); Gulf of Aden (Lamy, 1918); Madagascar Island (Bertin, 1880). Despite its considerable latitudinal range in Western Australia (from Roebuck Bay to Shark Bay) and relative abundance, its presence there has only recently been recorded (Slack-Smith, 1990). Lack of any specimens from the Timor and Arafura Seas probably indicates absence of suitable substrates.

Gari (Psammobia) livida (Lamarck, 1818)

Figs 158-170, 390

- Psammobia livida* Lamarck, 1818: 515, *Psammobia* species 17.–Blainville, 1826: 480.–Deshayes & Milne-Edwards, 1835: 178, *Psammobia* species 17.–Hanley, 1843: 58.–Dautzenberg & Fischer, 1913: 486, 1914: 224, pl.7 figs 4-6.–Lamy, 1914: 61.–Cotton & Godfrey, 1938: 262 fig.296.–Macpherson & Chapple, 1951: 153.
- Psammotaea zonalis* Lamarck, 1818: 517, *Psammobia* species 2.–Deshayes & Milne-Edwards, 1835: 182, *Psammobia* species 2.–Hanley, 1843: 60.
- Psammobia puella* Deshayes, 1855: 320, no.14.–Reeve, 1857: *Psammobia* pl.1, species 2.
- Psammobia compta* Deshayes, 1855: 321, no.18.–Reeve, 1856: *Psammobia* pl.4, species 24.–Willan, 1992: 227.
- Psammobia striata* Deshayes, 1855: 321, no.20.–Paetel, 1890: 40.
- Psammobia zonalis* (Lamarck).–Reeve, 1856: *Psammobia* pl.5, species 29.–Chenu, 1858, *Psammobia* pl.1 fig.9a-c.–E.A. Smith, 1885: 94.–Tate, 1887a: 87, no.38.
- Psammobia tellinaeformis* Reeve (not Deshayes), 1856: *Psammobia* pl.5, species 31.
- Gari zonalis* (Lamarck).–Angas, 1867: 917, no.38.–Tryon, 1868: 76, no.42.–Tenison-Woods, 1878a: 49.–Bertin, 1880: 109, no.27.–Whitelegge, 1889: 237, no.55.–Tate & May, 1901: 425.–Pritchard & Gatliff, 1903: 113.
- Gari compta* (Deshayes).–Tryon, 1868: 73, no.8.
- Gari puella* (Deshayes).–Tryon, 1868: 75, no.29.

- Gari tellinaeformis* (Deshayes).–Tryon, 1868: 75, no.37.–Bertin, 1880: 109, no.26.
- Gari striata* (Deshayes).–Tenison-Woods, 1878a: 49.
- Gari livida* (Lamarck).–Bertin, 1880: 109, no.25.–Hedley, 1918a: M28, no.281.–May, 1921: 25, no.193, 1923, pl.11 fig.9.–Iredale, 1924: 212, 213.–Allan, 1950: 341, fig 80, no.1.–Cotton, 1961: 279 fig.305.–Macpherson & Gabriel, 1962: 373, fig.435.–Ludbrook, 1978: 68.–Willan, 1980: 178.–Richmond, 1990: 57, no.158.–Willan, 1992: 231, figs 14, 15, 21.
- Psammobia hamiltonensis* Tate, 1885 n.syn.: 4, 1887b: 167, pl.16 fig.13.
- Psammobia (Gari) compta* Deshayes.–Paetel, 1890: 39.
- Psammobia (Gari) puella* Deshayes.–Paetel, 1890: 40.
- Psammobia (Gari) tellinaeformis* Deshayes (sic = error pro. Reeve).–Paetel, 1890: 41.
- Psammobia (Gari) zonalis* Lamarck.–Paetel, 1890: 41.
- Sanguinolaria livida* (Lamarck).–Lamy, 1914: 3.
- Milligareta livida* (Lamarck).–Iredale & McMichael, 1962: 25, no.421.
- Gari hamiltonensis* Tate.–Darragh, 1970: 138.
- Gari (Gari) livida* (Lamarck).–Lamprell & Whitehead, 1992: 56, pl.52 fig.388.

Comments on synonymy. Dautzenberg & Fischer (1913, 1914) were the first to realise that Lamarck's two names, *Psammobia livida* and *Psammotaea zonalis*, represented the same species and were identical to *Psammobia tellinaeformis* Reeve. E.A. Smith (1885) had earlier concluded that *Psammobia puella*, *P. compta* and *P. striata* all of Deshayes, as well as *P. tellinaeformis* Reeve, applied to the one species for which he used the "Lamarckian" name *Psammobia zonalis*; he also erroneously added *Psammobia radiata* Dunker (sic = error pro. Dunker in Philippi) to the synonymy. Smith's conclusions formed the basis for later synonymies, notably those of Pritchard & Gatliff (1903) and May (1921). Pritchard & Gatliff (1903) excluded *P. tellinaeformis* and *P. radiata* without explanation. Prashad (1932:300) disagreed strongly with Smith's incorporation of *P. radiata* on the grounds of shape and sculpture. I concur with Prashad in interpreting *P. radiata* as the valid name for a tropical Asian species (Willan, 1992).

Iredale (1924) introduced confusion by claiming Lamarck's type material of *Psammobia livida* consisted of two species. He misinterpreted the shell depicted in figures 4 and 5 of Dautzenberg & Fischer's (1914) plate 7. The separated valves illustrated therein, which are in MNHN, come from a perfectly typical *P. livida* (Figs 158,159), as also does the single left valve depicted in Dautzenberg & Fischer's figure 6.

Furthermore, Iredale (1924) also sparked uncertainty regarding the type locality for *Psammobia livida* which was originally cited as "la baie des Chiens marins" by Lamarck (1818:515). Cotton & Godfrey (1938:262) and Cotton (1961: 279) indicated the type locality was probably southern Tasmania, whereas Ludbrook (1978:68), presumably following Iredale, gave Shark Bay, Western Australia. The former Tasmanian locality is more credible because *P. livida* only extends to Albany in southern Western Australia, definitely not as far north as Shark Bay.

In order to end the controversy over the status of *Psammobia compta* Deshayes, a debate fuelled by Reeve's (1857), Tryon's (1868) and Bertin's (1880) interpretations, I have herein selected as lectotype a shell from the syntopic series that conforms in description and especially type locality ("Van Diemen's Land" ie, Tasmania, Australia), to Deshayes' original concept. The wooden tablet in BMNH supporting

Deshayes' three syntypes bears, in fact, two species; 1837.7.15.310 and 1841.2.6.423 belong to *Psammobia livida*, whereas 1837.7.15.144 is *P. radiata* Dunker in Philippi. Consequently I have selected one of the Australian specimens (1841.2.6.423) as lectotype in order to fix the name *P. compta* Deshayes as a junior subjective synonym of *P. livida* Lamarck. This selection was foreshadowed in my study of *Gari radiata* (Willan, 1992:229). The lectotype is illustrated here in Figure 162.

Psammobia hamiltonensis Tate is a junior synonym based on fossils from the upper beds of the Grange Burn formation at Muddy Creek, Victoria. The features of shape on which Tate (1885, 1887a) distinguished *P. hamiltonensis* from *P. livida* (as *P. zonalis* Lamarck) vary intraspecifically. In fact there is no character separating the syntypes or other series (AM F2039) from Recent *G. livida*. Although all the beds at Muddy Creek were originally thought to be Miocene in age, the upper strata are now known to be Middle Pliocene (Kalinman) in age (Spencer-Jones, 1971:247; Abele *et al.*, 1988:289; B. McHenry, personal communication, 1990).

Types. *Psammobia livida* Lamarck: lectotype, here designated (larger syntype, single left valve - 28.0 mm) in MNHN; figured by Dautzenberg & Fischer 1914: pl.7 fig.6 (Fig.158). Paralectotype (complete specimen with hole in center of left valve - 24.8 mm) in MNHN; figured by Dautzenberg & Fischer, 1914: pl.7 figs 4,5 (Fig.159). Type locality "la baie des Chiens marins, Nouvelle-Hollande".

Psammobia zonalis Lamarck: holotype (complete specimen - 42.5 mm) in MHNG (1083/22); figured by Delessert, 1841: pl.5 fig.9a-c (Fig.160). Type locality unknown. Specimen figured as *Psammobia zonalis* Lamarck by Reeve, 1856: *Psammobia* pl.5, species 29 (complete specimen - 34.8 mm) in BMNH (1985181).

Psammobia puella Deshayes: holotype (right valve complete - 26.1 mm; left valve broken) in BMNH (1984289); figured by Reeve, 1857: *Psammobia* pl.1, species 2 (Fig.161). Type locality Australia.

Psammobia compta Deshayes: lectotype, here designated (complete specimen - 35.4 mm) in BMNH (1841.2.6.423) (Fig.162); illustrated by Willan, 1992: fig.14. Paralectotype (complete specimen - 27.4 mm) in BMNH (1837.7.15.310). Additional paralectotype (complete specimen of *P. radiata* Dunker in Philippi - 52.4 mm) in BMNH (1837.7.15.144); illustrated by Willan, 1992: fig.3. Type locality Van Diemen's Land (= Tasmania).

Psammobia striata Deshayes: possible syntypes (complete specimens - 44.4, 38.8 mm) in BMNH (1842.11.2.8,9 respectively) (left valve of larger specimen Fig.163). Type locality Van Diemen's Land (= Tasmania).

Psammobia tellinaeformis Reeve: lectotype, here designated (figured syntype, complete specimen with circular hole near centre of right valve - 34.9 mm) in BMNH (1985182/1); figured by Reeve, 1856: *Psammobia* pl.5, species 31 (Fig.164). Paralectotypes (complete specimens - 33.7, 31.7 mm) in BMNH (1985182/2,3 respectively). Type locality unknown.

Psammobia hamiltonensis Tate: lectotype, here designated (probable figured syntype, single right valve with broken ventral margin - 30.8 mm) in SAM (T1190A); figured (as a left valve) by Tate, 1887b, pl.16 fig.13 (Fig.165). Paralectotypic series (5 right valves and 4 left valves) in SAM (T1190B-J). Type locality Muddy Creek, Hamilton, Victoria. Type locality Muddy Creek, Hamilton, Victoria.

Material examined. "AUSTRALIA": 1c,1h, "Baie des Chiens marins" (MNHN - lectotype & paralectotype of *Psammobia livida* Lamarck); 1c (BMNH 1984289 - holotype of *P. puella* Deshayes).

AUSTRALIA - QUEENSLAND: 10h, on beach at south end The Esplanade, Burleigh Heads (Willan coll.); 125h, 19-28 m, approximately 2 km off Tugun Beach (Willan coll.). NEW SOUTH WALES: 1c, Iluka, Clarence River mouth (AMS); 1h, Angourie (WAM 1063-70); 2h, South West Rocks, Trial Bay, north-east Kempsey (WAM 1062-70); 1h, Hawk's Nest, Port Stephens (WAM 1061-70); series, Palm Beach, Broken Bay (WAM 1060-70); 3h, between Collaroy and Narrabeen Beaches, north of Sydney (Whitehead coll.); 5h, Cronulla Beach (Willan coll.); 1h, Bundeena, Port Hacking (WAM); 25c,3h, Twofold Bay (AMS C74201; NMNZ MF27524; WAM 1056-70). VICTORIA: 1c (Whitehead coll.); 1c, north-east Snake Island (Noonan coll.); 1c, Port Welshpool (Marrow coll.); 1h, Walkerville, Waratah Bay (WAM 1055-70); 10c, 9 m, off San Remo Back Beach (NMV); 2c, Western Port (Marrow coll.); 1c, 10-20 m, Western Port (ZMUC); 1c, 9-19 m, Hastings, Western Port (ZMUC); 12c, Port Phillip Bay (QM); 1c,1h, Gabo Island (NMV); 10h, upper beds, Grange Burn Formation, Muddy Creek, W Hamilton (SAM T119A-J - lectotype & paralectotypes of *P. hamiltonensis* Tate); 22h, upper beds, Grange Burn Formation, Muddy Creek, west of Hamilton (AMS F2039); 1c, McDonald's (AMS). TASMANIA: 2c (BMNH 1837.7.15.310, 1841.2.6.423 - lectotype & paralectotype of *P. compta* Deshayes); 2c (BMNH 1842.11.2.8,9 - possible syntypes of *P. striata* Deshayes); 19c,11h (CAS 223; Kroll coll.; NHMW G6793, 17379; NMNZ MF3796, MF3859, MF11953; QM; WAM 1787-68); 1c, north coast (Lamprell coll.); 8c, Browns River, north Tasmania (NMNZ MF11952); 12c, Bridport, north Tasmania (NMNZ MF3864); 1c, Coles Bay, west Freycinet Peninsula (NMNZ MF 27473); 1c, east coast (AMS C39180); 5c, Frederick Henry Bay, south-east coast (AMS C108162); series, Sandy Bay, Hobart (AMS C111408); 9c, Derwent Estuary, south-east coast (WAM 1053-70); 1h, South Arm, mouth Derwent Estuary, south-east coast (Noonan coll.); 3c, Bruny Island, south-east coast (WAM 1052-70); 8c, Southport, south-east coast (WAM 1051-70); 4c, Stanley, north-west coast (WAM 1054-70). SOUTH AUSTRALIA: 1c (QM); 3c, 18 m, Port Lincoln (NMV). WESTERN AUSTRALIA: 4h, Emu Point, Albany (AMS C90933); 2h, channel between Emu Point and Green Island, Oyster Harbour, Albany (WAM N3151).

LOCALITY UNKNOWN: 1c (MHNG 1083/22 - holotype of *P. zonalis* Lamarck); 3c (BMNH 1985182/1-3) - lectotype & paralectotype of *P. tellinaeformis* Reeve).

Description. Maximum length 45 mm. Shell moderately heavy, elongate-ovate; greatest width at level of umbones; adults nearly equilateral (umbones displaced a little posteriorly); juveniles more noticeably inequilateral; inflated; anterior end rounded; ventral margin evenly convex; posterior end rounded, subtruncate, sometimes subacute at intersection of posterodorsal and ventral margins (Fig.168); equivalve (but left valve slightly flatter in large adults); commissure at junction of shells' ventral margins straight; negligible anterior and small posterior gapes. Surface of both valves smooth, polished; sculptured with numerous, broad, flat-topped concentric cords that are most pronounced near anterodorsal margin; cords form distinctive, sharp lamellae on posterior slope of right

valve that extend to posterior ridge; posterior slope of left valve smooth, with obsolete concentric striae. Exterior with a thin, dehiscent, brown periostracum.

Hinge plate narrow, moderately elongate; ligament moderately thick, high. Right valve with 2 cardinal teeth, each oblique and of approximately equal strength, anterior one very weakly bifid, rear one strongly so, diverging by 60° from each other. Left valve with a single, deeply bifid anterior cardinal; posterior cardinal represented by no more than a weak, low ridge on hinge plate, sloping at 65° obliquely behind anterior cardinal; no lunular projection on anterior end of hinge plate. Pallial sinus obvious, deep (reaching half way between hinge plate and posterior adductor scar); broad, U-shaped; upper limb runs straight across middle of shell; anterior margin broadly rounded; lower limb confluent with pallial line for most of its length; ventral extremity of pallial line directed straight backward, reaches level with middle of posterior adductor scar. Single pedal retractor scar present dorsally in front of hinge plate.

Colour of exterior pale cream or livid pink, rayed with few or many, broad, subdued, pale fawn or purplish pink rays that emanate from white umbones; rays not symmetrical on right and left valves. Interior uniformly purplish pink, without any indication of external rays. Teeth white; rear of hinge plate and nymph flushed with pink.

Remarks. *Gari livida* is a moderate-sized psammobiid, distinctive on account of its subtruncate or subacute posterior end, equivalve condition, sculpture (especially the lamellate striae on the posterior slope of the right valve), U-shaped pallial sinus, and colouration.

Gari livida shows intraspecific variation in shape and colouration. That related to shape appears to be clinal. In comparison to shells from southern Australian waters, those from New South Wales and Queensland populations are relatively narrower and more elongate, having the posterior end narrower than the anterior end and the posterodorsal margin sloping more acutely so that the posterior end is more pointed (Fig.168). Colour variation does not appear to be clinal. The colouration described above is typical of shells from Victoria and Tasmania; South Australian shells are cream all over (Cotton, 1961). Uniformly white or yellow shells occur with low frequencies in all populations. Sculptural variation seems to be negligible.

Amongst Recent species of the subgenus *Psammobia*, *Gari livida* is most closely related to *G. convexa* (Reeve) from New Zealand and they have already been compared by E.A. Smith (1885) and Willan (1980). However, because these two species agree so much in shape, sculpture, dentition and pallial sinus, a further comparison is warranted here. *Gari convexa* attains a considerably larger adult size (nearly twice as large), its valves are not only more inequilateral but also usually markedly inequivalve and the commissure is curved, the striae on the posterior slope never extend to the posterior ridge, the ventral extremity of the pallial line reaches relatively further posteriorly and the

colouration is usually more showy with concentric zones interrupted by bright pink or red rays. Because *G. livida* and *G. convexa* are so close, it would appear that both evolved from a common ancestor. The third, and only other closely related, Recent species sharing striae on the posterior slope of the right valve is the tropical Asian *G. radiata* (Dunker in Philippi). In comparison to *G. livida*, that species is larger, more elongate, the striae on the posterior slope are coarser and less numerous, the upper limb of the pallial sinus is more bent, the shell's ground colour is mottled and its overall colouration is more like that of *G. convexa* (Willan, 1992).

Gari livida is sympatric with *G. kenyoniana* (Pritchard & Gatliff) in south-eastern and southern Australian waters; however, that species differs in being larger, heavier, more inequilateral and in possessing coarser sculpture. Another species that also occurs in these waters is *G. modesta* (Deshayes), but it is smaller and more elongate, its dorsal margin slopes less acutely, it has weaker oblique (not concentric) cords on the anterior and central areas and coarser lamellae on the posterior slope of the right valve (although the corresponding area on the left valve is smooth), its ground colour is usually bluish violet, its rays are narrower and darker, and its hinge plate and nymphs are flushed with violet.

Habitat. *Gari livida* inhabits (generally fine) clean sand substrates and it is predominantly a species of subtidal sand flats. It invariably occurs with *G. modesta*. Dead shells of *G. livida*, both complete specimens and isolated valves, wash ashore on open beaches.

The bathymetric range is from 0 to 64 m, although *Gari livida* is rare in the immediate subtidal.

Distribution. *Gari livida* is endemic to Australia. It is a relatively long ranging temperate water species extending from the Queensland/New South Wales border, along all the southern coast, to the vicinity of Albany in southern Western Australia. Within that distribution area, breeding populations are established from northern New South Wales through to western Victoria judging by the frequency with which shells are collected. Most shells in museums come from Tasmania.

Gari (Psammobia) convexa (Reeve, 1857)

Figs 171-179, 391

Psammobia convexa Reeve, 1857: *Psammobia* pl.8, species 59 (figs a,b).—Willan, 1980: 177, fig.3f-h.—Willan, 1992: 231, figs 13, 20.

Gari hodgei Willan, 1980 n.syn.: 174, figs 1a, 2a,b, 3i-n.—Grace & Hayward, 1980: 207.—Willan, 1981: 230, 246.—Hayward & Grace, 1981: 51.—Hayward *et al.*, 1982: 161.—Penniket, 1982: 71, pl.29 fig.115.—Cometti & Morton, 1985: 145.—Beu & Maxwell, 1990: 399.

Comments on synonymy. The present author showed in 1980 that, in New Zealand, two species of psammobiids were confused under the name *Gari lineolata* (Gray in Yate). Examination of the holotype of *Psammobia lineolata* showed that name was applicable to one, and the other species was newly named as *G. hodgei* after consideration of other Recent and fossil, New Zealand and foreign nominal species. For this reason references to, and accounts of, *Psammobia* (or *Gari lineolata* prior to 1980 must be considered as being composite.

Following publication of the description of *G. hodgei*, I received a letter from the late Dr R.A. Cumber saying that he had recognised two "forms" of *G. lineolata* in a collection of *Gari* shells he had made at Tahuna Beach, Nelson, in 1948; these "forms" were the species *G. lineolata* and *G. hodgei*. Obviously Dr Cumber had separated these two psammobiids many years before I had come to the conclusion they were distinct species.

In hindsight, I regret introducing the name *Gari hodgei* for this species instead of concluding it was really *Psammobia convexa* Reeve. However, the syntypes of *P. convexa* (in BMNH) are atypical specimens in not displaying the customary inequivalve condition, in possessing a straight (instead of curved) commissure between the shells' ventral margins, and in possessing stronger striae than normal on the right valve. Now, more than a decade after my paper on the subject (Willan, 1980), and with the opportunity to examine all *Gari* species worldwide, I realise there are only three Recent species of the subgenus *Psammobia* with striae confined to the posterior slope of the right valve. *Psammobia convexa* and *G. hodgei* must be synonymous because they are the only available names for the (New Zealand) species whose striae do not extend as far as the posterior slope (for examples see Figs 175,178), whereas the other two species, *G. livida* (Lamarck) and *G. radiata* (Dunker in Philippi), both possess striae extending to, or sometimes traversing, the posterior slope (Willan, 1992).

Only in those cases where a good illustration accompanies a reference, is it possible to know unequivocally whether an author intended to refer to *G. lineolata* or *G. convexa*. Therefore, illustrations of *G. convexa sensu stricto* appear only in works by E.A. Smith (1874:5, pl.2 fig.11), Suter (1915:pl.61, no.8), Bucknill (1924: pl.12, no.3), Dell (1955:49, no.115), Morton & Miller (1968:fig.181, no.5), Penniket & Moon (1970:pl.46 figs 2, 3), Child (1974:36, no.44), Grace & Whitten (1974:6,7) and Powell (1979:pl.76 fig.14). Penniket & Moon (1970) illustrated *G. convexa* on plate 46, figure 1 under the erroneous name of *Soletellina nitida* to which the accompanying text relates.

Types. *Psammobia convexa* Reeve: lectotype selected by Willan, 1980: 177 (complete specimen - 50.5 mm) in BMNH (1985185/2); figured by Reeve, 1857: *Psammobia* pl.8, species 59b; illustrated by Willan, 1980: fig.3f-h (Fig.171). Paralectotype (complete specimen - 46.9 mm; not 26.9 mm as erroneously stated by Willan, 1980: 177) in BMNH (1985185/1); figured by Reeve, 1857: *Psammobia* pl.8, species 59a (Fig.172). Type locality unknown.

Gari hodgei Willan: holotype (complete specimen - 77.9 mm) in AIM (TM-1360); illustrated by Willan, 1980: fig.3l (Fig.173). Paratypic series (10 complete specimens) in AIM (AM14290). Type locality Owenga, Chatham Islands.

Material examined. An extensive list of *Gari convexa* shells held in institutions and private collections in New

Zealand formed an appendix to my earlier paper (Willan, 1980:181-183), so only specimens in Australian and overseas museum collections are listed hereunder. The greatest number of specimens in any foreign institution are the 16 complete specimens in NHMW; all were collected at Hokianga by Andreas Reischek in 1879/80.

"NEW ZEALAND": 1h (BMNH 1869.2.8.40); 1c (MNHN).

NEW ZEALAND - NORTH ISLAND: 18c (QM; Lamprell coll.: Whitehead coll.); 2c, 1-2 m, High Island channel, off Taurikura, Whangarei Harbour entrance (WAM 188-86); 3c, Omaha Ocean Beach, Matakana, south Leigh (Kessner coll.; Whitehead coll.); 1c, Mercury Bay, east coast Coromandel Peninsula (QM); 16c, Hokianga (NHMW 16476, 16477, 16479, 16482, 16483). SOUTH ISLAND: 7c, Awarua, Southland (AMS C124208); 4c, Tahuna Beach, Golden Bay, Nelson (AMS). STEWART ISLAND: 6c (AMS C125622); 6c,13h, Halfmoon Bay, north-east coast (ZMUC); 3c, Horseshoe Bay, near Paterson Inlet (AMS C72265).

LOCALITY UNKNOWN: 2c (BMNH 1985 185/2,1 - lectotype & paralectotype respectively of *Psammobia convexa* Reeve).

Description. Maximum length 85 mm. Shell moderately heavy, elongate-ovate; greatest width at level of umbones; inequilateral, umbones displaced towards anterior end (especially so in large adults); anterior end rounded; ventral margin evenly convex; posterior end as broad as anterior end, pointed-truncate at posterior extremity, subrostrate in large adults; inequivalve, left valve relatively flatter; commissure at junction of shells' ventral margins curved (see Willan, 1980:fig.3k,n); small anterior and posterior gapes. Surface of both valves smooth, polished; sculptured with weak, flattened, concentric cords that are most numerous and prominent near dorsal margin; right valve with a ridge extending from umbo to posterior extremity; numerous, fine, raised, concentric striae present between posterodorsal margin and ridge; striae do not extend on to, or beyond, ridge onto central area; no striae in corresponding position on left valve. Exterior covered with a thin, dehiscent, greenish brown periostracum.

Hinge plate narrow, moderately elongate; nymph moderately developed; ligament moderately thick, high. Right valve with 2 cardinal teeth, each oblique, of approximately equal strength, diverging by 60° from each other; anterior one weakly bifid; rear one strongly bifid. Left valve with single, deeply bifid anterior cardinal; rear cardinal represented by no more than a slight, low lamella on hinge plate, sloping at 65° obliquely behind anterior cardinal; very weak lunular projection present on left valve in front of anterior cardinal. Pallial sinus deep (reaches half way between hinge plate and rear margin of anterior adductor scar), broad, U-shaped; upper limb runs straight across middle of shell; anterior margin broadly rounded; lower limb confluent with pallial line for most of its length; ventral extremity of pallial line downturned, reaches level with rear of posterior adductor scar. Single pedal retractor scar present dorsally in front of hinge plate.

Colour of exterior usually reddish orange with concentric zones of pink, purple, cream and red,

frequently interrupted by pale (either wide or narrow) red rays that originate from pale lavender pink to creamish pink umbones; rays not symmetrical on both valves. Interior uniformly purplish pink, rayed only at ventral margin. Teeth white; rear of hinge plate and nymph flushed with pink.

Remarks. The most important diagnostic characters of *Gari convexa* are its relatively large size, inequilateral shape, inequivalve condition, striae on the posterior slope of the right valve, U-shaped pallial sinus and radial colour zones that intersect the concentric bands on the shell's exterior. Willan (1980) gave full comparisons with the New Zealand Recent *G. lineolata* (Gray in Yate) and Miocene *G. oamarutica* Finlay. Beyond New Zealand, *G. convexa* is closely related only to the temperate Australian *G. livida* (Lamarck) and the tropical Asian *G. radiata* (Dunker in Philippi). Comparisons with *G. livida* have been presented earlier under the remarks section for that species. *Gari radiata* is slightly smaller when fully grown (to 60 mm), more equilateral, narrower, its posterior margin is relatively narrower and more truncate, its valves are both equally convex so the commissure is straight, the striae (which are stronger and less numerous) always extend across the posterior slope to the posterior ridge on the right valve, the background is finely mottled, the internal glaze is pinkish white, there are two thickened whitish ligamental buttresses radiating internally from the cardinal area below the umbones towards to the adductor scars (particularly evident in the right valve), and finally, the posterior adductor scar reaches level with the posterior edge of the nymph (see also Willan, 1992).

Habitat. *Gari convexa* inhabits clean, medium- to coarse-grained sands often in environments subject to current scour. Willan (1981) found *G. convexa* to be one of the characteristic species of clean sands in relatively protected habitats on the eastern coast of Stewart Island. *Gari convexa* regularly occurs with molluscs such as *Zeacolpus pagoda* (Reeve), *Zegalerus tenuis* (Gray) and *Myadora boltoni* E.A. Smith in northern New Zealand. In the south of New Zealand, molluscs such as *Maoricolpus roseus* (Quoy & Gaimard), *Pecten novaezelandiae* Reeve, *Tawera spissa* (Deshayes) and *Myadora striata* (Quoy & Gaimard) typically occur with *G. convexa*.

The records given by Willan (1980:181-183) indicate *Gari convexa* has a bathymetric range of 0 to 60 m, and that it extends continuously throughout that range.

Distribution. *Gari convexa* is endemic to New Zealand. It ranges throughout the North and South Islands, and also Chatham and Stewart Islands. No specimens are known from the Three Kings Islands immediately to the north, or any of the subantarctic islands to the south of New Zealand.

***Gari (Psammobia) lineolata* (Gray in Yate, 1835)**

Figs 180-185, 392

- Psammobia lineolata* Gray in Yate, 1835: 309.—Hanley, 1843: 59, pl.14 fig.1.—Gray in Dieffenbach, 1843: 253, no.181.—Reeve, 1857: *Psammobia* pl.8, species, 58.—Martens, 1873: 42.—Hutton, 1873: 66, no.33, 1880: 142.—E.A. Smith, 1874, pl.2 fig.11, 1885: 92.
Gari lineolata (Gray).—Tryon, 1868: 75, no.21.—Bertin, 1880: 121, no.63.—Willan, 1980: 173-180, figs 1b, 2c, 2d, 3a-c.—Eisenberg, 1981: 172, pl.154, no.19.—Hayward *et al.*, 1981: 120, 1982: 161.—Gunson, 1983: 76.—Cometti & Morton, 1985: 145.—Beu & Maxwell, 1990: 399.—Hayward, 1990: 5.
Gari (Psammocola) strangei (sic = error pro. *stangeri*) (Gray).—Shikama, 1964: 85, pl.50 fig.4 (misidentification, not *Psammobia stangeri* Gray in Dieffenbach, 1843).

Comments on synonymy. All other references that cite either *Psammobia lineolata* or *Gari lineolata* must be considered as composite (ie, providing insufficient detail to separate between *G. lineolata sensu stricto* and *G. convexa* (Reeve)). However, the following works all reproduce the same illustration which unquestionably shows the true *G. lineolata*: Moss (1908:pl.8 fig.17).—Powell (1937:pl.1 fig.13).—Powell (1961:pl.1 fig.13).—Powell (1976:pl.1 fig.13).

Details of the correct citation of authorship (ie, Gray in Yate, rather than Gray) and the type material of *Psammobia lineolata* are given elsewhere (Willan, 1980). The illustrations of this species in my earlier paper (Willan, 1980) reproduced badly, so they are both reproduced here for clarity (Figs 180,182).

The Maori name for *Gari lineolata* is Kuwhara or Takarape (Moss, 1908).

Types. *Psammobia lineolata* Gray in Yate: holotype (right valve with a crack and chipped margins - 41.4 mm; left valve with central break and chipped margins - 40.6 mm) in BMNH (1852.10.29.8); illustrated by Willan, 1980: fig.3a,b (Fig.180). [Willan, 1980: 177 gives further details about this specimen.] Type locality New Zealand.

Specimen figured as *Psammobia lineolata* Gray by Reeve, 1857: *Psammobia* pl.8 fig.58 (complete specimen - 54.5 mm) in BMNH (196451) (Fig.181). [Probably neither this specimen, nor the complete 55.7 mm specimen (BMNH 196452) in the same lot with it, constitute type material.]

Material examined. "NEW ZEALAND": 1c (BMNH 1852.10.29.8 - holotype of *Psammobia lineolata* Gray in Yate).

NEW ZEALAND - NORTH ISLAND: 56c, Taipa, Doubtless Bay (Boswell coll.; Grange coll.; Willan coll.); 2c, Whatawhiwi Beach, Doubtless Bay (Boswell coll.; Willan coll.); 1c, Tokerau Beach, Doubtless Bay (Coles coll.); 1h, 42 m, approximately 2.4 km west Hamaruru Island, Cavalli Islands (Willan coll.); 11c, Matapouri Beach, north Whangaroa (Willan coll.); 1h, Tauranga Bay, north Whangaroa (Willan coll.); 1c, Bland Bay, Whangaruru Harbour (Hole coll.); 1c, Church Bay, Tutukaka (Hole coll.); 4c, Tutukaka Harbour beach (Douglas coll. G4784); 1c, Whangarei Heads (NHMW E4550); 6c, 3-4.5 m, off High Island, Taurikura, Whangarei Harbour entrance (Willan coll.); 1h, Pakiri Beach, north Leigh (Willan coll.); 2c, 3-4.5 m, Leigh Harbour (Willan coll.); 15c.2h, 24-27 m, approximately 1 km off Ti Point, Leigh (Willan coll.); 2c, Matheson Bay, Leigh (Coles coll.); 137c.5h, Omaha Ocean Beach, Matakana, south Leigh (Hole coll.; Willan coll.); 4c.2h,

12 m, approximately 800 m offshore from middle of Omaha Ocean Beach, Matakana, south Leigh (Willan coll.); 4c, 9-12 m, off Jones' Bay, Takatu, Tawharanui Peninsula, south Leigh (Willan coll.); 2c, Baddley's Beach, south Leigh (Willan coll.); 6c, Sandspit, Warkworth (Penniket coll.); 1c, 6-9 m, Sandy Bay, Bon Accord Harbour entrance, Kawau Island (Willan coll.); 6c, Opahi Bay, Mahurangi (Coles coll.; Penniket coll.); 9c, Mahurangi South (Hole coll.); 1c, Waiwera Beach, north Auckland (Hole coll.); 6c, Hatfields Beach, north Orewa (Hole coll.; Willan coll.); 4c, Red Beach, south Orewa (Willan coll.); 8c, Takapuna Beach, Rangitoto Channel, Auckland (AIM AM13722; Grange coll.); 2c, 1h, Oneroa Beach, Waiheke Island (WAM 941-68); 1c, 2h, Little Oneroa Beach, Waiheke Island (Willan coll.); 9c, Piemelon Bay, Waiheke Island (Hole coll.); 2c, Beachlands Beach, Tamaki Strait (Willan coll.); 3c, Brophy's Beach, Whitianga (Coles coll.); 1c, Mercury Bay, east coast Coromandel Peninsula (QM); 4c, Matakana Island, Bay of Plenty (AIM AM33195); 5c, Mount Maunganui, Tauranga, Bay of Plenty (Hazelwood coll.; Hodge coll. 220, AUZ); 1c, Gisborne (Trevor coll.); 2c, Ohope Beach, Bay of Plenty (Hazelwood coll.); 1c, Westshore, Napier (Hazelwood coll.); 59h, Otaki Beach, Levin (Hazelwood coll.); 10c, Paekakariki, north Wellington (AIM AM13699); 2c, 2h, Raumati Beach, north Wellington (Hazelwood coll.; WAM); 1c, Paremata Harbour, Wellington (Hazelwood coll.); 2c, Wanganui (MHNG); 26c, 47 m, off Albatross Point, south Kawhai Harbour (ZMUC); 7c, Te Tau Bank, off Cornwallis, Manukau Harbour, west Auckland (Willan coll.); 2c, Puponga Point, Manukau Harbour, west Auckland (Douglas coll. G1265); 5c, Kakamatua Beach, Manukau Harbour, west Auckland (Hole coll.); 17c, 2h, north side Waikato River mouth (Douglas coll. G5102; Willan coll.); 1c, Waiuku Gap to Maioro Gap, south Auckland (Douglas coll. G3262); 5c, Orua Bay, Manukau Harbour entrance, west Auckland (AIM AM13703; Douglas coll. G1781); 1h, south end Piha Beach, north Auckland (Willan coll.); 1c, Bethells Beach, north Auckland (Willan coll.); 7h, south end Muriwai Beach, north Auckland (Coles coll.); 1c, Hokianga (NHMW 16483). SOUTH ISLAND: 1c, Picton, Marlborough Sounds (Hazelwood coll.); 3c, 18 m, near Tory Island, Queen Charlotte Sound, Marlborough (BMNH 1887.2.9.2539-2541); 1c, 140 m, Pegasus Bay, Canterbury (Willan coll.); 2c, Sumner, Christchurch (NHMW 25203); 1c, 2h, Big Bay, 48 km north Milford (Willan coll.); 2c, Coquille Bay, Abel Tasman National Park, Nelson (BMNH); 2c, Pakawau Bay, Collingwood, north-west Nelson (AIM AM33779); 100c, Pohara Beach, Golden Bay, Nelson (Hole coll.; QM; Willan coll.); 4c, Tomatea Point, Pakawau, Golden Bay, Nelson (Willan coll.); 7c, Tahunanui Beach, Golden Bay, Nelson (Lamprell coll.; WAM 1081-68). CHATHAM ISLAND: 6c (AIM; Hodge coll. 225, AUZ). STEWART ISLAND: 2c, Halfmoon Bay, north-east coast (Hazelwood coll.); 1c, 1h, Horseshoe Bay, near Paterson Inlet (Boswell coll.; Willan coll.).

Description. Maximum length 60 mm. Shell thin, elongate to elongate-ovate; greatest width at level of umbones; equilateral, umbones at middle of dorsal margin in both juveniles and adults; anterior end broadly rounded; ventral margin almost straight, bulging a little posteriorly; posterior end broadly rounded with only the merest indication of an angle at termination of posterior ridge, subtruncate in juveniles, never subrostrate, posterodorsal margin distinctly angled half way along its length; equivalve, both valves equally compressed; commissure at junction of shells' ventral margins straight; moderate anterior gape, small posterior

gape. Surface of both valves smooth, polished; sculpture of numerous, weak, flattened, concentric growth striae that are most pronounced close to anterodorsal margin. Exterior covered with a very thin, dehiscent orange-brown periostracum that is usually present only as a narrow band around ventral and posterior margins.

Hinge plate exceedingly narrow; nymph elongate. Right valve with 2, equally developed, delicate, sharp cardinal teeth, both bifid (the posterior one especially so), diverging obliquely by 60° from each other. Left valve with a single, deeply bifid anterior cardinal tooth, directed vertically downward; rear cardinal represent merely by a weak, low lamella, obliquely directed, diverging by 50° behind anterior cardinal; low, but sharply angled, lunular projection present on hinge plate immediately in front of anterior cardinal. Pallial sinus moderately deep (extends to level just in front of umbones), relatively broad; upper limb leaves middle of posterior adductor scar then descend obliquely without any change of direction; anterior margin acute; lower limb confluent with pallial line for most of its length; ventral extremity of pallial line upturned, reaches level with rear of posterior adductor scar. Anterior adductor scar circular-elliptic; posterior adductor scar circular; single, small, circular pedal retractor scar present dorsally in front of hinge plate.

Colour of exterior pale flesh or creamish pink (blood red when alive), marked with numerous, narrow or broad, reddish or purplish concentric bands, that occur symmetrically in both valves (Figs 184, 185); radials never present; umbones rose pink or purplish. Interior showing concentric markings and a thin purplish glaze that is darkest under hinge plate, margins white. Hinge plate purple; teeth and nymphs white.

Remarks. *Gari lineolata* possesses several distinctive characters, these being: its thin shell with the lightness of a species of *Soletellina*; high external gloss; lack of sculpture generally, and particularly on the posterior slope; thin periostracum; shape of the posterior end; larger gape anteriorly than posteriorly; exceedingly narrow hinge plate; equal development and deep bifidity of both cardinals in the right valve (in other species of the subgenus *Psammobia* the anterior cardinal is weaker and only slightly bifid); colour pattern of concentric bands only. Of these characters, the most significant phylogenetically are the thinness, shape, dentition and colouration. *Gari lineolata* has no close living relations and indeed, the species appears suddenly in the lower Pliocene of New Zealand without any earlier fossil history (Willan, 1980). The lineage that has culminated in *G. lineolata* appears to have evolved by concordant reduction of shell thickness, sculpture and (radial) colour components.

In view of its distinctive characters, it is surprising *Gari lineolata* was not separated from *G. convexa* Reeve until 1980. This is probably because of their similar sizes and the colour variation exhibited by *G. convexa*. Characters separating these two species have been tabulated by Willan (1980:175), the most significant

relate to shell shape, sculpture, pallial sinus and colouration.

No other Recent species of *Gari* in Australia or elsewhere in the Indo-Pacific Ocean is similar to *G. lineolata*. It is, in fact, the most isolated species phylogenetically in the subgenus *Psammobia*. The eastern Atlantic *G. fervensis* (Gmelin) may be distantly related, but it possesses all the (presumably plesiomorphic) characters *G. lineolata* has reduced, ie, heavy shell, strong concentric sculpture, thick periostracum, marked posterior ridge (on both valves) and radial colour markings.

Habitat. *Gari lineolata* inhabits clean, fine- to medium-grained sands in protected and semi-protected localities. Although apparently capable of tolerating a range of substrates from slightly muddy, through fine and medium sands, to slightly gravelly or shelly sands, its marked preference is for well-sorted fine sands. Other invertebrates that regularly co-occur with *G. lineolata* are the bivalves *Pleuromeris zelandica* (Deshayes), *Nucula nitidula* A. Adams and *Leptomya retiaria* (Hutton) and the polychaete *Pectinaria australis* (Ehlers). Sometimes *G. convexa* also occurs with *G. lineolata*. *Gari lineolata* lives buried at a depth of about 20 cm.

The bathymetric range is from 0 to 140 m, ie, virtually across the continental shelf, but greatest densities occur in the uppermost 30 m. Following storms freshly dead shells wash ashore in large numbers on open beaches.

Distribution. *Gari lineolata* is endemic to New Zealand. Bertin's (1880:121) record of *G. lineolata* from Australia is definitely incorrect. Its range extends throughout the three principal islands of New Zealand. It is present, but rare, at the Chatham Islands.

Gari (Psammobia) kenyoniana (Pritchard & Gatliff, 1904)

Figs 186-191, 393

Tellina kenyoniana Pritchard & Gatliff, 1904: 339, pl.20 figs 1-4.

Gari kenyoniana (Pritchard & Gatliff).—May, 1921: 25, no.192, 1923, pl.11 fig.10.—Allan, 1950: 341, fig 80, no.2.—Cotton, 1953: 23, 1961: 280, fig.309.—Macpherson & Gabriel, 1962: 373, fig.436.

Psammobia kenyoniana (Pritchard & Gatliff).—Cotton & Godfrey, 1938: 264, fig.300.—Macpherson & Chapple, 1951: 153.—Richmond, 1992: 94, 95, no.135.

Gari (Gari) kenyoniana (Pritchard & Gatliff).—Lamprell & Whitehead, 1992: 56, pl.52 fig.387.

Comments on synonymy. Because it is distinctive and large, and it occurs within a relatively small area of southern Australia, *Gari kenyoniana* has never been confused with any other species in the literature. Tate (1885) unknowingly included two valves in the type series of *Psammobia aequalis* because they were small and worn and

occurred in the same fossil horizon as *P. aequalis*.

Types. *Tellina kenyoniana* Pritchard & Gatliff: holotype (complete specimen - 61.0 mm) in NMV (F496); illustrated by Pritchard & Gatliff, 1904: pl.20 figs 1-4 (Figs 186,187). Type locality Airey's Inlet, South Australia.

Psammobia aequalis Tate: paralectotypes (single right valve with broken posterior margin - 23.5 mm and single left valve - 17.0 mm) in SAM (T1189D, G respectively). [Lectotype and all other paralectotypes belong to *Psammobia modesta* Deshayes.]

Material examined. AUSTRALIA – VICTORIA: 1h, off San Remo (NMV F52137); 1c,2h, off Portsea, Port Phillip Bay (NMV F4022, F28250); 2h, bank of Symond's Channel, Port Phillip Bay (NMV F27323); 1c, near Split Point, Airey's Inlet, south Anglesea (NMV F496 - holotype of *Tellina kenyoniana* Pritchard & Gatliff); 2c, 1 m, Boat Harbour, Apollo Bay (NMV F52138); 2h, upper beds, Grange Burn Formation, Muddy Creek, west Hamilton (SAM T1189D,G - paralectotypes of *Psammobia aequalis* Tate). TASMANIA: 1h, Flinders Island, Furneaux Group, east Bass Strait (NMV F52136); 1c, Stanley, north coast (Lamprell coll.); 3h, Adventure Bay, east Bruny Island, south-east coast (AMS C27852; Lamprell coll.; Willan coll.); 1h, Pegg's Beach (NMV F52135).

Description. Maximum length 76 mm. Shell heavy, elongate to oblong-ovate; greatest width at level of umbones; inequilateral, umbones displaced a little towards anterior end (equally so in juveniles); inequivalve, left valve relatively flatter; anterior end rounded, narrower than posterior end; ventral margin straight or slightly convex; posterior end rounded to subtruncate (never subtruncate), weakly angled at intersection of ventral and dorsal margins; commissure at junction of shells' ventral margins straight; anterior gape absent; posterior gape small; long and deep, narrow lunular area between dorsal margins in front of umbones. Sculpture identical on the outside of both valves, consisting of numerous, crowded, crisp striae that become sharp and erect at ventral margin as well as extremities; striae never crenulated; striae extend to, and cross, posterior ridge of both valves, and are continuous over posterior slope; striae number 19 per cm counting from ventral margin transversely towards umbo of 61 mm adult holotype shell. Thin, brownish periostracum present on exterior, dehiscent, only present near ventral margin in living specimens, rapidly lost from dead shells.

Hinge plate moderately strong, elongate; nymph moderately well developed; ligament tall; teeth large and prominent (except left rear cardinal). Right valve with 2 cardinal teeth, each oblique, diverging by 60° from each other, of approximately equal strength; rear one deeply bifid. Left valve with deeply bifid anterior cardinal, directed vertically downward; rear cardinal merely a low lamella that slopes by 65° obliquely behind anterior one; weak lunular projection present on hinge plate in front of anterior cardinal. Pallial sinus moderate (reaches one-third of distance between hinge plate and rear margin of anterior adductor scar), A-shaped; upper limb leaving middle of adductor scar, descending; anterior

margin narrowly rounded, subacute (sharper in right valve); lower limb confluent with pallial for most its length; ventral extremity of pallial line upturned, reaches level with middle of posterior adductor scar. Single pedal retractor scar present immediately in front of hinge plate.

Colour of exterior creamish white, crossed with broad, concentric, pale orange bands; flushed with orange-red near umbones, umbones white; fresh specimens possess indistinct, narrow, pale red or orange rays emanating from umbones; interior white, tinted with light purple centrally; narrow, thickened, whitish buttress often extending vertically downward from hinge plate in left valve. Hinge plate, teeth and nymph white.

Remarks. *Gari kenyoniana* appears to be not closely related to any other Recent species. Its distinctive characters are its large adult size, solidness, long and narrow sunken lunule, sculpture of numerous, sharp striae, pallial sinus shape, and uniform colouration. Occasionally the striae anastomose just in front of the posterior ridge. The presence of a posterior ridge on both valves is unusual; such a ridge is usually absent from the left valve in species of *Gari*.

In the original description, Pritchard & Gatliff (1904) stated the holotype had about nine, narrow, somewhat indistinct reddish yellow rays extending from the umbo across the shell. I cannot see any such rays on the holotype (Figs 186, 187), and assume they must have faded as it is in perfect condition and was probably live when collected. The colour patterns of psammobiids do fade appreciably with time.

Gari kenyoniana appears to be a rare species, so only a small sample (5 complete specimens and 12 isolated valves) was available for examination. However, the species shows little intraspecific variation. One left valve has an orange instead of white ground colour and there are slight differences in the coarseness of the concentric striae between specimens. Those shells that have a straight ventral margin on the left valve have a relatively narrower posterior end which is subacute (Fig. 189). In contrast, those shells (like the holotype) with a convex ventral margin have a relatively broader, rounded posterior end.

Only two species of *Gari* occur sympatrically with *G. kenyoniana* – *G. livida* (Lamarck) and *G. modesta* (Deshayes). *Gari livida*, which is more similar, is smaller when adult, more equilateral, broader anteriorly, without concentric striae on the anterior and central areas of the right valve and entire left valve, its pallial sinus is deeper and quite differently shaped, being much broader, and it is usually rayed externally and purplish-glazed within. Shells of Recent *G. kenyoniana* are unlikely to be confused with those of *G. modesta*.

The New Zealand *Gari convexa* (Reeve) is similar to *G. kenyoniana* in size, but *G. convexa* is decidedly more inequilateral (particularly in adults), smooth externally (apart from striae on the posterior slope of the right valve), its posterior end is subrostrate, the commissure is curved, the pallial sinus is broader and much deeper,

and like *G. livida* it is rayed externally and purplish-glazed within.

Gari amethysta (Wood) is the only other Indo-Pacific species in the subgenus *Psammobia* that bears concentric striae on the exterior of both valves. However, *G. amethysta* is lighter, more elongate and compressed, the striae differ across the shell and they are absent from the posterior slope of the left valve, its pallial sinus is shallower yet broader, and its colouration is completely different.

Habitat. Because of the rarity of *Gari kenyoniana*, its habitat is unknown. The shell's thickness and sculpture suggests the species might inhabit coarse sand or shell gravel as occur in scour channels. Mr R. Burn brought to my attention two very small juveniles (both less than 6 mm in length) he collected at Boat Harbour, Apollo Bay, Victoria. Both were sieved live at low tide from patches of seagrass (*Zostera* sp.) on sand.

Gari kenyoniana has a known bathymetric range of 1 to 40 m. Specimens are rare all through that range and least plentiful in the uppermost 10 m.

Distribution. *Gari kenyoniana* is endemic to south-eastern Australia. It ranges from eastern Bass Strait, eastern through Tasmanian waters, and west along the upper continental shelf to Investigator Strait in eastern South Australia.

Gari (Gobraeus) Brown, 1844

Type species. *Solen vespertinus* Gmelin, 1791 (= *Tellina depressa* Pennant, 1777) by monotypy. Recent, eastern Atlantic.

Diagnosis. Moderate to large-sized psammobiids with thick, quadrate shells; equilateral and equivalve; posterior end truncate; commissure straight; no distinct posterior ridge; valves gaping moderately posteriorly. Outer surface smooth, or with sculpture of concentric growth lines only. Right valve with 2, approximately equal, obliquely-diverging cardinals, the rear of which is deeply bifid; left valve with a single, vertically-directed, deeply bifid anterior cardinal and the rear merely a short, oblique lamella. Pallial sinus moderately deep, relatively broad, lower limb confluent with pallial sinus for its entire length. Interior heavily calcified, often with a purplish glaze.

Members of this subgenus are like those of *Gari sensu stricto* and *Psammobia*, but they are united by their general lack of sculpture, quadrate shape, moderate posterior gape and lack of a posterior ridge. Usually their shells are more inflated as well. Further distinguishing characters are given in Table 1.

Most species belonging to the subgenus *Gobraeus* occur in temperate waters, with *Gari stangeri*, *G. castrensis oriens* and *G. eos* being the only Recent representatives in Australasia. I include the following

exotic species in this subgenus: *Gari depressa* (Pennant) (= *Solen vespertinus* Gmelin, *Psammobia florida* Lamarck, *P. grata* Deshayes, *P. affinis* Reeve and *P. albanyana* Turton); *G. virgata* (Lamarck) (= *P. costata* Hanley and *P. intermedia* Deshayes); *G. californica* (Conrad) (= *P. rubroradiata* Carpenter and *P. lilacina* Wilkins in Palmer); *G. edentula* (Gabb); *G. fucata* (Hinds); *G. regularis* (Carpenter); *G. panamensis* Olssen; *G. kazuensis* (Yokoyama); *G. solida* (Gray), *G. maxima* (Deshayes); *G. lata* (Deshayes).

Gari castrensis castrensis (Spengler), its subspecies *G. castrensis oriens* (Deshayes) and *G. eos* n.sp. seem best located in this subgenus despite several discordant characters. They all possess very slender, peg-like teeth and there is no indication of even a weak lunular projection in front of the anterior cardinal tooth in the left valve as occurs in all other *Gobraeus* species, the lower limb of the pallial sinus is free from the pallial line for almost half its length, and finally, the surface is glossy with numerous, sharp, concentric striae (confined to the posterior slope in *G. castrensis*) of both valves instead of being dull and smooth all over like the others. *Gari castrensis sensu lato* and *G. eos* certainly do not belong in any of the other currently described subgenera of *Gari* and I prefer to place them

in *Gobraeus* rather than prejudice future decisions about their relationships by creating a new subgenus for them.

One problematic name, both historically and geographically, is *Psammobia costata*. I wish to set the record straight. Hanley certainly intend to publish that name himself by way of a brief Latin description, but events dictated otherwise. The description was unintentionally published by Reeve (1843:112) under the heading “Descriptions of four new species of bivalve shells by Mr Hanley” instead of “Descriptions of four new species of bivalve shells” by Mr Hanley as Hanley intended. However, that part (pages 1-144) of Hanley’s own book covering the genus *Psammobia* appeared “in the early part of 1843” (Hanley, 1856:V). It contained an English description and figure of *P. costata* (Hanley, 1843:59, pl.11 fig.12). Therefore Hanley’s account must be taken as the earlier one and the specific name must date from it. Hanley (1843:59) gave the type locality as Australia, but Reeve (1843) inexplicably gave New Zealand. Overseas authors retained *P. costata* in their catalogues of names (Tryon, 1868; Bertin, 1880), but no Australian or New Zealand malacologist ever used it. *Psammobia costata* Hanley is a junior synonym of the North Atlantic and Mediterranean *Gari virgata* (Lamarck).

Key to Species of Subgenus *Gobraeus* in Australasia

- 1. Shell heavy; posterior slope of both valves smooth; lower limb of pallial sinus confluent with pallial line for most of its length; New Zealand only*G. stangeri*
- Shell moderately thin to very thin; posterior slope of both valves with concentric lamellae or striae; lower limb of pallial sinus free from pallial line for almost half its length; tropical waters2
- 2. Shell moderately thin; posterior end approximately equal in amplitude to anterior end; central area smooth; posterior slope of both valves with numerous striae*G. castrensis oriens*
- Shell very thin; posterior end broader than anterior end; central area and especially posterior ridge of both valves with concentric lamellae*G. eos* n.sp.

***Gari (Gobraeus) stangeri* (Gray in Dieffenbach, 1843)**

Figs 204-212, 394

Psammobia stangeri Gray in Dieffenbach, 1843: 253, no.179.—Reeve, 1856: *Psammobia* pl.2, species 12.—Martens, 1873: 42.—Hutton, 1873: 65, no.32.—Hutton, 1880: 141.—Hutton, 1885: 519.—Suter, 1907: 264, no.40.—Suter, 1913: 1003.—Suter, 1915 pl.61 fig.9,9a.—Bucknill, 1924: 110, pl.12, no.4. *Psammobia küsteri* Anton in Philippi, 1845 n.syn.: 193, *Psammobia* sp. 1, pl.2 fig.1a-c. *Psammobia tristis* Deshayes, 1855 n.syn.: 318, no.6.—Reeve, 1856: *Psammobia* pl.2, species 13.

Psammobia zelandica Deshayes, 1855 n.syn.: 319, no.8.—Martens, 1873: 42.—Suter, 1907: 260, no.49.—Suter, 1913: 1004.—Suter, 1915: pl.62 fig.10. *Gari (Psammacola)* (sic = error pro. *Psammocola*) *küsteri* (Anton in Philippi).—Tryon, 1868: 76, no.49. *Gari (Psammacola)* (sic = error pro. *Psammacola*) *stangeri* (sic = error pro. *stangeri*) (Gray).—Tryon, 1868: 77, no.58. *Gari (Psammacola)* (sic = error pro. *Psammocola*) *tristis* (Deshayes).—Tryon, 1868: 77, no.60. *Psammobia zonalis* Lamarck.—Hutton, 1873: 66, no.34 (misidentification, not *Psammotaea zonalis* Lamarck, 1818). *Psammobia affinis* Reeve.—Martens, 1873: 42.—Hutton, 1873: 66, no.35.—Hutton, 1880: 142 (misidentification, not *Psammobia affinis* Dujardin, 1837 or *P. affinis* Reeve, 1856). *Gari zelandica* (Deshayes).—Bertin, 1880: 119, 120, no.58, pl.5

fig.5a,b.

Gari tristis (Deshayes).—Bertin, 1880: 121, no.60.

Gari kusteri (sic = error pro. *kuesteri*) (Anton).—Bertin, 1880: 121, no.61.

Gari stangeri (Gray).—Bertin, 1880: 121, no.62.—Marwick, 1931: 78.—Powell, 1937: 61, no.54, pl.11 fig.21.—Powell, 1961: 123, pl.11 fig.21.—Williams, 1964: 27.—Fleming, 1966: 32.—Morton & Miller, 1968: 566, 567, 581, fig.211, no.1, fig.216, no.9.—Penniket & Moon, 1970: 98.—Child, 1974: 36, no.45.—Powell, 1976: 130, pl.18 fig.21.—Gordon & Ballantine, 1977: 116.—Powell, 1979: 418, pl.76 fig.13.—Grace & Hayward, 1980: 197, 207, fig.5c.—Willan, 1980: 173, 1981: 246.—Eisenberg, 1981: 172, pl.154, no.20.—Brook *et al.*, 1981: 77, 78.—Penniket, 1982: 71, pl.29 fig.114.—Abbott & Dance, 1982: 346.—Hayward *et al.*, 1982: 153, 157, 1984: 141, 145, 160.—Beu & Maxwell, 1990: 399.

Psammobia zealandica (sic = error pro. *zealandica*) Deshayes.—Hutton, 1880: 142.

Psammobia neozelanica (sic = error pro. *zealandica*) Deshayes.—Hutton, 1885: 520.

Psammobia (Psammocola) strangeri (sic = error pro. *stangeri*) Gray.—Paetel, 1890: 40.

Psammobia (Psammocola) tristis Deshayes.—Paetel, 1890: 41.

Psammobia (Gobraeus) zealandica (sic = error pro. *zealandica*) Deshayes.—Suter, 1911: 282.

Gari (Psammobia) stangeri (Gray).—Odhner, 1924: 83.

Gari (Psammobia) zealandica (Deshayes).—Odhner, 1924: 83.

Comments on synonymy. J.E. Gray contributed an appendix to Ernst Dieffenbach's "Travels in New Zealand; with Contributions to the Geography, Geology, Botany and Natural History of that Country Volume 2" (1843) in which Gray described several new New Zealand sea shells, *Psammobia stangeri* being one of them. Consequently, authorship of the name *Psammobia stangeri* must be credited to Gray in Dieffenbach, rather than Gray as has been the practice (Powell, 1937, 1979; Fleming, 1966).

This endemic New Zealand species has three junior synonyms (*Psammobia kusteri* Anton in Philippi, *P. tristis* Deshayes and *P. zealandica* Deshayes) and two misidentifications (*P. zonalis* of Hutton, 1873 and *P. affinis* of Martens, 1875) besides numerous unjustified spelling emendations. The excellent figures of *P. kuesteri* (= emendation pro. *küsteri*) leave no doubt that name is a synonym of *P. stangeri*; Anton did not know where this species originated. Two shells in MNHN identified as *P. kuesteri* (presumably by Bertin) are certainly *P. stangeri*. Although Deshayes (1855) described *P. tristis* from Amboina (= Ambon Island, Moluccas Islands), the syntypes match *P. stangeri* more closely than any other Recent species in the genus; therefore the designated type locality must be erroneous. The name *P. zealandica* Deshayes appeared in New Zealand's first faunal lists (Martens, 1873; Hutton, 1880) alongside that of *P. stangeri* and no nineteenth century conchologist questioned the supposed differences between them. Even Suter (1907, 1913, 1915) continued to use both names. I have been unable to ascertain which author first realised they referred to the same species. To Suter both species existed, yet to Marwick (1931) sixteen years later, there was only one. All subsequent New Zealand workers have accepted the synonymy with good reason; *P. zealandica* is based on strongly sculptured juvenile shells. Some (not all) juvenile shells of this species have sharp, concentric striae that become raised and lamellate on the posterior slope of both valves (Fig.211). However, these striae always become obsolete with continued growth and the adult sculpture of concentric growth lines prevails. In addition, the vividly coloured rays typical of

young shells become fainter.

Hutton's (1873) misidentification of this species as *Psammobia zonalis* Lamarck was not serious because it was not perpetuated. But, on the other hand, Martens' (1873) use of *P. affinis* Reeve was followed by New Zealand workers until late into last century when Hutton (1885:519 footnote) omitted it on the grounds that the species came from the Philippine Islands. However, the status of the name *P. affinis* Reeve has not been settled to this date. The problem was inherent in Reeve's (1856) original locality designation of "New Zealand and the Philippine Islands". Based on all available material, *P. affinis* Reeve is the same as the European *P. depressa* Pennant; this is true for the syntypes in BMNH (Fig.213) and three shells supposedly one from each of New Zealand, Tahiti and Australia labelled *P. affinis* in MNHN. Therefore the New Zealand locality must be rejected. So also must that of the Philippines; there is no *Gari* species resembling *G. stangeri* or *G. depressa* in South-east Asian waters. Incidentally, the specimen recorded as *P. affinis* from the Philippines by Hidalgo (1903:87) and now in MNCN, and it is a mislocalised *P. virgata* (Lamarck). Also in this context, I should mention that *P. grata* Deshayes, which was localised from Amboina, is also based on mislocalised *P. depressa*. These mislocalisations (of *P. tristis*, *P. grata* and *P. affinis*) probably all stemmed from Hugh Cuming.

The Maori name for *Gari stangeri* is Wahawaha (Hutton, 1873; Moss, 1908). Illustrations of living *Gari stangeri* appear in books by Williams (1964) and Morton & Miller (1968).

Types. *Psammobia stangeri* Gray in Dieffenbach: lectotype, here designated (largest syntype, complete specimen - 60.0 mm) in BMNH (1842.11.18.67/1) (Fig.204). Paralectotypes (8 complete specimens) in BMNH (1842.11.18.67/2-9). Type locality New Zealand.

Specimen of *Psammobia stangeri* Gray figured by Reeve, 1856: *Psammobia* pl.2, species 12 (complete specimen - 44.6 mm) in BMNH (1985177/1) (Fig.205).

Psammobia kuesteri Anton: type material, which was figured by Anton, 1832: *Psammobia* pl.2 fig.1a-c, ought to be in ZMB, but it cannot be found there and is presumed lost (R. Kilius, personal communication, 1990). Type locality unknown.

Psammobia tristis Deshayes: lectotype, here designated (figured syntype, complete specimen - 47.2 mm) in BMNH (1984282/1); figured by Reeve, 1856: *Psammobia* pl.2, species 12 (Fig.206). Paralectotype (complete specimen - 46.9 mm) in BMNH (1984282/2). Type locality Amboina.

Psammobia zealandica Deshayes: lectotype, here designated (figured syntype, complete specimen - 34.0 mm) in MNHN; figured by Bertin, 1880: pl.5 fig.5a,b (Fig.207). Paralectotype (single, broken right valve - 28.0 mm) in MNHN. Type locality New Zealand.

Despite Bertin's (1880:120) description, clear figures and mention that Deshayes' type material of *Psammobia zealandica* was in the Ecole des Mines, Paris, Suter (1913:1005) claimed: "Type, which was in the Cuming collection, lost." Suter gave no explanation of how he reached that conclusion. I believe this information had been conveyed to him by E.A. Smith, then Curator of Mollusca at the BMNH. We know that these two workers did correspond about New Zealand molluscs (Suter, 1907; Suter, 1913: xii, 1084). In fact the syntypes of *P. zealandica* were neither in Cuming's coll. nor BMNH, but they had remained in Deshayes' collection in Paris. Presumably this is why Reeve never mentioned *P. zealandica* in *Conchologia Iconica*. These syntypes were transferred from

the Ecole des Mines to MNHN in 1984 (P. Bouchet, personal communication, 1985).

Material examined. "NEW ZEALAND": 9c (BMNH 1842.11.18.67 - lectotype & paralectotypes of *Psammobia stangeri* Gray in Dieffenbach); 1c, 1h (MNHN - lectotype & paralectotype of *Psammobia zelandica* Deshayes). "AMBOINA" (error pro. New Zealand): 2c (BMNH 1984282/1,2 - lectotype & paralectotype of *Psammobia tristis* Deshayes).

NEW ZEALAND - NORTH ISLAND: 1c, 21-24 m, Rosemary Rock, south-east end Princess Rocks, Three Kings Islands (Willan coll.); 1c, 6-9 m, off North Cape (Willan coll.); 2c, 6-8 m, North Cape Bay (Willan coll.); 1c, 2.5 m, off east end Waikato Bay, Matai Bay, Doubtless Bay (Willan coll.); 2c, Taipa Beach, Doubtless Bay (Coles coll.); 1h, 6 m, north side Horseshoe Bay, Motukawanui Island, Cavalli Islands (Willan coll.); 2c, 11 m, approximately 100 m south Te Anaputa Island, Cavalli Islands (Willan coll.); 5c, 5.5 m, bay on south side Hamaruru Island, Cavalli Islands (Willan coll.); 1h, 5.5 m, off rock pinnacle west Kahangaro Island, south end Cavalli Islands (Willan coll.); 2c, main beach, Mahinepua, coast north Whangaroa (Willan coll.); 1c, 3.5 m, Raupuke Beach, Mahinepua, coast north Whangaroa (Willan coll.); 1c, Bay of Islands (ZMUC); 4c, Russell, Bay of Islands (Coles coll.); 1c, Long Beach, Russell, Bay of Islands (BMNH); 3c, Moturoa Island, Bay of Islands (Coles coll.); 4c, Bland Bay, Whangaruru Harbour (Hole coll.); 3h, 15 m, "Labrid Channel", north side Archway Island, Poor Knights Islands (Willan coll.); 10c, Church Bay, Tutukaka (Coles coll.; Willan coll.); 2c, 9 m, off High Island, Taurikura, Whangarei Harbour (Willan coll.); 1c, Taurikura Beach, north side Whangarei Harbour entrance (Willan coll.); 5c, Reotahi Bay, south side Whangarei Harbour entrance (Hole coll.); 1c, 6 m, rocks on south-west side Trig Island, Moko Hinau Island (Willan coll.); 17c, 12-15 m, north-west coast, Little Barrier Island (Willan coll.); 5c, Smokehouse Bay, Port Fitzroy, Great Barrier Island (Willan coll.); 1c, 5 m, Nagle Cove, Port Fitzroy, Great Barrier Island (Willan coll.); 10c, Te Arai, Pakiri, north Leigh (Penniket coll.; Willan coll.); 1c, 12 m, Goat Island, north Leigh (Willan coll.); 1c, 20 m, "Deep Point", Goat Island, north Leigh (Willan coll.); 2c, 15 m, Goat Island Bay, north Leigh (Willan coll.); 3c, 3-4 m, Leigh Harbour (Willan coll.); 5c, 9 m, Ti Point, Leigh (Coles coll.; Willan coll.); 8c, 3 m, approximately 200 m off Whangateau Harbour entrance, Leigh (Willan coll.); 22c, 4h, Omaha Ocean Beach, Matakana, south Leigh (Grange coll.; Hole coll.; Willan coll.); 1c, 10.5 m, off Takatu Beach, south Leigh (Willan coll.); 2c, 6-9 m, Sandy Bay, Bon Accord Harbour entrance, Kawau Island (Willan coll.); 1c, Te Haruhi Bay, Whangaparua Peninsula (Willan coll.); 5c, Matakatia Bay, Whangaparua Peninsula (Willan coll.); 6c, Waiwera, north Auckland (Coles coll.; Willan coll.); 1c, Devonport Beach, Auckland (Willan coll.); 2c, St Helier's Bay, Auckland (QM); 2c, 2h, Oneroa Beach, Waiheke Island (Willan coll.); 1c, 3h, Little Oneroa Beach, Waiheke Island (AMS C99786; Willan coll.); 1h, south-west side Motuihe Island, Tamaki Strait (Willan coll.); 1c, 3 m, off Ponui Head, Ponui Island (Willan coll.); 6c, Waitawa Bay, west Kawakawa Bay, Firth of Thames, south Auckland (Willan coll.); 2c, Mercury Bay, Whitianga, east coast Coromandel Peninsula (QM); 3c, Whitianga, east coast Coromandel Peninsula (AMS C97782); 5c, Tauranga, Bay of Plenty (NHMW E46455); 1c, Hawkes Bay (AMS C97331); 8c, Wellington Harbour (WAM 1016-69; Whitehead coll.); 2c, 1h, Cook Strait (AMS C125623); 1c, 11-12 m, approximately 1.2 km offshore from Historic Site Headland, Tataraimaka, south New Plymouth (Willan coll.); 1c, 8 m, east side Moturoa Island, Sugarloaf

Island New Plymouth (Willan coll.); 2c, Orua Bay, Manukau Harbour entrance, west Auckland (Willan coll.); 1c, Cornwallis Beach, Manukau Harbour, west Auckland (Willan coll.); 8c, 1h, Hokianga (NHMW 16478, 16480, 16481). SOUTH ISLAND: 7c, Pelorous Sound, Marlborough (AMS C8927; MHNG; NHMW O5667); 2c, Kenepuru Sound, Marlborough (NHMW 25202); 8c, 5.5-18 m, Queen Charlotte Sound, Marlborough (ZMUC); 1c, Tennyson Inlet, Marlborough (Morley coll. 1873); 1h, 79 m, Kaikoura Canyon, south Kaikoura Peninsula (Willan coll.); 4c, 15-18 m, south-east Cape Wandrow, Oamaru (AMS C117701); 2c, North Beach, Riverton (Willan coll.); 2c, Oreti Beach, Bluff (Willan coll.); 12c, 3-12 m, north end Narrows Bend, Long Sound, Preservation Inlet, Fiordland (Willan coll.); 3c, Tomatea Point, Pakawau, Golden Bay, Nelson (Willan coll.); 1c, 1h, Tahunanui Beach, Golden Bay, Nelson (AMS C96246); 1c, 1h, Cyathea Cove, Abel Tasman National Park, Nelson (BMNH). CHATHAM ISLANDS: 2c, Owenga Beach, south Hanson Bay, Chatham Island (Willan coll.). STEWART ISLAND: 2c, Horseshoe Bay, near Paterson Inlet (Willan coll.); 1c, Golden Bay, Paterson Inlet (Willan coll.); 8c, 10.5 m, west side Bradshaw Peninsula, Paterson Inlet (Willan coll.); 6c, 21.5 m, channel between Native Island and Bradshaw Peninsula, Paterson Inlet (Willan coll.); 5c, 12-18 m, off east tip Native Island, Paterson Inlet (Willan coll.); 1c, Ringaringa Beach (Coles coll.).

Description. Maximum length 60 mm. Shell solid, heavy, elongate-ovate; greatest width at level of umbones; equilateral, umbones at middle of dorsal margin in both juveniles and adults; anterior end broadly rounded; ventral margin smooth, nearly straight or weakly convex centrally; posterior end truncate; inflated; equivalve; commissure at junction of shells' ventral margins straight; very small anterior and posterior gapes. Surface of both valves dull, sculptured with irregular, flattened, concentric striae that are more deeply incised close to anterodorsal and posterodorsal margins; striae sometimes lamellate on posterior slopes of both valves in juveniles. Exterior covered with a thick, flakey, golden brown periostracum.

Hinge plate strong; nymphs strong, moderately elongate; ligament exceedingly tough. Right valve with 2, strong, equally well-developed cardinal teeth, both bifid (the rear one more deeply cleft), both directed obliquely, diverging by 60° from each other. Left valve with a strong, deeply bifid anterior cardinal tooth directed vertically downward; rear cardinal represented merely by a sharp thin lamella, directed backward, diverging by 60° behind anterior cardinal, very frequently broken off in dead shells; left valve's hinge plate also carries a low, but sharply angled, lunular projection in front of anterior cardinal. Pallial sinus moderately deep (reaches level with pedal retractor scar), broad, U-shaped; upper limb leaves from lower third of posterior adductor scar, ascends slightly (or runs straight) to middle of shell; anterior margin broadly convex; lower limb free from pallial sinus for one third length; ventral extremity of pallial line directed straight backward, reaches level of middle of posterior adductor scar. Single, small, circular pedal retractor scar present dorsally in front of hinge plate.

Colour of exterior cream or stone-white, with numerous

narrow and/or broad violet or orange or red rays emanating from orange or lilac or cream umbones; interior thickly purple glazed, sometimes with a narrow marginal belt of purple rays, often with white secondary calcification below hinge plate. Teeth and hinge plate white or pale lilac; nymphs without exception dark purple or lilac, always darker than interior.

Remarks. *Gari stangeri* has a heavy shell, but this weight does not come from extensive secondary calcification as in *Gari crassula* (Deshayes), instead consecutive shell layers are thickened as they are laid down. Besides thickness, the distinctive characters of *G. stangeri* are its equilateral shape, inflated valves, truncate posterior margin, generally smooth surface, tough ligament, strong dentition, broad pallial sinus, rayed colouration, purplish internal glaze and dark purple-pink nymphs. Juveniles display greater sculptural variation than adults. In some juveniles (Fig.211), the irregular, concentric striae are almost lamellate posteriorly, reminiscent of *G. kenyoniana*, but with growth, these striae inevitably become obsolete; at no time are they regular enough nor strong enough to be considered as ridges. Juveniles possess not only stronger sculpture (form *zelandica*) but they also display greater colour variation than adults. In juveniles, the ground colour can be white, cream, orange, (rarely) vivid red, lilac, bluish or violet, and the rays can be almost any shade of orange or purple. All intergrades are possible. Adult shells are far less variable; they are usually creamish with violet rays, although these rays are often interrupted by darker concentric bands.

Gari stangeri has a more solid shell than either *G. convexa* (Reeve) or *G. lineolata* (Gray in Yate), the only other Recent members of the genus in New Zealand. *Gari stangeri* also differs from them both in being truncate posteriorly, having a more inflated and equivalve shell, rougher sculpture, greater thickness of periostracum, greater robustness of hinge plate, teeth and nymphs, shape of its pallial sinus, exterior colouration and heavy purplish internal glaze. Differences between *G. stangeri* and *G. castrensis oriens* (Deshayes) are given in the remarks section for that species.

Without any doubt, the species most closely related to *Gari stangeri* is the north-eastern and eastern Atlantic *G. depressa* (Pennant). Indeed the two species are so similar that it is almost impossible to correctly identify some specimens if their location is unknown. This similarity was not realised by earlier workers with results of numerous misidentifications and synonymous taxa like *Psammobia kuesteri* Anton, *P. tristis* Deshayes, *P. grata* Deshayes and *P. affinis* Reeve. This confusion was exacerbated by the incorrect type localities of Amboina or the Philippines but, in fact, no *Gobraeus* species resembling *G. stangeri* or *G. depressa* occurs in South-east Asia or elsewhere in the Indo-west Pacific Ocean. *Gari depressa* is relatively more elongate, narrower, generally thinner (juveniles are always thinner), adults generally (but not always) have a series of regular, broad, raised, plicate, concentric striae or ridges on the posterior

slope of the right valve, it has a glossier exterior, its shell is often maculated with white externally, it lacks the purplish thickening internally, and it never possesses purple nymphs. The only exclusive definitive characters possessed by adults appear to be the concentric striae on the right valve's posterior slope, cream interior and white nymph of *G. depressa* as opposed to the relatively smooth posterior slope, purplish internal thickening and purplish-pink nymph of *G. stangeri*.

Habitat. *Gari stangeri* is the commonest psammobiid in New Zealand. Consequently a good deal of information has been gathered on its habitats, much of which originated from studies of soft benthic associations (eg, Powell, 1937; Brook *et al.*, 1981; Willan, 1981; Hayward *et al.*, 1982,1984). What has emerged is that its occurrence is not related to sediment type: *G. stangeri* has been found live in all of the following substrates: slightly muddy fine sand; fine to medium clean sand; gravelly medium sand; pebbly coarse sand; gravel. The energy of the environment (ie, water flow) is of greater importance in determining its occurrence. *Gari stangeri* prefers channels where, because of current action, the substrate is coarse yet clean. Other rheophilic bivalves that regularly co-occur with *G. stangeri* are *Glycymeris laticostata* (Quoy & Gaimard), *Venericardia purpurata* (Deshayes), *Tawera spissa* (Deshayes), *Venerupis largillierti* (Philippi), *Corbula zelandica* Quoy & Gaimard and *Oxyperas elongata* (Quoy & Gaimard). *Gari stangeri* lives buried about 5 cm below the substrate surface.

The bathymetric range is 0 to 80 m, but most specimens have been taken in depths less than 25 m. Given suitable habitats, specimens can be collected intertidally not infrequently. Freshly dead shells wash ashore in large numbers on open beaches following storms.

Distribution. *Gari stangeri* is endemic to New Zealand. It is of ubiquitous occurrence, ranging continuously from the Three Kings Islands off the northern tip of the North Island, along the inner shelf as far as the Chatham and Stewart Islands to the east and south respectively. There are no records from the subantarctic islands.

***Gari (Gobraeus) castrensis oriens* (Deshayes, 1855)**

Figs 214-222, 395

- Psammobia castrensis* (Chemnitz) (sic = error pro. Spengler).
-Reeve, 1856: *Psammobia* pl.5, species 32.
Psammobia oriens Deshayes, 1855: 318, no.3 and var. β .
-Reeve, 1857: *Psammobia* pl.1, species 1.-Dunker, 1882: 186.
Gari (Psammocola) (sic = error pro. *Psammocola*) *oriens* (Deshayes).-Tryon, 1868: 77, no.55
Psammobia rossiteri Crosse, 1873 n.syn.: 66, pl.5 fig.6.
Gari (Psammocola) oriens (Deshayes).-Bertin, 1880: 124, no.73.
Gari (Psammocola) rossiteri (Crosse).-Bertin, 1880: 124,

no.76.

Psammobia castrensis (Spengler).—E.A. Smith, 1885: 91, 92.—Hedley, 1910: 350.

Psammobia (Psammocola) oriens Deshayes.—Paetel, 1890: 40.

Psammobia (Psammocola) rossiteri Crosse.—Paetel, 1890: 40.

Psammobia castrensis (Chemnitz) (sic = error pro. Spengler).—Hidalgo, 1903: 87, no.71.

Dysmea oriens (Deshayes).—Kuroda & Habe, 1952: 20.—Matsukuma, 1989: 106, 107, pl.1 figs 4-7.

Gari (Dysmea) occidentis (Gmelin).—Cernohorsky, 1978: 186, pl.68 fig.1.—Springsteen & Leobrera, 1986: 305, pl.86 fig.26 (misidentification, not *Solen occidentis* Gmelin, 1791 or *Sanguinolaria occidentis* Lamarck, 1818).

Gari oriens (Deshayes).—Cosel, 1990: 707.

Gari (Dysmea) oriens (Deshayes).—Lamprell & Whitehead, 1992: 58, pl.53 fig.396.

Comments on synonymy. I interpret Indo-Pacific populations as the subspecies *oriens* Deshayes of the tropical West African species *Gari castrensis* Spengler, 1794. The reasons for this opinion are given here under the remarks section for this subspecies.

Until the very recent publication of Cosel's (1990) revision of West African Psammobiidae, there was uncertainty about *Solen castrensis* Spengler. Spengler's *Monographier af de mange og toskallede Conchyliælaegter* was read before the Naturhistorieselskabet [the Natural History Society of Copenhagen] in 1793, but it was not published until 1794. One year later, Chemnitz (1795) figured the holotype and cited Spengler's description. The inaccessibility of Spengler's original publication led subsequent authors to credit the name *S. castrensis* erroneously to either Chemnitz (Hanley, 1843; Reeve, 1856; Tryon, 1868; Bertin, 1880) or Hanley (Paetel, 1890). Wood (1815) repeated Spengler's description of *S. castrensis*.

In addition to the obscurity of Spengler's original publication, two factors contributed to the uncertainty surrounding *Solen castrensis*. First is the beachworn condition and immaturity of the holotype, characters matched in the shell subsequently figured by Reeve (1857: *Psammobia* pl.5, species 32). [I have illustrated both these specimens here in Figs 214 and 215 respectively.] Second is Spengler's type locality of "Fra Kysten Guinea". Instead of taking this to mean the Gulf of Guinea [West Africa], it has been misinterpreted as New Guinea Island [western Pacific Ocean], and the mistaken belief consequently arisen that *S. castrensis* is a Pacific Ocean species (E.A. Smith, 1885; Hidalgo, 1903; Hedley, 1910).

The synonymy of *Psammobia rossiteri* Crosse with *P. oriens* Deshayes is borne out by their type material. The dimensions given by Crosse (1873) for *P. rossiteri* match those of the presumed holotype (in AMS) which was in the Rossiter collection. Its accompanying location of New Caledonia suggests Crosse accidentally transposed New Caledonia and Lifu Island, Loyalty Islands in his original publication because there he gave Lifu Island as the locality for Rossiter's shell. Iredale (1950) explains how the Rossiter collection came into AMS.

Cernohorsky (1978) provided a good illustration of a shell of *Gari castrensis oriens*, even though he misidentified it as *G. occidentis*. Specimens of *G. castrensis castrensis* from West Africa are well illustrated by Cosel (1990).

Types. *Solen castrensis* Spengler: holotype (complete specimen - 37.7 mm) in Spengler coll., ZMUC; figured by Chemnitz, 1795: pl.198 figs 1935, 1936; illustrated by Cosel,

1990: pl.5 fig.18 (Fig.214). Type locality "Fra Kysten Guinea".

Specimen figured as *Psammobia castrensis* Chemnitz by Reeve, 1856: *Psammobia* pl.5, species 32 (complete specimen - 41.4 mm) in BMNH (1985176) (Fig.215).

Psammobia oriens Deshayes: lectotype, here designated (figured syntype, complete specimen - 63.2 mm) in BMNH (1984278/1); figured by Reeve, 1857: *Psammobia* pl.1, species 1 (Fig.216). Paralectotype (complete specimen - 65.1 mm) in BMNH (1984273/2). Type locality Sea of Japan.

Psammobia rossiteri Crosse: holotype (complete specimen - 38.5 mm) in AMS (C30599) (Fig.217). Type locality "Lifou, insularum - Loyalty dictarum (G. Rossiter), Noumea, Novae Caledoniae (E. Marie)." Here restricted to Nouméa, New Caledonia.

Material examined. AUSTRALIA - QUEENSLAND: 1c, 15 m, off Granite Bluff, Lizard Island (AMS C128031); 1c, 4 m, Watsons Bay, Lizard Island (AMS C147537); 1c, Watsons Beach, Lizard Island (Spooners coll.); 1h, Lizard Island (AMS C41543); 1c, St Crispin Reef, east Cape Tribulation (Marrow coll.); 1c, 18 m, Outer Rudder Reef, south-east Cape Tribulation (Lamprell coll.); 1c, Black Island, Whitsunday Group (Whitehead coll.); 2c, 5 m, Swain Reefs (Trevor coll.); 1h, Fairfax Island, Bunker Group (AMS C69053). WESTERN AUSTRALIA: 2h, 18.5 m, off Peak Island, near Onslow (WAM); 1c, Delambre Island, Dampier Archipelago (WAM 1726-68); 1h, north-eastside Rosemary Island, Dampier Archipelago (WAM); 1h, 60-64 m, north Rosemary Island, Dampier Archipelago (WAM). NORTHERN TERRITORY: 2c, Torres Strait (BMNH).

TONGA: 1c, 18 m, Tongatabu Island (BMNH 1884.2.9. 25370). FIJI ISLANDS: 1h (AMS C143651); 1h, 9-35 m Nadi Bay, Viti Levu Island (AMS C149152). NEW CALEDONIA: 1c (AMS C30599 - holotype of *Psammobia rossiteri* Crosse); 2c, 1h (AMS C15982, C84064, C125999); 1c (in fragments), 50 m, Lagon Nord - 19°06'S 163°10'E (MNHN); 1h, 26 m, north Hienghène - 20°38'S 165°08'E (MNHN); 1c, 1h, Ile Ste Marie, Nouméa (AMS C83686); 2c, Anse Vata Beach, Nouméa (AMS C86261; Willan coll.) 1h, 1 m, Croissant Reef, off Nouméa (AMS C80632); 1c, 1h, Nouméa (AMS C15983). CORAL SEA: 1h, 65 m, Chesterfield-Bellona Plateau - 20°31.7'S 158°50.9'E (MNHN). VANUATU: 2h, 46 m, north-east side Pango Peninsula, Efate Island (Willan coll.). SEA OF JAPAN: 2c (BMNH - 1984278/1,2 - lectotype & paralectotype of *P. oriens* Deshayes). PHILIPPINE ISLANDS: 2c (WAM); 1c, Sorsogon, Luzon Island (BMNH 1985176); 1c, 16.5-24 m, 14.5 km off Bongao light, Tawitawi Bay, Sulu Archipelago (WAM 1725-68). SEYCHELLES: 1c, dredged, Cerf Passage, Mahé Island (BMNH). PORTUGUESE EAST AFRICA: 1c (AMS C124401). KENYA: 1c, 3h, 8-10 m, Wasin channel, Shimoni (BMNH). MADAGASCAR: 1h, Tuléar (MNHN). MOZAMBIQUE: 1c, west fisheries buildings, south-west Lunga Bay (NMSA H1443); 1c, south-west Conducia Bay, east Conducia (NMSA H1442).

Description. Maximum length 80 mm. Shell fairly thin, but moderately solid when fully adult, elongate; maximum width at level of umbones; umbones central; anterior and posterior ends broadly rounded, posterior end angled at junction of posterodorsal and ventral margins; equivalve; commissure slightly bent; small anterior and posterior gapes. Surface of both valves smooth, polished; sculptured with numerous, regular, concentric striae that strengthen near dorsal margins (especially posterior), striae stronger on left valve where

they become almost lamellate and can be felt with finger; both valves moderately inflated, evenly curved, without any indication of a posterior ridge. Exterior covered with a thin, brown periostracum that dehisces readily; periostracum generally remains only near ventral margin and on posterior slope (particularly of left valve).

Hinge plate moderately broad, its ventral margin convex; nymph moderate, elongate; ligament strong and raised. Right valve with 2 diverging cardinal teeth, rear one stronger, bifid, pointing obliquely backward. Left valve with 2 cardinal teeth, diverging by 45° from each other; anterior one considerably stronger, not bifid, projecting like a peg at right angles to hinge's longitudinal axis; rear one merely a short lamella, pointing posteriorly. Pallial sinus extensive (reaches just past level of anterior edge of hinge plate), broad; upper limb nearly straight; anterior edge broadly rounded; lower limb free from pallial line for a little less than half its length; ventral extremity of pallial line extends rearwards of level of posterior adductor scar, weakly downturned. Single pedal retractor scar present dorsally immediately in front of anterior edge of hinge plate.

Colour of exterior opaque white, crossed by numerous reddish pink radial lines that emanate from white umbones; numerous, small, rose or violet flecks or zig-zag, tent-shaped markings impart a delicately mottled appearance, these markings become obsolete beyond half way across the shell. Interior white, with red rays (but not violet mottlings) showing through from exterior particularly near ventral margin. Teeth, hinge plate and nymph white.

Remarks. *Gari castrensis* is a distinctive psammobiid on account of its elongate shape, central umbones, equivalve condition, small (anterior and posterior) gapes, smooth and polished surface with concentric striae as the only sculptural component, strengthening of these striae near the dorsal margins (particularly posteriorly), thin periostracum (Figs 219, 220, 222) that readily dehisces (Figs 218, 221), prominent anterior cardinal tooth (that is like a peg in the left valve), connection of the lower limb of the pallial sinus to the pallial line for more than half its length and colouration. The two subspecies can be separated by slight but consistent differences: *G. castrensis castrensis* (Figs 214, 215) is broader (without the posterior elongation noticeable in *oriens*), it has larger and more definite purple tent-shaped markings externally that persist for a relatively greater distance across the shell, it has narrower red rays externally, it has a relatively narrower yet longer hinge plate adjacent to the posterior dorsal margin, its nymphs are lower. These differences have been consistent in all the (8 complete and 2 half) *G. castrensis castrensis* and (27 complete and 20 half) *G. castrensis oriens* I have examined to date.

Although I have placed *Gari castrensis oriens* in the same subgenus, *Gobraeus*, as the New Zealand *G. stangeri* (Gray in Dieffenbach), the two species are completely different. *Gari stangeri* is heavier, flatter, differently shaped posteriorly, has a narrow gape

anteriorly, is thickly purple-glazed within, and the anterior cardinal tooth in the left valve is low instead of tall and peg-like as in *G. castrensis*. Comparisons with *G. eos*, the species I take to be most closely related within the geographical region encompassed by this revision, are given under the remarks section for that species.

Several authors of popular books have misidentified *Gari castrensis oriens* as *G. occidens* (Gmelin) (Allan, 1950; Rippingale & McMichael, 1961; Cernohorsky, 1978; Springsteen & Leobrera, 1986). I compare these two species under the remarks section for *G. occidens*. The red-rayed colour pattern of (both subspecies of) *G. castrensis* vaguely recalls that of *G. convexa* (Reeve) and *G. radiata* (Dunker in Philippi), but *G. castrensis* differs so considerably in shape, dentition and pallial sinus from those two species that it can be readily distinguished from both these *Psammobia* species.

Habitat. *Gari castrensis oriens* inhabits clean sand or comminuted coral substrates in open locations. It occurs in fine and medium grades of sediment. *Gari maculosa* and *G. occidens* often live in the same habitat, and they are always more abundant than *G. castrensis oriens*.

In the Indo-Pacific Ocean, the bathymetric distribution of live *Gari castrensis oriens* is 5 to 65 m. Compared to other species of *Gari* with similar geographical distributions, *G. castrensis oriens* is relatively rare; possibly this is because it apparently prefers depths in excess of 20 m. Cosel (1990) gives a similar depth range for the nominal subspecies in the eastern Atlantic Ocean.

Distribution. Since the holotype of *G. castrensis* can be localised from Guinea, West Africa, with certainty, the nominal subspecies must be the one that occurs in tropical eastern Atlantic waters. Cosel (1990) gives the range of *G. castrensis castrensis* from Guinea (Company Banks) southward to Gabon (Port Gentil). The absence of records from temperate southern African waters indicates a discontinuity. On the continental shelf, *G. castrensis* reappears, as subspecies *oriens*, at the coral coast of northern Mozambique (R. Kilburn, personal communication, 1989). This subspecies is widespread throughout the tropical (central and western) Pacific Ocean as well as the Indian Ocean. Because there are no specimens in museums or literature records from the Arabian or Red Seas, one must assume *G. castrensis oriens* does not occur anywhere in the north-west Indian Ocean. The existence of subspecies in the Atlantic and Indo-Pacific Oceans with relatively little divergence indicates a relatively recent separation; I assume *G. castrensis castrensis* evolved during an incursion of *G. castrensis oriens* around southern Africa during an episode of elevated seawater temperatures. It is significant that neither subspecies extends into warm temperate seas at present.

Literature records for *Gari castrensis oriens* are as follows: Tonga (E.A. Smith, 1885); Loyalty Islands

(Crosse, 1873); New Caledonia (Crosse, 1873; Bertin, 1880); Torres Strait (E.A. Smith, 1885); Queensland (Hedley, 1910); Luzon Island, Philippine Islands (Reeve, 1856; Springsteen & Leobrera, 1986); Japan (Deshayes, 1855; Reeve, 1857); Hainan Island, China (E.A. Smith, 1885); Madagascar (Bertin, 1880). Matsukuma (1989) has recently confirmed this taxon's presence in Japan on the basis of a specimen from Kochi Prefecture (NSMT Mo65152).

***Gari (Gobraeus) eos* n.sp.**

Figs 192, 193, 396

Type material examined. *Gari eos* Willan: holotype (single right valve - 60.7 mm) in MNHN (Fig.192). Paratypes (2 single valves - right 34.2 mm, left 28.9 mm) in MNHN (right valve Fig.193). Type locality, Chesterfield-Bellona Plateau, Coral Sea.

Additional material examined. CORAL SEA: 1h, 62 m, Lansdowne-Fairway - 20°50'S 161°37'E (MNHN - paratype); 1h, 69 m, Chesterfield-Bellona Plateau - 21°13.6'S 158°49.3'E (MNHN - holotype).

NEW CALEDONIA: 1h, 62-65 m, east of Yaté - 22°18'S 167°04'E (MNHN - paratype).

Description. Maximum length 61 mm. Shell thin, fragile, elliptical, transversely elongate; maximum width posterior to umbones; umbones in front of centre (more so in adults than juveniles); anterior end broadly rounded (considerably narrower than posterior end); ventral margin straight; posterior end flaring, subtruncate; moderately compressed, without any distinct posterior ridge. Sculpture distinctive, anterior section with broad, concentric striae; striae sharp near anterodorsal margin, rounded to flattened near central section; approximately 10 per cm counting inwards from ventral margin towards umbo of holotype. Central area and posterior slope covered with numerous (approximately 20 per cm counting as above), crowded, thin, sharp, crisp, concentric lamellae, erect on middle of shell, recurved near ventral margin, lamellae not comb-like or crossed by radial striae. Exterior glossy anteriorly and centrally, with a very thin, pale straw-brown periostracum in vicinity of anterior margin of paratype; lost from holotype.

Hinge plate moderate, nymph strong, elongate; ligament lost in type material. Right valve with 2 strong cardinal teeth, diverging by 50° from each other; anterior one slightly weaker, triangular, directed vertically downward; rear one shallowly bifid, directed posteriorly. Dentition of left valve as described for *G. castrensis oriens*. Pallial sinus relatively deep for genus (reaches in front of level of umbo); upper limb straight, runs horizontally; anterior margin broadly convex; lower limb free from pallial line for approximately one-third its length; ventral extremity of pallial line pointing downward, reaches well beyond posterior adductor scar. Single pedal retractor scar midway between umbo and posterior end of anterior

adductor scar.

Colour of exterior white, anterior and central sections copiously marked with large rose-pink spots and indefinite zig-zags near umbones; faint, narrow reddish rays emerging beyond middle of shell (more conspicuous on larger paratype); umbones pale pink, with dense darker specks; lamellae creamish white; no dark oblique dashes near dorsal margin. Shell's transparency enables black type to be read through valve; interior colouration more vivid than exterior, clouded with rich rose-pink markings of equivalent brightness everywhere, never yellow stained. Hinge plate, teeth and nymph white. No thickened, whitish buttress present internally.

Etymology. Named according to the Greek word for dawn.

Remarks. Had a left valve not been known, I would have placed *Gari eos* in the subgenus *Dysmea* without hesitation, on account of its posteriorly flaring shell. However, the absence of any lunular projection anterior to the umbo on the left valve preclude this species' location in *Dysmea* and indicate a relationship with *G. castrensis*, the only other species of *Gobraeus* with similar dentition.

Gari castrensis castrensis (Spengler) and *G. castrensis oriens* (Deshayes) are similar to *G. eos* in size, colouration (particularly in possession of red radial zones) and dentition of the right valve. However, *G. castrensis* (both subspecies) is not flaring posteriorly, more solid, more inflated, smooth externally, has a shallower pallial sinus, and its tent-shaped markings are finer, sharper and more extensive.

In comparison to *Gari occidens* (Gmelin), the type species of *Dysmea*, *G. eos* is thinner, it bears numerous and crowded concentric lamellae, rose-pink mottlings and zig-zags. Further, *G. eos* apparently attains a smaller adult size, has a deeper pallial sinus, lacks both dark dashes near the anterodorsal margin and dark spots externally, and it lacks yellow staining internally. *Gari eos* and *G. occidens* are certainly potentially sympatric in the Coral Sea.

Gari galatheae (Powell) is another potentially sympatric, similar looking species. However, it is more elongate and more solid than *G. eos*. *Gari galatheae* has lamellae over the entire outer surface of both valves and these lamellae, which are less crowded, consist of microscopic recurved riblets (Fig.197), it has a longer and lower nymph, the lower limb of the pallial sinus is free from the pallial sinus for its entire length and reddish zig-zag markings are never present.

Habitat. *Gari eos* has been taken from substrates of clean coral sand indicative of considerable water movement.

The available material indicates a depth range of 60 to 70 m.

Distribution. Only three valves of this new species

are known to me; two (including the holotype) from the Chesterfield-Bellona Plateau in the central Coral Sea and one from south-east of New Caledonia. Further sampling in that tropical south-west section of the Pacific Ocean might also reveal this species' presence on neighbouring plateaux and seamount chains. However, it is unlikely to have a much wider distribution.

Gari (Dysmea) Dall, Bartsch & Rehder, 1939

Type species. *Solen occidens* Gmelin, 1791, by original designation. Recent, Indo-Pacific.

Diagnosis. Shell large, subelliptical-ovate; posterior end flaring, subtruncate; inequivalve, commissure curved; moderately compressed; small anterior gape, larger posterior gape. Surface smooth, with concentric growth lines and enlarged striae on posterior slope. Right valve with 2, strong, unequal cardinals; left valve with 2, unequal cardinals (posterior one merely a lamella) and a stout, triangular lunular projection anterior to umbo. Pallial sinus moderately deep, lower limb free from pallial line for more than half its length (occasionally free to almost ventral extremity of pallial line). Colour creamish, crossed by broad, reddish rays and maculated with white streaks.

The presumed apomorphies of this subgenus are the posteriorly flaring shell and suppression of sculpture on the anterior and central sections. These characters are insufficient to justify a subgenus but, when taken in conjunction with the prominent lunular projection on the left valve, point perhaps to a natural unit. The lunular projection was first noted by Dall, Bartsch & Rehder (1938) and subsequently clearly illustrated by Powell (1958:fig A5). It is not homologous with the anterior lateral tooth of other tellinoids. Although very obvious in *Dysmea*, this projection is not unique to that subgenus; I have also observed it, though much weaker, in *Psammobia* and (some species of) *Gobraeus*. The placement of *Dysmea* must await an anatomical investigation of its type species; if no apomorphies are found in comparison to similar-looking species of *Gobraeus* (ie, *Gari castrensis* (Spengler), *G. depressa* (Pennant), *G. eos* n.sp. or *G. regularis* (Carpenter)), I recommend uniting *Dysmea* in *Gobraeus*. In that instance *Dysmea* would revert to *Gobraeus* and then *Gobraeus* would encompass species showing a progression in this character, from absent to strongly developed, and *G. occidens* would represent the culmination of the series.

Powell (1958) erected *Kermadysmea* on the basis of a comparison with *Dysmea*. However, these two subgenera do not share any apomorphies, so they cannot be closely related. The peculiar recurved and comb-like concentric ribs of *Kermadysmea* are clearly derived, but its dentition and pallial configuration are plesiomorphic.

Gari (Dysmea) occidens (Gmelin, 1791)

Figs 223-236, 397

- Sol. occidens*...Chemnitz, 1782: 74, pl.7 fig.61 (not binomial).
Solen occidens Gmelin, 1791: 3228, no.21, pl.226 figs 2a, 2b.–
 Wood, 1815: 137, *Solen* species 29.–Dillwyn, 1817: 68,
Solen species 26.–Wood, 1818: 16, *Solen* species 29.
Solen pictus, var. c Spengler, 1794: 109.
Solen sp. Bruguière, 1797: pl.226 fig.2a,b.
Sanguinolaria occidens Lamarck, 1818: 510, *Sanguinolaria*
 species 1.–Blainville, 1824: 350.–Deshayes & Milne-
 Edwards, 1835: 168, *Sanguinolaria* species 1.–Chenu, 1858,
Sanguinolaria pl.1 fig.4.–Lamy, 1914: 20.
Psammobia nivosa Deshayes, 1855 n.syn.: 317, no.2.–Reeve,
 1856: *Psammobia* pl.3, species 21.–Hidalgo, 1903: 88,
 no.173.
Psammobia occidens (Gmelin).–Reeve, 1856: *Psammobia* pl.2,
 species 11.–Fischer, 1858: 336.–Dunker, 1882: 186.–
 Shopland, 1902: 177.–Hidalgo, 1903: 88, 102, no.172.
Psammobia (Psammocola) occidens Lamarck.–Chenu, 1862:
 64, fig.260.–Martens, 1897: 241, no.1.–Paetel, 1890: 40.
Gari (Psammacola) (sic = error pro. *Psammocola*) *occidens*
 (Gmelin).–Tryon, 1868: 77, no.53.–Paetel, 1890: 40.
Gari (Psammacola) (sic = error pro. *Psammocola*) *occidens*
 (Gmelin).–Tryon, 1868: 77, no.54.
Gari occidens (Chemnitz) (sic = error pro. Gmelin).–Bertin,
 1880: 12, no.70.
Gari nivosa (Deshayes).–Bertin, 1880: 124, no.74.
Gari occidens (Gmelin).–Melville & Standen, 1906: 841.–
 Smythe, 1982: 108, pl.16b.–Slack-Smith, 1990: 137.–Lamprell
 & Whitehead, 1992: 56, pl.52 fig.386.
Gari (Psammocola) occidens (Chemnitz) (sic = error pro.
 Gmelin).–Lamy, 1918: 250.
Dysmea occidens (Gmelin).–Dall, Bartsch & Rehder, 1938:
 174.–Kuroda & Habe, 1952: 20.–Powell, 1958: 69, 73, fig
 A5.–Habe & Kosuge, 1966: 172, pl.67 fig.2.–Matsukuma,
 1989: 105, 106, pl.1 figs 10-12.
Dysmea vitrea Dall, Bartsch & Rehder, 1938 n.syn.: 174, pl.44
 figs 13,14.–Kay, 1979: 565 (not *Sanguinolaria vitrea*
 Deshayes, 1855).
Gari rossiteri (Crosse).–Allan, 1950: 342, fig.80, no.4.–
 Ripplingale & McMichael, 1961: 205, pl.29 fig.20
 (misidentification, not *Psammobia rossiteri* Crosse, 1873).
Gari (Dysmea) occidens (Gmelin).–Keen in Moore, 1969:
 N631, fig.E115, no.6a,b.–Pliver, 1992: 163, pl.36 fig.10a,b.
Dysmea (Dysmea) occidens (Gmelin).–Habe, 1977: 220.
Gari (Dysmea) tongana (Quoy & Gaimard).–Cernohorsky,
 1978: 186, pl.68 fig.2 (misidentification, not *Psammobia*
tongana Quoy & Gaimard, 1835).

Comments on synonymy. The long synonymy of *Gari occidens* comes about because of the species' abundance and widespread Indo-Pacific distribution, rather than through confusion with others. *Gari occidens* is the largest species of *Gari* known and its two (previously unrecognised) synonyms, *Psammobia nivosa* Deshayes and *Dysmea vitrea* Dall, Bartsch & Rehder, both relate to juveniles. The former is based on a medium-sized shell that has not attained adult colouration (Fig.228). The latter is founded on a single very small specimen from Hawaii (Fig.229). Besides being a junior synonym of *Solen occidens* Gmelin, *Dysmea vitrea* is preoccupied by the homonymous *Sanguinolaria vitrea* Deshayes. Both *P. nivosa* and *D. vitrea* possess all the characters of *G. occidens*.

The first figure of *Gari occidentis* (by Chemnitz, 1782) has never been equalled in my opinion. It is reproduced here in Figure 223.

Types. *Solen pictus*, var. c Spengler: (complete specimen - 82.0 mm, but left valve with broken ventral margin) in Spengler coll., ZMUC (Fig.224). Type locality Nicobar Islands.

Sol. occidentis Chemnitz: type material originally in Chemnitz' own coll., but now probably lost (T. Schitte, personal communication, 1986); not found during personal search in ZMUC in 1989 (type figure Fig.223). Type locality Western Ocean.

Sanguinolaria occidentis Lamarck: lectotype, here designated (figured syntype, complete specimen - 84.9 mm, but right valve with broken ventral margin) in MNHN; figured by Chenu, 1858: *Sanguinolaria* pl.1 fig.4 (Fig.225). Paralectotypes (complete specimens - 99.0, 94.2 mm) in MHNG (1083/6); larger paralectotype probably that figured by Bruguière, 1797: pl.226 fig.2a,b (Fig.226). Type locality unknown.

Specimen of *Psammobia occidentis* figured by Reeve, 1856: *Psammobia* pl.2, species 11 (complete specimen - 97.8 mm) in BMNH (1985174/1) (Fig.227).

Psammobia nivosa Deshayes: lectotype, here designated (figured syntype, complete specimen - 75.7 mm) in BMNH (1984277/1); figured by Reeve, 1856: *Psammobia* pl.3, species 21 (Fig.228). Paralectotype (complete specimen - 70.5 mm) in BMNH (1984277/2). Type locality Philippine Islands.

Dysmea vitrea Dall, Bartsch & Rehder: holotype (complete specimen - 33.5 mm, but left valve broken anteriorly and centrally) in USNM (173001); right valve illustrated by Dall, Bartsch & Rehder, 1938: pl.44 figs 13,14 (Fig.229). Type locality off south coast Molokai Island, Hawaii.

Material examined. AUSTRALIA – QUEENSLAND: 2c, Cape York (NMNZ; QM); 1h, 17 m, Granite Head, north-west side Lizard Island (Willan coll.); 2h, 7.5-10.5 m, Mermaid Cove, north-west side Lizard Island (Willan coll.); 1c, Watsons Beach, north-west side Lizard Island (Sponner coll.); 3h, 12-18 m, Lizard Head, south-east side Lizard Island (Willan coll.); 1h, 24.5 m, south-west edge South Island, off Lizard Island (Willan coll.); 2c, Low Is (NMNZ MF29766; Whitehead coll.); 1c, Batt Reef, (AMS C87913); 4c, Hayman Island, Whitsunday Group (NMV); 1c, Langford Island, Whitsunday Group (Whitehead coll.); 1c, North Keppel Island, Keppel Bay (AMS C125995); 1c, Yeppoon, Keppel Bay (WAM 1081-70); 1h, 10-11 m, reef no.21-184, Swain Reefs - 21°23'S 151°42'E (AMS); 1c, 9 m, south-east side Heron Island, Capricorn Group (Willan coll.); 4c, 4h, 26-35 m, north-east side Wistari Reef, Capricorn Group (Willan coll.); 13c, 6h, 6-12 m, Shag Rocks, north-west Point Lookout (Willan coll.); 1h, 0 m, east Goat Island, Moreton Bay (Willan coll.). WESTERN AUSTRALIA: 1c, 2h, Long Island, Passage Islands (WAM); 2c, Sholl Island, Passage Islands (WAM); 1h, 2-3.5 m, east side South Pasco Island, near Barrow Island (WAM); 1c, 2h, 2-3 m, Hermite Island, Monte Bello Islands (WAM); 1c, Regnard Bay, Dampier (Turnbulle coll.); 1c, Arc Beach, Rosemary Island, Dampier Archipelago (WAM 1724-68); 1c, Rosemary Island, Dampier Archipelago (WAM 1722-68); 1c, Lady Nora Flats, north-east side Rosemary Island, Dampier Archipelago (WAM); 1c, east side Delambre Island, Dampier Archipelago (WAM); 1c, Port Sampson (WAM 1723-68); 1c, 23 m, Hibernia Reef (NTM).

HAWAII: 1c, 79-120 m, south coast Molokai Island (USNM 173001 - holotype of *Dysmea vitrea* Dall, Bartsch & Rehder). NEW CALEDONIA: 3c (Lamprell coll.; WAM 3699-67, 1827-68); 1h, 42 m, north Hienghène - 20°13'S 164°18'E (MNHN); 2c,

north-east side Isle de Brun, Nouméa (WAM 1731-68). SOLOMON ISLANDS: 1c, 6 m, 2.4 km, off Honiara, Guadalcanal Island (Willan coll.). PHILIPPINE ISLANDS: 7c (NMCN; NMV); 2c, Dumaguete, Negros Island (BMNH 1984277/1,2 - lectotype & paralectotype of *Psammobia nivosa* Deshayes); 1c, 1h, Negros Island (CAS). INDONESIA: 6c, Moluccas Islands (NMSA G5000; NMV 23386-89); 1c, Java (NHMW 44898). NICOBAR ISLANDS: 1c (ZMUC - type of *Solen pictus* var. c Spengler). SRI LANKA: 11c (AMS; BMNH 1985174/1,2; NHMW G234, G7613, NMV). GULF OF OMAN: 1c, 18 m, near Khasab, Oman (BMNH). PERSIAN GULF: 1c, Ras Tanura, near Dhabran (BMNH); 1c, Dhabran (ZMUC); 1c, Kuwait (BMNH); 3c, Dubai'ah (MNHN). GULF OF ADEN: 1c (BMNH); 1c, 3h, Socotra Island, Aden (MNHN); 1c, 5 m, Conquest Bay (BMNH). RED SEA: 1c, Nokra Island, Dahlak Archipelago (NHMW E25.349).

LOCALITY UNKNOWN: 3c (MNHG 1083/6; MNHN - lectotype & paralectotype of *Sanguinolaria occidentis* Lamarck).

Description. Shell very large, maximum length 120 mm. Shell solid, elliptical, transversely elongate; maximum width posterior to umbones; umbones in front of centre (both in juveniles and adults); anterior end broadly rounded (considerably narrower than posterior end); ventral margin straight; posterior end flaring, subtruncate; inequivalve, right valve somewhat flatter; commissure curved; both valves moderately compressed; small anterior gape, larger posterior gape. Surface of both valves smooth, crossed by numerous, concentric growth striae that are stronger on posterior slope, without any discernible posterior ridge. Exterior with thick, greenish-brown periostracum that extends beyond margins.

Hinge plate strong; nymph strong, elongate and relatively broad (wider than hinge plate); ligament raised and very strong. Right valve with 2 strong cardinal teeth, diverging by 50° from each other; anterior one slightly weaker, directed vertically downward; rear one bifid, directed posteriorly. Left valve with a pronounced, triangular or spoon-shaped lunular projection on hinge line in front of anterior cardinal tooth, stronger than any tooth; anterior cardinal deeply bifid, directed vertically downward; posterior cardinal a short, high lamella, diverging at 40° behind anterior one. Pallial sinus moderately deep, reaches level with anterior third of nymph (ie, not level with hinge plate); upper limb straight, runs horizontally; anterior margin broadly convex; lower limb free from pallial line for more than half its length (sometimes free almost to ventral extremity of pallial line); ventral extremity of pallial line points rearward with a slight upward flexure, reaches level with rear end of posterior adductor scar. Single pedal retractor scar in each valve immediately below anterior end of hinge plate.

Colour of exterior white, regularly maculated with mauve-pink, markings often coalesce to form broad rays; rays more obvious towards margins; umbones creamish or pale yellow; dorsal margins with series of dark purple, oblique dashes at edge. Interior porcellanous white, faintly clouded with pink, vividly stained with yellow or (rarely) orange dorsal to pallial sinus and pallial line. Hinge plate, teeth and nymph white. Adult shells with a white, thickened internal buttress

running obliquely forward from umbo.

Remarks. Among Indo-Pacific psammobiids, *Gari occidentis* is distinctive on account of its large size, posteriorly flaring shell and striking colouration. The significance of the lunular projection in the left valve has been commented on here under the diagnosis of the subgenus *Dysmea*. In describing the dentition, Powell (1958) said that the anterior cardinal in the right valve was "much the stronger" of the two teeth in that valve, but the posterior cardinal has been a little taller (ie, stronger) in all the shells I have examined. Examination of 85 valves of *G. occidentis* has shown that, both in juveniles and adults, the lower limb of the pallial sinus is free from the pallial line for more than half its length. This observation contradicts the diagnosis given for *Dysmea* by Dall, Bartsch & Rehder (1939) (repeated by Keen in Moore, 1969). Juvenile *G. occidentis* (Figs 228, 229) are relatively thinner and paler in colour than adults. Sometimes there is a series of small, pink dots between the maculations (Figs 224, 229, 234), and juveniles do not show the distinctive, reddish pink rays of adults (Figs 228, 229). One element of colouration that is present without exception in (all sizes of) *G. occidentis* is the series of purple dashes along the dorsal margins; these markings are relatively more conspicuous in juveniles (Figs 228, 231).

Within Australian waters, *Gari occidentis* is most similar to *G. eos*, so a full comparison is provided under the remarks section for that species. *Gari occidentis* has been confused several times with *G. castrensis oriens* (Deshayes) in modern popular literature (Allan, 1950; Ripplingale & McMichael, 1961; Cernohorsky, 1978; Springsteen & Leobrer, 1986). *Gari castrensis oriens* is smaller, more elongate and inflated, not flaring posteriorly, it lacks a lunular projection on the left valve, it has a different colour pattern externally (ie, narrower rays and arrow-shaped markings rather than broad rays and purple dots), and it is never yellow stained internally.

The tropical eastern Pacific *Gari helenae* Olsson is smaller, more convex, more rounded posteriorly, its lunular projection, which is like that of *G. occidentis*, is purple and both its valves have numerous, fine, close radial ribs on the posterior slopes.

Habitat. *Gari occidentis* inhabits clean, fine to medium sand substrates in open locations. The substrate can be either sand or comminuted coral. The preferred habitat appears to be steep seaward reef slopes of coral isles. *Gari maculosa* also regularly occurs in these situations as well.

Gari occidentis lives only subtidally and the known depth range for live specimens is 6 to 35 m (with maximum abundance over the lower half of that bathymetric range).

Distribution. *Gari occidentis* is widespread throughout the (western and central) Pacific and Indian

Oceans. *Gari occidentis* ranges throughout the tropics and extends, along continental coastlines, into warm temperate waters.

Literature records are too numerous to cite in full, so I give only those that indicate the probable limits of distribution: Hawaii (Dall, Bartsch & Rehder); New Caledonia (Fischer, 1858; Bertin, 1880); northern Australia (Allan, 1950); Shark Bay, Western Australia (Slack-Smith, 1990); Japan (Habe, 1977); Sri Lanka (Chemnitz, 1782); Gulf of Oman (Melvill & Standen, 1906); Persian Gulf (Smythe, 1982; Glayzer *et al.*, 1984); Aden (Lamy, 1918). This extensive distribution coincides with that of *G. maculosa* for the most part, yet *G. occidentis* extends further east to the Hawaiian Islands. Because specimens are so rare in Hawaiian waters, its occurrence there is probably the result of occasional eastward larval transportation instead of established breeding populations.

In Australia, *G. occidentis* ranges around the northern coasts, extending southwards to Moreton Bay on the east and Dampier on the west coast.

Gari (Kermadysmea) Powell, 1958

Type species. *Kermadysmea galathea* Powell, 1958, by original designation. Recent, Indo-Pacific.

Diagnosis. Medium-sized psammobiids; transversely elongate; posterior end rounded truncate, broader than anterior end; inequivalve, commissure curved; moderately compressed; small posterior gape. Sculpture distinctive, consisting of sharp, concentric, lamellate cords formed from microscopic, recurved riblets. Both valves with 2 cardinal teeth; lunular projection in left valve. Pallial sinus moderately deep, lower limb free from pallial line for entire length. Colour creamish, crossed by pale, salmon-pink, concentric bands and rays.

Although the form of the sculpture in *Kermadysmea* is highly derived, its shell shape, dentition, pallial impressions and colouration are those of *Gari*. Indeed, I take the latter three character suites to be plesiomorphic and, therefore, consider full generic status unwarranted. Judging by the characters presented in Table 1, *Kermadysmea* is closest to *Psammobia*. This conclusion needs to be tested by way of comparative anatomy. *Kermadysmea* is not particularly closely related to *Dysmea* as Powell (1958) suggested since the inferred similarities are plesiomorphies.

Habe (1976) placed a new Japanese species in *Kermadysmea* – *K. nishimurai* Habe. I completely endorse Matsukuma's (1989) reassignment of it to a new genus, *Aenigmotellina*, in the Tellinidae. This reassignment restores monotypic status to *Kermadysmea*.

Both Powell (1958) and Matsukuma (1989) have provided detailed drawings of the sculpture and dentition of *Gari galathea*.

Gari (Kermadysmea) galathea (Powell, 1958)

Figs 194-196, 398

Kermadysmea galathea Powell, 1958: 74, figs 1,4, pl.10 fig.4.–Okutani, 1983: 12, pl.47 fig.7.–Lan, 1985: pl.161f.–Matsukuma & Yoosukh, 1988: 568.–Matsukuma, 1989: 108-110, figs 3-5, pl.3 figs 1-11.

Gari (Kermadysmea) galathea (Powell).–Keen, 1969: N631, fig.E115-12.

Dysmea (Kermadysmea) galathea (Powell).–Habe, 1977: 220.

Types. *Kermadysmea galathea* Powell: holotype (complete specimen; right valve with irregular hole in centre - 43.3 mm) in ZMUC; illustrated by Powell, 1958: pl.10 fig.4. Paratypes (2 single right valves with broken posterior margins - 38.4, 35.7 mm plus complete specimen - 27.3 mm) in AIM (AK72300). Type locality, off Raoul Island, Kermadec Islands.

Material examined. KERMADEC ISLANDS: 1c, 146-165 m, south-east Nugent Island, Raoul Island - 29°14.7'S 177°49.4'W (NMNZ MF25686); 1h, 135-146 m, east Dantrell Island, Herald Islets - 29°14.73'S 177°50.34'W (NMNZ MF26631); 2c,2h, 83 m, off Raoul Island - 29°15'S 177°57'W (ZMUC; AIM AK72300 - holotype & paratypes of *Kermadysmea galathea* Powell respectively); 3h, 82-100 m, south-east Smith Bluff, Raoul Island - 29°18'S 177°56.4'W (NMNZ MF26586); 1h, 135 m, 2.3 n.ml. off Fleetwood Bluff (NMNZ MF25424); 1h, 100-420 m, off Curtis Island - 30°34.5'S 178°34.5'W (NMNZ MF49907).

RÉUNION ISLAND: 4h, 40 m, 20°52'S 55°37'E (MNHN); 1h, 165-195 m, 21°02'S 55°11'E (MNHN); 2h, 170-225 m, 21°05'S 55°12'E (MNHN); 1h, 97-110 m, 21°05'S 55°13'E (MNHN); 1h, 73-77 m, 21°21'S 55°27'E (MNHN); 5h, 74-77 m, 21°21'S 55°27'E (MNHN); 1 fragment, 205-215 m, 21°23'S 55°37'E (MNHN).

Description. Maximum length 50 mm. Shell thin and fragile, transversely elongate; maximum width posterior to umbones; umbones in front of centre, more so in adults; anterior end rounded (considerably narrower than posterior end); ventral margin straight; posterior end rounded-truncate, often markedly truncate; inequivalve, right valve flatter; commissure curved; both valves moderately compressed; negligible anterior gape, small posterior gape. Surface of both valves ornamented by regular, thin, concentric, lamellate cords consisting of numerous, microscopic, recurved riblets (Fig.197); riblets often broken, especially in vicinity of umbo; cords number 10-12 per cm counting in from ventral margin transversely towards umbo of adult shells; entire surface crossed by fine radial lines. Periostracum apparently absent.

Hinge plate relatively narrow; nymph elongate, narrow, low; ligament low. Right valve with 2 cardinal teeth, diverging by 50° from each other; anterior one triangular, directed forward; posterior one slightly stronger, bifid, directed obliquely backward. Left valve with 2 cardinal teeth, diverging by 45° from each other; anterior one much stronger, triangular, weakly bifid, directed vertically downward; posterior one reduced to a lamella. Interior smooth, only slightly corrugated by external cords. Pallial

impressions not difficult to observe in adult shells; pallial sinus moderately deep, reaches level with anterior third of nymph (ie, not level with hinge plate), broad, non-tapered; upper limb ascending slightly, slopes upward at about 30° to ventral margin; anterior margin broadly convex; lower limb free from pallial line for its entire length; ventral extremity of pallial line downturned, reaches level with rear third of posterior adductor scar. Single pedal retractor scar in each valve immediately below anterior end of hinge plate.

Colour cream or pinkish-buff, rarely reddish, marked with irregular, pale, salmon-pink, concentric bands and rays. Interior transparent, colouration more conspicuous. Hinge plate, teeth and nymphs white.

Remarks. *Gari galathea* is rendered unique by a combination of all the characters that define the subgenus. The sculpture is unique, but is insufficient by itself to accord full generic status as Powell (1958) and Matsukuma (1890) have done. In describing the sculpture, Powell (1958:74) observed how the riblets that constitute the lamellate cords impart a dense, comb-like effect when the exterior is examined microscopically. I disagree with Powell (1958) that the nymph is broad; at approximately 5% of the shell's height it is relatively narrow.

Matsukuma (1890:108) believed that the possession of a sliver of ligament on the hinge plate in front of the anterior cardinal tooth was autapomorphic for the genus *Gari* and, because he did not observe it in *Kermadysmea*, concluded *Kermadysmea* was distinct. This cardinal ligament is, in fact, present not only in fresh shells of *Kermadysmea* (for example, NMNZ MF26586) but also in *Heteroglypta*, so it is of no taxonomic significance within the Psammobiidae.

Gari galathea is distinct from *Gari occidentis* (Gmelin), *G. castrensis oriens* (Deshayes) and *G. eos* by its concentric lamellate cords and complete separation of the lower limb of the pallial sinus from the pallial line. These are the only three Indo-Pacific species even remotely like *G. galathea*. Some species of the subgenus *Psammobia* (*G. fervensis* (Gmelin), *G. jousseaumeana* Bertin and *G. pseudoweinkauffi* Cosel) bear a slight resemblance to *G. galathea* in possessing strong concentric sculpture, but all three differ in sculptural detail, shape of the pallial sinus and colouration.

Habitat. The type specimens of *Gari galathea* were taken in coarse shell sand and gravel. Powell (1958) obtained numerous living specimens at the type locality.

Valves of *Gari galathea* have been taken at all depths between 40 and 420 m, but the maximum depth is probably too deep for living specimens. Most specimens have come from 75 to 215 m.

Distribution. The first specimens came from the Kermadec Islands (Powell, 1958). In the last decade, additional specimens have come from the Ryukyu Islands (Okutani, 1983; Matsukuma, 1989) and Réunion Island (6 lots MNHN). Such far-flung occurrences suggest *Gari galathea* has a wide, tropical Indo-west pacific

distribution. The occurrence of *G. galathea* at Réunion Island in the Indian Ocean probably indicates that the species is wide-ranging instead of antitropical as proposed by Matsukuma & Yoosukh (1988). It is noteworthy that there is still no material known from northern Australia, New Caledonia or the Philippine Islands. Matsukuma (1989) cites a Pleistocene record from Kagoshima Prefecture, Japan.

Gari (*Psammotaena*) Dall, 1900

Type species. *Solen effusa* Lamarck, 1806, by original designation. Mid-Eocene, France.

Comments. Although a naturally circumscribed group of species constitutes this subgenus, its taxonomy has had a confused history. Lamarck (1818) conceived the genus *Psammotaea* for a group of eight species of his "Tribe Nymphacea" that differed from *Psammobia* in having only a single cardinal tooth in each valve. [Incidentally that particular character was erroneous – Lamarck's shells had broken hinges.] Lamarck never designated any species as type. Children (1823) designated *Psammotaea donacina* Lamarck as type species. This action is regrettable because *P. donacina* is not congeneric nor confamilial with any of the other seven Lamarckian species. It must remain nevertheless and *Psammotaea* must, accordingly, be removed from the Psammobiidae. *Psammotaena* Dall is the next available name for the group. [I agree with McMichael (1961) that Bowdich's (1822) mention of *P. serotina* Lamarck does not constitute a valid type designation.] Two other generic names, *Capsella* Deshayes and *Psammotella* Deshayes, have also been applied to this group (eg, by Reeve, 1857). However, both are preoccupied, the former by *Capsella* Gray (= *Iphigenia* Schumacher) and the latter by *Psammotella* Blainville (= *Sanguinolaria* Lamarck). Instead of employing *Psammotaea* for Lamarck's species group, Blainville (1824) introduced yet another new genus, *Psammocola*.

I believe *Amphipsammus* Cossmann, 1914 is another synonym of *Psammotaena*. *Amphipsammus* which, like *Psammotaena* is based on a fossil, differs merely in the extent of development of concentric striae near the posterodorsal margin.

Diagnosis. Medium- to moderately large-sized psammobiids. Shells elongate or elongate-ovate, posterior end enlarged; inequilateral (umbones always displaced anteriorly); moderately fragile, but adults can be solid because of secondary calcification internally; moderately inflated; moderately large posterior gape; equi-valve; sculpture identical on both valves, consisting of concentric striae only; without a posterior ridge; periostracum moderately thick; right valve with 2 cardinal teeth, the rear stronger and

directed obliquely backward, the anterior weaker and pointing downward; left valve with anterior cardinal tooth much stronger, not bifid, directed rearward, rear a low, oblique ridge; pallial sinus deep, upper limb straight, lower limb free from pallial line for over half (sometimes two-thirds) its length; several small pedal retractor scars present; no glaze internally.

The apomorphies of *Psammotaena* are the enlargement of the posterior end (with concomitant anterior displacement of umbones and elongation), relatively large posterior gape, slight posterior downslant of anterior cardinal tooth in each valve and subdivision of the pedal retractor muscle at its origin. Other characters possessed by this subgenus also occur in other subgenera, notably the lack of sculpture, posterior ridge, thick periostracum, weakly bifid right anterior cardinal tooth, relative enlargement of the posterior cardinal tooth in the left valve, relatively deep pallial sinus, separation of the lower limb of the pallial sinus for greater than half its length and lack of glaze internally.

All members of the subgenus *Psammotaena* are also united by habitat; they live in low energy, intertidal environments such as mangrove forests or sheltered muddy bays. This environment is probably responsible for the elongate shape, secondary calcification internally, posterior gape, lack of sculpture, thick periostracum and lack of internal glaze. I view *Psammotaena* as the product of an intertidal radiation from *Gari* ancestral stock. Thus many of the characters seen in *Psammotaena* are convergent with those of *Soletellina*, another psammobiid lineage that independently adopted the estuarine habitat.

Psammotaena approaches *Gobraeus* most closely overall, but *Gobraeus* is less produced and more truncate posteriorly, thicker shelled, with a less extensive pallial sinus, with a much weaker posterior cardinal in the left valve and with a considerably stronger ligament.

Just as the subgenera *Gari* and *Psammobia* constitute one sister group pair, so *Gobraeus* and *Psammotaena* probably constitute another.

I have experienced great difficulty in assessing the number of exotic species that belong to *Psammotaena* because I cannot gauge the extent of intraspecific variation. Members of this subgenus appear to exhibit greater intraspecific variation than those in other subgenera, possibly because of their existence in euryhaline environments. A critical taxonomic revision of the following nominal *Psammotaena* species, all of which supposedly occur in the tropical Indo-west Pacific, would show many to be synonymous: *G. candida* (Reeve); *G. chinensis* (Deshayes); *G. layardi* (Bertin); *G. micans* (Bertin); *G. oblonga* (Deshayes). As an example of how extensive synonymy can be in this subgenus, I have herein amalgamated over a dozen nominal species under *G. elongata* (Lamarck).

Key to the Species of the Subgenus *Psammotaena* in Australasia

1. Shell elongate, rectangular, with straight ventral margin and truncate posterior margin *G. elongata*
- Shell ovate or elliptical, with convex ventral margin and broadly rounded posterior margin 2
2. Shell elongate-ovate; whitish in colour *G. togata*
- Shell markedly ovate; violet in colour *G. inflata*

Gari (Psammotaena) elongata (Lamarck, 1818)

Figs 246-268, 399, 400

? *Tellina gari* Rumphius, 1705: 146, pl.45 fig.D (pre-Linnaean).
Psammobia elongata Lamarck, 1818: 514, *Psammobia* species 7.—Blainville, 1826: 478.—Deshayes & Milne-Edwards, 1835: 176, *Psammobia* species 7.—Delessert, 1841: pl.5 figs 4a-d.—Hanley, 1843: 57, pl.11 fig.46.—Philippi, 1845: 193, *Psammobia* pl.2 figs 2,3.—Martens, 1897: 240, no.3.—Hidalgo, 1903: 94, no.185.—Lamy, 1914: 57.—Oostingh, 1925: 310, no.296.—Fischer & Fischer-Piette, 1938: 409.—Habe, 1951: 204, fig.486.
Psammotaena violacea Lamarck, 1818: 517, *Psammotaena* species 1.—Blainville, 1826: 483.—Deshayes & Milne-Edwards, 1835: 181, *Psammotaena* species 1.—Hanley, 1843: 60, pl.12 fig.60.—Martens, 1897: 239, no.2.—Hidalgo, 1903: 95, no.186.—Dautzenberg & Fischer, 1913: 486, 1914: 226, 227, pl.7 figs 7-11.—Lamy, 1914: 62.—Habe, 1951: 204.—Higo, 1973: 369, no.1154.
Psammotaena serotina Lamarck, 1818: 517, *Psammotaena* species 5.—Blainville, 1826: 483.—Deshayes & Milne-Edwards, 1835: 182, *Psammotaena* species 5.—Dautzenberg & Fischer, 1914: 227, 228, pl.7 figs 12,13.—Lamy, 1914: 64.
Psammobia violacea (Lamarck).—Reeve, 1841: 77, pl.53 fig.2.
Capsa (Capsella) minor Deshayes, 1855 n.syn.: 347, no.140.
Capsa (Capsella) difficilis Deshayes, 1855 n.syn.: 347, no.141 and vars β , τ and σ .
Capsa (Capsella) rufa Deshayes, 1855 n.syn.: 347, no.142.
Capsa (Capsella) radiata Deshayes, 1855 n.syn.: 348, no.143 and vars β and τ .—Willan, 1992: 229, fig.17 (misidentification, not *Psammobia radiata* Dunker in Philippi, 1845).
Capsa (Capsella) rosacea Deshayes, 1855 n.syn.: 348, no.144.
Capsa (Capsella) solenella Deshayes, 1855 n.syn.: 349, no.151.
Capsella difficilis (Deshayes).—Reeve, 1857: *Capsella* pl.1, species 2.
Capsella rufa (Deshayes).—Reeve, 1857: *Capsella* pl.1, species 3.
Capsella elongata (Lamarck).—Reeve, 1857: *Capsella* pl.1, species 4.
Capsella solida Reeve, 1857 n.syn.: *Capsella* pl.1, species 5.
Capsella violacea Reeve, 1857 n.syn.: *Capsella* pl.1, species 6 (misidentification, not *Psammotaena violacea* Lamarck, 1818).
Capsella radiata (Deshayes).—Reeve, 1857: *Capsella* pl.1, species 7 (misidentification, not *Psammobia radiata* Dunker in Philippi, 1845).
Capsella minor (Deshayes).—Reeve, 1857: *Capsella* pl.2, species 9.
Capsella solenella (Deshayes).—Reeve, 1857: *Capsella* pl.2, species 11.

Capsella rosacea (Deshayes).—Reeve, 1857: *Capsella* pl.2, species 15.
Soletellina (Psammotaena) violacea (Lamarck).—Chenu, 1862: 65, fig.267.—Paetel, 1890: 42.
Soletellina (Psammotella) elongata (Lamarck).—Chenu, 1862: 65, fig.269.
Hiatula (Psammotea) (sic = error pro. *Psammotaena*) *elongata* (Lamarck).—Tryon, 1868: 80, no.21.
Hiatula (Psammotaena) elongata (Lamarck).—Bertin, 1880: 95, no.33.
Hiatula (Psammotaena) violacea (Lamarck).—Bertin, 1880: 96, no.34.
Hiatula (Psammotaena) sordida Bertin, 1880 n.syn.: 99, no.50, pl.5 fig.4a,b.
Soletellina (Psammotaena) elongata (Lamarck).—Paetel, 1890: 42.
Soletellina (Psammotaena) minor (Deshayes).—Paetel, 1890: 42.
Soletellina (Psammotaena) radiata (Deshayes).—Paetel, 1890: 42 (misidentification, not *Pammobia radiata* Dunker in Philippi, 1845).
Soletellina (Psammotaena) rosacea (Deshayes).—Paetel, 1890: 42.
Soletellina (Psammotaena) rufa (Deshayes).—Paetel, 1890: 42.
Soletellina (Psammotaena) serotina (Lamarck).—Paetel, 1890: 42.
Soletellina (Psammotaena) solenella (Deshayes).—Paetel, 1890: 42.
Soletellina (Psammotaena) solida (Reeve).—Paetel, 1890: 42.
Psammotellina serotina (Lamarck).—Martens, 1897: 234, no.1.
Psammotaena difficilis (Deshayes).—Hidalgo, 1903: 93, no.183.
Psammotaena rufa (Deshayes).—Hidalgo, 1903: 94, no.184.
Psammotaena radiata (Deshayes).—Hidalgo, 1903: 95, no.187 (misidentification, not *Psammobia radiata* Dunker in Philippi, 1845).
Psammotaena minor (Deshayes).—Hidalgo, 1903: 96, no.189.—Kira, 1962: 170, pl.60 fig.8.—Higo, 1973: 369, no.1158.—Higo, 1973: 369, no.1158.—Matsumoto, 1979: 109, no.1848.
Psammotaena solenella (Deshayes).—Hidalgo, 1903: 97, no.191.
Soletellina dautzenbergi G.B. Sowerby III, 1909 n.syn.: 314.
Gari gari (Linné).—Allan, 1950: 342 (misidentification, not *Tellina gari* Linné, 1758).
Sanguinolaria elongata (Lamarck).—Kuroda & Habe, 1952: 30.
Sanguinolaria violacea (Deshayes).—Kuroda & Habe, 1952: 30.
Sanguinolaria minor (Deshayes).—Kuroda & Habe, 1952: 30.
Psammotaena elongata (Lamarck).—Azuma, 1960: 88, no.1486.—Kira, 1962: 170, pl.60, no.3.—Higo, 1973: 369, no.1155.—Habe, 1977: 221.
Sanguinolaria (Psammotaena) minor (Deshayes).—Scarlato, 1965: 55, pl.5 fig.6.
Sanguinolaria (Psammotaena) violacea (Lamarck).—Scarlato, 1965: 55, pl.2 fig.7.
Psammotaena elongata (Lamarck).—Abbott & Dance, 1982: 347.

Gari (Gobraeus) elongata (Lamarck).-Springsteen & Leobrera, 1986: 300, pl.85 fig.4.

Hiatula chinensis Mörch.-Dharma, 1992: 94, pl.25 fig.3,3a.

Comments on synonymy. I agree with Martens (1897: 239) and Dall (1900:970) that this species is most probably the *Tellina gari* of Rumphius (1705) (= *Tellina gari* Linné, 1758), but because of confusion with *T. truncata* Linné and *G. vulgaris* Schumacher, the name *Tellina gari* Linné has been suppressed (ICZN, 1970:16, Opinion 910).

Solen variegatus Wood, 1815 possibly represents an unused senior synonym for *Psammobia elongata* Lamarck. However, Wood's description and figure are inadequate, and *S. variegatus* could refer equally well to a species of *Soletellina*. *Soletellina lunulata* (Deshayes), for example, corresponds not only in colouration (orange umbones and reddish violet rays), but also in being thin and pellucid. Lamy, an astute conchologist, believed *S. variegatus* and *P. elongata* were different species (Lamy, 1914:57). Because the type material of *S. variegatus* Wood is lost (S. Morris, personal communication, 1989; personal search in BMNH in 1989), I consider the name should be treated as a *nomen dubium*.

Whilst redescribing the type material of *Psammotaea violacea* Lamarck and *P. serotina* Lamarck, Dautzenberg & Fischer (1913:486, line 34) acted as first reviser by synonymising these two names under *Psammobia elongata* Lamarck. Furthermore, these same authors (Dautzenberg & Fischer 1913,1914) suggested *Psammotellina ruppelliana* Reeve (for which the type locality of the Red Sea is the same as that for *P. elongata*) might also be the same species. I disagree and consider *P. ruppelliana* as a valid erythraean species of *Soletellina*.

The names *Capsa difficilis*, *C. rufa*, *C. radiata*, *C. rosacea* and *C. solenella* of Deshayes (1855), as well as *Capsella solida* and *C. violacea* of Reeve (1857) are all based on shells showing minor differences in shape and colouration to *Psammobia elongata*. Deshayes' *Capsa radiata* and Reeve's *Capsella violacea* are secondary homonyms of *Psammobia radiata* Dunker in Philippi and *Psammotaea violacea* Lamarck respectively. Neither needs replacing.

The type specimens of *Capsa minor* Deshayes (Fig.250) and *Soletellina dautzenbergi* G.B. Sowerby III (Fig.259) are almost identical to each other. Both are based on juvenile shells and as such they are small and unthickened with conspicuous, narrow, purple rays and extensive periostraca. The holotype of *Hiatula sordida* Bertin (Fig.258) is only a little larger; it has especially prominent umbones and a very thin, almost unrayed, shell.

There is little doubt that Hutton's (1880:145) record of "*Capsa radiata* Deshayes" (sic) from Stewart Island, New Zealand, was based on *Gari stangeri* (Gray in Dieffenbach).

Popular books containing good coloured illustrations of *Gari elongata* are those by Kira (1962), Abbott & Dance (1982) and Springsteen & Leobrera (1986).

Types. *Psammobia elongata* Lamarck: lectotype, here designated (figured syntype, complete specimen - 65.5 mm) in MHNG (1083/17/1); figured by Delessert, 1841: pl.5 fig.4a-d (Fig.246 - exterior; Fig.247 - interior). Paralectotype (complete specimen - 65.7 mm) in MHNG (1083/17/2). Type locality Red Sea.

Psammotaea violacea Lamarck: lectotype, here designated (largest syntype, complete specimen - 47.7 mm) in MNHN (M4 1175); figured by Dautzenberg & Fischer, 1914: pl.7 figs 7,8 (Fig.248). Paralectotypes (complete specimens - 36.0, 34.5

mm) in MNHN (M4 1174); figured by Dautzenberg & Fischer, 1914: pl.7 figs 9-11. [For further information see Dautzenberg & Fischer, 1914 and Lamy, 1914.] Type locality "les mers de la Nouvelle-Hollande".

Psammotaea serotina Lamarck: holotype (complete specimen - 52.8 mm) in MNHN (M4 1176); figured by Dautzenberg & Fischer, 1914: pl.7 figs 12,13 (Fig.249). [Front of cardboard mount supporting holotype labelled "*P. violacea*" by someone other than Lamarck.] [For further information see Dautzenberg & Fischer, 1914 and Lamy, 1914.] Type locality "les mers de l'Inde".

Capsa (Capsella) minor Deshayes: lectotype, here designated (figured syntype, complete specimen - 23.6 mm) in BMNH (1984269/1); figured by Reeve, 1857: *Capsella* pl.2, species 9 (Fig.250). Paralectotypes (complete specimens - 22.1, 21.7, 19.9 mm) in BMNH (1984269/2-4). Type locality Manilla (sic), Philippine Islands.

Capsa (Capsella) difficilis Deshayes: lectotype, here designated (figured syntype, complete specimen - 42.1 mm) in BMNH (1984262/1); figured by Reeve, 1857: *Capsella* pl.1, species 2 (Fig.251). Paralectotypes (complete specimens - 41.2, 40.7 mm) in BMNH (1984262/2,3). Type locality Philippine Islands.

Capsa (Capsella) rufa Deshayes: lectotype, here designated (figured syntype, complete specimen - 38.1 mm) in BMNH (1984263/1); figured by Reeve, 1857: *Capsella* pl.1, species 3 (Fig.252). Paralectotype (complete specimen - 37.7 mm) in BMNH (1984263/2). Type locality Manilla (sic), Philippine Islands.

Capsa (Capsella) radiata Deshayes: lectotype, here designated (figured syntype, complete specimen - 36.2 mm) in BMNH (1984267/1); figured by Reeve, 1857: *Capsella* pl.1, species 7 (Fig.253); illustrated by Willan, 1992: fig.17. Paralectotypes (complete specimens - 34.7, 33.8 mm) in BMNH (1984267/2,3). Type locality Philippine Islands.

Capsa (Capsella) rosacea Deshayes: lectotype, here designated (figured syntype, complete specimen - 30.5 mm) in BMNH (1984275/1); figured by Reeve, 1857: *Capsella* pl.2, species 15 (Fig.254). Paralectotype (complete specimen - 31.1 mm) in BMNH (1984275/2). Type locality Philippine Islands.

Capsa (Capsella) solenella Deshayes: lectotype, here designated (figured syntype, complete specimen - 35.7 mm) in BMNH (1984271/1); figured by Reeve, 1857: *Capsella* pl.2, species 11 (Fig.255). Paralectotypes (complete specimens - 34.5, 34.0 mm) in BMNH (1984271/2,3). Type locality Manilla (sic), Philippine Islands.

Specimen figured as *Capsella elongata* (Lamarck) by Reeve, 1857: *Capsella* pl.1, species 4 (left valve only - 53.8 mm) in BMNH (1984264/1).

Capsella solida Reeve: lectotype, here designated (figured syntype - 56.0 mm) in BMNH (1984265/1) figured by Reeve, 1857: *Capsella* pl.1, species 5 (Fig.256). Paralectotype (complete specimen - 50.4 mm) in BMNH (1984265/2). Type locality Malacca.

Capsella violacea Reeve: lectotype, here designated (figured syntype - 53.4 mm) in BMNH (1984266/1) figured by Reeve, 1857: *Capsella* pl.1, species 6 (Fig.257). Paralectotypes (complete specimens - 57.9, 55.5 mm) in BMNH (1984266/2,3). Type locality Bay of Manila.

Hiatula sordida Bertin: holotype (complete specimen 27.9 mm) in MNHN; figured by Bertin, 1880: pl.5 fig.4a,b (Fig.258).

Soletellina dautzenbergi G.B. Sowerby III: holotype (complete specimen 19.6 mm) in BMNH (1909.10.19.81);

figured by G.B. Sowerby III, 1909: 314 (fig.) (Fig.259). Type locality New Caledonia.

Material examined. "AUSTRALIA": 3c (MNHN M4 1174, M4 1175 - lectotype & paralectotypes of *Psammotaea violacea* Lamarck).

AUSTRALIA - QUEENSLAND: 1h, Four Mile Beach, Port Douglas (AMS); 1h, Port Douglas (WAM 1093-70); 2c, south side Bingil Bay, south Innisfail (AMS C127106); 7c,4h, Dunk Island, east Tully (AMS C9937, C100705; NMV F23925); 1c, Cardwell, Hinchinbrook Channel (BMNH); 4h, Little Pioneer Bay, north-west coast Orpheus Island, Palm Island Group (Willan coll.); 2c, Orpheus Island, Palm Island Group (NMV F25752); 7c,1h, Great Palm Island, Palm Island Group (Kessner coll.; QM); 1c, Horseshoe Bay, Magnetic Island, north of Townsville (AMS C124426).

FIJI ISLANDS: 1h (BMNH); 3c, Suva Harbour, Viti Levu Island (BMNH; Lamprell coll.; Whitehead coll.); 1c,7h, foreshore, Nasese, Suva Harbour, Viti Levu Island (Willan coll.); 5c, Lami Beach, 8 km west Suva, Viti Levu Island (WAM 1826-68). NEW CALEDONIA: 1c (BMNH 1909.10.19.81 - holotype of *Soletellina dautzenbergi* G.B. Sowerby III); 5c (WAM 1825-68, 1831-68); 4c, Ouaco (WAM 1090-70); 9c,3h, Poindimié (WAM 1091-70, 1094-70); 1c, Baie des Citrons, Nouméa (Hole coll.); 1h, Anse Vata, Nouméa (Willan coll.). VANUATU: 1c, Maskelye and Mallicols Islands (NMV); 1c,1h, Espiritu Santo Island (MNHN); 2c,1h, beach adjacent to Rowa River mouth, east Néafou, Espiritu Santo Island (Willan coll.); 1c, Malekula Island (MNHN); 5h, Blacksands Beach, Mele Bay, south-west Efaté Island (Willan coll.); 2h, beach near Devils Point, Mele Bay, south-west Efaté Island (Willan coll.); 1h, foreshore, Vila Harbour, Mele Bay, south-west Efaté Island (Willan coll.); 1c, Le Lagon, Erakor, south-west Efaté Island (Willan coll.); 1h, Veras Island (WAM). SOLOMON ISLANDS: 1c, Honiara, Guadalcanal Island (Trevor coll.); 1c, Roviana lagoon, New Georgia Group (Whitehead coll.). PAPUA NEW GUINEA: 1c,1h, Madang (WAM). RYUKYU ISLANDS: 3c, Naha, Okinawa Island (AIM AM29328); 4c, Nase, Oshima Island (AIM AM17634). HONG KONG: 1c, Tai Tam Bay (AMS C103428). PHILIPPINE ISLANDS: 3c (BMNH 1984262/1-3 - lectotype & paralectotypes of *Capsa (Capsella) difficilis* Deshayes); 3c (BMNH 1984267/1-3 - lectotype & paralectotypes of *Capsa (Capsella) radiata* Deshayes); 2c (BMNH 1984275/1,2 - lectotype & paralectotype of *Capsa (Capsella) rosacea* Deshayes); 2c (NHMW 253); 6c (NMV); 2c, Manila, Luzon Island (BMNH 1984263/1,2 - lectotype & paralectotype of *Capsa (Capsella) rufa* Deshayes); 4c, Manila, Luzon Island (BMNH 1984269/1-4 - lectotype & paralectotypes of *Capsa (Capsella) minor* Deshayes); 3c, Manila, Luzon Island (BMNH 1984271/1-3 lectotype & paralectotypes of *Capsa (Capsella) solenella* Deshayes); 3c, Manila Bay, Luzon Island (BMNH 1984266/1-3 - lectotype & paralectotypes of *Capsella violacea* Reeve); 1c, Manila Bay, Luzon Island (QM); 6c, Naujan, Manila, Luzon Island (MNCN); 5c, Taloban, Manila, Luzon Island (MNCN); 1c, 2-9 m, Luzon Island (WAM); 25c,3h, Villa Carmen, Cabcaban Island (WAM 984-68, 1055-68, 1701-68). INDONESIA: 2c, Bali Island (AMS C60786); 6c, Moluccas Islands (BMNH; NHMW 252); 1c, Sumatra (MNHN - holotype of *Hiatula sordida* Bertin). SINGAPORE: 2h (WAM 1092-70); 2c, Kg Loyang (WAM); 2h, Pulu Besar (NHMW 1105). MALAYSIA: 2c, Malacca Strait (BMNH 1984265/1,2 - lectotype & paralectotype of *Capsella solida* Reeve). "INDIAN OCEAN": 1c (MNHN M41176 - holotype of *Psammotaea serotina* Lamarck). "RED SEA": 2c (MHNG 1083/17/1,2 - lectotype &

paralectotype of *Psammobia elongata* Lamarck); 1c,1h, Elat, Gulf of Aqaba (HUIJ 32.234). MAURITIUS: 1c (ZMUC). SEYCHELLES: 1c (BMNH 1882.12.6.261); 2c, Mahé (BMNH); 5c,1h, near short pier, Port Victoria, Mahé (BMNH). TANZANIA: 1h, Dar es Salaam (BMNH 1933.1.5.138).

Description. Maximum length 65 mm. Shell fragile to moderately (or sometimes rather) heavy; subrectangular, elongate and rather narrow; greatest width at level of prominent, rounded umbones; approximately equilateral (umbones displaced slightly anteriorly in some specimens); valves moderately inflated; anterior end rounded; ventral margin straight or occasionally smoothly convex; posterior margin distinctly truncate, meeting straight posterodorsal margin at angle of approximately 125°; equivalve; small anterior gape and moderately large posterior gape. Surface of both valves smooth, polished in juveniles, dull in adults and beach-worn shells; sculptured with numerous, obsolete, concentric growth striae that become more prominent near posterodorsal margin on posterior slope; both valves with a distinct, rounded ridge extending from umbo to posterior extremity of shell. Exterior covered with a moderately thick, adherent, greenish brown periostracum.

Hinge plate narrow; nymph elongate (nearly half length of posterodorsal margin). Right valve with 2 cardinal teeth, diverging by 40° from each other; anterior one pointed, directed vertically downward; rear one a little stronger, weakly bifid. Left valve with a single, triangular, uncleft anterior cardinal tooth, directed vertically downward or slightly rearward; some shells show a low and exceedingly weak lamella that represents posterior cardinal tooth. Pallial sinus deep (reaches just in front of level with anterior end of hinge plate ie, in front of umbones); U-shaped; upper limb runs straight across middle of shell parallel to longitudinal axis; anterior margin broadly rounded; lower limb passes obliquely downward, curving somewhat to join pallial line from which it is free for over half (sometimes two-thirds) its length; ventral extremity of pallial line points rearward, reaches level with posterior third of posterior adductor scar. Several (usually 2) pedal retractor scars present dorsally immediately in front of, and below, hinge plate.

Colour variable, externally with lilac, pale pink, reddish orange or creamish yellow ground marked with few or many purple rays (sometimes entire posterior slope consists of a single ray); rays can be interrupted, but pattern never maculated. In uniformly purple shells, 2 pale rays are evident passing from umbones posteriorly to ventral margin as in *Soletellina*. Juvenile shells paler than adults. Interior similarly coloured and patterned to exterior, with a transparent glaze; area enclosed within pallial sinus often displaying fine, longitudinal rugae (evidence of insertion of siphonal retractor muscles onto mantle). Teeth and nymphs white; purple streak present in most shells along eschutcheon area of posterodorsal margin.

Remarks. Shells of *Gari elongata* do not deviate greatly from an elongate, rectangular shape although some mature specimens possess a concave (instead of straight) ventral margin. Valve outline together with inflation and truncate posterior margin are consistent and reliable characters for identification of adults of this species. The same cannot be said for colouration however, and its great variability (in shades of violet, reddish orange or cream) has resulted in several synonyms, even though the purple rays are almost always present.

Juveniles show a considerably greater separation of the lower limb of the pallial sinus from the pallial line than adults, but I have also observed some intraspecific variability as regards the extent of separation in adults. Usually in adults, the distance for which the lower limb of the pallial sinus is free from the pallial line is just over half the sinus' length, so the zone of contact can be up to 7 mm long. In a few specimens, the sinus meets the pallial line immediately in front of the line's ventral extremity, and then the zone of contact is as short as 2 mm.

As noted in the description given above, some *Gari elongata* shells have two pale lines radiating from the umbo to the ventral margin immediately in front of the posterior ridge as in *Soletellina* (see for example Fig.264). Their presence indicates successive locations of the cruciform muscles at the base of the animal's siphons, a characteristic of all tellinoids, so no phylogenetic connections can be made between *G. elongata*, or other species of the subgenus *Psammotaena*, and *Soletellina* on the basis of these unpigmented lines.

Gari elongata is apparently most closely related to *G. togata* (Deshayes). That species is larger, more rounded anteriorly, less produced posteriorly, less inflated, always possesses a convex ventral margin, is coarser sculptured, white, and its periostracum is thicker. *Gari inflata* (Bertin) is similar too, but its shell has a much more ovate outline, is thicker when adult, has a significantly shorter nymph, stronger teeth, a more prominent posterior cardinal tooth in the left valve, and it never has purple radial markings. The only other similar species in the region is *G. crassula* (Deshayes), and differentiating features are given under the remarks section for that species.

Dautzenberg & Fischer (1914) suggested, on the basis of Reeve's description and figure, that *Psammotella ruppelliana* Reeve might be synonymous with *Psammobia elongata*. This is certainly not the case because *Soletellina ruppelliana* (Figs 275,276) is an endemic Red Sea species that differs from *Gari elongata* in being larger, thinner, more compressed, more inequilateral (ie, the umbones are displaced further anteriorly), in possessing a broadly rounded posterior end, uniform cream colour with lilac flush, never being rayed, in having a thicker periostracum, in possessing much shorter nymphs, and (most especially) the lower limb of the pallial sinus is always confluent with the pallial line for most of its length.

Habitat. *Gari elongata* inhabits sheltered intertidal sand banks and mud flats. Lagoons and mangrove forests with sandy substrates are the most preferred sites. Seagrass beds are apparently not habitable. *Gari elongata* is intolerant of excessive fresh water and also accumulations of fine silt. Dr J. Taylor collected this species alive inshore in deep, vertical burrows at Port Victoria, Mahé Island, Seychelles. The crab *Uca* sp. and venerid bivalve *Gafrarium tumidum* (Röding) were also common in this habitat.

Gari elongata is restricted to the intertidal zone.

Distribution. *Gari elongata* is widespread throughout the tropical western Pacific and Indian Oceans. Unlike *G. togata* which occurs in similar microhabitats, *G. elongata* does not extend into warm temperate waters. Apparently its substrate preferences confine it to the coasts of continents and larger islands.

Gari elongata occurs commonly in bays of coastal northern Queensland, Australia, but strangely there are no records or specimens from the Northern Territory (personal observation) or northern Western Australia. I am at a loss to explain its absence from northern Australia.

Literature records are as follows: New Caledonia (Bertin, 1880); New Guinea (Bertin, 1880); Japan (Bertin, 1880; Kira, 1962; Habe, 1977); China (Scarlato, 1965); Philippine Islands (Deshayes, 1855; Reeve, 1857; Hidalgo, 1903); Java (Martens, 1897); Sumatra (Bertin, 1880); Malacca Strait (Reeve, 1857; Oostingh, 1925); Seychelles (Bertin, 1880); Zanzibar (Bertin, 1880).

Lamy (1918:343 following Jousseume's notes) and Oostingh (1925:31) rejected all Red Sea records on the grounds they were based on misidentified *Psammotaea rosea* Deshayes (= *Soletellina ruppelliana* (Reeve)). I concur with Lamy and Oostingh despite the presence of two specimens in HUI localised as "Elat 1951" that are undoubtedly *G. elongata*. The absence of *G. elongata* from Israeli waters has been confirmed by Professor A. Barash (personal communication, 1990). The species is not included in Oliver's *Bivalved Seashells of the Red Sea*; it is mentioned on page 164 of that work simply in comparison with *Soletellina ruppelliana*. In fact this species' presence anywhere in the north-western Indian Ocean is dubious.

Gari (Psammotaena) togata (Deshayes, 1855)

Figs 269-274,401

Psammobia togata Deshayes, 1855: 318, no.5.—Reeve, 1856:

Psammobia pl.2, species 14.—Hidalgo, 1903: 88, no.174.

Psammobia (Psammocola) togata Deshayes.—Chenu, 1862: 64, fig.262.—Paetel, 1890: 41.

Hiatula montrouzieri A. Adams & Angas, 1863 n.syn.: 425, no.4.

Gari (Psammacola) (sic = error pro. *Psammocola*) *togata* (Deshayes).—Angas, 1867: 917, no.36.—Bertin, 1880: 69, 125, no.79.

- Gari togata* (Deshayes).—Whitelegge, 1889: 237, no.53.—Hedley, 1918a: M28, no.283.—Allan, 1950: 342, fig.80, no.7.—Purchon, 1960: 462-465, fig.13.
- Soletellina montrouzieri* (A. Adams & Angas).—Paetel, 1890: 42.
- Soletellina (Psammotaena) togata* (Reeve) (sic = error pro. Deshayes).—Paetel, 1890: 42.
- Milligareta togata* (Deshayes).—Iredale & McMichael, 1962: 25, no.420.
- Sanguinolaria (Psammotaea) togata* (Deshayes).—Scarlato, 1965: 55, pl.4 fig.2.
- Psammotaea togata* (Gmelin) (sic = error pro. Deshayes).—Habe & Kosuge, 1966: 172, pl.67 fig.13.—Lamprell & Whitehead, 1992: 60, pl.54 fig.404.

Comments on synonymy. Probably because this species is large and distinctive, and was well figured by Reeve (1856), it has been relatively unburdened with synonyms. *Hiatula montrouzieri* A. Adams & Angas is the only junior synonym, being based on an immature shell from New Caledonia. Angas (1867) must have assumed it was endemic to that country because, when, only four years after the description of *H. montrouzieri*, he recorded the same species from Port Jackson [New South Wales], he used the name *Psammobia togata*.

Good illustrations of *Gari togata* have appeared in works by Allan (1950) and Habe & Kosuge (1966).

Types. *Psammobia togata* Deshayes: lectotype, here designated (smaller syntype, complete specimen - 73.0 mm) in BMNH (1984280/1) (Fig.269). Paralectotype (complete specimen - 74.4 mm) in BMNH (1984280/2). Type locality Philippine Islands.

Specimen of *Psammobia togata* figured by Reeve, 1856: *Psammobia* pl.2, species 14 (complete specimen - 90.6 mm) in BMNH (1984281) (Fig.270).

Hiatula montrouzieri A. Adams & Angas: holotype (complete specimen - 52.2 mm) in BMNH (1870.10.26.13) (Fig.271). Type locality New Caledonia.

Material examined. AUSTRALIA – QUEENSLAND: 1c (AMS C17059); 1c, Torres Strait (AMS C17060); 1c,1h, Elliot River, north of Bowen (QM); 1c,2h, Edgumbe Bay, north of Bowen (AMS C125991); 1c, Lindeman Island, Lindeman Group (AMS C125990); 1c, Turkey Beach, Rodds Bay, south Gladstone (Willan coll.); 1c, Moreton Bay (QM); 1h, Dohles Rocks, Pine River, Bramble Bay, Moreton Bay (Willan coll.); 1c, Sandgate, Moreton Bay (AMS C13073); 1c, Deception Bay, Moreton Bay (Willan coll.); 3c,9h, Nudgee Beach, Bramble Bay, Moreton Bay (Willan coll.); 1c, mangrove forest, Myora Springs, north of Dunwich, North Stradbroke Island, Moreton Bay (Willan coll.); 1h, Coolangatta (AMS C125987). WESTERN AUSTRALIA: 1c, 1.6 km north of Langini landing, Napier, Broome Bay (WAM). NORTHERN TERRITORY: 2c,2h, Buffalo Creek, Darwin (NTM); 1c, Casuarina Beach, Darwin (AMS C125988); 2h, Cape Condor, Melville Island (AMS C125989); 1c, Port Essington (AMS C15987); 10h, beach below crocodile research station, Maningrida, Arnhem Land (AMS C121422); 1h, Elcho Island (AMS C99138); 1c, Grootte Eylandt, Gulf of Carpentaria (AMS C92402).

FIJI ISLANDS: 6c, Veiuto, near Suva, Viti Levu Island (WAM 3764-67). NEW CALEDONIA: 8c (AMS C125986; BMNH 1870.10.26.13 - holotype of *Hiatula montrouzieri* A. Adams & Angas; MNHN). PAPUA NEW GUINEA: 3c (QM); 1h, Mebar, Sek Harbour, approximately 19.3 km north of

Madang (AMS C95272); 1c,2h, Biliu Island, near Madang (WAM); 1c, Madang (WAM); 1c, Kiriwina Island, Trobriand Islands (AMS C83574). CHINA: 4c, Haiphong (MNHN). PHILIPPINE ISLANDS: 8c (BMNH 1984280/1,2 - lectotype & paralectotype of *Psammobia togata* Deshayes; MNCN); 3c, Manila, Luzon Island (AMS C38750; MHNG 16447; MNHN); 1h, Wellington Point, Manila Bay, Luzon Island (QM); 1h, Perez Beach, Bauang, west Luzon Island (AMS C141991). SINGAPORE: 4h, mangroves backing Mandai River estuary (AMS C136173); 1c,1h, mangrove swamp, Kranji (AMS); 1h, Point Sekudu (WAM). MALAYSIA: 2c, Johor Lama, Sungai, Johore (AMS C129487). INDONESIA: 1c, Sumatra (NHMW 16447). PERSIAN GULF: 1c, off fisheries laboratory, Ju Fair, Bahrain (WAM).

Description. Maximum length 105 mm. Shell usually moderately thick, sometimes greatly thickened; elongate-ovate; greatest width at level of umbones; inequaliteral, umbones displaced towards anterior end (equally so in both juveniles and adults); moderately inflated; anterior end broadly rounded; ventral margin moderately or greatly (large adults) convex; posterior end subtruncate or truncate, slightly narrower than anterior end; equivalve; commissure straight; moderate anterior gape; large posterior gape. Surface of both valves dull, sculptured with numerous, irregular, coarse, concentric striae; striae often strengthened near dorsal margin, never lamellate; posterior ridge broad and weak. Exterior covered, in life, with a tough brownish green or dark reddish (almost rust red) periostracum; periostracum usually worn off umbones; after death, periostracum lost or remaining as marginal remnants only.

Hinge plate moderately narrow; nymph elongate, not particularly wide or strong. Right valve with 2 cardinal teeth, diverging by 50° from each other; anterior one directed vertically downward; rear one slightly stronger and directed obliquely backward. Left valve also with 2 cardinal teeth; anterior one much stronger, triangular, not bifid, directed vertically downward or rearward; rear cardinal represented merely by a weak lamella that points obliquely backward and diverges at an angle of 30° behind anterior tooth. Pallial sinus deep (reaches just in front of level of front of hinge plate ie, anterior to umbones), broad; upper limb short, runs straight across middle of shell; anterior margin deeply convex; lower limb curving slightly, running obliquely downward to pallial line; lower limb free from pallial line for at least half (sometimes two-thirds) of its length; ventral extremity of pallial line directed backward, level with posterior third of posterior adductor scar. Several small pedal retractor scars present just beneath, and slightly anterior to, front end of hinge plate.

Colour of exterior dull creamish white, obscured by periostracum in live specimens. Interior white, not glazed. Mature shells thickened by much additional calcification internally.

Remarks. The most important specific diagnostic characters of *Gari togata* are its ovate-elongate shape, often reinforced by ample convexity of the ventral margin (see for example Fig.269), moderate inflation,

large posterior gape, thick and dark periostracum, creamish white colour, dull exterior and interior surfaces (the interior of adults with additional calcification), and separation of the lower limb of the pallial sinus from the pallial line for at least half (sometimes two-thirds) of its length.

Gari togata bears some resemblance to *G. elongata* (Lamarck), but the two species differ in size, thickness, shape and colouration. From *G. crassula* (Deshayes), with which *G. togata* shares whitish colouration, thick periostracum and secondary calcification (the latter two characters probably induced by habitat), *G. togata* differs in size, outline (its umbones are relatively much further forward), posterior gape, coarser sculpture, hinge and pallial sinus detail. *Gari togata* can be distinguished from the sympatric *G. inflata* (Bertin) on shape (*G. togata* is more elongate, particularly posteriorly), nymphs (those of *G. inflata* are much shorter) and colouration (*G. togata* is creamish white and *G. inflata* is violet).

Soletellina ruppelliana (Reeve) (Figs 275, 276) from the Red Sea differs in being smaller (maximum size 85 mm), more elongate, relatively narrower, having greater development of the posterior end, a sharp posterior angle to nymph, thinner periostracum, deeper pallial sinus, fusion of lower limb of pallial sinus to pallial line for its entire length, and flush of rose pink or pale purple over the entire shell.

Habitat. *Gari togata* dwells in thick muddy substrates on very sheltered shores (such as mangrove swamps, seagrass meadows and mud flats). Living specimens are uncommon because of the species' deep burrowing habit; specimens bury to a depth of about 15 cm. *Gari togata* apparently avoids estuaries where salinity falls appreciably. *Glauconome virens* (Linné), a bivalve with a considerable external similarity to *G. togata*, occurs with it in banks of mangrove creeks.

Gari togata is strictly intertidal.

Distribution. *Gari togata* ranges throughout the tropical Indo-Pacific Ocean westward from Fiji. It probably occurs wherever suitable habitats exist. Under such conditions it penetrates well into temperate latitudes as is shown by its occurrence at Port Jackson, New South Wales (Angas, 1867).

The literature documents the presence of *Gari togata* in the western Pacific, but not the Indian Ocean. I found no material from the Indian Ocean in any museum, but there is one specimen from the Persian Gulf in WAM, suggesting it does occur in that ocean. Records are as follows: New Caledonia (A. Adams & Angas, 1863; Bertin, 1880); northern coast of Australia (Reeve, 1856; Bertin, 1880; Allan, 1950); New South Wales (Angas, 1867; Hedley, 1918a; Allan, 1950; Iredale & McMichael, 1962); China (Scarlato, 1965); Philippine Islands (Deshayes, 1855); Reeve, 1856; Hidalgo, 1903). Habe & Kosuge (1966) indicated merely that *G. togata* occurred in the tropical Pacific Ocean without specifying whether it reached Japan.

Gari (Psammotaena) inflata (Bertin, 1880)

Figs 280-288, 402, 403

- Hiatula inflata* Bertin, 1880: 93, 94, no.28, pl.4 fig.1a,b.
Hiatula (Psammotella) innominata Bertin, 1880 n.syn.: 102, 103, no.60, pl.4 fig.3a,b.
Psammotellina innominata (Bertin).—Hidalgo, 1903: 100, no.198.
Gari ruppelliana (Reeve).—Allan, 1950: 342, pl.40 fig.12.—Rippingale & McMichael, 1961: 205, pl.29 fig.18 (misidentification, not *Psammotella ruppelliana* Reeve, 1857)
Sanguinola (sic = error pro. *Sanguinolaria*) (*Psammotaea*) *inflata* (Bertin).—Scarlato, 1965: 55, pl.3 fig.4.
Gari (Psammotaena) inflata (Bertin).—Lamprell & Whitehead, 1992: 58, pl.53 fig.401.

Comments on synonymy. Bertin (1880) described both *Hiatula inflata* and *H. innominata* from unknown localities and he did not compare them with each other. Of the two holotypes, that for *H. inflata* (Fig.280) is more typical of the species so, acting here as first reviser, I select *inflata* as the name for this species. The holotype of *H. innominata* (Fig.281) is more elongate and heavier than most specimens, and its pallial line is malformed so it is crenulated and appears not to be distinct from the lower limb of the pallial sinus for its entire length.

Allan (1950) first recorded this species from northern Australia under the erroneous name of *Gari ruppelliana* (Reeve). In fact, *Psammotella ruppelliana* Reeve applies to an endemic Red Sea species of *Soletellina* with a complicated synonymy of its own, part of which is given by Oliver (1992:164).

Excellent coloured illustrations of *G. inflata* have been given by Allan (1950) and Rippingale & McMichael (1961).

Types. *Hiatula inflata* Bertin: holotype (complete specimen - 42.6 mm, not 44.0 mm as originally stated) in MNHN; figured by Bertin, 1880: pl.4 fig.1a,b (Fig.280). Type locality unknown.

Hiatula innominata Bertin: holotype (complete specimen - 57.6 mm) in MNHN; figured by Bertin, 1880: pl.4 fig.3a,b (Fig.281). Type locality unknown.

Material examined. AUSTRALIA - QUEENSLAND: 4c,1h (NMV); 3h, Cooktown (QM); 4c,4h, Annam River, Cooktown (AMS C38749, C41545; BMNH); 5c, Newell Beach, Trinity Bay (BMNH 1989123; Trevor coll.; Willan coll.); 2c, Wonga Beach, north of Mossman (Trevor coll.); 1h, Port Douglas (AMS C124427); 1h, Four Mile Beach, Port Douglas (WAM 1096-70); 1c, Buchan Point, north of Cairns (NMV); 2c,2h, Trinity Beach, north of Cairns (AMS C124428); 3h, Mission Beach, east Tully (NMV); 3h, Townsville (AMS C83800 - largest specimen is that figured by Rippingale & McMichael); 1h, near Bowen (AMS).

NEW CALEDONIA: 5c,1h (NHMW O5805; MNCN; MNHN). PAPUA NEW GUINEA: 3h, Manus Island, Bismarck Archipelago (ZMUC). HONG KONG: 1h, near Tap Mun Chau, Mirs Bay (AMS C142033). PHILIPPINE ISLANDS: 1c (NMV); 2c, Naujan, Manila, Luzon Island (MNCN); 1h, Cowit, Marinduque Island, south Luzon Island (AMS C105264).

LOCALITY UNKNOWN: 1c (MNHN - holotype of *Hiatula*

inflata Bertin); 1c (MNHN - holotype of *H. innominata* Bertin).

Description. Maximum length 60 mm. Shell moderately heavy, ovate-elliptical; greatest width at level of umbones; inequilateral, umbones displaced in front of centre (equally so in juveniles and adults); moderately inflated; anterior end broadly rounded; ventral margin evenly convex; posterior margin broadly rounded or subtruncate, usually broader than anterior margin; equivalve; small anterior and relatively large posterior gapes. Surface of both valves dull; umbones smooth, remainder of shell crossed by fine, irregular, concentric growth striae; striae stronger near dorsal margin (particularly posteriorly); no indication of a posterior ridge. Exterior covered with a thick, adherent, dark greenish brown periostracum that is usually worn off around umbones. Ligament short, strong.

Hinge plate moderately narrow; nymph about equal in width to hinge plate, very short (approximately one quarter length of posterodorsal margin), posterior end of nymph dips beneath line of shell's dorsal margin. Hinge teeth particularly strong. Right valve with 2 strong cardinal teeth, diverging by 60° from each other; anterior one directed vertically downward; posterior one directed obliquely backward. Left valve also with 2 cardinal teeth; anterior one much larger and more robust, triangular, deeply bifid, directed vertically downward or rearward; rear one a short, low, almost obsolete lamella that diverges at 50° obliquely behind anterior one. Pallial sinus deep (reaches midway between hinge plate and back edge of anterior adductor scar), moderately broad, U-shaped; upper limb relatively short, almost straight; anterior edge deeply and evenly convex; lower limb evenly convex, descending obliquely to pallial line, lower limb free from pallial line for virtually its entire length (exceptionally fused for posterior third of its length); ventral extremity of pallial line pointed downward, reaches level with hind third of posterior adductor scar. Several small pedal retractor scars present beneath umbones at anterior edge of hinge plate.

Colour of exterior violet, darker near umbones; sometimes two obscure, broad, white rays present posteriorly. Interior same colour but richer; adults occasionally possess additional, milk-white, calcareous deposits; area enclosed within pallial sinus often displaying longitudinal rugae (evidence of insertion of siphonal retractor muscles onto mantle). Hinge plate pale violet; teeth and nymphs white.

Remarks. The distinctive characters of *Gari inflata* are its ovate-elliptic shape, moderate inflation, broadly rounded extremities (the posterior end is sometimes subtruncate, but never truncate), numerous concentric striae, thick periostracum, strong teeth, short nymph, separation of the lower limb of the pallial sinus for almost its entire length, and uniform deep violet or purple colour. The lower limb of the pallial sinus was entirely free from the pallial line in almost every specimen I

examined, but fusion occurred over the posterior third of the sinus' length in less than 5% of my sample. Such variation can be demonstrated as intraspecific because it occurs between individuals in the same population (Figs 287,288,402,403).

Through joint possession of some of the above characters with *G. elongata* (Lamarck) and *G. togata* (Deshayes), *G. inflata* resembles them both. Distinguishing features have been given under the remarks section for each of the latter two species. I emphasise here that *G. elongata* and *G. togata* are more closely related to each other than either is to *G. inflata*.

Although not occurring in the region under study, *Gari ambigua* (Reeve) (type species of the subgenus *Psammotellina* Fischer) [synonyms are *P. subradiata* Reeve, *P. malaccensis* Reeve and *P. philippinensis* Reeve] shows a resemblance externally to *G. inflata*, ie, both are inequilateral, bear concentric striae and are uniform violet in colour. However, as shown in Figures 277 to 279, *G. ambigua* is markedly enlarged posteriorly to the extent that its posterior end has become subtruncate, and by consequence the umbones are displaced considerably further forward, its nymphs are longer, the teeth are weaker, the dentition differs, and (most significantly) the lower limb of the pallial sinus is confluent with the pallial line for its entire length (Fig.279).

The Red Sea *Soletellina ruppelliana* (Reeve) (Figs 275,276), with which *Gari inflata* was confused by Allan (1950), is larger (to 60 mm), considerably more elongate and narrower, thinner, white or flushed with rose pink and the lower limb of the pallial sinus is confluent with the pallial line for its entire length. *Soletellina ruppelliana* is, in fact, like *G. elongata* in shape. *S. ruppelliana* has an extensive synonymy of its own (Oliver, 1992:164).

Some specimens of *Gari inflata* are superficially similar to *Soletellina biradiata* (Wood), but that temperate water Australian species differs in shape, degree of inflation, hinge, pallial sinus and colour amongst many other characters.

Habitat. As Allan (1950) indicated, *Gari inflata* inhabits muddy sand substrates in protected situations. Presumably it burrows reasonably deeply because of the depth of the pallial sinus and lack of freshly-taken specimens in collections.

Gari inflata is apparently confined to the intertidal zone.

Distribution. *Gari inflata* occurs only in the tropical western Pacific Ocean, apparently not even extending westwards to South-east Asia. That distribution shows it to be an entirely stenothermal species. Its range is restricted to the coasts of continents and continental islands. Within Australia, it extends down coastal northern Queensland only to Townsville. It appears to be absent from the Northern Territory (personal observation) and northern Western Australia.

Gari (Crassulobia) n.subgen.

Type species. *Capsa (Capsella) crassula* Deshayes, 1855, here designated. Recent, tropical western Pacific.

Diagnosis. Medium-sized psammobiids; elongate-ovate; anterior end broader than posterior end; equilateral; equivalve; wider gape anteriorly than posteriorly. Adult shell very heavily calcified by way of secondary deposition internally; nymph massively calcified; ligament secondarily downwarped around hinge plate and nymph; hinge with 2 cardinal teeth in right valve and a single backward-directed one in left valve. Pallial sinus relatively narrow, lower limb attached to pallial line for most of its length. Sculpture obsolete; exterior covered by a thick, persistent periostracum. Colour uniform throughout.

Crassulobia is a monotypic subgenus distinguished by its remarkable (secondary) calcification (see for example Figs 294-297) and also by way of its gapes, secondary ligamental downwarping, dentition, pallial sinus and periostracum. Should these characters be other than ontogenetic, I would consider them sufficient to elevate *Crassulobia* to full generic status. Juveniles (see for example Figs 290, 293) are like typical *Gari*, and the changes related to secondary calcification etc. come about with growth. Possibly they represent evolutionary adaptations to waters of low salinity. I believe *Crassulobia* is related to *Psammotaena* on account of dentition, in particular the backward-directed left anterior cardinal tooth (this character is synapomorphic for *Crassulobia* and *Psammotaena*). However, the pallial configuration is unresponsive of such a grouping.

***Gari (Crassulobia) crassula* (Deshayes, 1855)**

Figs 289-297, 404, 405

- Capsa (Capsella) crassula* Deshayes, 1855: 349, no.148.
Capsella crassula (Deshayes).-Reeve, 1857: *Capsella* pl.1, species 8.
Hiatula (Psammotea) (sic = error pro. *Psammotaea*) *crassula* (Deshayes).-Tryon, 1868: 80, no.19.
Hiatula (Psammotaea) crassula (Deshayes).-Bertin, 1880: 97, no.39.
Hiatula (Psammotaea) complanata Bertin, 1880: 100, no.51, pl.5 fig.3a, b.
Hiatula (Psammotaea) subglobosa Bertin, 1880 n.syn.: 100, no.52, pl.5. fig.2a,b.
Soletellina (Psammotaea) crassula (Deshayes).-Paetel, 1890: 42.
Psammotellina semmelinki Martens, 1897 n.syn.: 236, pl.10 figs 23,24, and vars *strubelli* and *borneensis*.
Psammotaea crassula (Deshayes).-Hidalgo, 1903: 96, 190.-McMichael, 1961: 51, 52, pl.4 figs 1-3.-Lamprell & Whitehead, 1992: 60, pl.54 fig.403.

Comments on synonymy. This species was first recorded from Australia by McMichael (1961). McMichael followed Bertin (1880) and Hidalgo (1903) in assigning it to

the genus *Psammotaea* Lamarck. As discussed here under the introduction to the previous subgenus, Children's (1823) designation of *P. donacina* Lamarck as type species of *Psammotaea* necessitated the removal of that genus from the Psammobiidae. Actually the characters possessed by *Capsa crassula* are sufficiently distinct to warrant a new subgenus which I have named herein as *Crassulobia*.

I agree with McMichael's (1961) merging of *Hiatula complanata* Bertin under *Capsa crassula*. Further, *Hiatula subglobosa* Bertin ought to be incorporated also; its holotype is a small adult shell possessing the thickening characteristic of this species. Jousseume may well have collected the holotypes of *H. complanata* and *H. subglobosa* at the same locality.

Psammotellina semmelinki Martens is a synonym based on thin, immature specimens. According to the original label, Martens initially identified them as *P. crassula* but later changed his mind and gave them a new name. Martens' description makes no mention of *P. crassula* or either of Bertin's species. Actually Martens' *P. semmelinki* var. *borneensis* matches *Hiatula subglobosa* Bertin in every detail.

In saying that *Hiatula crassula* was "Too close to *rufa*", Tryon (1868:80) wrongly implied *Capsa crassula* Deshayes and *Capsa rufa* Deshayes were synonymous. The syntypes of *C. rufa* (BMNH 1984263) are narrower, they have a broader posterior end, are thinner, rather compressed, covered with a reddish periostracum and are rose-purple internally. *Capsa rufa* Deshayes is, in fact, based on *Psammobia elongata* Lamarck.

Types. *Capsa (Capsella) crassula* Deshayes: lectotype, here designated (figured syntype, complete specimen - 31.5 mm) in BMNH (1984268/1); figured by Reeve, 1857: *Capsella* pl.1, species 8 (Fig.289). Paralectotypes (complete specimens - 30.5, 30.1 mm) in BMNH (1984268/2,3 respectively). Type locality Philippine Islands.

Hiatula complanata Bertin: holotype (complete specimen - 37.8 mm) in MNHN; figured by Bertin, 1880: pl.4 fig.3a,b (Fig.290). Type locality unknown.

Hiatula subglobosa Bertin: holotype (complete specimen - 21.6 mm) in MNHN; figured by Bertin, 1880: pl.5 fig.2a,b (Fig.291). Type locality unknown.

Psammotellina semmelinki Martens: lectotype, here designated (figured syntype, complete specimen - 29.0 mm) in ZMB (21055b); figured by Martens, 1897: pl.10 figs 23,b,c (Fig.292). Paralectotype (complete specimen - 19.3 mm) in ZMB (21055b). Type locality Java.

Psammotellina semmelinki Martens var. *strubelli*: type material not found in ZMB (R. Kiliyas, personal communication, 1990). Type locality Java.

Psammotellina semmelinki Martens var. *borneensis*: complete specimen - 20.3 mm in ZMB (21055c); figured by Martens, 1897: pl.10 figs 24,b,c. Type locality Borneo.

Material examined. AUSTRALIA - QUEENSLAND: 12c,2h, Daintree River, north of Mossman (Kessner coll. 7145); 7c, Barron River, north of Cairns (AMS C1332); 1c, Cairns (AMS C87899); 2c,1h, Goondi, Johnstone River, north of Innisfail (AMS C51816); 7h, Johnstone River, Innisfail (AMS C51818); 1c,2h, Innisfail (AMS); 2c,2h, sandbank, Herbert River, Ingham (AMS); 4c, Ross River, Townsville (Kessner coll. 7146); 1c, Shelly Beach, Townsville (Lamprell coll.); 4c, Fitzroy River, south Rockhampton (AMS C70390); approximately 200c, 3.5-4 m, Logan River, Beenleigh (AIM; AMS C143679; MNCN; WAM; Willan coll.; ZSI). NEW

SOUTH WALES: 1h, 3 km upstream, Tweed River (AMS C135545); 2c, Clarence River (AMS C63355 - larger specimen is that illustrated by McMichael); 3h, excavation of Aboriginal camp site, Clarence River district (AMS C63356 - largest specimen is that illustrated by McMichael).

PHILIPPINE ISLANDS: 3c (BMNH 1984268/1-3 - lectotype & paralectotype of *Capsa (Capsella) crassula* Deshayes); 2c (AMS C33556); 3c (BMNH 1984268/1-3 - lectotype & paralectotypes of *Capsa crassula* Deshayes); 1c, Batangas Bay, Luzon Island (WAM); 3c, Manila, Luzon Island (WAM); 3c, Manila, Luzon Island (MNCN; MNHN). BORNEO: 1c, Tanah-laut (ZMB 21055c - type material of *Psammotellina semmelinki* var. *borneensis* Martens). JAVA: 2c, Bezuki (ZMB 21055b - lectotype & paralectotype of *Psammotellina semmelinki* Martens).

LOCALITY UNKNOWN: 1c (MNHN - holotype of *Hiatula complanata* Bertin); 1c (MNHN - holotype of *H. subglobosa* Bertin).

Description. Maximum length 40 mm. Shell exceptionally heavy when fully grown, ovate to elongate-ovate; greatest width at level of umbones; both juveniles and adults equilateral; considerably inflated; anterodorsal and (particularly) posterodorsal margins slope steeply away from umbones; anterior end broadly rounded; ventral margin evenly convex or sinuous, with a concavity posteriorly; posterior end always narrower than anterior end, narrowly rounded or subtruncate; equivalve; commissure straight; moderately large anterior gape, small posterior gape. Surface smooth, covered with a thick, persistent, flakey greenish brown periostracum; surface usually extensively corroded about umbones where periostracum lost; sculpture consists only of irregular, concentric growth striae.

Hinge plate broad; nymph broad - becoming massively so through secondary calcification, elongate; ligament elongate, high, very strong. Right valve with 2 cardinal teeth, diverging by 70° from each other; anterior one stronger, triangular, directed vertically downward; rear one deeply bifid, pointing obliquely backward. Left valve with a narrow, deeply bifid, posteriorly directed anterior cardinal tooth and a minute lamella behind that representing posterior cardinal tooth; hinge plate becomes distorted with age due to downwarping of ligament and massive secondary calcification of nymphs. Adductor scars and pallial line deeply impressed on shell, easy to observe. Pallial sinus deep (extends in front of level of hinge plate), relatively narrow; upper limb straight or slightly ascending, runs transversely across middle of shell; anterior margin evenly rounded; lower limb confluent with pallial line for most of its length; ventral extremity of pallial line downturned, reaches level with front margin of posterior adductor scar; cluster of small pedal retractor muscles present adjacent to dorsal margin in front of hinge plate.

Exterior covered with periostracum that obscures underlying colour. Uneroded adult and juvenile shells chalky, whitish to violet with a broad, purplish zone radiating from umbones; sometimes a narrow, salmon streak radiates forward from umbones. Interior dull, usually uniformly deep violet or (particularly in juveniles)

violet interrupted by a white zone radiating forward from umbones; heavy by way of secondary calcification in adults. Teeth, hinge plate and nymphs white.

Remarks. *Gari crassula* is remarkable for the considerable secondary calcification that is deposited internally in shells of adults (Fig.297). Juveniles (Figs 290-293), however, show no such calcification. With growth, several ontogenetic changes occur internally: the nymphs become much-enlarged through calcification; a portion of the ligament downwarps to surround, firstly, the hinge plate, and eventually, both the hinge plate and nymphs; growth at the ventral margin more or less ceases and shell material is deposited internally within the valves thereby making the mantle cavity narrower and narrower. One must consider whether all these changes are edaphic (ie, phenotypic), and might only occur in specimens that live in hyposaline environments. The evidence, however, points to a genotypic basis for these changes and they probably represent adaptations to habitats of very low salinity where all populations of *G. crassula* occur (see additional comments under section on distribution for this species).

Besides these characters that warrant subgeneric recognition, *Gari crassula* has others that render it distinctive as a species; these are its elongate-ovate shape, considerable inflation, narrow posterior end, relatively large anterior gape (wider than the posterior gape), persistent periostracum, exceptionally strong and high ligament, broad nymph, straight or slightly ascending upper limb of the pallial sinus, cluster of separate pedal retractor muscle scars and uniform violet colour internally.

Gari crassula could be mistaken for *G. elongata* (Lamarck), but that species is more elongate and fragile, its anterior end is narrower, its pallial sinus is broader, the lower limb of the pallial sinus is free from the pallial line for most of its length and it always possesses some radial colour lines. A second member of *Psammotaena*, the subgenus to which *G. elongata* belongs, *G. inflata* (Bertin), also resembles *G. crassula*. However, *G. inflata* is larger, thinner, more ovate, relatively broader, its periostracum is much thinner, its pallial sinus is broader and the lower limb of the pallial sinus is free from the pallial line for most of its length.

So great is the ontogenetic variation exhibited by *Gari crassula* that developmental stages might be classified as belonging to a different species unless a growth series were obtained. Juvenile *G. crassula* could be mistaken for the sympatric *Soletellina petalina* (Deshayes) because both are fragile, have comparable shell lengths, and purple radial markings. However, at comparable shell lengths, *S. petalina* is more elongate, more fragile and transparent, more compressed, more inequilateral (its umbones are relatively further forward), its posterior end is narrower and more rounded, it possesses a thinner periostracum, has a deeper and narrower pallial sinus in which the lower limb is confluent with the pallial line for a greater distance, and finally, it has a completely different colour pattern.

Habitat. Although *Gari crassula* has been recorded very rarely in the past, it occurs at extraordinarily high densities in the estuarine sections of large tropical and warm subtropical rivers. To my knowledge it is the only psammobiid that lives in such markedly stenohaline environments. Mr V. Kessner has informed me that he found specimens (mostly juveniles) plentifully in sand in fresh or brackish water under tidal influence in the Daintree River and Ross River I obtained almost 200 adult shells in a single beam trawl sample in 3.5 to 4 m in the Logan River, southern Queensland, in December 1982. The substrate at that Loganlea reach of the Logan River is gravel with a little silt as would indicate considerable current scour. The water's salinity at the time was only 6‰, which may explain why only three specimens were alive. Nevertheless, *G. crassula* can obviously tolerate salinities far below that of normal seawater. The only other molluscs in my Logan River sample were freshwater species – the gastropod *Plotiopsis balonnensis* (Conrad) and the bivalve *Corbiculina australis* (Deshayes).

McMichael (1961) recorded shells of *Gari crassula* amongst material from an Aboriginal midden near Grafton in northern New South Wales. Presumably Aborigines had collected this bivalve for food from the Clarence River which is nearby.

The bathymetric range is 0 to 4 m.

Distribution. There are too few specimens of *Gari crassula* available to allow its complete distribution to be understood. At present, its range appears identical to that of *G. inflata* (ie, the tropical western Pacific excluding South-east Asia). There is no evidence for its occurrence in the Indian Ocean. *Gari crassula* extends along the eastern Australian coastline, in the estuarine sections of virtually all the larger rivers, as far south as the Clarence River. It appears to be absent from the Northern Territory (personal observation) and northern Western Australia.

Literature records are as follows: Philippine Islands (Deshayes, 1855; Reeve, 1857); Clarence River and surrounding district (McMichael, 1961).

Gari (Psammobella) Gray, 1851

Type species. *Psammobia costulata* Turton, 1822, by subsequent designation of Kobelt, 1881. Recent, eastern Atlantic.

Diagnosis. Small psammobiids; transversely elongate; inequilateral, umbones displaced posteriorly; posterior end rounded to truncate; gapes very small or negligible. Surface of both valves with numerous, fine concentric cords on anterior and posterior areas and rounded radial ribs on posterior slope (absent only in *G. tellinella*). Right valve with 2 cardinal teeth; anterior one sometimes lamellate; posterior one bifid. Left valve with bifid anterior cardinal much stronger than rear one.

Pallial sinus deep; lower limb confluent with pallial line for most of its length.

Members of this subgenus could be misinterpreted as juveniles of the subgenus *Psammobia*, but their shells are thicker, their teeth are relatively stronger and their sculpture is much finer. In *Psammobella*, a lunular projection is never developed in front of the umbo on the left valve. *Psammobella* might have evolved from *Psammobia* by neoteny.

I include only *Gari pusilla* Bertin, *G. costulata* (Turton) and *G. tellinella* (Lamarck) in the subgenus *Psammobella*.

Gari (Psammobella) pusilla Bertin, 1880

Figs 198-203, 406

Gari pusilla Bertin, 1880: 71, 116, 117, no.50, pl.5 fig. 8a-c.

Types. *Gari pusilla* Bertin: lectotype, here designated (figured syntype, complete specimen - 11.4 mm) in MNHN; figured by Bertin, 1880: pl.5 fig.8a,b (Fig.198). Paralectotypes (two complete specimens - 11.3 mm left valve with broken anterior margin, 7.7 mm) in MNHN; smaller paralectotype probably that figured by Bertin, 1880:pl.5 fig.8c. Type locality New Caledonia.

Material examined. AUSTRALIA – QUEENSLAND: 1h, 8-13 m, reef no.14-151, south Ribbon Reef, Outer Barrier Reef - 14°55'S 145°41'E (AMS C149154); 1c, dredged in lagoon, Lady Musgrave Island, Bunker Group (AMS C149140).

FIJI ISLANDS: 1c, 7 m, within the reef, Matuku Island (BMNH 1856.11.3.47). NEW CALEDONIA: 3c, (MNHN - lectotype & paralectotypes of *Gari pusilla* Bertin). KERMADEC ISLANDS: large series (AMS C167092); series, Sunday Island (NMNZ MF12460); 11h, Low Flat Beach, Sunday Island (NMNZ MF12461); large series, Sunday Island (NMNZ MF13887); large series, Sunday Island (NMNZ MF 13889); series, off Raoul Island (AMS C149161; C149162; C36628); 10c, 15 m, west coast Meyer Island (Brook coll.); 9h, 135 m, north-west Fleetwood Bluff, Raoul Island - 29°12.7'S 177°56.1'W (NMNZ MF25456); 14h, 38 m, north-west Hutchinson Bluff, Raoul Island - 29°14'S 177°59.28'W (NMNZ MF26726); series, 22-27 m, off Boat Harbour, Meyer Island, Raoul Island - 29°14.7'S 177°52.7'W (NMNZ MF25800); 2h, 135-146 m, east Dayrell Island, Herald Islets - 29°14.73'S 177°50.34'W (NMNZ MF26640); 4c, Raoul Island - 29°15'S 177°52'W (AMS C30211); series, 42-47 m, East Anchorage, Raoul Island - 29°16'S 177°51.58'W (NMNZ MF26623); 1c, 40-47 m, east Smith Bluff, Raoul Island - 29°18.4'S 177°56.28'W (NMNZ MF26554); 2h, 82-100 m, south-east Smith Bluff, Raoul Island - 29°18.9'S 177°56.4'W (NMNZ MF27110). NORFOLK ISLAND: 1c, 11h, 38 m, north-west Steels Point - 28°59'S 167°58'E (NMNZ MF25121); 2h, 38 m, north-west Steels Point - 28°56'S 167°58'E (NMNZ MF24896); 2h, 33 m, north of Steels Point - 28°54'S 167°59'E (NMNZ MF24531); 9h - 29°02'S 167°58'E (AMS C167132; C167133). CORAL SEA: 1h, 31 m, Chesterfield Plateau - 19°06'S 159°00'E (MNHN). LORD HOWE ISLAND: 1c, 2h (AMS C59678); 1h, 36.5 m (AMS C167134); 1h, 49-51 m, north Lord Howe Island - 30°25.5'S 159°05.6'E (AMS

C149160). RÉUNION ISLAND: 35h, 65 m, off Réunion Island - 19°45'S 54°09'E (MNHN).

Description. Maximum length 15 mm. Shell moderately solid, transversely elongate, donaciform; greatest width at level of small, prominent umbones; markedly inequilateral (in both juveniles and adults), umbones displaced to posterior third of dorsal margin; moderately inflated, right valve slightly more convex; anterodorsal margin usually straight (occasionally slightly convex towards anterior end in adults); anterior end broadly rounded; ventral margin straight or with a weak posterior concavity in adults; posterior end truncate or slightly convex; equivalve, commissure straight; no anterior gape and very small posterior gape. Exterior glossy; both valves ornamented with very numerous, fine, close concentric cords; cords flatter on anterior area, sharper in front of posterior slope; posterior slope of both valves bearing 10-15, strong, broad, radial ribs; ribs either smooth or nodulose or scaly on both valves; radial ribs separated by convex furrows approximately half their width; terminations of ribs produce undulations along valve's posterior margin. Periostracum very thin, straw brown, retained only near margins in living specimens, always lost from dead shells.

Hinge plate thick, relatively broad, excavated below umbones; nymph short. Right valve with 2, strong cardinal teeth, diverging by 50° from each other; anterior one elongate, directed obliquely forward, distal end connected by ridge to anterior end of hinge plate, not bifid; rear one triangular, shallowly bifid. Left valve with strong triangular, deeply bifid anterior cardinal tooth directed obliquely forward; posterior cardinal tooth merely a short, high, backward-directed lamella; no lunular projection in front of hinge on left valve. Pallial sinus extensive, deep (reaches level with hind end of anterior adductor scar); upper limb descending obliquely, evenly convex; anterior end broadly rounded; lower limb confluent with pallial line for most of its length; posterior extremity of pallial line directed rearward, reaching level with centre of posterior adductor scar. Anterior adductor scar elongate-ovate; posterior adductor scar circular; several small pedal retractor scars present dorsally immediately in front of, and below, hinge plate.

Colouration variable – exterior pellucid white or flushed with brown, pink, rose, orange or (rarely) yellow, sometimes rayed, exterior often with brown and opaque white maculations; adults often with additional calcification internally; interior glossy, reflecting ground colour of exterior, but maculations invisible. Hinge plate and teeth white.

Remarks. Being a small species, *Gari pusilla* is likely to be mistaken for a member of the Tellinidae or Thraciidae. Its distinguishing characters are its thickness, pronounced inequilaterality, sculpture (particularly the 10-15 ribs on the posterior slope of

each valve), strong teeth; lamelliform condition of the anterior cardinal tooth in the right valve and deep elongate pallial sinus. Besides colouration, there is considerable intraspecific variation in sculpture on the posterior slope; most shells have smooth radial ribs (Figs 202, 203) and scales are least common (Figs 198, 199, 201). The absence of scales is definitely not the result of post mortem abrasion.

Gari pusilla resembles juvenile *Gari anomala* (Deshayes), *G. livida* (Lamarck) and *G. gracilentia* (E.A. Smith) in its markedly inequilateral outline. However, all these three Australian species have entirely different sculpture – none has raised ribs on the posterior slope.

Gari pusilla is, in fact, more similar to the eastern Atlantic *G. costulata* Turton. *Gari costulata* is larger (to 25 mm) and broader, its posterior end is relatively narrow and more rounded, it bears more numerous (17-20) and weaker radial ribs that are never scaly or nodulose, the anterior cardinal tooth in the right valve is not lamelliform, the rear cardinal in the left valve is relatively stronger, its shell is pinkish and/or faintly pink rayed and there is always a vivid salmon unilunar flare and purplish blotch internally.

Agnomyax nana (Powell), a similar-looking tellinid occurs sympatrically with *Gari pusilla* at the Kermadec Islands and Norfolk Island. Actually its appearance is so similar, Powell (1958) originally classified it as a psammobiid and there are mixed lots of both species in several museums. *Agnomyax nana* is thinner, relatively broader, possesses fewer and stronger concentric cords, radial cords are present over the entire shell, the cardinal teeth are weaker, there are two lateral teeth in each valve, and a much shallower pallial sinus (only reaching level with the umbo).

Habitat. There are virtually no data on habitat accompanying specimens in museums. In AMS there is a note on the label of C149154 that the substrate consisted of clean sand amongst coral heads.

Based on material in collections, the depth range is 7 to 146 m. Specimens have only been taken on beaches at the Kermadec Islands.

Distribution. If the sample in MNHN from Réunion Island, Indian Ocean, is excluded, *Gari pusilla* can be considered to have a relatively small distribution in the south-western Pacific Ocean. On the other hand, accepting the Réunion Island locality gives *G. pusilla* an extended distribution throughout the tropical Pacific and Indian Oceans. Further collections need to be made. In order of decreasing frequency, most specimens in museums come from the Kermadec Islands, Norfolk Island and Lord Howe Island.

Irrespective of the range, the available lots indicate *Gari pusilla* occurs on coral reefs and atolls that are separated from turbid coastal waters by a considerable distance.

Gari (*Psammodonax*) Cossmann, 1887

Type species. *Psammobia caillati* Deshayes, 1857, by original designation. Mid-Eocene, France.

Diagnosis. Small to medium-sized psammobiids; relatively thick; elongate to oval-elliptical; markedly inequilateral, umbones displaced to posterior third of dorsal margin; both ends broadly rounded (anterior particularly so); posterior end short; equivalve; compressed; small anterior gape; small to medium posterior gape. Surface smooth, crossed by concentric growth striae; fine radial ribs on posterior slope of two species; posterior ridge absent. Right valve with two subequal cardinal teeth, the posterior one bifid. Left valve with bifid anterior cardinal tooth and short posterior cardinal tooth; no lunular projection anterior to umbo. Pallial sinus extensive, oval, moderately deep; lower limb free from pallial line for all, or almost all, its length. Ground colour pale, crossed by relatively narrow darker radial zones; umbones suffused with same hue as rays.

Characters defining the distinctive subgenus *Psammodonax*, probably the most isolated in *Gari*, are

the prolongation and broadening of the anterior end and hence displacement of the umbones rearwards, compression of the valves, weak sculpture, reduction in size of the right anterior cardinal tooth and concordant strengthening of the right posterior cardinal tooth, relative strength of the left posterior cardinal tooth, and separation of the pallial sinus from the pallial line. One could argue for elevation of *Psammodonax* to full generic rank, but cladistically this would be untenable because most of its defining characters are likely to be plesiomorphies; certainly those pertaining to shape, sculpture, hinge and pallial sinus are assumed to be primitive. The subgenus *Psammodonax* is the antithesis of the subgenus *Gari* in terms of phylogeny and biogeography.

Psammodonax was previously thought to contain only the type species, *G. caillati* (Deshayes), a European fossil. But three Recent species all possess the same distinctive characters and should be included too: *G. rasilis* (Melvill & Standen); *G. gracilentia* (E.A. Smith); *G. gofasi* Cosel. *Gari rasilis* is very similar to *G. caillati* and is almost certainly derived directly from it. All three Recent species have relatively restricted distributions in tropical seas and two of them, *G. rasilis* and *G. gracilentia*, are endemic to northern Australia.

Key to Species of the Subgenus *Psammodonax* in Australasia

1. Shell oval-elliptical; posterior slope of both valves with numerous, low, rounded radial ribs; colour of exterior creamish or pale pink with darker rays *G. rasilis*
- Shell transversely elongate, markedly inequilateral; surface of both valves smooth; colour of exterior white with brown rays *G. gracilentia*

Gari* (*Psammodonax*) *rasilis (Melvill & Standen, 1899)

Figs 237-242, 407

Psammobia rasilis Melvill & Standen, 1899: 197, no.397, pl.11 fig.18.—Hedley 1906: 466, 1910: 350.—Trew, 1987: 60.

Gari rasilis (Melvill & Standen).—Cosel, 1990: 712.—Slack-Smith, 1990: 137.—Lamprell & Whitehead, 1992: 56, pl.52 fig.385.

Types. *Psammobia rasilis* Melvill & Standen: lectotype, here designated (single right valve - 26.1 mm) in BMNH (1899.2.23.8/1); figured by Melvill & Standen, 1899: pl.11 fig.18 (Fig.237). Paralectotype (single left valve - 21.0 mm) in BMNH (1899.2.23.8/2). Type locality Torres Strait.

Material examined. AUSTRALIA - QUEENSLAND: 1c (QM); 2c, Torres Strait (BMNH 1899.2.23.8/1,2 - lectotype & paralectotype of *Psammobia rasilis* Melvill & Standen); 1c, Murray Island, north-east Torres Strait (QM); 2c, Gloucester Island, off Bowen (AMS C77967); 1c, Bowen (Lamprell coll.); 5h, 31-36.5 m, off Masthead Island, Capricorn Group (AMS

C11872); 1c,1h, Boyne Island, Gladstone (QM); 4h, Point Cartwright, Mooloolaba (QM); 14h, Caloundra (AMS C12883, C125983; Willan coll.). WESTERN AUSTRALIA: 1h, 50 m, 48 km west of Dongarra (WAM); 1h, 3.5-7.5 m, south-east corner Dirk Hartog Island (WAM); 1c,1h, 16 m, south-east Sholl Island, Passage Islands (WAM); 2c, Dampier (Hewitt coll.; Willan coll.); 1c, 5.5 m, Rosemary Island, Dampier Archipelago (WAM 1146-68); 1h, 40 m, 11-13 km north of Delambre Island, Dampier Archipelago (WAM); 1c, Finucane Island, south Port Hedland (Hansen coll.); 1c, Pretty Pool, Port Hedland (WAM 1821-68); 2c, Port Hedland (WAM 3363-68); 2h, 9 m, Little Turtle Island, north of Port Hedland (WAM 1802-68); 1h, 38-40 m, 92.3 km north-north-east of Port Hedland - 19°30'S 118°52'E (AMS); 2h, 22-44.5 m, west Lagrange Bay (WAM 1158-68). NORTHERN TERRITORY: 2h, 9 m, off Western Point, Darwin Harbour (WAM); 1h, 17 m, 2.5 km east of Mandorah, Darwin Harbour (NTM P16235); 1c,1h, Emery Point, Darwin (AMS; Kessner coll).

LORD HOWE ISLAND: 5h (AMS C59677).

Description. Maximum length 54 mm. Shell oval-elliptical; greatest width at level of umbones; markedly inequilateral (in both juveniles and adults), umbones displaced to posterior third of dorsal margin; anterodorsal

margin long, straight; anterior end very broadly rounded, shovel-like; ventral margin weakly convex; posterior end short, broadly rounded, narrower than anterior end; equivalve, commissure weakly sinuous; both valves compressed; small anterior gape; moderate posterior gape. Surface of both valves dull, almost smooth; bearing numerous, fine, concentric growth striae over entire anterior and central areas, striae not strengthened anywhere; posterior slope not marked off from rest of valve; sculpture on both valves consists of 20-30, close, low, smooth, rounded ribs passing from umbo to posterior margin; depressions between ribs exceedingly narrow, barely incised; terminations of ribs produce fine crenulations along posterior margin. Exterior with a thin, light brown periostracum that is usually worn off everywhere but near central and posterior margins.

Hinge plate narrow; nymph elongate, rather thin; ligament strong, high, relatively elongate, rather thin. Right valve with 2 cardinal teeth, diverging by 60° from each other; anterior one short and high, lamellate, directed obliquely forward; rear one much stronger, weakly bifid, directed obliquely rearward. Left valve with 2 cardinal teeth, diverging by 60° from each other; anterior one stronger, weakly bifid, directed obliquely forward; rear one lamelliform, directed obliquely posteriorly. Pallial sinus moderately deep (reaches middle of shell well in front of umbo), broad; upper limb runs as a straight line for a short distance transversely across middle of shell; anterior margin rounded, somewhat broader in left valve; lower limb passes obliquely rearward to meet pallial line near its ventral extremity (ie, lower limb of sinus is entirely free from pallial line); ventral extremity of pallial line directed downward, reaches level of middle of posterior adductor scar. Anterior adductor enlarged, unusual - posterior end narrowing and elongated dorsally toward umbo. Posterior adductor scar circular. Single pedal retractor scar present dorsally in front of hinge plate, situated midway between hinge plate and anterior adductor scar.

Ground colour of exterior creamish or pale pink, patterned concentrically, darkening to rose pink or (more rarely) orange toward umbones; anterior and central sections rayed with uninterrupted, dark pink, reddish, or (more rarely) orange radial colour zones that emanate from umbones; rays not symmetrical on right and left valves; posterior slope pallid, unrayed; maculations never present; interior clear-glazed, permitting external rays to be seen plainly for their entire length. Teeth white; nymphs opaque in adults, subpellucid in juveniles and subadults.

Remarks. Several characteristics immediately distinguish *Gari rasilis*: its inequilateral, compressed, telliniform shell with posteriorly-displaced umbones; broad anterior and short posterior ends; sculpture of numerous, low ribs on posterior slope of both valves; details of dentition, in particular the relative reduction of the anterior cardinal tooth in the right valve and enlargement of the rear one in the left valve; complete separation of the lower limb of the pallial sinus from

the pallial line; enlargement and prolongation of the anterior adductor muscle. Populations in northern Western Australia are not broader than those from Torres Strait as it would seem from the few specimens illustrated here. The form of the dark rays is strongly reminiscent of some species of the genus *Tellina sensu stricto*.

Gari rasilis is sympatric with *G. gracilentia* (E.A. Smith) around Australia's northern coastline and both species are more similar to each other than either is to any other Australian species. However, *G. gracilentia* is smaller (to 25 mm), heavier, narrower, entirely smooth, brownish in colour, its rays are consistently narrower and the lower limb of the pallial sinus is confluent with the pallial line for a short distance posteriorly. The West African *G. gofasi* Cosel shares resemblances by virtue of its position in the subgenus *Psammodonax*; in comparison to *G. rasilis*, it is smaller (to 15 mm), heavier, smooth except for a few shallow irregular lamellae on the posterior slope, whitish to pale yellowish in colour and 2 pale rays extend from the umbo to the ventral margin.

Habitat. Because very few live specimens of *Gari rasilis* have been obtained its habitat is uncertain. Live specimens have been collected on intertidal sand bars on two occasions (Kessner coll.; WAM 1821-68), but they could have been cast up live from adjacent channels. Although *G. rasilis* appears to prefer clean substrates, it has never been recorded from coral reefs or atolls along Australia's Great Barrier Reef.

Gari rasilis has a known bathymetric range of 0 to 50 m, but most shells in museums have been collected intertidally.

Distribution. *Gari rasilis* is essentially restricted to the northern half of Australia. It extends from Lord Howe Island, around the north-eastern and northern coasts of mainland Australia, to Shark Bay in Western Australia. This range probably represents a contraction (or, in view of the species' ancestry, even relict) from a previously greater one.

Gari (Psammodonax) gracilentia (E.A. Smith, 1884)

Figs 243-245, 408

Psammobia gracilentia E.A. Smith, 1884: 98, no.24, pl.7 figs b-b2.-Hedley, 1910: 350, 1918b: 8.

Gari gracilentia (E.A. Smith).-Cosel, 1990: 712.-Lamprell & Whitehead, 1992: 58, pl.53 fig.397.

Types. *Psammobia gracilentia* E.A. Smith: holotype (complete specimen - 19.3 mm) in BMNH (1882.2.23.603); figured by E.A. Smith, 1884: pl.7 figs B-B2 (Fig.243). Type locality Prince of Wales Channel, Torres Strait.

Material examined. AUSTRALIA - QUEENSLAND: 2c, Karumba, Gulf of Carpentaria (AMS C14964); 6h, Mapoon,

Gulf of Carpentaria (AMS C14246); 1c, 16 m, Prince of Wales Channel, Torres Strait (BMNH 1882.2.23.603 - holotype of *Psammobia gracilentia* E.A. Smith); 1h, 0-11 m, Gannet Passage, Torres Strait - 10°35'S 141°55'E (AMS); 10h, 7-26 m, Albany Passage, Cape York (AMS C36270); 2h, Annam River, north of Cooktown (AMS C41628); 6h, Trinity Bay (AMS); 2h, Buchan's Point, north of Cairns (AMS); 1c, Shelley Beach, Townsville (Willan coll.); 14h, 2-5.5 m, Quoin Island, north of Yeppoon (AMS C105957); 1c, 13h, 13 m, Port Curtis (AMS C18686); 7h, Facing Island, Port Curtis (AMS); 4h, Tannum Sands, Port Curtis (AMS). WESTERN AUSTRALIA: 1h, Buccaneer Archipelago (AMS C42469).

Description. Maximum length 25 mm. Shell transversely elongate, telliniform, markedly inequilateral; greatest width at level of umbones; umbones displaced to posterior third of dorsal margin so that shell is almost twice as long as high; anterodorsal margin long, straight; anterior margin broadly rounded; ventral margin straight, parallel to anterodorsal margin, sometimes with a broad and shallow embayment opposite umbo; posterior end very short, narrower than anterior end, margin subtruncate to rounded (subacute in large specimens); posterodorsal margin short, straight, descending steeply from umbo; equivalve, without any indication of posterior ridge or posterior flexure in either valve; commissure straight; both valves compressed; narrow anterior gape; slightly wider posterior gape. Surface of both valves glossy, anterior and central areas smooth apart from indistinct, broad, concentric growth striae; posterior slope not marked off from rest of valve; striae stronger, closer together, elevated yet rounded on posterior slope of each valve, definitely without radial ribs. Exterior of shell covered with a thin, transparent, yellowish brown periostracum in living specimens; periostracum entirely lost from dead shells, thus enhancing surface gloss.

Hinge plate narrow, nymph about half as long as posterodorsal margin; ligament strong, relatively short but prominent. Right valve with 2 cardinal teeth, diverging by 50° from each other; anterior one triangular, directed obliquely forward, projecting beyond hinge plate; rear one bifid. Left valve with 2 cardinal teeth, diverging by 45° from each other; anterior one stronger, triangular, bifid, directed obliquely forward; rear one short, directed posteriorly, distal extremity abruptly truncate. Pallial line and muscle scars relatively deeply impressed, easy to observe; pallial line considerably removed from shell margin, especially anteriorly. Pallial sinus extensive, broad, deep (reaches beyond middle of valve almost to level of rear end of anterior adductor scar); upper limb broadly convex; anterior margin rounded, subacute; lower limb straight, descending obliquely to pallial line, free for over half its length; ventral extremity of pallial line directed downward, reaches level of anterior margin of posterior adductor scar. Anterior adductor enlarged, unusual - posterior end narrowing toward umbo, obliquely truncate. Posterior adductor scar circular. Single, elongate pedal retractor scar present in front of hinge plate one-quarter of distance along

anterodorsal margin.

Shell subpellucid; exterior dirty white, patterned with numerous, pale brown, either wide or narrow, rays that emanate from pale brown umbones; zone near umbones sometimes suffused with brown; rays present over entire shell but generally fewer and narrower on anterior area, less intense near margins, not symmetrical on right and left valves; maculations never present; interior bluish white, clear glazed, permitting external brown rays to be seen indistinctly; sometimes with additional brown secondary calcification internally. Hinge plate and teeth white.

Remarks. *Gari gracilentia* is more likely to be identified as a tellinid or a donacid than a psammobiid because of its small size, elongate shape, enlarged anterior end, abbreviated posterior end, smooth glossy shell and brown rayed colouration. However, features of its dentition and pallial sinus stamp it as belonging to the genus *Gari* and subgenus *Psammodonax*. Within these taxa, its unique characters are its small adult size, shape, extensive pallial sinus and colouration.

Comparisons have already been made with the related *Gari rasilis* (Melvill & Standen) and *G. gofasi* Cosel. The distribution of *G. gracilentia* overlaps that of *Soletellina burnupi* G.B. Sowerby III throughout much of coastal northern Australia, even though it never occurs in the same habitat. Although both species are similar in outline, *S. burnupi* is thinner, more expanded anteriorly, more compressed, with a straighter posterodorsal margin, with a deeper yet narrower pallial sinus showing greater relative fusion of the lower limb of the sinus and pallial line, longer nymph, more delicate hinge and bluish violet colour with two pale rays posteriorly.

Habitat. Judging by the frequency with which *Gari gracilentia* has been collected in inter-island channels and passages, it inhabits areas of strong water movement and (presumably) clean, coarse sand. It never occurs within coral reef environments where similar hydrological conditions exist.

Based on material in collections, the depth range is 0 to 16 m, but it is not clear which depths are preferred.

Distribution. *Gari gracilentia* is apparently restricted to shallow shelf waters around northern Australia. I presume populations do exist between the Buccaneer Archipelago (from where the sole Western Australian specimen originates - Hedley, 1918b) and York Peninsula, despite there being no material known from intervening Northern Territory waters. On the east coast of the continent, populations occur south to the tropical/subtropical convergence just north of the Tropic of Capricorn. There are no records or specimens from Great Barrier Reef waters.

Soletellina Blainville, 1824

Type species. *Soletellina radiata* Blainville, 1824 (= *Solen diphos* Linné, 1771) by monotypy. Recent, tropical Indo-west Pacific.

Comments. The earliest name, *Aulus* Oken, cannot be used because the work containing it (Oken, 1815) has been rejected as non-binomial (ICZN, 1956 Opinion 417). Synonyms are *Psammotaea* auctt. not Lamarck, 1818, *Flavomala* Iredale, 1936 and *Florisarka* Iredale, 1936. Unintentional emendations are *Solenotellina*, *Solenotallina*, *Soletellaria* and *Solatellina*.

Because it was proposed in an important work and because its type species is well understood, *Soletellina* has been widely used since its introduction. However, it has been replaced repeatedly with *Hiatula* Modeer (Tryon, 1868, 1870; Bertin, 1880; Rehder, 1967; Abbott & Dance, 1982; Beu & Maxwell, 1990; Oliver, 1992) on grounds of chronological priority. Indeed, Modeer did propose the genus *Hiatula* in 1793 (p.178) (Winkworth, 1935), but his description was brief and ambiguous, and although he cited three species: “*Solen diphos* och *Bullatus*, *Mya arenaria* och *truncta*, *Mytilus Pholadis* o.s.v.”, none was indicated as type. Because *Hiatula* was polyphyletic when proposed, its interpretation rests on subsequent type designations. Stoliczka (1870:114) restricted *Hiatula* by selecting *Solen diphos* Linné as type, and Winkworth (1935:322) later chose *Mya arenaria* Linné. I am formulating a case to the ICZN for suppression of Stoliczka’s type designation on grounds of nomenclatural stability, likelihood that Modeer’s description referred solely to *Mya* (Winkworth, 1935:323), homonymy with *Hiatula* Martini, 1774, and incorrectness of Stoliczka’s other psammobiid type designations (ie, his selection of *Psammobia insignis* Deshayes as type species of *Gari* Schumacher, and his selection of *Psammobia modesta* Deshayes as type species of *Psammobella* Gray). ICZN intervention would leave Winkworth’s designation as the valid one and *Hiatula* would thereby be a synonym of *Mya*. Until the ICZN decision is known, I shall continue to use *Soletellina*.

Diagnosis. Small to large-sized psammobiids, thin-shelled, elliptical to elongate in shape, rounded to rostrate posteriorly; inequivalve, umbones displaced anteriorly; commissure straight; moderately large gapes anteriorly and posteriorly. Surface completely smooth, glossy beneath a relatively thick periostracum. No ridge separating central area from posterior slope. Nymph and ligament strong. Right valve with 2, delicate, approximately equal cardinal teeth. Left valve with only delicate anterior cardinal tooth developed; posterior cardinal reduced to a lamella. Pallial sinus very deep (extending almost to anterior adductor scar), narrow; lower limb of pallial sinus completely fused with pallial line (except *S. burnupi*). Colouration generally uniform purplish, often with 2 rays posteriorly.

Soletellina is distinctive on account of its thin and smooth shell, moderately large gapes (especially posteriorly), thick periostracum, and relatively deep yet narrow pallial sinus. Because the dentition in this genus is identical to that of *Gari*, separation of *Soletellina* from *Gari* at the level of subfamily is unjustified. Stoliczka (1870:114) noted the great resemblance of species of *Soletellina* (as *Hiatula*) to *Gari* and he considered the former as a subgenus of the latter.

The genus closest to *Soletellina* is *Nuttallia* Dall (*Hainania* Scarlato is a synonym). Essentially, *Nuttallia* differs in its rounded shape and inequivalve condition with the right valve more compressed than the left. *Orbicularia* Deshayes, which Keen (1969) grouped in the Psammobiidae, also has a rounded outline but Cosel (1991) has shown conclusively belongs to the Pharidae (Solenioidea).

Soletellina has sometimes been treated as a subgenus of *Sanguinolaria* Lamarck, or synonymised with that genus. Like Rehder (1967:27), I consider the two genera are distinct with *Sanguinolaria* the more primitive. Characters possessed by *Sanguinolaria* that differentiate it from *Soletellina* are: thickened shell; ovate shape; stronger hinge; whitish or roseate colouration; negligible periostracum; shallow embayment on anterior margin of both valves; moderately sinuous upper limb of pallial sinus (flexing dorsally towards umbo); nodules internally at extremity of cruciform muscle scars; pre-umbonal extension of hinge plate. The latter six characters are apomorphies of *Sanguinolaria*. By contrast, *Soletellina* is certainly more derived by way of: its thinner shell; stronger nymph; stronger ligament; more delicate and blade-like teeth; deepening of pallial sinus. Apomorphic traits evident within the genus *Soletellina* are for transverse elongation and rostration of the posterior end, valve inequilaterality, and reduction of the posterior cardinal tooth in the left valve.

Taxonomically I cannot recognise subgenera within *Soletellina* although there are apparently a large number of species, particularly in the tropical western Pacific Ocean. Part of my hesitation to split the genus stems from the fact that its type species, *Soletellina diphos* (Linné), is the most derived species; it is the only one to exhibit all the apomorphic traits listed above.

Four wide-ranging Indo-Pacific species of *Soletellina* occur in the northern part of the region under investigation. Two additional species are endemic to temperate Australia (*S. biradiata* (Wood) and *S. alba* (Lamarck)), and a further two species are endemic to New Zealand (*S. nitida* (Gray in Dieffenbach) and *S. siliquens* n.sp.). Besides *S. diphos*, I include the following exotic nominal species in *Soletellina*: *S. acuminata* Reeve, 1857; *S. acuta* (Cai & Zhuang, 1985); *S. adamsii* Reeve, 1857; *S. atrata* Reeve, 1857; *S. castanea* Scarlato, 1965; *S. clouei* (Bertin, 1880); *S. consobrina* Reeve, 1857; *S. cumingiana* Reeve, 1857; *S. hendersoni* Melvill & Standen, 1898; *S. jousseaumeana* (Bertin, 1880); *S. lunulata* (Deshayes, 1855); *S. moesta* Lischke, 1869; *S. ovalis* (Bertin, 1880); *S. petri* Bartsch, 1929; *S. planulata*

Reeve, 1857; *S. radiata* Blainville, 1824; *S. rostrata tenuis* (Deshayes, 1855); *S. truncata* Reeve, 1857; *S.*
 (Deshayes, 1832); *S. ruppelliana* (Reeve, 1857); *S. violaceus* (Lamarck, 1818); *S. virescens* (Deshayes,
skinneri (Reeve, 1857); *S. tchangsii* (Scarlato, 1965); *S.* 1855).

Key to the Species of *Soletellina* in Australasia

1. Shell equilateral or slightly inequilateral; lower limb of pallial sinus confluent with pallial line for its entire length 2
 - Shell markedly inequilateral, umbones displaced to posterior third of dorsal margin; lower limb of pallial sinus separated from pallial line for about one-third its length *S. burnupi*
2. Shell ovoid, inflated; umbones prominent; tropical waters 3
 - Shell transversely elongate, compressed; umbones not prominent; temperate waters 4
3. Shell approximately trigonal in shape, markedly inflated; shell and hinge plate purplish *S. tumens*
 - Shell approximately rectangular in shape, moderately inflated; shell white or pale fawn; hinge plate white *S. connectens*
4. Umbones more or less central; shell relatively broad, elliptical 5
 - Umbones displaced from centre (either forward or backward); shell relatively narrow, transversely elongate 6
5. Shell moderately solid, marked with concentric purple and creamish bands; periostracum brownish; southern Australia *S. biradiata*
 - Shell thin, white; periostracum greenish; New Zealand *S. siliquens* n.sp.
6. Shell with distinct, narrow, interrupted, purplish rays anteriorly and centrally; tropical waters *S. petalina*
 - Shell without rays anteriorly or centrally (but sometimes with rays posteriorly); temperate waters 7
7. Anterior end considerably longer than posterior; posterior end subangled; periostracum with fine, incised radials anteriorly; brown rays never present anywhere on shell; New Zealand *S. nitida*
 - Anterior end but little longer than posterior; posterior end generally broadly rounded; anterior end without fine, incised radials; brown rays sometimes present posteriorly; temperate Australia *S. alba*

Soletellina (Soletellina) biradiata (Wood, 1815)

Figs 298-312,409

- Solen biradiata* Wood, 1815: 135, no.26, pl.33 fig.1.–Dillwyn, 1817: 67, *Solen* sp. 24.–Wood, 1818: 15, no.26, 1825: 15, no.26, pl.3 fig.26, 1835: 135, pl.33 fig.1.
- Sanguinolaria livida* Lamarck, 1818: 511, *Sanguinolaria* species 3.–Deshayes & Milne-Edwards, 1835: 169, *Sanguinolaria* species 3.–Lamy, 1914: 21.
- Psammobia flavicans* Lamarck, 1818: 514, *Psammobia* species 8.–Deshayes & Milne-Edwards, 1835: 176, *Psammobia* species 8.–Delessert, 1841, pl.5 fig.5a-d.–Hanley, 1843, pl.11, no.52.–Philippi, 1845: 194, *Psammobia* pl.2 figs 4, 6.–Kobelt, 1881: 328.–Dautzenberg & Fischer, 1913: 484, 485.–Dautzenberg & Fischer, 1914: 217, 218, pl.6 figs 4-7.–Lamy, 1914: 57.
- Soletellina nymphalis* Reeve, 1857: *Soletellina* pl.1, species 2. *Soletellina epidermia* Reeve, 1857: *Soletellina* pl.1, species 3. *Soletellina biradiata* (Wood).–Reeve, 1857: *Soletellina* pl.1, species 7.–Tate, 1887a: 87, no.41.–Pritchard & Gatliff, 1903: 114.–Suter, 1913: 1083, 1915: pl.62 fig.13.–Hedley, 1918a: M28, no.284.–May, 1921: 25, no.194, 1923, pl.11 fig.11.–Finlay, 1926: 472.–Gabriel, 1936: 42, pl.4 fig.10.–Cotton & Godfrey, 1938: 265, fig.301.–Boreham, 1959: 20.–Macpherson & Gabriel, 1962: 371, fig.433.–Dartnall, 1974: 185, 186, fig.7.8 (top right).–Wilson & Allen, 1987: 46, top right fig.–Richmond, 1990: 57, no.157.
- Soletellina (Psammotella) flavicans* (Lamarck).–Chenu, 1862: 65, fig.268.
- Hiatula biradiata* (Wood).–Angas, 1865: 646, no.19, 1867: 918, no.41.–Tryon, 1868: 78, no.4.–Bertin, 1880: 88, no.10.–Whitelegge, 1889: 237, no.60.–Abbott & Dance, 1982: 348.
- Hiatula epiderma* (Reeve).–Angas, 1865: 646, no.20.–1867: 918, no.40.–Tenison-Woods, 1878a: 50.–Whitelegge, 1889: 237, no.59.
- Hiatula nyphalis* (Reeve).–Angas, 1865: 646, no.21.
- Psammotella flavicans* (Lamarck).–Kobelt, 1881: 328.
- Soletellina (Soletellina) biradiata* (Wood).–Paetel, 1890: 41. *Soletellina (Soletellina) epidermia* (Deshayes).–Paetel, 1890: 42. *Soletellina (Soletellina) flavicans* (Lamarck).–Paetel, 1890: 42.
- Soletellina (Soletellina) nymphalis* (Deshayes).–Paetel, 1890: 42.
- Soletotellina* (sic = error pro. *Soletellina*) *biradiata* (Wood).–Tate & May, 1901: 425.
- Gari biradiata* (Wood).–Hedley, 1916: 18.
- Flavomala biradiata* (Wood).–Iredale, 1936: 283, pl.20 fig.19.–Allan, 1950: 340, pl.39 fig.5.–Macpherson & Chapple, 1951: 153.–Cotton, 1961: 281, fig.310.–McMichael, 1962: 46, fig.73.–Iredale & McMichael, 1962: 25, no.422.
- Sanguinolaria (Psammotellina) biradiata* (Wood).–Ludbrook, 1978: 68, 69, pl.5 fig.3, pl.8 figs 2, 4, 6.–Roberts & Wells, 1980: 352.–Wells, 1981: 82, no.201, pl.41 fig.201.–Ludbrook, 1984: 188, pl.7m,n figs 46i,j, 75g,h, 80p,q.–Ludbrook & Gowlett-Holmes, 1989: 668, figs 11.5i,j.
- Soletellina (Flavomala) biradiata* (Wood).–Powell, 1979: 419.
- Sanguinolaria biradiata* (Wood).–Wells, 1984: 78, 79, 97.–Wells & Bryce, 1986: 174, pl.66 fig.632.–Dakin, 1987: 329.
- Solatellina* (sic = error pro. *Soletellina*) *biradiata* (Wood).–Phillips, 1984: 96.
- Psammotellina biradiata* (Wood).–Lamprell & Whitehead, 1992: 60, pl.54 fig.407.

Comments on synonymy. Deshayes & Milne-Edwards (1835:176, footnote 1) realised *Sanguinolaria livida* Lamarck and *Psammobia flavicans* Lamarck were synonymous. It is most fortunate that Wood had introduced *Solen biradiata* for this same species three years before Lamarck's descriptions or the correct names for two (of the commonest) species of psammobiids in temperate Australia would have been *Gari livida* (Lamarck) and *Soletellina livida* (Lamarck)!

Although Reeve (1857) attributed both *Soletellina nymphalis* and *S. epidermia* to Deshayes, neither was ever published by that author. Tryon (1868:78) amalgamated these two names of Reeve with *Solen biradiata* Wood, and this conclusion formed the basis of the first critical synonymy by Pritchard & Gatliff (1903). Dautzenberg & Fischer (1913, 1914) expanded this synonymy into its present form by incorporation of *Psammobia flavicans* Lamarck.

Iredale (1936) decided *Solen biradiata* Wood differed generically from *Solen diphos* Linné, the type species of *Soletellina*. Inexplicably, he followed Kobelt (1881) who had placed *S. biradiata* in *Psammotella*. Arguing that *Psammotella* was unavailable because Blainville only used the French vernacular word *Psammotelle*, Iredale created *Flavomala* in its place. Iredale designated *S. biradiata* as type species of *Flavomala*, and therefore that name falls as a synonym of *Soletellina*, not *Gari* or *Psammotella* H. & A. Adams, 1856, or *Psammotellina* Fischer, 1887.

Types. *Solen biradiata* Wood: type material ought to be in BMNH, but not found there (S. Morris, personal communication, 1987; personal search, 1989). Type locality unknown.

Sanguinolaria livida Lamarck: lectotype, here designated (larger syntype, complete specimen with circular hole in centre of right valve - 54.6 mm) in MNHN (Fig.298). Paralectotype (juvenile specimen with both valves badly damaged - 23.0 mm) in BMNH. Type locality "la Nouvelle Hollande, baie des Chiens marins".

Psammobia flavicans Lamarck: lectotype, here designated (larger syntype, complete specimen - 57.0 mm) in MNHN; figured by Dautzenberg & Fischer, 1914: pl.6 figs 3,4) (Fig.299). Paralectotype (complete specimen - 33.9 mm) in MNHN; figured by Dautzenberg & Fischer, 1914: pl.6 figs 6, 7. Additional paralectotype (single left valve - 50.1 mm) in MHNG (1083/18); figured by Delessert, 1841: pl.5 fig.5a,d (Fig.300). Type locality "la Nouvelle Hollande, port du Roi Georges".

Soletellina nymphalis Reeve: lectotype, here designated (figured syntype, complete specimen - 53.4 mm) in BMNH (1985190/1); figured by Reeve, 1857: *Soletellina* pl.1, species 2 (Fig.301). Paralectotype (complete specimen - 50.3 mm) in BMNH (1985190/2). Type locality Australia.

Soletellina epidermia Reeve: lectotype, here designated (figured syntype, complete specimen - 54.9 mm) in BMNH (1985191/1); figured by Reeve, 1857: *Soletellina* pl.1, species 3 (Fig.302). Paralectotypes (complete specimen - 56.8 mm and broken specimen - 44.5 mm) in BMNH (1985191/2,3). Type locality Port Adelaide, Australia.

Material examined. "AUSTRALIA": 2c (BMNH 1985190/1,2 - lectotype & paralectotype of *Soletellina nymphalis* Reeve); 6c (NHMW 2449, 6116, 9871, 60942); 2c, "Baie des Chiens marins" (MNHN - lectotype & paralectotype of *Sanguinolaria livida* Lamarck).

AUSTRALIA - NEW SOUTH WALES: 1c, Iluka, Clarence River mouth (AMS C124761); 5c, Pittwater, north of Sydney (AMS C74213); 1c,1h, Dee Why lagoon (AMS C74700); 3c, Port

Jackson (AIM AM17690); 1c, Sow and Pigs Reef, Port Jackson (AMS C76919); 1c, Sydney (NHMW 56.281); 1c, Balmoral, Sydney Harbour, Port Jackson (WAM 1105-70); 6c,2h, Botany Bay (WAM P450, 17700-68); 7c, Moonie Creek, Jervis Bay (BMNH); 3c, Murray's Beach, Jervis Bay (WAM). VICTORIA: 3c,5h (QM); 2c, Lakes Entrance (Willan coll.); 1c, Port Welshpool (Whitehead coll.); 1h, Cowes, Phillip Island, Western Port (AIM AM17646); 5c,1h, Flinders, Western Port (Lamprell coll.; Willan coll.); 1c,1h, Port Phillip Bay (QM); 3c, Rosebud, Port Phillip Bay (Lamprell coll.; Whitehead coll.); 31c, Macrae Beach, Port Phillip Bay (MNHN; WAM 1107-70); 1c, Port Fairy (AIM AM17681). TASMANIA: 1c (MNHN); 2c, George Bay, St Helens (AMS; MNCN); 1c, Swansea, Great Oyster Bay (WAM); 2c, Pirate's Bay (AIM AM17687); 1c, intertidal sandflats, Eaglehawk Neck (AMS C108430); 1h, Simpson's Bay, d'Entrecasteau Channel (AMS C54130); 5c, Dover, d'Entrecasteau Channel (WAM 1106-70); 1c, Cloudy Bay lagoon, Bruny Island, south-east coast (AMS C114442); 4c, Alannah, South Bruny Island, south-east coast (WAM 1104-70); 2c, estuary at rear of Bakers Beach, north coast (Willan coll.); 2c, Seven Mile Beach, Devonport (Whitehead coll.); 10c, Kelso (QM). SOUTH AUSTRALIA: 11c (AIM AM17682; CAS 43091; NHMW 246; QM); 2c, Lacedpede Bay (QM); 3c, Cape Jaffa (WAM); 2c, Goolwa (Lamprell coll.); 3c, Gulf St Vincent (AIM AM17755; CAS 230); 3c, Port Adelaide, Gulf St Vincent (BMNH 1985191/1-3 - lectotype & paralectotypes of *S. epiderma* Reeve); 3c, Holdfast Bay, Gulf St Vincent (AMS C124764); 5c, Semaphore, Adelaide, Gulf St Vincent (AIM); 6c, Largs Bay, Adelaide, Gulf St Vincent (WAM 1103-70); 2c, Glenelg, Gulf St Vincent (AIM); 16c,7h, Outer Harbour, Adelaide, Gulf St Vincent (AIM AM17631, AM 17691; WAM 1102-70; Willan coll.); 2c, Rocky Point, Kangaroo Island (Whitehead coll.); 3c, Yorke Peninsula (AMS C94182); 1c,2h, 8 km north of Stansbury, Yorke Peninsula (AIM AM29344); 2c, Black Point, Yorke Peninsula (Lamprell coll.); 1c, Pondalowie Bay, Yorke Peninsula (AMS C68325); 1h, Port Lincoln, Spencer Gulf (AMS C16008); 1c, Salmon Beach, Coffin Bay (WAM); 3c, Two Peoples Bay, Streaky Bay (Kroll coll.); 1h, St Peter Island (AMS C30055); 1c, Rocky Point (Lamprell coll.); 1c, Point Sinclair (AMS C107220); 5c, washed ashore, Twin Rocks, Head of the Bight, Great Australian Bight (Kroll coll.). WESTERN AUSTRALIA: 2c, Eucla Beach, Great Australian Bight (WAM 1806-68); 1h, Twilight Cove reef, Eucla Basin, Great Australian Bight (WAM 1327-68); 2c,6h, Noonaera Beach, south of Mundrabilla homestead, 166 km west of Eucla, Great Australian Bight (WAM); 4c, Esperance (WAM); 1c, Rossiter Bay, Esperance (WAM); series, Duke of Orleans Bay, Esperance (WAM 651-85); 5c,1h, estuary, Bremer Bay (WAM); 2c,5h, John Cove, Bremer Bay (WAM 28-90); 1c, Wellstead Inlet, Bremer Bay (WAM); 13c, Two People Bay, Albany (BMNH; WAM); 3c, Cheyne Beach, Albany (WAM); 1c, Frankland River mouth, Normalup Inlet (WAM 1095-68); 1h, 2-3 m, west-north-west Quaranup jetty, Princess Royal Harbour (WAM); 1c,5h, Princess Royal Harbour (ZMUC); 1c, W Princess Royal Harbour (WAM 1728-68); 1h, 1 m, Oyster Harbour (WAM N3345); 2c,1h, King George Sound (MHNG 1083/18, MNHN - lectotype & paralectotypes of *P. flavicans* Lamarck); 1c,18h, Mistaken Island, King George Sound (ZMUC); 3c, Middleton Beach, King George Sound (WAM); 1c, Dunsborough Beach, Geographe Bay (WAM N2358); 1c, North Beach, Bunbury (WAM 332-40); 4c, Cockburn Sound (Lamprell coll.; Whitehead coll.); 1c, explosives booth, Woodmans Point, Cockburn Sound (WAM N868); 11h, Swan River, Perth (ZMUC); 3h, Menim Cove, Perth (AIM AM29333); 1c, sand bank on south side Swan River, opposite Menim Cove, Perth (WAM N1341); 1c, 0.5

m, Clarkson Reserve, Maylands, upper Swan River, east of Perth (Willan coll.); 1h, east end Thomson Bay, Rottnest Island (Willan coll.); 1c, Cottesloe Beach, north of Fremantle (WAM 159-42); 12c,1h, Whitford Beach, north of Fremantle (WAM) 1h, Back Beach, Lancelin (Willan coll.); 2h, Kalbarri Beach, Murchison River mouth (WAM N3823); 1c, South West Beach, Point Peron (WAM N382).

Description. Maximum length 80 mm. Shell moderately solid, elliptical-orbicular; broad, inequilateral, maximum width at level of umbones; juveniles relatively more elongate; anterior end broadly rounded; ventral margin evenly convex; posterior end rounded, narrower than anterior end, substrate in large adults; equivalve; moderately compressed; small anterior gape; relatively large posterior gape. Surface of both valves polished in juveniles, dull in adults, with numerous concentric striae that strengthen at posterodorsal margin; no discernable posterior ridge. Exterior covered with a thin, horny, golden-brown, glossy periostracum that is always lost from umbonal area.

Hinge plate moderate; nymph strong, elongate, broad (wider than hinge plate); ligament strong, raised. Right valve with 2 close-set cardinal teeth, diverging by 40° from each other; anterior one triangular; rear one fractionally stronger, weakly bifid. Left valve with 2 cardinal teeth, diverging by only 35° from each other; anterior one stronger, weakly bifid, directed vertically downward. Adductor muscle scars and pallial line deeply impressed, easy to observe. Pallial sinus deep (reaches anterior quarter of shell), quite narrow; upper limb straight, descending obliquely across middle of shell directly to pallial line; lower limb confluent with pallial line for its entire length; ventral extremity of pallial line reaches level of two-thirds distance across posterior adductor scar, extremity downturned. Several, small, ill-defined pedal retractor scars run dorsally from in front of hinge plate toward anterior adductor scar.

Colour of exterior creamish yellow, with (few or many) broad, purple or purplish brown or rusty orange, concentric bands; two broad, radiating pale lines invariably present posteriorly. Interior dull, creamish due to secondary calcification, margin often bordered with a purplish zone. Hinge plate, nymph and teeth cream.

Remarks. The elliptical shape and solid shell of *Soletellina biradiata* distinguish it from other Australian congeners. On these two characters alone there is a superficial resemblance to species of the genus *Nuttallia*. Environmentally-induced oxidation of mineral ions in areas of high land runoff sometimes causes shells to acquire a brick-red colouration (Cotton & Godfrey, 1938). I could not detect any ontogenetic variation in shape or colouration, but colouration itself varies considerably intraspecifically. Externally, shells can be cream or violet or purplish, and the width and frequency of the darker concentric bands is never consistent. Internally, most shells are as described above, but others are much darker with violet and yellow predominating.

There appears to be a tendency for South Australian specimens to be relatively broader (Figs 307-312) than those from elsewhere in the range.

Soletellina biradiata occurs sympatrically with *S. alba* (Lamarck) across southern Australia; that species is smaller (to 50 mm), thinner, more elongate with a relatively narrower anterior end, it has a straighter ventral margin, more truncate posterior end, shorter nymph, more delicate hinge with a weaker posterior cardinal tooth in the left valve, deeper pallial sinus, longer posterior extremity to the pallial line, generally (not always) flushed with purple, and never possesses concentric cream or orange bands externally.

The New Zealand species *Soletellina siliquens* n.sp. (= *S. siliqua* auctt. not Reeve, 1857) is similar to *S. biradiata* in being relatively broad and in having nearly central umbones, but *S. siliquens* is thinner, uniformly white, without concentric purple bands, and its two pale posterior rays are less distinct.

Like *Soletellina biradiata*, the tropical Asian species *Gari ambigua* (Reeve) (Figs 277-279) has a broad and relatively inflated shell in which the lower limb of the pallial sinus is united with the pallial line for its entire length. However, *G. ambigua* is heavier, the umbones are more anterior, the posterodorsal margin is almost horizontal, the posterior end is much larger and broader, and the pallial sinus is much deeper – the upper limb curves upward rather than descending obliquely to the pallial line as in *S. biradiata*.

Habitat. *Soletellina biradiata* inhabits sand flats in sheltered and semi-sheltered localities. The substrate can be either mud or relatively clean sand. *S. biradiata* is capable of attaining relatively high densities (Cotton & Godfrey, 1938; Allan, 1950), and it is abundant in many southern Australian harbours. Despite this abundance its biology and ecology have never been studied. Other bivalves that occur in the same habitat, at least in southern Australia, are *Eumarcia fumigata* (G.B. Sowerby II), *Fulvia tenuicostata* (Lamarck), *Anapella cycladea* (Lamarck), *Electromacra antecedens* Iredale and *Amesodesma nitida* (Deshayes).

Soletellina biradiata probably only lives intertidally, with maximum density in the lower intertidal. I cannot substantiate Wells & Bryce's (1984) claim that it also extends subtidally.

Distribution. *Soletellina biradiata* is endemic to Australia. It extends from Iluka, northern New South Wales, across the southern half of the continent, to Point Peron, central Western Australia. The paucity of records from northern New South Wales indicates very limited occurrences there, and this species does not become common until approximately Sydney. Dartnall (1974:186, fig 7.8 (top right)) merely indicated the south-eastern extent of the range of *S. biradiata*, but his illustration was misinterpreted by Wilson & Allan (1987:46) as signifying a species pair relationship with *S. alba* (as *S. donacioides*).

At the end of his *Manual of the New Zealand*

Mollusca, in the section on additions and emendations, Suter (1913:1083) recorded *Soletellina biradiata* from New Zealand. [Suter (1915:pl.62 fig.13) subsequently figured an Australian shell in his *Atlas* (Boreham, 1959:20).] Suter's record was based on one shell collected in the Manukau Harbour by A.E. Brookes and identified by E.A. Smith. That single shell has served as the basis for the subsequent citations of the species from New Zealand (Powell, 1937, 1979). No further specimens of *S. biradiata* have been found in New Zealand and therefore, as Finlay (1926:472) suggested, the record should be rejected. I agree with Finlay that the shell was, in fact, a distorted *S. siliquens*. Unfortunately the actual shell cannot now be located, either in AIM, or the Brookes collection (dispersed in 1991 following auction), or in BMNH.

Soletellina (Soletellina) alba (Lamarck, 1818)

Figs 313-330, 410

Psammobia alba Lamarck, 1818: 514, *Psammobia* species 10.–Deshayes & Milne-Edwards, 1835: 176, *Psammobia* species 10.–Hanley, 1843: 57.–Dautzenberg & Fischer, 1913: 485, 1914: 218-220, pl.6 figs 8-11.–Lamy, 1914: 58.–Cotton & Godfrey, 1938: 262, fig.297.

Psammobia florida Gould, 1851 n.syn.: 254, 1852: 403, figs 513, 513a, 513b.–Tenison-Woods, 1878b: 255 (misidentification, not *Psammobia florida* Lamarck, 1818).

Soletellina donacioides Reeve, 1857 n.syn.: *Soletellina* pl.3, species 11.–Tate, 1887a: 87, no.42.–Pritchard & Gatliff, 1903: 115.–Gabriel, 1936: 42, pl.4 fig.7.–Cotton & Godfrey, 1938: 265, fig.302.–Macpherson & Gabriel, 1962: 371, fig.434.–Greenhill, 1965: 68, 69, fig.4.–Dartnall, 1974: 184, 186, fig.7.8 (top right figure).–Wilson & Allen, 1987: 46 (top right figure).–Lamprell & Whitehead, 1992: 60, pl.54 fig.408.

Soletellina incerta Reeve, 1857 n.syn.: *Soletellina* pl.3, species 13.–Martens, 1873: 42.–Hutton, 1880: 143.–Suter, 1911: 1084.

Hiatula vitrea (Deshayes).–Angas, 1865: 646, no.22.–Tenison-Woods, 1878a: 50 (misidentification, not *Sanguinolaria vitrea* Deshayes, 1855).

Gari (Psammocola) (sic = error pro *Psammocola florida* (Lamarck).–Tryon, 1868: 76, no.47 (misidentification, not *Psammobia florida* Lamarck, 1818).

Hiatula incerta (Reeve).–Hutton, 1873: 66, no.38.–Hutton, 1885: 520.

Hiatula alba (Lamarck).–Bertin, 1880: 89, no.13.

Sanguinolaria vitrea (Deshayes).–Tate, 1887a: 87, no.40.–Tate & May, 1901: 425 (misidentification, not *Sanguinolaria vitrea* Deshayes, 1855).

Psammobia (Psammocola) florida Gould.–Paetel, 1890: 40 (misidentification, not *Psammobia florida* Lamarck, 1818).

Soletellina (Soletellina) incerta Deshayes (sic = error pro. Reeve).–Paetel, 1890: 42.

Soletellina hedleyi G.B. Sowerby III, 1907 n.syn.: 302, pl.25 fig.12.–Hedley & May, 1908: 114.

Solenotellina haynesi Preston, 1914 n.syn.: 18, fig.–Hedley, 1916: 18.

Soletellina florida (Gould).–Hedley, 1918a: M28, no.285 (misidentification, not *Psammobia florida* Lamarck, 1818).

Florisarka onuphria Iredale, 1936 n.syn.: 283, pl.20 fig.14.–

- Allan, 1950: 341, pl.40 fig.6.—Rippingale & McMichael, 1961: 205, pl.29 fig.17.—Iredale & McMichael, 1962: 25, no.423.
- Flavomala donacioides* (Reeve).—Macpherson & Chapple, 1951: 153.—Cotton, 1961: 282, fig.311.
- Gari alba* (Lamarck).—Hedley, 1916: 18.—Cotton, 1961: 279 fig.306.—Roberts & Wells, 1980: 352.
- Sanguinolaria donacioides* (Reeve).—Robinson & Gibbs, 1982: 28, 29.
- Sanguinolaria (Psammotellina) donacioides* (Reeve).—Ludbrook, 1984: 188 fig.75i-k.
- Soletellina* (sic = error pro. *Soletellina*) *donacioides* (Reeve).—Phillips, 1984: 96.
- Soletellina alba* (Lamarck).—Lamprell & Whitehead, 1992: 62, pl.55 fig.409.
- Soletellina haynesi* (Preston).—Lamprell & Whitehead, 1992: 62, pl.55 fig.412.

Comments on synonymy. As the synonymy indicates, this species has been called by nine different specific names and double that number of combinations. This multitude of names has arisen because of the species' extensive distribution and variability of shape and colouration. The correct specific name, *alba* Lamarck, whilst the earliest valid one, is incongruous because the shell is most often purplish in colour. Dautzenberg & Fischer (1913,1914) have described and illustrated the three syntypic valves of *Psammobia alba* Lamarck that were collected by Peron in King George Sound, southern Western Australia. They are all juveniles and they represent the pale, translucent white southern Australian colour form.

Reeve (1857) based *Soletellina donacioides* on a purple shell from Port Adelaide, South Australia. Probably because of his excellent illustration, this is the specific name that has most often been used in recent Australian literature (eg, Cotton, 1961; Macpherson & Gabriel, 1962; Greenhill, 1965; Robinson & Gibbs, 1982; Phillips, 1984). However, one cannot justify its retention over *Psammobia alba* Lamarck on the grounds of general acceptance because *alba* Lamarck has also been used twice during the same period (Cotton, 1961; Roberts & Wells, 1980).

Soletellina incerta Reeve is based on adult *S. alba*. Despite Reeve's incorrect type locality of New Zealand, the name *S. incerta* was only used by two of that country's early molluscan catalogers (Martens, 1873; Hutton, 1873,1880,1885). Suter (1913:1084), following E.A. Smith's advice, eliminated the name from the New Zealand fauna.

Gould (1851) proposed *Psammobia florida* on material from Illawarra, New South Wales, in ignorance of Lamarck's or Reeve's earlier names, and fact that his [Gould's] name was preoccupied by *Psammobia florida* Lamarck, 1818. [*P. florida* Lamarck is a junior synonym of *Psammobia depressa* Pennant according to the holotype in MHNG.] Iredale (1936) recognised the homonymy and proposed *onuphria* as a replacement for Gould's *florida*, and in doing so introduced the new generic name *Florisarka*.

Tate (1887a) wrongly applied the name *Sanguinolaria vitrea* (Deshayes) to translucent white forms of this species in his first checklist of South Australian bivalves. G.B. Sowerby III (1907) proposed *hedleyi* as a replacement for *S. vitrea sensu* Tate. Dautzenberg & Fischer (1914) suggested *Soletellina hedleyi* applied to the same species as *Psammobia alba* Lamarck, and Hedley (1916) upheld this opinion. Preston (1914) introduced *Solenotellina haynesi* without comparison to any other psammobiid species; that name has had no subsequent usages. *Soletellina haynesi* is inseparable

from (purple forms of) *S. alba*.

Types. *Psammobia alba* Lamarck: lectotype, here designated (single right valve - 25.7 mm) in MNHN (M4 1016); figured by Dautzenberg & Fischer, 1914: pl.6 fig.10 (Fig.313). Paralectotypes (single left valve - 23.6 mm and single broken right valve - 20.6 mm) in MNHN (M4 1016); figured by Dautzenberg & Fischer, 1914: pl.6 figs 8, 9, 11. Type locality "la Nouvelle Hollande, port du Roi Georges".

Psammobia florida Gould: holotype (left valve - 26.8 mm) in USNM (5900); figured by Gould, 1852: figs 513,a,b (Fig.314). Type locality Illawarra, New South Wales.

Soletellina donacioides Reeve: lectotype, here designated (figured syntype, cracked right valve - 31.5 mm) in BMNH (1984254/1); figured by Reeve, 1857: *Soletellina* pl.3, species 11 (Fig.315). Paralectotypes (complete specimens - 30.4, 27.8 mm) in BMNH 1984254/2,3 respectively). Type locality Port Adelaide, Australia.

Soletellina incerta Reeve: lectotype, here designated (figured syntype, complete specimen - 38.6 mm) in BMNH (1986132/1); figured by Reeve, 1857: *Soletellina* pl.3, species 13 (Fig.316). Paralectotype (complete specimen - 33.8 mm) in BMNH (1986132/2). Type locality New Zealand.

Soletellina hedleyi G.B. Sowerby III: holotype (complete specimen - 23.0 mm) in BMNH (1907.8.28.43); figured by G.B. Sowerby III, 1907: pl.25 fig.12 (Fig.317). Type locality South Australia.

Solenotellina haynesi Preston: holotype (complete specimen with hole near anterodorsal margin - 24.4 mm, not 26.5 mm as erroneously stated by Preston) in BMNH (1905.8.19.17); illustrated by Preston, 1914: 18, fig. (Fig.318). Type locality Monte Bello Islands, Western Australia.

Florisarka onuphria Iredale: lectotype, here designated (complete specimen - 32.0 mm) in AMS (C60625) (Fig.319). Paralectotype (figured syntype, right valve in several small fragments and dorsal margin of left valve broken) in AMS (C60625); figured by Iredale, 1936: pl.20 fig.19. Type locality Manly Lagoon, New South Wales.

Material examined. AUSTRALIA – QUEENSLAND: 1c, Hervey Bay (QM Mo18847); 8c,1h, Dunclowran Beach, Hervey Bay (WAM 1088-70); 4c, Lake Weyba, Noosa (QM Mo18851); 1h, Deception Bay, Moreton Bay (Willan coll.); 2c, Clontarf Beach, Bramble Bay, Moreton Bay (Lamprell coll.); 4c,2h, Dohles Rocks, Pine River mouth, Bramble Bay, Moreton Bay (Lamprell coll.; Willan coll.); 3c, Sandgate, Bramble Bay, Moreton Bay (Lamprell coll.); 12c,75h, Nudgee Beach, Bramble Bay, Moreton Bay (Willan coll.); 1h, 4.5-6 m, Amity Point, North Stradbroke Island, Moreton Bay (Willan coll.); 4c, Peel Island, Moreton Bay (WAM 1087-70); 5c, 0.5 m, Benoa Waters, Nerang River, Surfers Paradise (Willan coll.). NEW SOUTH WALES: 1h, Arrawarra Headland, north of Coffs Harbour (Willan coll.); 3c, Pond B, Fisheries Research Station, Port Stephens (WAM); 2c, Narrabeen Lagoon, north of Sydney (WAM 1085-70); 1h, Manly Beach, north of Sydney (AMS C143436); 9c,1h, Port Jackson, Sydney (QM); 1c,1h, Manly Lagoon, North Harbour, Port Jackson, Sydney (AMS C60625 - lectotype & paralectotype of *Florisarka onuphria* Iredale); 5c, Clontarf, Middle Harbour, Port Jackson, Sydney (MNHN; WAM 1083-70); 3c, Botany Bay, Sydney (NHMW O5144); 1c, Gunnamatta Bay, Port Hacking, Sydney (Willan coll.); 1h, Bonnie Vale, Port Hacking, Sydney (WAM 1082-70); 1c, Illawarra (USMN 5900 - holotype of *Psammobia florida* Gould); 1c, Tabourie Lake, south of Ulladulla (MNHN); 11c, Eden (Lamprell coll.; Whitehead coll.); 2c, Lake Curralo, Eden (Kroll coll.). VICTORIA: 3c (QM); 6c, 5 km east of Marlo (BMNH); 8c,1h, Lakes Entrance (BMNH; Willan coll.); 3c,

Port Phillip Bay (QM); 10c,1h, Melbourne, Port Phillip Bay (MNHN; Whitehead coll.). TASMANIA: 2c (NHMW 35656); 1c, north coast (Lamprell coll.); 9c, Nutgrove Beach, Sandy Bay, Derwent River mouth, Hobart (NMV); 4c, Short Beach, Derwent River, Hobart (Willan coll.); 3c,2h, Long Beach, Derwent River, Hobart (Willan coll.); 7c, Browns River (NMV). SOUTH AUSTRALIA: 1c (BMNH 1907.8.28.43 - holotype of *Soletellina hedleyi* G.B. Sowerby III); 7c (CAS 231; NHMW G9869; QM); 1c, Port MacDonnell (Kroll coll.); 2c, Murray River mouth, Lake Alexandrina (Lamprell coll.); 2c, Goolwa, Encounter Bay (WAM); 1c, Henley Beach, Adelaide, Gulf St Vincent (WAM 26-90); 7c,8h, Semaphore, Adelaide, Gulf St Vincent (NMV; QM Mo18851); 2c, Port Adelaide River, Gulf St Vincent (AIM); 3c, Port Adelaide, Gulf St Vincent (BMNH 1984254/1-3 - lectotype & paralectotypes of *S. donacioides* Reeve); 22c, Troubridge Island, Gulf St Vincent (AIM AM32587; MNHN; NMV); 6c, Kangaroo Island (SAM; Whitehead coll.); 3c, American River, Kangaroo Island (Whitehead coll.); 30c, Little Island, Streaky Bay (NMV). WESTERN AUSTRALIA: 3h, King George Sound (MNHN M4 1016 - lectotype & paralectotypes of *P. alba* Lamarck); 1h, Middleton Beach, Albany (WAM N1975); 4c, Walpole, Nornalup Inlet (WAM 33-90); 23c,35h, Pelican Point, Matilda Bay, Swan River, Perth (WAM 32-90; Willan coll.); 12c,13h, beach near Barrack Street jetty, Perth Water, Swan River, Perth (Willan coll.); 6c, Mossman Bay, Swan River, Perth (Turnbulle coll.; WAM 25-90); 2c, Ledge Point, Jurien Bay (Turnbulle coll.); 4c, Shark Bay (WAM); 1c, sandflats, north side Denham jetty, Shark Bay (WAM N4668); 8c, Monkey Mia, Shark Bay (WAM; Willan coll.); 2c,2h, New Beach, south Greenough Point, Shark Bay (WAM); 1c, North West Cape (WAM); 2c, Bandicoot Bay, Barrow Island (WAM); 1c, Monte Bello Islands (BMNH 1905.8.19.17 - holotype of *S. haynesi* Preston); 1c, east side Hermite Island, Monte Bello Islands (WAM 27-90); 2c,1h, sand bank in Stevenson's Passage, Monte Bello Islands (WAM 30-90); 2c, north Maitland River, Dampier (WAM 29-90); 1h, between east and west Lewis Island, Dampier Archipelago. (WAM 31-90).

"NEW ZEALAND" (error pro. AUSTRALIA): 2c (BMNH 1986132/1,2 - lectotype & paralectotype of *S. incerta* Reeve).

Description. Maximum length 50 mm. Shell thin and fragile, elongate; maximum width at level of umbones; inequilateral, umbones displaced posteriorly in both juveniles and adults; anterior end broadly rounded; ventral margin straight; posterior end rounded, somewhat narrower than anterior end; equivalve; moderately compressed; moderately large gapes both anteriorly and posteriorly. Surface of both valves smooth, polished; without any discernable posterior ridge; with numerous, concentric growth striae that give the impression, in places, of broad undulating folds. Exterior covered with a glossy (when fresh), golden-brown periostracum which, when worn off, leaves shell vulnerable to corrosion so surface near umbones chalky and pitted (see for example Fig.325).

Hinge plate small; nymph relatively short; ligament quite short, strong, high and rounded. Right valve with 2 delicate cardinal teeth, diverging by 60° from each other; anterior one a little stronger; rear one bifid. Left valve also with 2 delicate cardinal teeth; anterior one stronger, weakly bifid, directed vertically downward; rear one merely a low lamella, directed backward, diverging by 55° to rear of anterior one. Pallial sinus deep (reaches

level with rear end of anterior adductor scar); relatively narrow; upper limb straight, descending smoothly and obliquely; anterior end narrowly rounded; lower limb confluent with pallial sinus for its entire length; ventral extremity of pallial line directed downward, reaching level with rear end of posterior adductor scar. Single pedal retractor scar present dorsally midway between hinge plate and anterior adductor scar (sometimes a second minute scar also present behind first one).

Colour variable, exterior generally livid purple, darker centrally and posteriorly (especially adjacent to white umbones); 2 white lines radiate posteriorly (obsolete in most shells); narrow darker rays generally outline white rays above and below; other shells pale creamish brown with broad, darker violet rays extending from umbones. Interior uniform purple or creamish, with an area of whitish calcification dorsally. Hinge plate, nymph and teeth cream; purple forms with purple streak along eschutcheon area of posterodorsal margin.

Remarks. *Soletellina alba* is recognisable by its thin shell, elongate and inequilateral shape usually with broadly rounded posterior end, moderately large gapes, smooth surface, glossy periostracum, small hinge plate and teeth, and deep pallial sinus. At first glance, considerable intraspecific variation exists principally in shape. The ventral margin can be either straight (Figs 321, 322, 325, 326) or evenly convex (Figs 317, 320, 323, 324) resulting in a narrowly or broadly rounded posterior end respectively. Because such variation in shape occurs within all populations, it cannot be used to subdivide the species. Nor can I correlate variation in any other character with growth or locality. The claim by Macpherson & Gabriel (1962:373) that South Australian populations are more inflated than those from Victoria is not significant.

Soletellina alba does vary considerably in colouration throughout its wide geographical range. It is possible to categorise purple (form *donacioides*) and white (form *alba*) colour morphs, although intergrades do occur. In the latter morph (Figs 313, 317, 324, 327, 329, 330), the shell is creamish white yet the narrow rays outlining the pale zones posteriorly are relatively darker compared to the purple form and consequently more conspicuous. Juvenile shells (to 10 mm) can be translucent or vitreous, with or without darker rays posteriorly (form *hedleyi*). The white morph only occurs in Tasmanian, South Australian and Western Australian populations. Greenhill (1965) noted that both the purple and white morphs occurred together in Tasmania, and the observation holds true for South Australian and Western Australian populations as well. The frequency of occurrence of the purple and white morphs ought to be analysed statistically. The periostracum that overlies the shell can also vary in colouration; usually it is glossy and semitransparent horn brown (Figs 317-324), but occasionally, particularly in southern populations, it is thick, blackened towards the margin and reddish brown (Fig.325) (Greenhill, 1965). Since specimens exhibiting thin and thick periostraca occur sympatrically, I expect

variation in periostracal thickness to be phenotypic, and its expression is probably dictated by the particular microhabitat of the individual.

Because it has such an extensive geographical distribution, *Soletellina alba* occurs sympatrically with four congeners: *S. burnupi* (G.B. Sowerby III) from Hervey Bay to Moreton Bay; *S. biradiata* (Wood) from Iluka, throughout southern Australia, to Point Peron; *S. burnupi* and *S. connectens* (Martens) in the vicinity of Dampier, and Monte Bello Islands. Comparisons with *S. burnupi* and *S. biradiata* are given in the remarks sections for those two species. *Soletellina connectens* is more equivalve, more inflated, it has a more acutely sloping anterodorsal margin, much more truncate posterior end, more prominent umbones, broader pallial sinus, and it is never purple in colour.

Soletellina petalina (Deshayes) is the only other Australian species that resembles *S. alba* on account of similarities of outline and valve compression. However, this allopatric species is much smaller (20 mm maximum length), its umbones are more central, its posterior end is more blunt, its periostracum is less glossy, its pallial sinus is relatively broader and deeper, it invariably possesses narrow interrupted purplish brown rays on all sections of the shell, and there is often a purplish blotch internally between the nymph and posterior adductor scar.

Several exotic *Soletellina* species resemble *S. alba* in size, thinness, inequilateral shape, dentition and (sometimes) colouration. *Soletellina clouei* (Bertin) (Fig.371) from temperate eastern Africa is apparently the most closely related Recent species; indeed it is inseparable from *S. alba* on most characters. *Soletellina clouei* is, however, consistently slightly less inequilateral and more inflated, its pallial sinus is relatively deeper yet broader, and adult shells often possess a white calcareous thickening internally between the dorsal margin and pallial sinus. *Soletellina nitida* (Gray in Dieffenbach) from New Zealand is more inequilateral, its posterior end is relatively longer and subangled, its periostracum has incised lines anteriorly, its pallial sinus is deeper, the ventral extremity of its pallial sinus is upturned, its shell is often suffused with pink, and it never possesses brown rays. *Soletellina lunulata* (Deshayes) from the tropical central and western Indian Ocean is narrower and more elongate, more inflated, relatively narrower posteriorly, it has 2 dark rays emanating from the umbones, and often possesses a pattern of fine zig-zags. *Soletellina ruppelliana* (Reeve) (Figs 275, 276) from the Red Sea is heavier, narrower, more elongate, more pointed posteriorly, more inflated, its periostracum is thicker, and its shell is always suffused with (either pale or dark) purple.

Habitat. *Soletellina alba* inhabits mud or muddy sand in protected situations. Adults bury to a depth of 6 cm. Three other bivalve species commonly occur in the same habitat – *Notospisula trigonella* (Lamarck), *Macomona deltoidalis* (Lamarck) and *Eumarcia fumigata* (G.B. Sowerby II). In southern Queensland, the dominant

co-occurring gastropods are *Pyrazus ebeninus* (Bruguière) and *Polinices sordidus* (Swainson), and *S. alba* is an important food source for *P. sordidus* as well as wading birds. The ability of *S. alba* to live in estuarine channels has enabled it to colonise the waterways of man-made marinas.

Soletellina alba has a depth range of 0 to 0.5 m with maximum density in the lower intertidal zone.

Distribution. *Soletellina alba* is the most widespread of all Australia's endemic psammobiids. It ranges continuously around the southern Australian coastline from Hervey Bay on the east coast to Dampier Archipelago on the west coast. Phillips (1984) mentioned that *S. alba* was relatively more abundant in eastern Victoria than central Victoria, and he also noted that virtually all records since 1960 came from localities east of Shallow Inlet. The Alva Beach [Ayr, south of Townsville] locality given by Rippingale & McMichael (1961) is erroneous (O. Rippingale, personal communication, 1985), and the figured specimen probably came from southern Queensland. Similarly, the four complete specimens and one valve supposedly from Yeppoon in WAM (1089-70) are mislocalised. The distribution given by Dartnall (1974), and repeated by Wilson & Allen (1987:46), is wrong.

Soletellina (Soletellina) petalina (Deshayes, 1855)

Figs 331-335, 411

- Psammobia petalina* Deshayes, 1855: 320, no.17.–Reeve, 1857: *Psammobia* pl.7, species 53.–Hidalgo, 1903: 89, no.176.–Scarlato, 1965: 96.
Gari petalina (Deshayes).–Tryon, 1868: 78, no.68.–Bertin, 1880: 127, no.84.
Psammobia (Psammobella) petalina Deshayes.–Paetel, 1890: 40.

Types. *Psammobia petalina* (Deshayes): lectotype, here designated (figured syntype, complete specimen - 14.9 mm) in BMNH (1984292/1); figured by Reeve, 1857: *Psammobia* pl.7, species 53 (Fig.331). Paralectotypes (complete specimens - 15.5, 14.0 mm) in BMNH (1984292/2,3) respectively. Type locality Chinese Seas.

Material examined. AUSTRALIA – QUEENSLAND: 20h, Dugong River mouth, Mornington Island (Willan coll.); 12c, clean sand, extreme low water neap, between Round Point and Rodney Island, Shelburne Bay (Willan coll.); 4h, Newell Beach, north of Mossman (AMS C100706); 4c, Yorkes Knob, Cairns (Whitehead coll.); 14c, 12h, Annam River, Cooktown (AMS C41629); 55h, 9-18m, Hope Island, south of Cooktown (AMS); 14c, Kurrimine Beach, south of Innisfail (AMS); 2h, Mission Beach, south of Innisfail (AMS C149146); 2h, intertidal mud-sand flats, Lucinda, Halifax Bay (AMS); 2c, Townsville (AMS C52194); 1c, 6h, Hinchinbrook Island (AMS C9934); 1c, debris from beach, headland between Kings and Queens Beaches, Bowen, Port Denison (AMS C149143); 12c, Bowen (AMS). NORTHERN TERRITORY:

4c,32h, Caiman Creek, Berkeley Bay, Port Essington, Cobourg Peninsula (AMS C115866; WAM 894-85); 1c,2h, Berkeley Bay, Port Essington, Cobourg Peninsula (AMS); 12c, clean sand, ELWN, Reef Point, Cobourg Peninsula (Lamprell coll.; Willan coll.); 1c,1h, Smith Point, Cobourg Peninsula (AMS C143432); 3c, Cobourg Peninsula (Whitehead coll.); 1c,18h, Ocean Beach, Crab Creek, Boucaut Bay (AMS).

FIJI ISLANDS: 1c, mangrove forest, Viti Levu Island (Hole coll.). NEW CALEDONIA: 4c, (AMS; QM); 4c, Nouméa (AMS); 3c, close to Ducos Island, Nouméa Harbour (AMS). "CHINESE SEAS": 3c (BMNH 1984292/1-3 - lectotype & paralectotypes of *Psammobia petalina* Dehayes). HONG KONG: 2c,4h, Lok Wo Sha, Tolo Harbour (AMS). PHILIPPINE ISLANDS: 9c (MNCN); 14c, Malabon, Manila Bay, Luzon Island (MNHN).

Description. Maximum length 20 mm. Shell thin, transversely elongate; maximum width at level of umbones; anterior end rounded; ventral margin straight; posterior end rounded or subtruncate, a little broader than anterior end; umbones almost central in adults (displaced considerably posteriorly in small juveniles); equivalve; moderately compressed; no anterior gape, small posterior gape. Surface of both valves smooth, polished, crossed by numerous very fine concentric growth striae that are not strengthened on posterior slope. Exterior covered by a thin, yellowish, translucent periostracum that peels off readily.

Hinge plate narrow; nymph moderately long; ligament short. Right valve with 2 cardinal teeth, diverging by 50° from each other, fine, peg-like, equally well developed. Left valve also with 2 cardinal teeth, diverging by 50° from each other; anterior one larger (stronger than either tooth in right valve), weakly bifid, directed vertically downward; rear one merely a narrow, elongate, backwardly-directed lamella. Pallial sinus extensive (extends level with posterior third of anterior adductor scar); relatively narrow; upper limb evenly concave, its anterior half descending smoothly to pallial line; lower limb confluent with pallial line for its entire length; ventral extremity of pallial line directed obliquely downward, extending level with hind end of posterior adductor scar. Two small, discrete pedal retractor scars present dorsally midway between hinge plate and front of anterior adductor scar.

Colouration very variable; exterior whitish, pale peach-orange or rarely uniform purple; usually ornamented with narrow, interrupted, purplish or brown rays emanating from umbones; rays often appear as a series of arrow heads (see for example Figs 333 and 335). Interior whitish or pale peach-orange, translucent, permitting observation of external rays; purple blotch often present dorsally between nymph and anterior edge of posterior adductor scar. Teeth, hinge and nymph white.

Remarks. This is the smallest species of *Soletellina* in Australasia. Besides its diminutive adult size (less than 20 mm), it is distinguished by its more or less equilateral shape, smooth and glossy transparent shell, interrupted purple rays often appearing as a series of arrow heads and internal purple blotch delimited by the nymph and

posterior adductor scar. Colouration is extremely variable and no two shells are identical. Hidalgo (1903) recognised six colour forms. Unlike most other psammobiids, the pattern is symmetrical on the right and left valves. *Soletellina petalina* could be mistaken for a juvenile of either of its two sympatric congeners, *S. connectens* (Martens) or *S. burnupi* (G.B. Sowerby III). Juveniles of *S. connectens*, however, are more inflated, possess a shallower pallial sinus, are uniformly pale cream or brown, and never purple-rayed. Juveniles of *S. burnupi*, on the other hand, are much more inequilateral, much more compressed, dark brown and the pallial sinus is entirely different.

Soletellina petalina could be misidentified as juvenile *S. alba* (Lamarck), and comparisons are given under the remarks section for that allopatric species.

Habitat. *Soletellina petalina* inhabits a variety of substrates in sheltered, intertidal locations. Dr P. Saenger collected live juveniles while sieving clean sand in Shelburne Bay, northern Queensland. There are several records of this species from coasts adjoining mangrove forests. Judging by the numbers of freshly dead shells on some beaches, populations can attain high densities.

Distribution. *Soletellina petalina* is confined to the coasts of continents and larger islands in the tropical western Pacific Ocean. Literature records are from Japan (Bertin, 1890), "Chinese Seas" (Dehayes, 1855) and Philippine Islands (Hidalgo, 1903). These records, plus authentic specimens, presently indicate a range from Fiji through tropical Asia to northern Australia. In Australia, *S. petalina* occurs as far east as Cobourg Peninsula and as far south as Bowen. Probably its range is even more extensive but it has been overlooked on account of its small adult size.

Soletellina (Soletellina) nitida (Gray
in Dieffenbach, 1843)

Figs 336-343, 412

Psammotia (sic = error pro. *Psammobia*) *nitida* Gray in Dieffenbach, 1843: 252, no.180

Soletellina nitida (Gray).—Reeve, 1857: *Soletellina* pl.2, species 6.—E.A. Smith, 1874: 5, pl.2 fig.9.—Hutton, 1880: 142.—Suter, 1913: 1005, 1915, pl.62 fig.11.—Bucknill, 1924: 111, pl.12, no.14, Odhner, 1924: 83.—Powell, 1937: 61, no.256, pl.11 fig.20, 1961: 123, pl.11 fig.20.—Fleming, 1966: 33.—Morton & Miller, 1968: 464, fig.171, no.4.—Child, 1974: 37, no.46.—Powell, 1976: 130, pl.18 fig.20.—Gordon & Ballantine, 1977: 116.—Powell, 1979: 418, pl.76 fig.12.—Gardner, 1979: 22.—Cometti & Morton, 1985: 145.

Soletellina siliqua Reeve, 1857 n.syn.: *Soletellina* pl.3 species 10.—Martens, 1873: 42.—Hutton, 1880: 142.

Hiatula nitida (Gray).—Tryon, 1868: 70, no.10.—Hutton, 1873: 66, no.36, 1885: 520.—Bertin, 1880: 91, no.22.—Hutton, 1885: 520.—Beu & Maxwell, 1990: 399.

Hiatula siliqua (Reeve).—Tryon, 1868: 79, no.14.—Bertin, 1880: 91, no.23.—Hutton, 1885: 520.

Hiatula siliquae, Hart. (sic = error pro. *siliqua* Reeve).—Hutton, 1873: 66, no.37.

Hiatula incerta (Reeve).—Hutton, 1873: 66, no.38, 1885: 520 (misidentification, not *Soletellina incerta* Reeve, 1857).

Solenotellina nitida (Gray).—Moss, 1908: 34, pl.8 fig.16.

Comments on synonymy. *Soletellina nitida* is the more inequilateral, narrower, more compressed and more oceanic in habitat of New Zealand's two *Soletellina* species. Reeve (1857) figured this species twice in *Conchologia Iconica*; firstly (pl.2, species 6) under the name of *S. nitida* Gray, and secondly (pl.3, species 10) under the new name of *S. siliqua*. The resident New Zealand conchologist Suter later realised that two biological species of *Soletellina* did occur in that country, but apparently in a lapsus, he misinterpreted Reeve's *S. siliqua*. That is, Suter (1913, 1915) applied the name *S. siliqua* to the broader, more equilateral, estuarine species which has a similar appearance to that figured by Reeve as species 6. Possibly Suter merely relied on Reeve's figures and accidentally transposed Reeve's usages. Although the type material of *S. nitida* and *S. siliqua* shows those names to be synonymous, Suter's erroneous interpretation has become entrenched in New Zealand literature.

Although both *Soletellina incerta* Reeve and *Soletellina nitens* Tryon were originally stated as coming from New Zealand and both names became incorporated into that country's faunal lists, both are, in fact, based on mislocalised shells. The holotype of *S. incerta* (Fig.316) is actually the Australian *S. alba* (Lamarck) and that of *S. nitens* is the Red Sea *S. ruppelliana* (Reeve). The name *S. nitens* Tryon needs incorporation into the synonymy of *S. ruppelliana* as presented by Oliver (1992:164). I cannot explain how such errors in the type locality might have come about for either species.

Illustrations of *Soletellina nitida* are given by Gardner (1979) and Powell (1979).

Types. *Psammobia nitida* Gray in Dieffenbach: lectotype, here designated (syntype, complete specimen - 47.7 mm) in BMNH (1842.11.18.84) (Fig.336). Paralectotypic series (7 complete specimens) in BMNH (1842.11.18.83-92, but 88 missing). Additional paralectotype (complete specimen of *Soletellina siliquens* n.sp.) in same lot in BMNH (1842.11.18.87). Type locality New Zealand.

Specimen figured as *Psammobia nitida* Gray by Reeve, 1857: *Psammobia* pl.2, species 6 (complete specimen - 53.8 mm) in BMNH (1985193/1) (Fig.337).

Soletellina siliqua Reeve: lectotype, here designated (figured syntype, complete specimen - 39.8 mm) in BMNH (1984253/1); figured by Reeve, 1857: *Psammobia* pl.3, species 10 (Fig.338). Paralectotypes (complete specimens - 35.3, 35.1 mm) in BMNH (1984253/2,3). Type locality New Zealand.

Material examined. "NEW ZEALAND": 8c, (BMNH 1842.11.18.83-92 - lectotype & paralectotypes of *Psammobia nitida* Gray in Dieffenbach); 3c (BMNH 1984253/1-3 - lectotype & paralectotypes of *Soletellina siliqua* Reeve); 3c,3h (BMNH 1856.12.27.67, 1985193/1; NHMW G8426, G9870, 35657).

NEW ZEALAND - NORTH ISLAND: 4c, Great Exhibition Bay (Willan coll.); 1c, Rarawa Beach (Hole coll.); 3c, Tokerau Beach, Doubtless Bay (Hole coll.; Willan coll.); 2c, 2 m, Bland Bay, Whangaruru Peninsula (Hole coll.; Willan coll.); 4c,1h, 12 m, 800 m off Ocean Beach, Omaha Bay, Matakana (Willan coll.); 3c,2h, Ocean Beach, Omaha Bay, Matakana (Willan coll.); 5c, Opahi Bay, Mahurangi (Coles coll.); 6h, Te Haruhi

Bay, south of Whangaparoa Peninsula (Willan coll.); 1c, Okoromaia Beach, south of Whangaparoa Peninsula (Hole coll.); 5c, Orewa Beach (Coles coll.); 4c, Hadfields Beach (Hole coll.); 9c, Wenderholm Beach, north Waiwera (Willan coll.); 6c, Red Beach (Willan coll.); 2c, Mairangi Bay (Hole coll.); 7c, Milford Beach (CAS; WAM 1098-70); 2c, Takapuna Beach (BMNH); 4c, Piemelon Bay, north of Waiheke Island (Hole coll.); series, Oneroa Beach, north Waiheke Island (Willan coll.); 2c,1h, Onetangi Beach, south Waiheke Island (Crosby coll.); 1c,6h, Ocean Beach, Whangamata (Hole coll.; Willan coll.); 4c, Whitianga (Coles coll.); 4c, Brophy's Beach, Whitianga (Coles coll.); 3c,1h, Mercury Bay (Willan coll.); 2c, Sulphur Point, Tauranga Harbour (Smith coll.); 4c, Tauranga, Bay of Plenty (MNHN); 1c, Paraparaumu Beach (WAM); 2c, Raumati Beach (WAM); 1h, Ti Tau Bank, near Cornwallis, Manukau Harbour (Willan coll.); 1c, Piha (Hole coll.); 7c, Hokianga (NHMW 16484, 16485); 1c, Huketiri lookout, Ninety Mile Beach (Willan coll.). SOUTH ISLAND: 2c, Tennyson Inlet, Marlborough Sounds (Morley coll. 1875); 4c, Sumner Beach, Christchurch (NHMW O5657; WAM 1099-70); 2c, Otago (MNHN); 1c, Pakawau Beach, Golden Bay, Nelson (Hole coll.); 1c, Pohara Beach, Golden Bay, Nelson (Hole coll.). CHATHAM ISLANDS: 1c, Kaiangaroa Beach, north-east corner Chatham Island (Morley coll. 2026); 2c, Owenga Beach, south end Hanson Bay, Chatham Island (Willan coll.); 6h, south coast Port Hutt, Petre Bay, Chatham Island (Willan coll.). STEWART ISLAND: 3c (MNHN); 2c, Horseshoe Bay, near Paterson Inlet (Smith coll.); 1c, Oban Beach, near Paterson Inlet (Smith coll.).

Description. Maximum length 50 mm. Shell thin and fragile, elongate; greatest width at level of umbones; inequilateral, umbones displaced towards posterior end (more so in juveniles); very compressed; both ends rounded, anterior end broader; ventral margin slightly convex; equivalve; commissure straight; moderately large anterior and posterior gapes. Surface of both valves polished; smooth apart from obsolete, irregular, concentric growth striae; no indication of a posterior ridge. Exterior covered with a moderately thick, dehiscent, greenish-olive periostracum that is crossed by very fine radial scratches anteriorly.

Hinge plate narrow, short; nymph elongate; 2 thickened ligamental buttresses present internally. Right valve with 2 cardinal teeth, diverging by 60-65° from each other; anterior one directed obliquely forward; rear one stronger, peg-like, directed obliquely backward. Left valve also with 2 cardinal teeth, diverging by 60° from each other; anterior one stronger, triangular (a little broader than right posterior cardinal), directed slightly in front of vertical; rear one a small sharp lamella, directed posteriorly. Pallial sinus very deep (extends level with middle of anterior adductor scar), relatively narrow; upper limb straight, with a slight downward flexure at midlength just in front of level of umbones; anterior margin narrowly rounded; lower limb confluent with pallial line for its entire length; ventral extremity of pallial line upturned, extends level with middle of posterior adductor scar. Anterior adductor scar elongate, curved. Posterior adductor scar circular. Small, elongate pedal retractor scar present close to anterior dorsal margin half way between hinge plate and posterior end

of anterior adductor scar.

Colour of exterior pale, uniform, livid purple with obscure paler (and sometimes darker) violet concentric zones; 2 pale rays (corresponding to successive positions of cruciform muscle) always present, extending from umbones to posteroventral margin. Interior slightly darker than exterior, glossy, uniform pale violet with 2, conspicuous pale rays posteriorly; adults possessing some secondary calcification in vicinity of umbones. Teeth and hinge plate white; nymph flushed with violet.

Remarks. Adult *Soletellina nitida* shells vary somewhat in convexity of the ventral margin (see for example Figs 337 and 340), but this margin is never as broad as that of *S. siliquens* n.sp. or *S. biradiata* (Wood). Colour shows negligible intraspecific variation, and it thus serves as the most immediately recognisable character. Other distinctive characters of *S. nitida* are its posteriorly displaced umbones, very compressed shell, moderately large gapes, very deep pallial sinus and crescentic anterior adductor scar.

Soletellina nitida is sympatric with *S. siliquens* only. That species can be, and often has been, confused with *S. nitida* but it is larger, its umbones are consistently central, its ventral margin is much more convex, its valves are more inflated, its posterior end is equal in amplitude to the anterior end, the pallial sinus is shorter and relatively broader, the shell is uniformly white in colour, and the teeth are relatively stronger. Examination of a large series of shells of both species failed to reveal any consistent differences in periostraca (ie, similar colour and texture, and usually with radial scratches anteriorly).

Comparisons with the Australian species *Soletellina alba* (Lamarck) are given under the remarks section for that species.

Habitat. *Soletellina nitida* inhabits clean (or slightly muddy) sandy substrates along open coasts where currents prevent the deposition of silt. It apparently cannot tolerate gravelly sands. Other molluscs that regularly co-occur are the bivalves *Gari lineolata*, *Myadora striata* (Quoy & Gaimard), *Bassina yatei* (Gray) and *Offadesma angasi* (Crosse & Fischer), and the gastropods *Amalda mucronata* (G.B. Sowerby I), *Struthiolaria papulosa* (Martyn) and *Zethalia zelandica* (Hombron & Jacquinot). Drs Grace and Brook collected living specimens of both *S. nitida* and *G. lineolata* buried at a depth of about 20 cm in slightly muddy fine sand in 12 meters depth off Ocean Beach, Omaha. I know of no locations where *S. nitida* and *S. siliquens* have been obtained together live.

Available records indicate the bathymetric range is from 0 to 80 m, with greatest densities occurring in 10 to 20 m. *Soletellina nitida* regularly washes ashore on ocean beaches after storms.

Distribution. *Soletellina nitida* is endemic to New Zealand. It extends throughout the North, South, Stewart and Chatham Islands.

Soletellina (Soletellina) siliquens n.sp.

Figs 344-348, 413

Soletellina siliqua Reeve.-Suter, 1913: 1006, 1915, pl.62 fig.12.-Powell, 1937: 61, no.257, pl.11 fig.19.-Powell, 1961: 123, pl.11 fig.19.-Morton & Miller, 1968: 490.-Penniket & Moon, 1970: 98, pl.46 fig.1.-Child, 1974: 37, no.47.-Powell, 1976: 130, pl.18 fig.19.-Powell, 1979: 419, pl.76 fig.11.-Gardner, 1979: 22.-Thrush *et al.*, 1989: 529-535.-Pridmore *et al.*, 1990: 87, 93 (misidentification, not *Soletellina siliqua* Reeve, 1857).

Hiatula nitida (Gray).-Abbott & Dance, 1982: 348 (misidentification, not *Psammobia nitida* Gray in Dieffenbach, 1843).

Comments on synonymy. The name *Soletellina siliqua* Reeve has been associated with this common, New Zealand estuarine psammobiid since Suter's (1913) *Manual of the New Zealand Mollusca* and *Atlas* (1915). However, that association is wrong because the sole syntype of *S. siliqua* Reeve is actually a specimen of the other New Zealand species *S. nitida* (Gray in Dieffenbach). There are no junior synonyms, so a new name is required. I have kept the new name as close in sound and spelling to *siliqua* as possible to avoid unnecessary confusion in interpretation of literature since 1913.

Illustrations that unequivocally depict this species are in works by Suter (1915), Penniket & Moon (1970), Gardner (1979) and Powell (1979). Abbott & Dance (1982) illustrate a specimen of this species under the incorrect name of *Hiatula nitida* (Gray).

Type material examined. *Soletellina siliquens* Willan: holotype (complete specimen - 46.1 mm) in AIM (TM-1377) (Fig.344). Type locality Beachlands Beach, Tamaki Strait, New Zealand.

Additional material examined. "NEW ZEALAND": 1c (BMNH 1842.11.18.87 - paralectotype of *Psammobia nitida* Gray in Dieffenbach).

NEW ZEALAND - NORTH ISLAND: 13c, Te Haumi, Bay of Islands (Coles coll.); 5c, Opahi Bay, Mahurangi Harbour (Coles coll.); 1h, Casnell Island, Mahurangi Harbour (Willan coll.); 3c,1h, Ngataringa Bay, Waitemata Harbour (Willan coll.); 1h, Shelly Beach, Tamaki Strait (Willan coll.); 1c, Beachlands Beach, Tamaki Strait (AIM TM-1377 - holotype of *Soletellina siliquens* Willan); 3c, Beachlands Beach, Tamaki Strait (Willan coll.); 3c, Tapu Beach, Firth of Thames (Coles coll.); 1c, Buffalo Beach, Whitianga, Coromandel Peninsula (Hole coll.); 9c, Mill Bay, Manukau Harbour (Willan coll.); 3c, Kakamatua, Manukau Harbour (Hole coll.); 2c, Parau, Manukau Harbour (Hole coll.); 14c, Wattle Bay, Manukau Harbour (Hole coll.); 4c, Orua Bay, Manukau Harbour (Willan coll.); 2c, Ti Tau Bank, near Cornwallis, Manukau Harbour (Willan coll.); 5c, Shelly Beach, Kaipara Harbour (Willan coll.); 3c, Wairoa River estuary, Kaipara Harbour (BMNH 1850.12.9.26-28). SOUTH ISLAND: 1c,2h, beach at north-west end Tory Channel (AMS); 9c, Sandy Point, north end Narrows Bend, Preservation Inlet (Willan coll.); 1c, Tahunanui Beach, Golden Bay, Nelson (Coursey coll.); 2c, Rabbit Island, Nelson (Coursey coll.). STEWART ISLAND: 4c, Half Moon Bay (MNH); 5c,1h, Horseshoe Bay, near Paterson Inlet (AMS C66735; Willan coll.).

Description. Maximum length 60 mm. Shell thin and fragile, elongate-ovate; greatest width at level of umbones; equilateral, umbones located nearly at middle of dorsal margin (equally so in juveniles) or sometimes a little towards anterior end; both ends broadly rounded; ventral margin evenly convex, with moderate curvature; posterodorsal margin sloping acutely from umbo; valves moderately compressed; equivalve; commissure straight; moderate anterior and posterior gapes. Surface of both valves smooth, sculptured with numerous weak growth striae; without any indication of posterior ridge. Exterior covered with a moderately thick, dehiscent, olive green periostracum that is crossed by very fine, radial scratches anteriorly.

Hinge plate narrow, short; nymph elongate. Right valve with 2 cardinal teeth, diverging by 50° from each other; anterior one small, peg-like, straight-sided; rear one stronger, bifid, directed almost vertically downward. Left valve also with 2 cardinal teeth; anterior one stronger, bifid, directed vertically downward; rear one merely a small, backward-directed lamella, diverging by about 40° behind anterior cardinal. Pallial sinus deep (extends level with hind end of anterior adductor scar), relatively narrow; upper limb passes straight across middle of shell to a level beyond umbones then descends gradually; anterior margin either broadly or narrowly rounded; lower limb confluent with pallial line for its entire length; ventral extremity of pallial line downturned, extends level with middle of posterior adductor scar. Anterior adductor scar elongate. Posterior adductor scar rounded. Cluster of small pedal retractor scars near anterodorsal margin, closer to hinge plate than hind end of anterior adductor scar.

Colour of exterior uniform milky-white, rarely with pale lilac flush near umbones. Interior uniform, dull white, often with pale lilac streaks emanating from hinge plate and extending towards adductor scars; some large adults possess a pale violet flush. Hinge plate, teeth and nymphs white.

Remarks. The distinctive characters of *Soletellina siliquens* are its fragile shell, elongate-ovate yet equilateral shape, broadly rounded posterior end that is nearly equal in amplitude to the anterior end, sloping posterodorsal margin, sculpture of growth striae only, olive green or golden periostracum, relatively narrow angle of divergence of cardinal teeth in both valves, and uniform whitish colouration.

Soletellina siliquens definitely shows intraspecific variation as regards the position of the umbones on the dorsal margin. In the majority of shells (Figs 344, 345, 348) the umbones are located near the middle, but in others (Figs 346, 347) they are in front of the middle. There is negligible variation in the extent of curvature of the ventral margin. The periostracum is usually greenish in colour but some shells, particularly large adults from southern New Zealand localities, have a golden-brown periostracum. Living specimens or freshly dead shells frequently possess a narrow band of iron deposited on the periostracum close to the

posterodorsal margin. I have noticed some variation in the shape of the upper limb and anterior margin of the pallial sinus in *S. siliquens*. In most specimens, the anterior margin of the sinus is narrowly rounded (almost subacute), but in others from all populations, the margin is relatively broadly rounded. Regardless of shape, the level to which the pallial sinus extends appears constant. The shell's surface is normally smooth externally, but when the periostracum is lost, the surface becomes pitted very rapidly and soon acquires a chalky texture.

The features distinguishing between *Soletellina siliquens* and *S. nitida* (Gray in Dieffenbach), the only other Recent species of *Soletellina* in New Zealand, are dealt with fully under the remarks section for *S. nitida*.

The characters Marwick (1948) used to distinguish *Soletellina siliquens* (as *S. siliqua*) and *S. nitida* from the New Zealand Late Pliocene *S. waitemata* Marwick hold good, ie, the broader shell, more abrupt posterior end, and broader pallial sinus of *S. waitemata*. Furthermore, the holotype of *S. waitemata*, although probably juvenile, possesses elevated concentric growth striae on the posterior slope that are stronger than those possessed by occasional specimens of *S. siliquens*.

Both the Recent Australian temperate species *Soletellina biradiata* (Wood) and *S. alba* (Lamarck) have some resemblance to *S. siliquens*, and *S. siliquens* has been mistaken with *S. biradiata* at least once (by E.A. Smith in Suter, 1913: 1083, 1084). However, *S. biradiata* is heavier, broader (with greatest width below the level of the umbones), its posterodorsal margin is straight and relatively short, its colouration consists of concentric purple and creamish bands, and its periostracum is brownish. Juveniles of *S. siliquens* and *S. alba* look very similar, but *S. alba* is consistently more elongate and narrower, its shell is more equilateral with the umbones displaced posteriorly, and it is usually purplish in colour. *Soletellina siliquens* is unlikely to be confused with any tropical species of *Soletellina*.

Habitat. *Soletellina siliquens* inhabits the muddy sands of estuaries and harbours. It replaces the clean-water species *S. nitida* in such sheltered conditions, and it can become abundant (Thrush *et al.*, 1989). Other molluscs that regularly co-occur with *S. siliquens* are the bivalves *Nucula hartvigiana* Pfeiffer, *Macomona liliana* (Iredale), *Paphies australis* (Gmelin) and *Austrovenus stutchburyi* (Wood), and the gastropods *Diloma subrostrata* (Gray), *Cominella glandiformis* (Reeve) and *Amalda australis* (G.B. Sowerby I). *Soletellina siliquens* lives buried at about 8 cm below the substrate surface.

Soletellina siliquens inhabits intertidal and shallow subtidal depths.

Distribution. *Soletellina siliquens* is endemic to New Zealand. It extends throughout the North, South and Stewart Islands.

Soletellina (Soletellina) burnupi
(G.B. Sowerby III, 1894)

Figs 349-366, 414

Psammobia burnupi G.B. Sowerby III, 1894: 375.—G.B. Sowerby III, 1897: 22, pl.6 fig.30 and var. *B*.

Gari (Gobraeus) burnupi (Sowerby).—Kilburn, 1975: 617, 618, fig.24.

Soletellina sp. Lamprell & Whitehead, 1992: 62, pl.55 fig.413.

Comments on synonymy. Although this species was described in the genus *Psammobia*, and has remained there (or rather, under its senior synonym, *Gari*) in South African literature ever since, it possesses the characteristics of *Soletellina*.

Soletellina burnupi was well illustrated by Kilburn (1975).

Types. *Gari burnupi* G.B. Sowerby III: holotype (complete specimen - 27.4 mm) in BMNH (1901.12.10.8); figured by G.B. Sowerby III, 1897: pl.6 fig.30 (Fig.349). Paratypes (two complete specimens plus single right valve - 26.4, 25.9, 21.8 mm) in BMNH (1899.4.14.2889-2890 respectively). Type locality Natal, South Africa.

Material examined. AUSTRALIA – QUEENSLAND: 1h, 7.5-25.5 m, Albany Island, Torres Strait (AMS C36269); 1h, Trinity Bay, north of Port Douglas (AMS C149156); 1h, Buchan's Point, north of Cairns (AMS); 9c,9h, Lucinda, north of Halifax Bay (AMS; AMS C107075); 2c, Shelly Beach, Townsville (Lamprell coll.); 2c, Eliot River, Bowen (QM); 1c, Kings Beach, Bowen (WAM); 1h, 9 m, Platypus Bay, north-west side Fraser Island (Willan coll.); 11c, beach on east side Bribie Island (Willan coll.); series, 15 m, south end Pearl Channel, north-west section Moreton Bay (Willan coll.); 1c, 6-7.5 m, channel south of Tangalooma, Moreton Bay (Willan coll.); 1h, Amity Point, North Stradbroke Island, Moreton Bay (AMS). WESTERN AUSTRALIA: 4h, South Passage, Shark Bay (WAM 1089-68, 1316-68); 2h, 37 m, Houtman Abrolhos Island - 28°35'S 114°07'E (WAM); 1c, Dampier (Willan coll.). NORTHERN TERRITORY: 1c, Lee Point, Darwin (Kessner coll.); 3h, off Emery Point, Darwin (AMS); 1c, sand bar no.1, Darwin (AMS); 1h, Casuarina Beach, Darwin (NTM); 1h, Groote Eylandt (AMS C92402).

PERSIAN GULF: 1c, Kuwait (BMNH). MOZAMBIQUE: 2c,1h, south sandbank, Santa Carolina Island, Bazaruto Archipelago (NMSA J5117). SOUTH AFRICA: 3c,1h, Natal (BMNH 1901.12.10.8, 1899.4.14.2899-2890 - holotype & paralectotypes of *Gari burnupi* Sowerby); 1h, Durban Bay, Natal (NMSA 1754).

Description. Maximum length 29 mm. Shell thin, fragile, elongate; relatively narrow, maximum width at anterior end; juveniles possess the same outline as adults but are less expanded anteriorly; inequilateral, anterior end greatly expanded, broadly rounded; ventral margin straight, shell narrows considerably posteriorly; posterior end narrow, subtruncate; umbones low, well behind middle (approximately two-thirds length of dorsal margin); equivalve; greatly compressed (particularly juveniles); no anterior gape, small posterior gape. Surface of both valves smooth but not glossy,

sculptured with numerous, regular, very fine, concentric striae over entire surface; striae sometimes a little strengthened where crowded on posterior slope; striae resulting from growth cessations nowhere apparent; weak, broadly rounded ridge extends posteriorly from umbo to ventral margin on both valves. Periostracum very thin, light brown.

Hinge plate narrow; nymph relatively long (occupies half posterodorsal margin between umbo and posterior end), narrow; ligament rather thin, not greatly raised. Right valve with 2, small, delicate, subequal, triangular cardinal teeth, diverging from each other by 70°, neither bifid; anterior cardinal pointing forward; rear cardinal pointing vertically downward. Left valve with 2, small, delicate cardinal teeth; anterior one stronger, bifid, directed vertically downward; rear one merely a short, sharp lamella directed at 65° behind anterior cardinal. Pallial sinus deep (reaches anterior third of shell, ie, level with rear end of anterior adductor scar), narrow yet extensive; upper limb weakly convex; anterior end narrowly rounded; lower limb approaches pallial line obliquely but is free from it for one-half to two-thirds its length (relatively less in juveniles); ventral extremity of pallial line reaches level with middle of posterior adductor scar. Pedal retractor scar long and narrow, situated close to shell's dorsal margin half way between nymph and rear of anterior adductor scar.

Shell transparent. Exterior brown or purplish brown, darker towards umbones, marked with concentric (pale or dark) violet growth bands; 2 broad, close-set whitish rays pass from umbo to ventral margin posteriorly. Interior rich, pale brown, frequently with purple hue near dorsal margin and centre; white rays conspicuous. Hinge plate, teeth and nymphs white.

Remarks. *Soletellina burnupi* is the only Australasian species of the genus in which the lower limb of the pallial sinus is not confluent with the pallial line for its entire length (Fig.357). This character, together with the shell's fragility, compression, telliniform shape and inequilaterally, render it immediately distinctive.

I can find no character which differs consistently between African and Australian populations. One specimen from Kuwait (Figs 356,357) shows a bulge posteriorly in the ventral margin.

The distribution of *Soletellina burnupi* overlaps that of *S. alba* (Lamarck) at the tropic of Capricorn on both the east and the west coasts of Australia, however differences in shape, exterior sculpture, dentition, pallial sinus and colour readily separate them. *Soletellina connectens* (Martens), which is sympatric with *S. burnupi* throughout northern tropical Australia, can be identical in colouration, but valve outlines, dentition and pallial sinuses are dissimilar.

Habitat. *Soletellina burnupi* inhabits clean, fine to medium sand substrates as occur on open sandbanks or in scour channels between them. Mudflats, mangrove forests and seagrass meadows are inimical to *S. burnupi*. It apparently never occurs on coral atolls. Other bivalves

occurring in the same habitat in southern Queensland are *Tentidonax veruinus* Hedley, *Mactra eximia* Reeve, *M. contraria* Reeve and *Tellina imbellis* Hanley.

Soletellina burnupi inhabits depths from the immediate subtidal to about 25 m, wherever suitable habitats occur. Many specimens were dredged live in 15 m from the Pearl Channel, north-west Moreton Bay, in 1984.

Distribution. Despite its abundance around the northern coasts of Australia, *S. burnupi* has not been previously recorded from this country. It apparently ranges continuously in tropical and warm temperate waters around the continent, from Moreton Bay on the east coast to Shark Bay on the west coast. I believe that the absence of records between Australia and eastern Africa does not imply a disjunct distribution or human transportation; probably more collecting in suitable habitats in the Indian Ocean will produce *S. burnupi* in the future. Dr Richard Kilburn (personal communication, 1990) has clarified the distribution of *S. burnupi* in eastern Africa. He considers it to be a tropical species. Durban Bay is a subtropical refuge for tropical eastern African species that otherwise do not occur south of Mozambique. Dr Kilburn believes that the type material of *S. burnupi* might have been the entire Durban Bay population because no specimen has been found there subsequently despite the locality being an intensively collected one.

***Soletellina (Soletellina) connectens* (Martens, 1865)**

Figs 358-366, 415

- Psammobia (Psammotaea) connectens* Martens, 1865: 431.
Psammotellina connectens Martens.-Martens, 1897: 237, pl.10 fig.22.
Hiatula (Psammotaea) connectens Martens.-Bertin, 1880: 70, 98, no.46.
Soletellina virescens (Deshayes).-Melvill & Standen, 1899: 198, no.403 (misidentification, not *Capsa virescens* Deshayes, 1855).
Psammobia virescens (Deshayes).-Hedley, 1910: 350 (misidentification, not *Capsa virescens* Deshayes, 1855).
Psammobia tenuis (Deshayes).-Hedley, 1910: 350 (misidentification, not *Capsa tenuis* Deshayes, 1855).
Psammobia ecolorata Preston, 1914 n.syn.: 18, fig.
Gari ecolorata (Preston).-Hedley, 1916: 18.
Soletellina atrata Reeve.-Lamprell & Whitehead, 1992: 62, pl.55 fig.410 (misidentification, not *Soletellina atrata* Reeve, 1857).
Soletellina ecolorata (Preston).-Lamprell & Whitehead, 1992: 62, pl.55 fig.411.

Comments on synonymy. This species has two synonyms. The senior one, *Psammobia connectens* Martens, relates to a pale purple-brown shell from Bangka Island, Indonesia, and the junior one, *P. ecolorata* Preston, relates to white juvenile shells from Monte Bello Islands, northern Western Australia. Neither Martens nor Preston compared their new species with any existing species.

Types. *Psammobia (Psammotaea) connectens* Martens: holotype (complete specimen - 26.4 mm) in ZMB (7592); figured by Martens, 1897: pl.10 figs 22, 22b, 22c (Fig.358). Type locality Muntok Bay, Bangka Island, Indonesia.

Psammobia ecolorata Preston: lectotype, here designated (larger remaining syntype - complete specimen, but right valve with broken ventral margin - 16.8 mm) in BMNH (1905.8.19.48) (Fig.359). Paralectotype (complete specimen - 15.4 mm) in BMNH (1905.8.19.49). Type locality Monte Bello Islands, Western Australia. Syntype of *Psammobia ecolorata* illustrated by Preston, 1914: 18 (fig.) apparently lost; not found during personal search in BMNH in 1989.

Material examined. AUSTRALIA - QUEENSLAND: 1c,3h, Mapoon, Gulf of Carpentaria (AMS C14248); 2h, Friday Island, Torres Strait (AMS C124597); 6c, Cape York (AMS C15740, C66767; WAM 1100-70, 1101-70); 3c, vicinity of telegraph station, Cape York (AMS); 1c, Lizard Island (Whitehead coll.); 4c, Trinity Bay, east of Mossman (AMS); 3c, Dunk Island (AMS; QM); 3c, Bluewater Beach, north of Townsville (BMNH); 2c, Shelly Beach, Townsville (Lamprell coll.; Willan coll.); 2c,1h, Edgumbe Bay (AMS); 10c, Sinclair Bay, Edgumbe Bay (AMS C78124); 17c,1h, Bowen (AMS; WAM); 1c, Black Reef, Hayman Island, Whitsunday Group (Lamprell coll.); 2c,1h, Lindeman Island, Lindeman Group (AMS C58978); 9c, Brampton Island (AMS); 1c, Gladstone (WAM 1832-68). WESTERN AUSTRALIA: 2c, Bay of Rest, Exmouth Gulf (WAM); 1c, Barrow Island (WAM 647-68); 1c, east side Pasco Island, Barrow Island (WAM 895-85); 1c, east Cape Poivre, Barrow Island (WAM 899-85); 40h, Bandicoot Bay, Barrow Island (WAM 898-85); 2c, Monte Bello Islands (BMNH 1905.8.19.48-49 - lectotype & paralectotype of *Psammobia ecolorata* Preston); 1h, Monte Bello Islands (AMS C69265); 1h, east side Hermite Island, Monte Bello Islands (WAM); 1h, Dolphin Island, Dampier Archipelago (AMS C69341); 9c, Lewis Island, Dampier Archipelago (WAM); 10c, between East & West Lewis Islands, Dampier Archipelago (WAM 891-85); 9c, Broome (AIM AM17689; AMS C68507; BMNH; Trevor coll.); 2c, Roebuck Bay, Broome (AMS C56618, C56626); 2c, beach drift, Langi, approximately 4 km south of Prior Point, Kimberley (WAM); 1c,1h, Careening Bay, Kimberley (WAM); 1c,1h, One Arm Point, near Cape Leveque, north-west coast King Sound (Willan coll.); 1c, Lawley Point, Admiralty Gulf (WAM 893-85); 2c,2h, Malcolm Island, Admiralty Gulf (WAM).

PHILIPPINE ISLANDS: 1c, Danajon Bank, Banacon Island, north-west Bohol Island (AMS C112219). INDONESIA: 1c, Muntok Bay, Bangka Island (ZMB 7592 - holotype of *P. connectens* Martens). MALAYSIA: 2c, Tangong Bunga, Penang (AIM AM17695); 1c,1h, Monkey Beach, north Batu Ferrungi Beach, west coast Penang (WAM); 41h, on beach, Tg Rhu, Langrawi, west Malaysia (WAM 897-85).

Description. Maximum length 31 mm. Shell thin, elongate-elliptic, nearly rectangular, maximum width at level of umbones; juveniles with virtually the same outline but umbones relatively a little closer to posterior end; anterior end broadly rounded; ventral margin straight in juveniles, evenly convex in adults; posterior end subtruncate, wider than anterior end; equivalve; relatively well inflated; small to negligible anterior gape, moderate posterior gape. Surface of both valves smooth, polished; crossed by numerous, fine, concentric growth

striae; striae closest to posterodorsal margin stronger; posterior ridge very weak. Exterior covered with a thin, straw-yellow periostracum that readily peels off and is always lost from umbonal area of adult shells.

Hinge plate thin; nymph moderately long, relatively narrow; ligament short, moderately raised. Right valve with 2, delicate cardinal teeth, diverging by 60° from each other; anterior one somewhat stronger, bifid, directed vertically downward; rear one with a thickened extremity, directed posteriorly. Left valve also with 2 cardinal teeth, diverging by 50° from each other; anterior one stronger, weakly bifid, curving vertically downward; rear one merely a short, pointed lamella. Pallial sinus deep, almost reaches level with posterior end of anterior adductor scar, U-shaped; upper limb runs horizontally across middle of shell; anterior margin broadly and smoothly convex; lower limb confluent with pallial line for its entire length; ventral extremity of pallial line directed downward, extends level with middle of posterior adductor scar. Several (about 6), small pedal retractor scars clustered close to anterodorsal margin, situated closer to anterior adductor scar than hinge plate.

Colour pale, uniform, honey-brown, purple-brown, fawn, creamish white or milk-white externally, darker (often peach) near umbones, occasionally with pale purple hue in posterior area near umbones; periostracal presence gives impression of darker shell; juveniles with 2, narrow, pale rays but these are obsolete in adults. Interior light yellowish brown to white. Hinge plate, teeth and nymphs white.

Remarks. The distinctive characters of *Soletellina connectens* are its thin, relatively inflated, broad shell with subtruncate posterior margin, moderate posterior gape, thin yellowish brown periostracum, short ligament, broad pallial sinus and pale, uniform colouration. Colouration varies particularly between populations; those from Indonesia and Malaysia (Figs 358, 365, 366) are purple-brown (form *connectens*), whereas those from northern Australia are fawn (Figs 360-362, 364) or white (form *ecolorata*) (Figs 359, 363). All specimens from Dampier are white. It is quite apparent from other locations in northern Western Australia where both white and fawn morphs occur together, that variation between these morphs is continuous and not discontinuous.

Comparisons with the three northern Australian congeners, *Soletellina petalina* (Deshayes), *S. burnupi* (G.B. Sowerby III) and *S. tumens* Reeve, are given under the remarks sections for those species. Comparisons with *S. alba* Lamarck, which occurs sympatrically in the vicinity of Dampier and the Monte Bello Islands, are given under the remarks section for that species.

Comparisons with exotic species are difficult because of uncertainty regarding their taxonomy, particularly those from the tropical western Pacific Ocean. *Soletellina atrata* (Deshayes) is less inflated, more elongate and inequilateral, with less prominent umbones, and it is dark purple in colour. *Soletellina truncata* Reeve and *S. planulata* Reeve are both much

larger (to 90 mm) as adults and dark purple; the former is inequivalve with a truncate posterior margin, and the latter has a markedly convex ventral margin. Melville & Standen (1899) and Hedley (1910) confused *S. connectens* with *S. virescens* (Deshayes), but *S. virescens* is more elongate with a narrowly rounded posterior end, it has a more sinuous ventral margin and a thicker shell.

Habitat. *Soletellina connectens* inhabits protected bays and estuaries around the margins of continents and continental islands. In northern Australia, it regularly occurs in the estuarine sections of river mouths where mangroves grow. Sandy and muddy sand substrates are inhabited. In such situations dead shells can be common on intertidal flats.

Soletellina connectens only occurs intertidally.

Distribution. When the following list of localities is scrutinised, *Soletellina connectens* is found to occupy a relatively restricted range from the southern Philippine Islands, through Indonesia, to northern Australia. Its absence from New Guinea and Torres Strait probably reflects lack of collecting. Possibly it does extend further north in the tropical western Pacific Ocean but it is confused with other nominal species in those waters. In northern Australia, *S. connectens* ranges as far south as Exmouth Gulf on the west coast and Gladstone on the east coast. A specimen supposedly from Moreton Bay in QM is definitely mislocalised.

Soletellina (Soletellina) tumens Reeve, 1857

Figs 367-370, 416

Soletellina tumens Reeve, 1857: *Soletellina* pl.4, species 20.–Hidalgo, 1903: 92, no. 182.–Lamprell & Whitehead, 1992: 62, pl.55 fig.415.

Hiatula tumens (Reeve).–Tryon, 1868: 79, no.16.–Bertin, 1880: 68, 72, 89, no.15.

Soletellina (Psammotaea) tumens (Deshayes = error pro. Reeve).–Paetel, 1890: 42.

Comments on synonymy. References pertaining to this psammobiid have appeared very seldom; a fact that belies the species' abundance at suitable locations. Reeve (1857) erroneously attributed authorship to Deshayes, but Deshayes never published such a name. However, two complete specimens of *P. tumens* are present in Deshayes collection, MNHN.

Types. *Soletellina tumens* Reeve: lectotype, here designated (largest figured syntype, complete specimen - 37.2 mm) in BMNH (1985198/1); figured by Reeve, 1857: *Soletellina* pl.4 fig.20a (Fig.367). Paralectotypes (complete specimens - 35.0, 35.0 mm) in BMNH (1985198/2,3). Additional paralectotypes (complete specimens - 37.0, 35.0, 34.0 mm) in BMNH (1985199/1-3 respectively); 1985199/1 figured by Reeve, 1857: *Soletellina* pl.4 fig.20b. Type locality Island of Negros, Philippine Islands.

Material examined. AUSTRALIA – QUEENSLAND: 1c, Newell Beach, north of Mossman (AMS C100706); 2h, Trinity Bay, east of Mossman (AMS); 1c, Machin Beach, north of Cairns (Willan coll.); 2c,3h, Innisfail (AMS); 15h, Lucinda Point, north-east of Ingham (AMS C107075; QM). WESTERN AUSTRALIA: 1c, Malcolm Island, Admiralty Gulf (WAM 892-85). NORTHERN TERRITORY: 2h, main beach near Minto Head, Victoria Settlement, Port Essington, Cobourg Peninsula (Willan coll.).

PHILIPPINE ISLANDS: 3c (MNCN 1403; MNHN); 6c, Negros Island (BMNH 1985198, 1985199 - lectotype & paralectotypes of *Soletellina tumens* Reeve); 1c, Negros Island (BMNH). SRI LANKA: 6c (AMS C38747; BMNH; MNHN; NHMW G9872, 35685).

Description. Maximum length 33 mm. Shell thin, subelliptical to almost trigonal, maximum width at level of umbones; dorsal margin sloping steeply, both in front of, and behind, prominent umbones; anterior end broadly rounded; ventral margin smooth, amply convex; posterior end broadly rounded, subtruncate, slightly narrower than anterior end; equivalve; relatively well inflated, subglobose; inequivalve, umbones located a little behind centre; no gape, neither anteriorly nor posteriorly. Surface of both valves smooth, glossy when fresh, crossed by numerous, fine, irregular, concentric growth striae which are occasionally a little stronger close to posterodorsal margin. Exterior covered with a thin, light yellow-brown periostracum which is usually more substantial anteriorly and posteriorly; periostracum finely lamellate, appearing fibrous in adult shells; not readily dehiscent.

Hinge plate thin; nymph short, rather narrow, projecting well beyond shells' posterodorsal margin, hind end abruptly truncate; ligament relatively short, quite low. Right valve with 2 equally strong cardinal teeth, diverging by 55° from each other; rear one bifid. Left valve also with 2 cardinal teeth, diverging by 60° from each other; anterior one much stronger, bifid, directed vertically downward; rear one a short lamella. Pallial sinus very deep (extends level with hind end of anterior adductor scar), broad; upper limb straight, runs parallel to shells' longitudinal axis across middle of shell; anterior margin steeply oblique to almost vertical, barely convex; lower limb confluent with pallial line for its entire length; ventral extremity of pallial line reaches one-third of distance across posterior adductor scar; 1 or 2 small pedal retractor scars present dorsally, immediately in front of anterior end of hinge plate.

Colour externally uniform purple, purplish brown or violet-brown, fading to lilac in dead shells; interrupted posteriorly by 2, more or less distinct, pale rays; anterior and central areas sometimes with short, irregular, dark rays. Interior translucent, same colour as exterior, dull, sometimes with white secondary calcification above pallial sinus in adults. Hinge plate violet-purple; nymph and teeth white.

Remarks. *Soletellina tumens* is distinctive in possessing subglobose or tumid valves, a steeply

sloping dorsal margin, and a shortened, subtruncate posterior end. This shortening gives the shell an almost triangular outline (see for example Fig.370) and this, combined with the inflated valves, produces an appearance more reminiscent of a mactrid than a psammobiid. Further definitive characters are the lack of gape, finely lamellate periostracum (Fig.370), short and abruptly truncate nymph (Fig.369), deep and broad pallial sinus and purple-violet-brown colouration. Of the three other species of *Soletellina* in northern Australia, *S. tumens* could only be confused with brown forms of *S. connectens* (Martens). However, that species is more elongate (approximately rectangular in shape), its dorsal margins slope less acutely, its valves are less inflated, the anterior margin of its pallial sinus is rounded, and its hinge plate is white. The characters that separate *S. connectens* from its foreign congeners – like *S. atrata* Reeve, *S. truncata* Reeve, *S. planulata* Reeve and *S. virescens* (Deshayes) – stand good for *S. tumens* as well.

Habitat. *Soletellina tumens* inhabits sheltered bays and the mouths of larger rivers. It has been collected from habitats with sandy or muddy sand substrates. It is unknown from coral atolls.

Soletellina tumens only occurs intertidally.

Distribution. *Soletellina tumens* is distributed in the tropical western Pacific Ocean from the Philippine Islands to northern Australia, and to Sri Lanka in the Indian Ocean. Presumably it does occur on intervening continents and continental islands, but it has not yet been recorded from any of them. Of the four species of *Soletellina* occurring in northern Australia, *S. tumens* has the most restricted range, apparently only reaching Ingham (18°39'S) on the east coast.

Species Excluded from Psammobiidae

During the course of my investigations for this monograph, five species were examined that ought to be excluded from the Psammobiidae as presently constituted. The opportunity is herein taken formally to locate them into more appropriate families.

Asaphis nana Powell, 1958

Fig.372

Asaphis nana Powell, 1958: 75, fig.6, pl.9 fig.5.

Types. *Asaphis nana* Powell: holotype (complete specimen - 9.8 mm) in ZMUC; figured by Powell, 1958: pl.9 fig.5 (Fig.372). Paratypes (complete specimens - 8.1, 8.0, 7.8 mm) in SAM (D14594). Type locality 75-85 m, off Raoul Island, Kermadec Islands.

Remarks. Although *Asaphis nana* resembles a small psammobiid, its shell is thicker, the outer surface bears (about 40) radial ribs which are most pronounced on the posterior slope, the pallial sinus is broader (extending to directly beneath the umbo) and both valves bear lateral teeth. Because the possession of lateral teeth precludes this species from the Psammobiidae as presently defined, it must be transferred to the Tellinidae where it possibly belongs in the genus *Agnomyx* Stewart on account of the ornamentation and ventrally directed cardinal teeth.

In addition to the type material, I have examined specimens of this species from the Kermadec Islands (AIM AK75116; NMNZ MF22126, MF25442, MF25667, MF26668, MF26911, MF27105), from Wanganella Bank, Norfolk Ridge (NMNZ MF57170, MF60523, MF60524, MF60525, MF60527), and from off Norfolk Island (NMNZ MF24738).

Psammobia brazieri Tate, 1886

Figs 373,374

Psammobia brazieri Tate, 1886: 65, pl.5 fig.1.–Tate, 1887a: 87, no.39.–Cotton & Godfrey, 1938: 263, fig.299.
Gari brazieri (Tate).–Cotton, 1961: 280, fig.308.

Types. *Psammobia brazieri* Tate: holotype (complete specimen - 11.8 mm) in SAM (D12858); figured by Tate, 1885: pl.5 fig.1 (Figs 373, 374). Type locality Aldinga Bay, South Australia.

Remarks. An examination of the holotype of *Psammobia brazieri*, shows it to be unquestionably a member of the Tellinidae, probably in the genus *Tellina sensu stricto*. In addition to two cardinals, the right valve has an anterior lateral tooth. Possession of such a tooth decisively excludes *P. brazieri* from the Psammobiidae.

Sorting out the correct name for this species will be complicated by the fact that the specific name *brazieri* was introduced in the genus *Tellina* at least once prior to Tate's usage.

Psammobia flexuosa A. Adams & Reeve, 1850

Fig.375

Psammobia flexuosa A. Adams & Reeve, 1850: 80, pl.24 fig.3.–Bertin, 1880: 107.

Types. *Psammobia flexuosa* A. Adams & Reeve: probable syntype (complete specimen - 17.0 mm) in BMNH (1985188/1); figured by A. Adams & Reeve, 1850: pl.24 fig.3 (Fig.375). Type locality Shores of Borneo.

Remarks. This species belongs in the Tellinidae and

is conspecific with *Cymatoica undulata* (Hanley, 1844). [An additional junior synonym of *C. undulata* Hanley is *C. occidentalis* Dall, 1890 (Keen, 1971:227).] Despite the stated type locality of *P. flexuosa*, *C. undulata* is actually a tropical eastern Pacific species occurring from the Gulf of California to Ecuador (Keen, 1971:227).

Psammobia vitrea Quoy & Gaimard, 1835

Fig.376

Psammobia vitrea Quoy & Gaimard, 1835: 540, pl.83 figs 15-18.

Types. *Psammobia vitrea* Quoy & Gaimard: lectotype, here designated (figured syntype, single right valve - 15.0 mm) in MNHN; illustrated by Quoy & Gaimard, 1835: pl.83 figs 15-18 (Fig.376). Type locality Vanikoro Island.

Remarks. The sole syntype of *Psammobia vitrea* shows this taxon is referable to the family Galeommatidae, probably to the genus *Scintilla* Deshayes.

Tellina urinatoria Suter, 1911

Figs 377-380

Tellina urinatoria Suter, 1911: 280, 1913: 950, pl.54 fig.13.
Tellina (*Maoritellina*) *charlottae* (E.A. Smith).–Finlay, 1926: 466 (misidentification, not *Tellina charlottae* E.A. Smith, 1885).
Ascitellina urinatoria (Suter).–Marwick, 1931: 74.–Powell, 1935: 333.–Powell, 1937: 61, no.255.–Powell, 1945: 62, no.267.–Powell, 1955: 44.–Boreham, 1959: 20.–Powell, 1961: 123.–Fleming, 1966: 32.–Beu *et al.*, 1970: 47.–Powell, 1976: 130.–Powell, 1979: 419, pl.76 fig.10.
Elliptotellina urinatoria (Suter).–Beu & Maxwell, 1990: 399.

Comments on synonymy. I have been unable to ascertain why Suter described *Tellina urinatoria* as a new species twice (Suter, 1911, 1913). Because the wording of both descriptions is identical, it seems Suter was following the then current practice of publishing the same article in a local and an overseas journal. Suter's illustration (1915: pl.54 fig.13) does not match any of the type specimens precisely and therefore it must be considered as composite.

Marwick indicated Finlay's (1926) probable misidentification of *T. urinatoria* as *T. charlottae* E.A. Smith, and the matter was settled in 1951 with Fleming's redescription of the holotype of *T. charlottae*. That shell was subsequently figured by Dell (1963) and it is not conspecific with *Tellina urinatoria*.

Types. *Tellina urinatoria* Suter: holotype (left valve with bryozoan colony on exterior - 7.8 mm) in CMNZ (M810) (Fig.377). Paratypic series (3 right and 4 left valves - 9.5,7.6,7.5,7.0,6.5,5.1,4.8 mm) in CMNZ (M846A-G respectively) (M846B Fig.378). Additional paratypes (2 right and 5 left valves - 8.6,7.7,7.2,5.9,5.7,5.4,5.1 mm plus 4

small fragments) in NZGS (TM389-379, not 388-379 as erroneously stated by Boreham, 1959:20). Type locality south-east of Long Point, Otago, New Zealand.

Remarks. There are several reasons why this endemic New Zealand species has been transferred repeatedly between the Tellinidae and the Psammobiidae.

Marwick (1931) placed *Tellina urinatoria* Suter in his genus *Ascitellina* alongside the middle to upper Eocene fossil type species *A. donaciformis* Marwick, 1928. In doing so, Marwick shifted *A. urinatoria* from the Tellinidae where Suter originally located it to the Psammobiidae. Although Marwick's (1928) original generic diagnosis was incomplete, subsequent New Zealand authors from that time until 1990 have left *Ascitellina* in the Psammobiidae. Keen in Moore (1969) did likewise.

Afshar (1969) replaced *Ascitellina* back into the Tellinidae as a subgenus of *Macoma*. Beu & Maxwell (1990:399) followed suit as regards familial placement but gave no explanation. Furthermore, they apparently considered *Ascitellina* a junior synonym of the fossil tellinid *Elliptotellina* Cossmann, but again there was no explanation.

Although neither valve of *Tellina urinatoria* possesses a posterior flexure, both valves do possess two lateral teeth (arrowed in Fig. 380). The possession of lateral teeth precludes this species from the Psammobiidae as presently defined.

Conclusions

This revision has established that 37 species exist in the Recent psammobiid fauna of the Australian and New Zealand region. Names for these species and even the genera and subgenera containing them have been confused because of insufficient original descriptions and the inability of earlier workers to comprehend intraspecific variation. Taxonomic outcomes of this revision are application of the first reviser rule in four instances (ie, selection of *Psammobia anomala* Deshayes, *P. pennata* Deshayes, *P. pulcherrima* Deshayes and *Hiatula inflata* Bertin as valid), resurrection of two senior synonyms (*Psammobia convexa* Reeve and *P. alba* Lamarck), and the renaming of *Soletellina siliqua* auctt. (not Reeve, 1857) as *S. siliquens*. One new subgenus, *Crassulobia*, and one new species, *Gari eos*, are described.

This investigation failed to establish the monophyly of the Psammobiidae despite consideration of approximately 40 shell characters. The only invariable characters are those of smooth shell margins, dentition and ligament situation, all plesiomorphies. Indeed, the existence of small, primitive species, such as *Ascitellina urinatoria*, seemingly with both psammobiid and tellinid characters, causes me to suspect these two families ought not be separated. Certainly, continued recognition of the Psammobiinae and Sanguinolariinae

as separate subfamilies is unjustified. Despite my doubt over the status of the family, it is possible to recognise four monophyletic genera – *Asaphis* Modeer, *Heteroglypta* Martens, *Gari* Schumacher and *Soletellina* Blainville. *Gari*, the largest of these genera with 25 species, is divisible into nine subgenera – *Gari sensu lato*, *Psammobia* Lamarck, *Gobraeus* Brown, *Dysmea* Dall, Bartsch & Rehder, *Kermadysmea* Powell, *Psammotaena* Dall, *Crassulobia* Willan, *Psammobella* Gray, and *Psammodonax* Cossmann – all demonstrably monophyletic, except for *Gobraeus* which is arguably diphyletic. Anatomical investigations are now needed to test the interrelations of these higher taxa.

Three character sets proved very reliable in establishing this higher classification – ornamentation, hinge structure and pallial sinus details. All ten members of one species group (subgenus *Gari*) possess unique derived sculpture by way of oblique cords on the anterior and central areas of both valves. Three other taxa with autapomorphic ornamentation are *Asaphis*, *Heteroglypta* and *Kermadysmea*, the latter two both monotypic. All species in the subgenera *Dysmea*, *Psammotaena*, *Crassulobia* and *Psammodonax*, and all but one species in each of *Psammobia* and *Gobraeus* are predominantly smooth. [Exceptions being *Gari kenyoniana* Pritchard & Gatliff and *G. eos* Willan respectively.] Overall, *Psammodonax* is considered the most primitive and outlying subgenus; indeed one of its three Recent species, *Gari rasilis* Melvill & Standen, is almost identical to the Eocene *G. caillati* (Deshayes) attesting to the antiquity of the lineage. The hinge of psammobiids is derived from (and convergent with) that of tellinids by loss of both lateral teeth and there has been a concomitant tendency to suppress the posterior cardinal tooth in the left valve. Because the existing definition of the Psammobiidae excludes species with lateral teeth, taxa possessing them such as *Asaphis nana* Powell, *Psammobia flexuosa* A. Adams & Reeve, *P. brazieri* Tate and the genus *Ascitellina* Marwick must be transferred to the Tellinidae. Although this transfer pigeonholes the Psammobiidae, it does not render it monophyletic. It simply makes the assessment of the Tellinidae, which is undoubtedly polyphyletic, all the more crucial.

Some members of the *Gari*-*Psammobia*-*Gobraeus*-*Dysmea* species group possess a projection on the hinge plate in the lunular area of the left valve which is likely analogous (ie, compensatory) in function to a lateral tooth. Interestingly, this lunular projection is best developed in the largest known species of the group *Gari occidentis* (Gmelin).

Convergent adaptations to estuarine environments are evident in the *Soletellina* and *Psammotaena*-*Crassulobia* species groups. These adaptations are elongation of the posterior end, thickening of the periostracum, lengthening of the pallial sinus, widening of the posterior gape and absence of internal glaze. *Gari crassula* (Deshayes), which can tolerate salinities of 6‰, represents the culmination of this estuarine radiation; its valves have become secondarily calcified to withstand the acidic, almost fresh waters of river

mouths. Two independent trends are evident in the evolution of the pallial sinus, lengthening (never broadening) and fusion of the lower limb with the underlying pallial line. It would appear that taxa with relatively short, free sinuses (like *Kermadysmea* and *Psammodonax*) are more primitive than those with long and/or fused sinuses. Presence or absence of a posterior flexure and degree of curvature of the commissure are rejected as definitive characters because they can vary ontogenetically, as in *Gari convexa* (Reeve).

The region possesses the highest species diversity known anywhere for the family. The total of 37 species is achieved by combining the 27 tropical species with the temperate species endemic to southern Australia and New Zealand (5 species each). Within the region, species richness is greatest in the tropical waters of Queensland and Western Australia (23 and 21 species respectively). The northern Australian coastline (20 species) is comparable in richness to New Caledonia (16 species). Richness decreases significantly in lower latitudes (central eastern Australia – 10 species; southern Australian coastline – 5 species; New Zealand mainland – 5 species; Chatham Islands – 4 species) and eastwards (Fiji – 10 species; Tonga – 6 species; Kermadec Islands – 2 species). No endemic species occur along this eastern gradient. The three endemic northern Australian species (*Gari rasilis* (Melvill & Standen), *G. gracilentia* (E.A. Smith) and *G. eos* Willan), have relatively restricted ranges, but most other tropical species are widespread in Indo-Pacific waters. Indeed, the distribution of the subgenus *Gari* is solely Indo-Pacific, and all 10 known species occur in the region under study. In contrast, the ranges of all four temperate water species of the subgenus *Psammobia* (*Gari livida* (Lamarck), *G. convexa* (Reeve), *G. lineolata* (Gray in Yate), *G. kenyoniana* (Pritchard & Gatliff)) are restricted. *Asaphis violascens* (Forsskål) and *Gari castrensis oriens* (Deshayes) are recognised as Indo-Pacific cognates of the western Atlantic *A. deflorata* (Linné) and eastern Atlantic *G. castrensis castrensis* (Spengler) respectively.

The absence from northern and north-eastern Australia of several key species of the western Pacific psammobiid estuarine radiation (ie, *Gari elongata*, *G. inflata*, *G. crassula*) is inexplicable considering the extensive development of mangrove forests along these coasts. Not only are these psammobiids absent, but other equally important estuarine bivalves of other families, like *Batissa violacea* (Lamarck) (Corbiculidae) and *Glaucanome virens* (Linné) (Glauconomidae), are also missing from these same coasts.

The following checklists summarise distributions within the four principal subregions of the area investigated.

Species of Psammobiidae occurring in tropical northern Australia (includes coast of Queensland and Western Australia (north of Tropic of Capricorn) and Northern Territory):

- Asaphis violascens* (Forsskål, 1775)
- Heteroglypta contraria* (Deshayes, 1863)
- Gari (Gari) anomala* (Deshayes, 1855)

- G. (G.) lessoni* (Blainville, 1826)
- G. (G.) maculosa* (Lamarck, 1818)
- G. (G.) pallida* (Deshayes, 1855)
- G. (G.) pennata* (Deshayes, 1855)
- G. (G.) pulcherrima* (Deshayes, 1855)
- G. (G.) sibogai* Prashad, 1932
- G. (G.) squamosa* (Lamarck, 1818)
- G. (G.) truncata* (Linné, 1767)
- G. (Psammobia) amethysta* (Wood, 1815)
- G. (Psammobella) pusilla* Bertin, 1880
- G. (Gobraeus) castrensis oriens* (Deshayes, 1855)
- G. (G.) eos* Willan, herein (endemic)
- G. (Dysmea) occidens* (Gmelin, 1791)
- G. (Psammodonax) gracilentia* (E.A. Smith, 1884) (endemic)
- G. (G.) rasilis* (Melvill & Standen, 1899) (endemic)
- G. (Psammotaena) elongata* (Lamarck, 1818)
- G. (P.) inflata* (Bertin, 1880)
- G. (P.) togata* (Deshayes, 1855)
- G. (Crassulobia) crassula* (Deshayes, 1855)
- Soletellina (Soletellina) burnupi* (Sowerby, 1894)
- S. (S.) connectens* (Martens, 1865)
- S. (S.) petalina* (Deshayes, 1855)
- S. (S.) tumens* Reeve, 1857

Note: Although *Gari (Kermadysmea) galatheae* (Powell, 1958) occurs in the region under investigation, it is not known from northern Australian waters.

Species of Psammobiidae occurring in temperate southern Australia (all endemic):

- Gari (Gari) modesta* (Deshayes, 1855)
- G. (Psammobia) kenyoniana* (Pritchard & Gatliff, 1904)
- G. (P.) livida* (Lamarck, 1818)
- Soletellina (Soletellina) alba* (Lamarck, 1818)
- S. (S.) biradiata* (Wood, 1815)

Species of Psammobiidae occurring in New Zealand (all endemic):

- Gari (Psammobia) convexa* (Reeve, 1857)
- G. (P.) lineolata* (Gray in Yate, 1835)
- G. (Gobraeus) stangeri* (Gray in Dieffenbach, 1843)
- Soletellina (Soletellina) nitida* (Gray in Dieffenbach, 1843)
- S. (S.) siliquens* Willan, herein

Species of Psammobiidae occurring at the Kermadec Islands:

- Gari (Kermadysmea) galatheae* (Powell, 1958)
- G. (Psammobella) pusilla* Bertin, 1880

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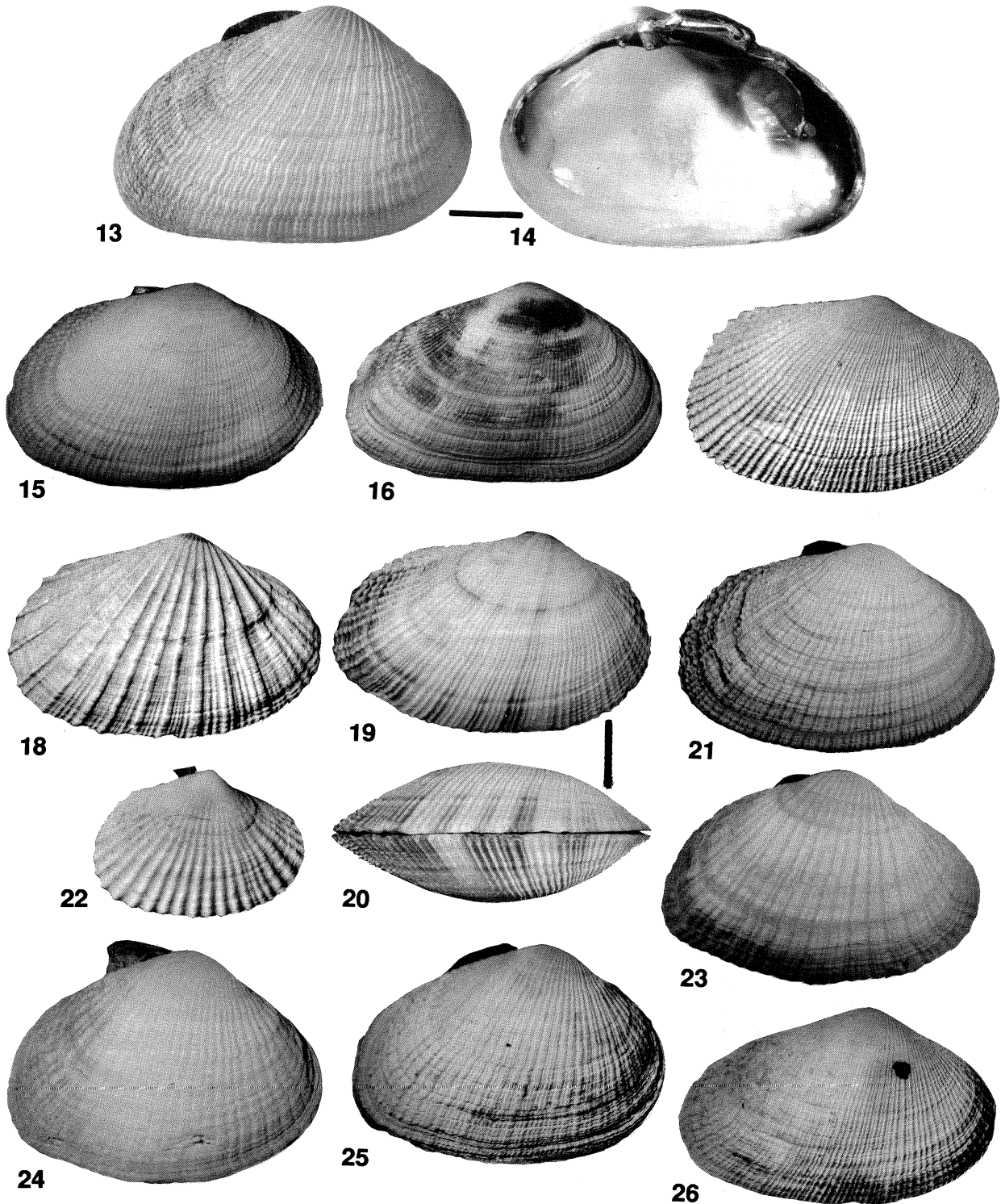
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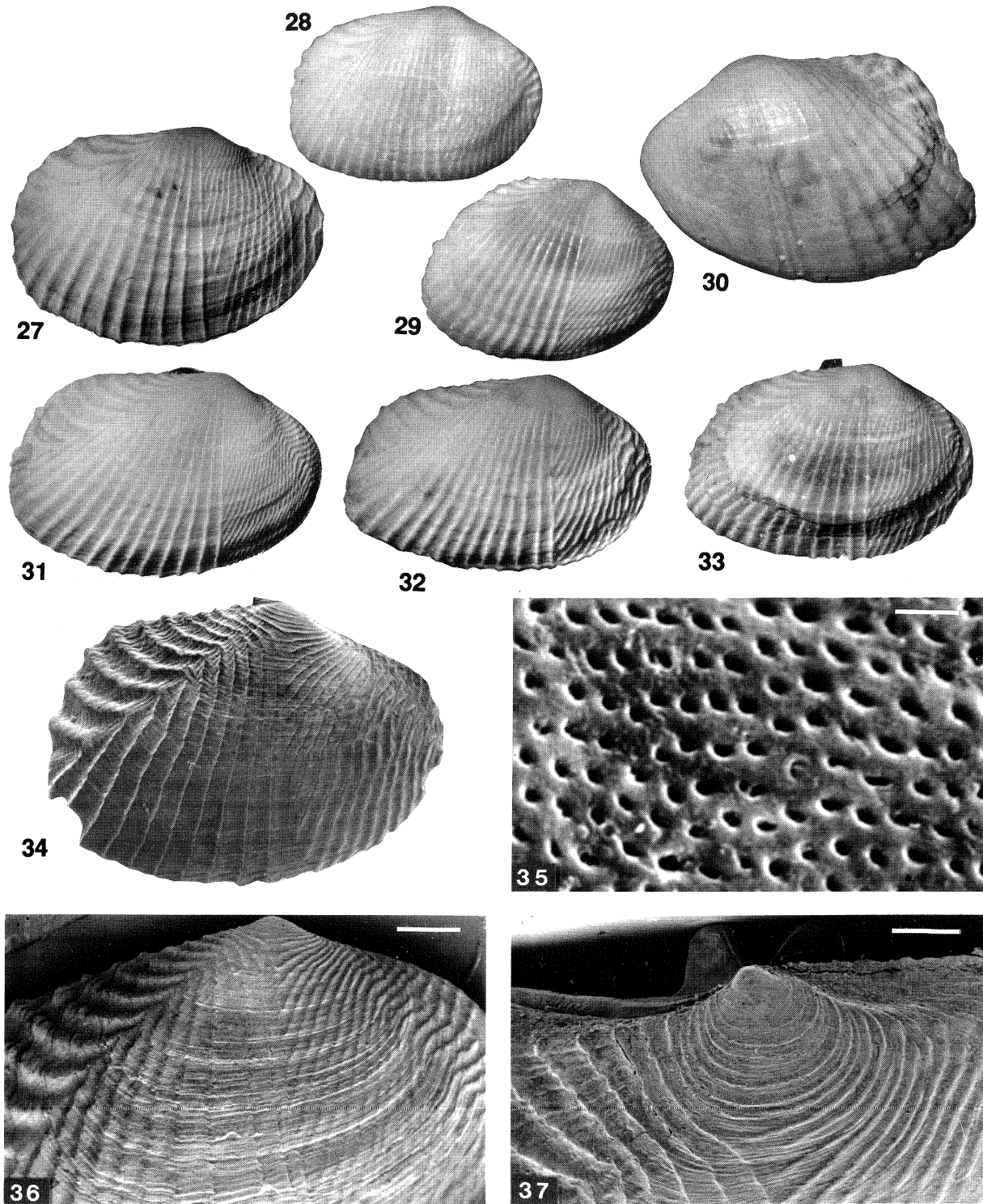
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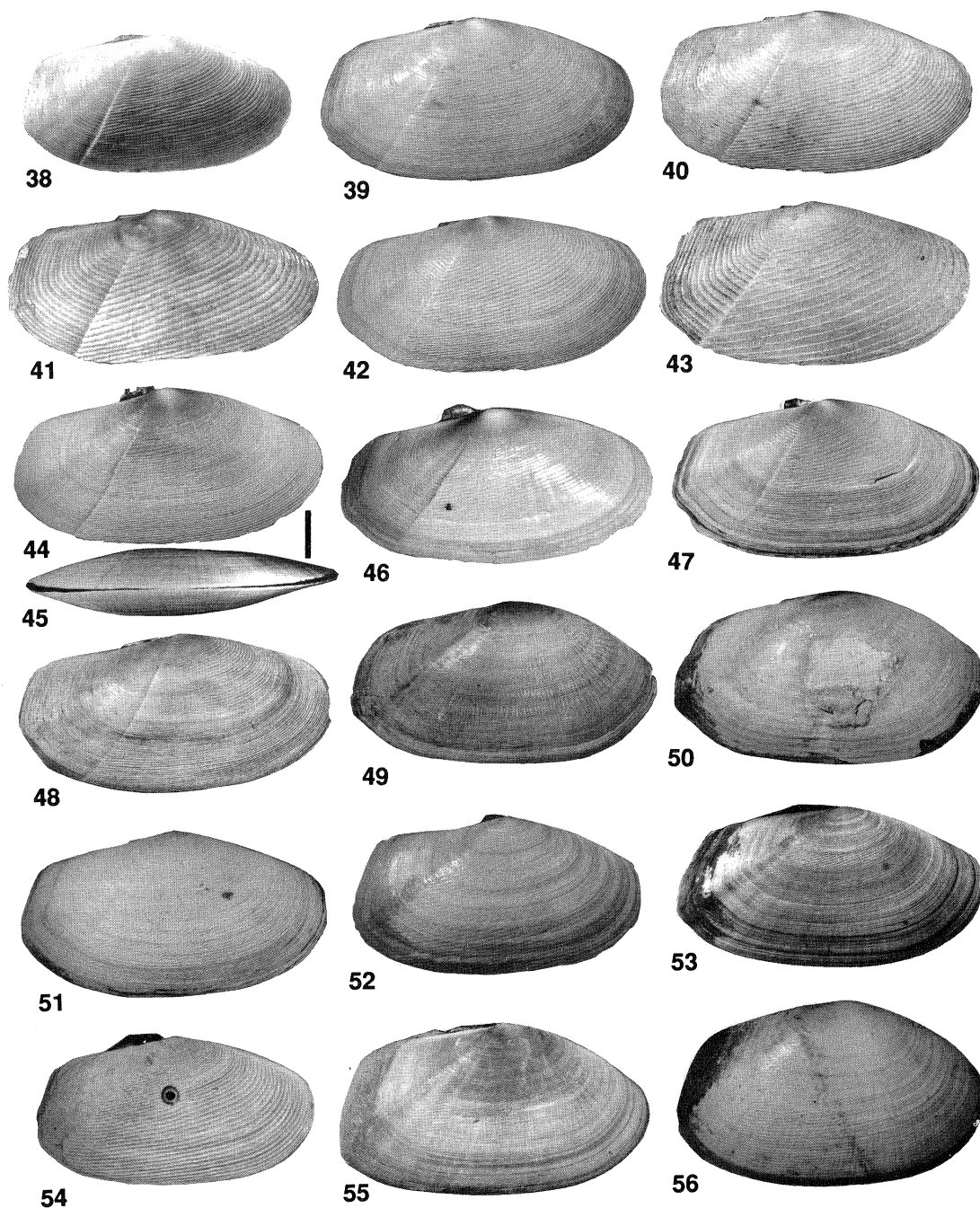
FIGURES 13–416



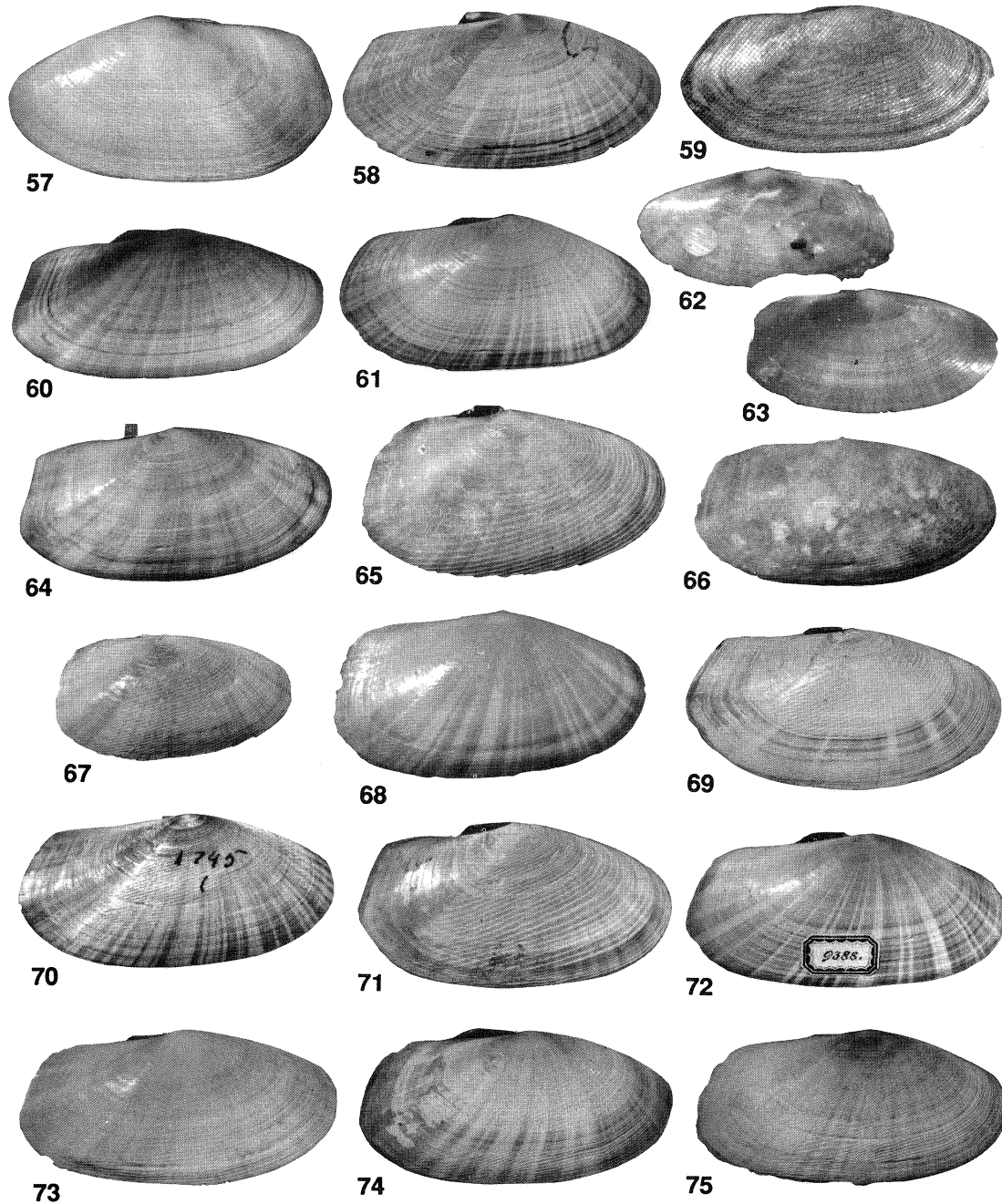
Figs 13-26. *Asaphis violascens* (Forsskål): **13, 14**, *Venus violascens* Forsskål, lectotype, 68.2 mm, Red Sea, ZMUC; **15**, *Tellina anomala* Born, lectotype, 48.7 mm, Unknown locality, NHMW 3051; **16**, *Sanguinolaria rugosa* Lamarck, lectotype, 80.0 mm, Indian Ocean, MNHN; **17**, *Capsa tahitensis* Reeve, lectotype, 62.4 mm, Tahiti, BMNH 1989121/1; **18**, Specimen figured as *Capsa deflorata* (Linné) by Reeve, 32.5 mm, "Eastern Seas", BMNH 1989122/1; **19, 20**, 61.3 mm, Lord Howe Island, Whitehead coll.; **21**, 54.2 mm, Mon Repos Beach, Bundaberg, Qld, Willan coll.; **22**, 16.0 mm, Burnett Heads, Bundaberg, Qld, Willan coll.; **23**, 55.6 mm, Sunday Island, Cobourg Peninsula, NT, Whitehead coll.; **24**, 47.1 mm, Nickol Bay, Dampier, WA, Willan coll.; **25**, 57.9 mm, Lammermoor Beach, Keppel Bay, Qld, Willan coll.; **26**, 83.3 mm, Kosi Bay, Zululand, South Africa, NMSA D9760.



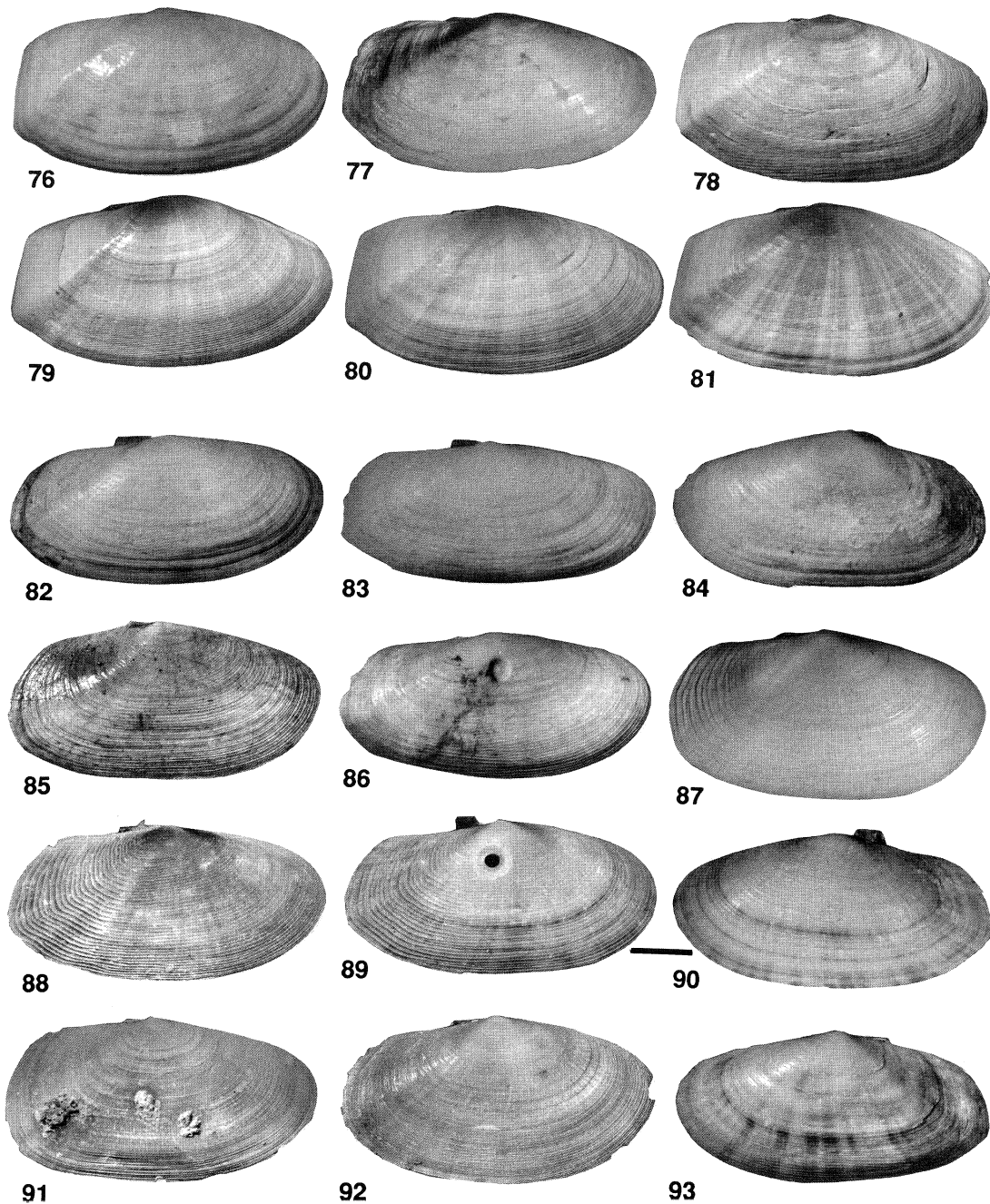
Figs 27-37. *Heteroglypta contraria* (Deshayes): **27**, *Heteroglypta hedleyi* Iredale, holotype, 9.0 mm, Nambucca Heads, NSW, AMS C8974; **28**, *Heteroglypta avecta* Iredale, lectotype, 11.5 mm, Michaelmas Reef, Qld, AMS C149155; **29**, *Heteroglypta pansa* Iredale, holotype, 9 mm, New Caledonia, AMS C28799; **30**, *Heteroglypta saltatrix* Iredale, holotype, 18.0 mm, Michaelmas Reef, Qld, AMS C57816; **31**, 16.3 mm, 7-20 m, Shag Rocks, North Stradbroke Island, Qld, Willan coll.; **32**, 19.6 mm, Djibouti, Gulf of Aden, MNHN; **33**, 12.8 mm, 7.5 m, 19 km, north Tantabiddi Well, North West Cape, WA, WAM 325-86; **34**, SEM showing detail of sculpture on exterior of valve, 6.4 mm, 7 m, north Cape Moreton, Qld, Willan coll.; **35**, Microsculpture of pores, here shown between radial cords on centre of valve shown in Figure 34, scale = 4 μ m; **36,37**, Detail of sculpture on central and umbonal area of same valve, 9.1 mm, Caloundra, Qld, scales = 1.0 mm, 0.4 mm respectively.



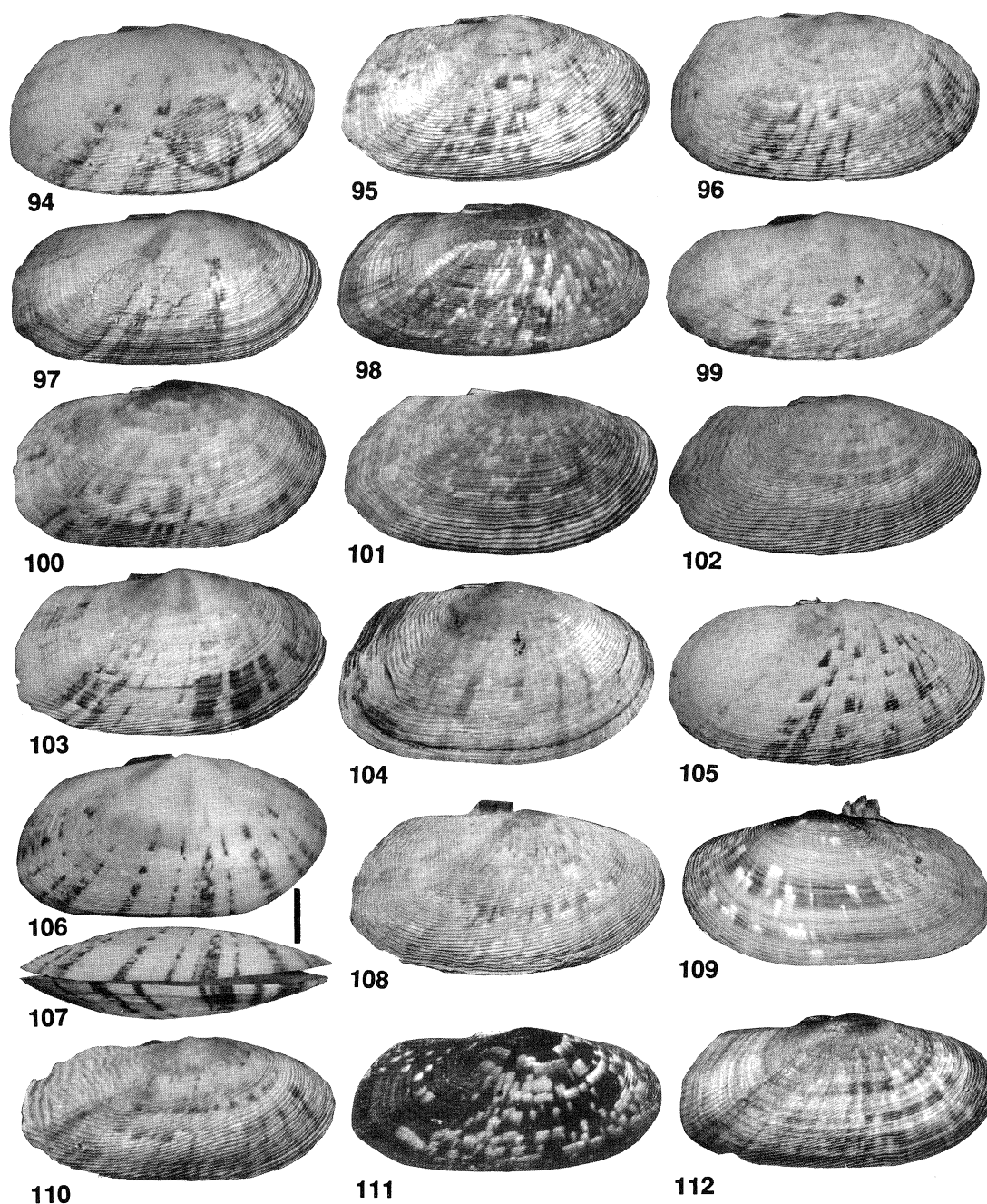
Figs 38-48. *Gari truncata* (Linné): **38**, *Tellina truncata* Linné, holotype, 34.0 mm, Unknown locality, Linnean Society of London, Linné coll.; **39**, *Gari vulgaris* Schumacher, lectotype, 40.0 mm, Unknown locality, ZMUC; **40**, *Gari vulgaris* Schumacher, paralectotype, 37.5 mm, Unknown locality, ZMUC; **41**, *Psammobia pulchella* Lamarck, lectotype, 22.6 mm, Unknown locality, MNHN M4 R1113; **42**, Specimen figured as *Psammobia caerulescens* Lamarck by Reeve, 57.8 mm, Ceylon, BMNH 1960963; **43**, *Psammobia arakanensis* E.A. Smith, holotype, 30.8 mm, 37-55 m, off Cheduba, Arakan Coast, India, ZSI M3063/1; **44,45**, 52.8 mm, Yirrakala Beach, Gove Peninsula, NT, Lamprell coll.; **46**, 47.8 mm, Gove Peninsula, NT, Whitehead coll.; **47**, 47.8 mm, Japan, MNHN; **48**, 58.6 mm, Manila, Luzon Island, Philippine Islands, MNHN. **Figs 49-56**, *Gari lessoni* (Blainville): **49**, *Psammobia lessoni* Blainville, holotype, 58.4 mm, Bourou, Moluccas Islands, MNHN; **50**, Specimen of *Psammobia lessoni* Blainville figured by Reeve, 59.2 mm, Samar Island, Philippine Islands, BMNH 196420; **51**, *Psammobia malaccana* Reeve, lectotype, 34.8 mm, Malacca, BMNH 1964049; **52**, *Gari schepmani* Prasad, holotype, 24.0 mm, 36 m, Sapeh Bay, E coast Sumbawa Island, Indonesia, ZMA 3.32.054; **53**, 40.3 mm, Sandy Creek Beach, west Arnhem Land, NT, Kessner coll.; **54**, 30.3 mm, Toorbul Point, Moreton Bay, Qld, Willan coll.; **55**, 35.2 mm, Dingo Beach, Bowen, Qld, Lamprell coll.; **56**, 49.6 mm, Broome, WA, WAM 1075-70.



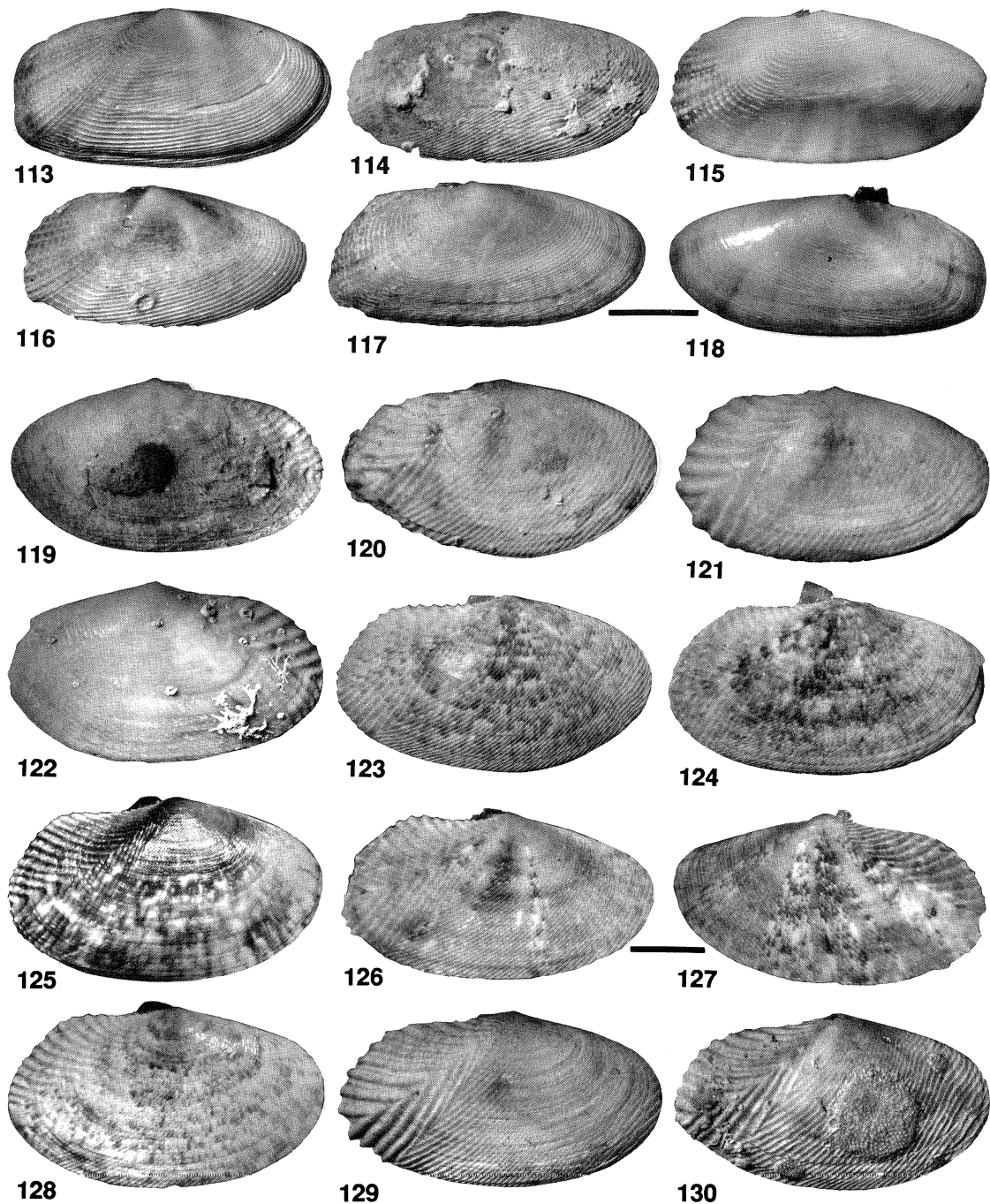
Figs 57-75. *Gari pallida* (Deshayes): **57**, *Psammobia pallida* Deshayes, lectotype, 39.6 mm, Gulf of Aden, BMNH 1964046/1; **58**, specimen figured as *Psammobia pulchella* Lamarck by Reeve, 46.2 mm, Bay of Manila, Philippine Islands, BMNH 196444; **59**, *Psammobia weinkauffi* Crosse, holotype, 45.5 mm, "Algeria", USNM 178599; **60**, *Psammobia reevei* Martens, holotype, 31.3 mm, Flores Island, Indonesia, ZMB; **61**, *Psammobia bertini* Hidalgo, lectotype, 47.2 mm, Philippine Islands, MNCN 15.07/0308; **62**, *Psammobia valdiviae* Jaeckel & Thiele, lectotype, 21.0 mm, off Dar es Salaam, Tanzania, ZMB 69972; **63**, *Psammobia valdiviae* Jaeckel & Thiele, paralectotype, 19.5 mm, off Dar es Salaam, Tanzania, ZMB 69972; **64**, *Gari hosoyai* Habe, holotype, 29.5 mm, Sagami Bay, Honshû Island, Japan, NSMT Mo39913a-1; **65**, 16.0 mm, 36.5 m, off Watsons Bay, north-west side Lizard Island, Qld, Willan coll.; **66**, 14.6 mm, 24 m, south Townsville, Qld, AMS C149144; **67**, 23.3 mm, 33-40 m, off west coast Wissar Island, west Wokam, Aru, Moluccas Islands, WAM 902-85; **68**, 21.4 mm, 51-58 m, approximately 8 km north of Labuan Olendir, Selaru, Tanimbar, Moluccas Islands, WAM 901-85; **69**, 40.2 mm, Mikawa Bay, Honshû Island, Japan, NSMT Mo63131; **70**, 39.3 mm, Manila, Luzon Island, Philippine Islands, CAS 1745; **71**, 23.2 mm, Rikuzen, Tokada City, Honshû Island, Japan, NSMT Mo63221; **72**, 44.6 mm, Unknown locality, NHMW G9388; **73**, 30.0 mm, Red Sea, Lamprell coll.; **74**, 40.9 mm, Lumbo, Mozambique, BMNH 1920.6.15.49; **75**, 50.7 mm, Durban, Natal, South Africa, BMNH 1902.10.14.2.



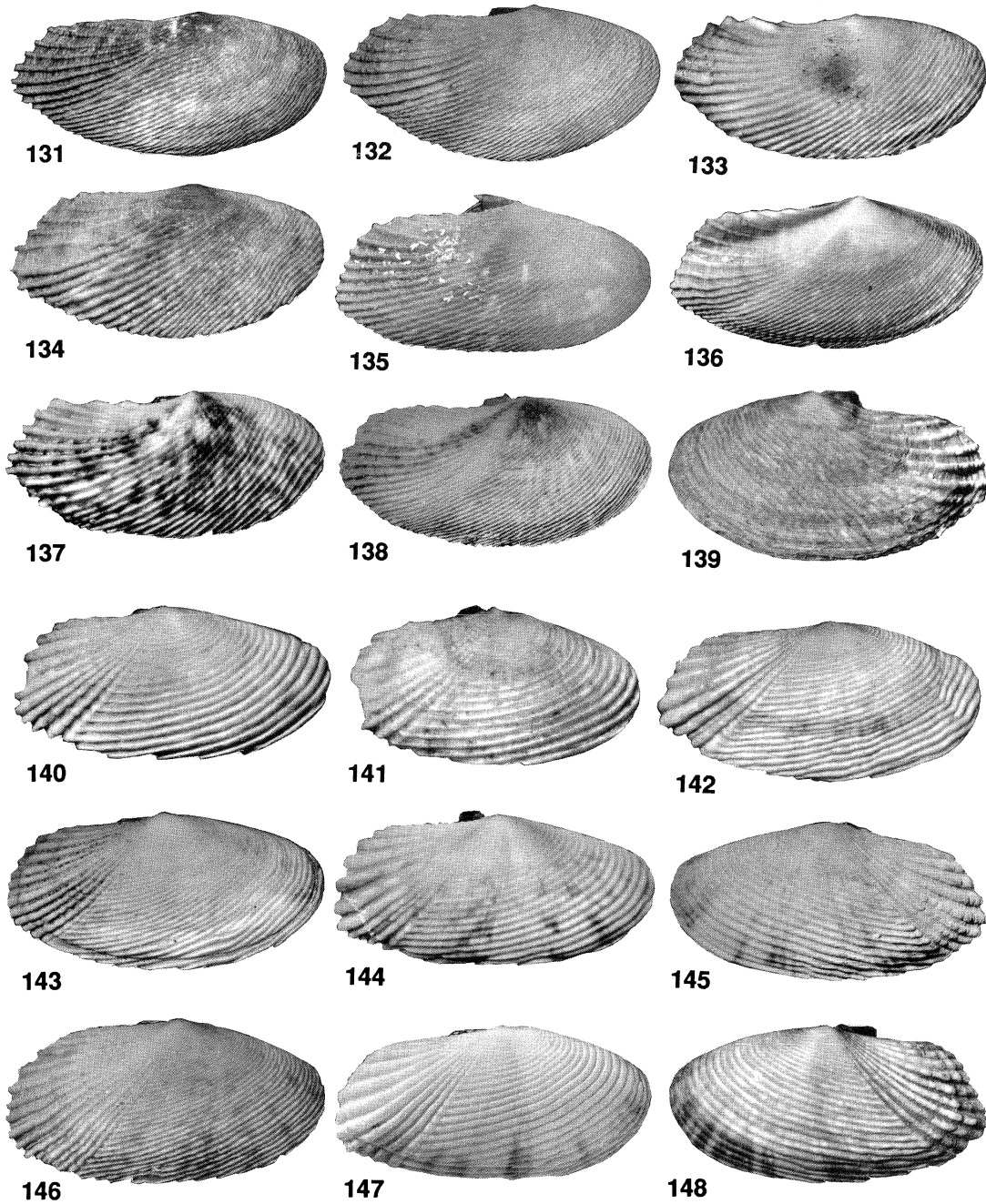
Figs 76-81. *Gari anomala* (Deshayes): **76**, *Psammobia anomala* Deshayes, lectotype, 28.7 mm, Cebu Island, Philippine Islands, BMNH 1984290/1; **77**, *Psammobia tenuis* Deshayes, lectotype, 23.8 mm, Philippine Islands, BMNH 1984291/1; **78**, 21.8 mm, Saibai Island, Torres Strait, Qld, AMS C121653; **79**, 32.2 mm, Cape York, Qld, WAM 1067-70; **80**, 27.4 mm, Dingo Beach, Bowen, Qld, Whitehead coll.; **81**, 38.7 mm, Dingo Beach, Bowen, Qld, Lamprell coll. **Figs 82-93.** *Gari modesta* (Deshayes): **82**, *Psammobia modesta* Deshayes, lectotype, 27.8 mm, Moreton Bay, Qld, BMNH 1984285/1; **83**, *Psammobia menkeana* Deshayes, lectotype, 21.2 mm, east coast of Australia, BMNH 1984287/1; **84**, *Psammobia angusta* Deshayes, lectotype, 19.6 mm, "Senegal", BMNH 1984288/1; **85**, *Psammobia aequalis* Tate, lectotype, 19.6 mm, Grange Burn Formation, Muddy Creek, west of Hamilton, Vic., SAM T1189B; **86**, *Milligaretta venta* Iredale, holotype, 28.6 mm, Sydney Harbour, Port Jackson, NSW, AMS C60624; **87**, *Psammobia temperata* Cotton & Godfrey, holotype, 19.9 mm, 7.5 m, off Black Point, Whyalla, Spencer Gulf, SA, SAM D12857; **88**, 20.5 mm, Woody Island, Hervey Bay, Qld, Lamprell coll.; **89**, **90**, 20.6 mm, 4.5-6 m, Amity Point, North Stradbroke Island, Qld, Willan coll.; **91**, 19.5 mm, Portsea, Port Philip Bay, Vic., NMV; **92**, 23.8 mm, 73 m, Botany Bay, NSW, AMS C143431; **93**, 24.5 mm, 19-28 m, approximately 2 km off Tugun Beach, Qld, Willan coll.



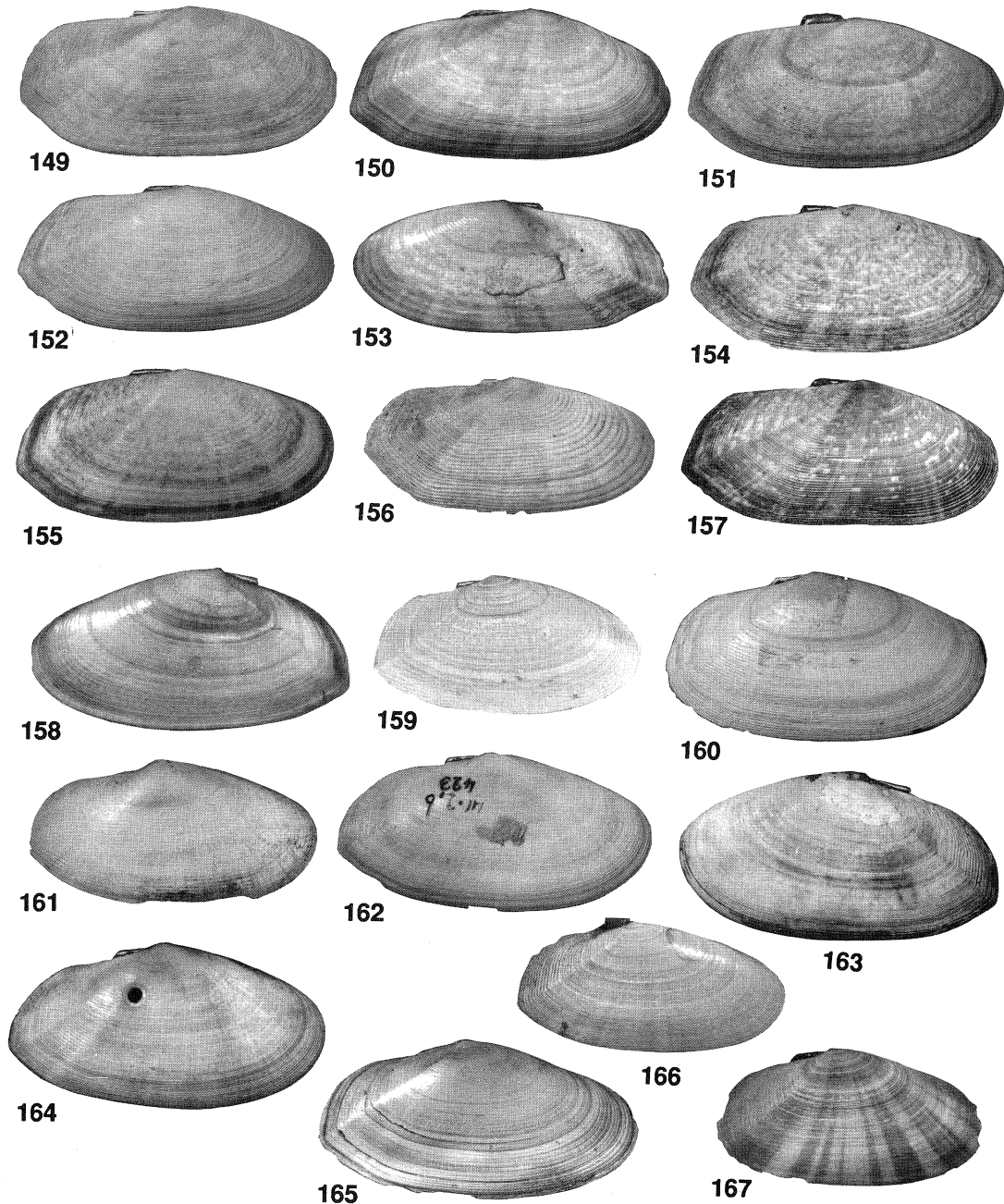
Figs 94-112. *Gari maculosa* (Lamarck): **94**, *Tellina scabra* ... Chemnitz, probable specimen figured by Chemnitz, 35.3 mm, unknown locality, ZMUC; **95**, *Psammobia maculosa* Lamarck, lectotype, 45.0 mm, Indian Ocean, MNHN M4 R1077; **96**, *Psammobia maculosa* Lamarck, paralectotype, 46.5 mm, Indian Ocean, MHNG 1083/15/2; **97**, *Psammobia tongana* Quoy & Gaimard, lectotype, 45.8 mm, "Tonga Tabou", MNHN; **98**, *Psammobia praestans* Deshayes, lectotype, 50.5 mm, Moluccas Islands, BMNH 196416; **99**, *Psammobia layardi* Deshayes, holotype, 31.0 mm, Philippine Islands, BMNH 196422; **100**, *Psammobia ornata* Deshayes, lectotype, 46.8 mm, Ticao Island, Philippine Islands, BMNH 196423; **101**, *Psammobia rubicunda* Deshayes, lectotype, 46.3 mm, Ticao Island, Philippine Islands, BMNH 1984299/1; **102**, *Psammobia corrugata* Deshayes, holotype, 46.4 mm, Cebu Island, Philippine Islands, BMNH 1964013; **103**, *Psammobia marmorea* Deshayes, holotype, 39.1 mm, Moluccas Islands, BMNH 1846.9.16.112; **104**, *Psammobia obtusa* Preston, holotype, 42.25 mm, Andaman Islands, ZSI M22856/4; **105**, 44.3 mm, 35 m, north-east side Wistari Reef, Qld, Willan coll.; **106**, **107**, 56.9 mm, Great Barrier Reef, Qld, Lamprell coll.; **108**, 46.0 mm, 26 m, north-east side Wistari Reef, Qld, Willan coll.; **109**, 55.9 mm, 6-12 m, Shag Rocks, North Stradbroke Island, Qld, Willan coll.; **110**, 25.6 mm, 33 m, Stiffe's Bank, Persian Gulf, ZMUC; **111**, 38.9 mm, Marau Sound, Maraunibina Island, Solomon Islands, Coles coll.; **112**, 37.0 mm, Sri Lanka, MNHN.



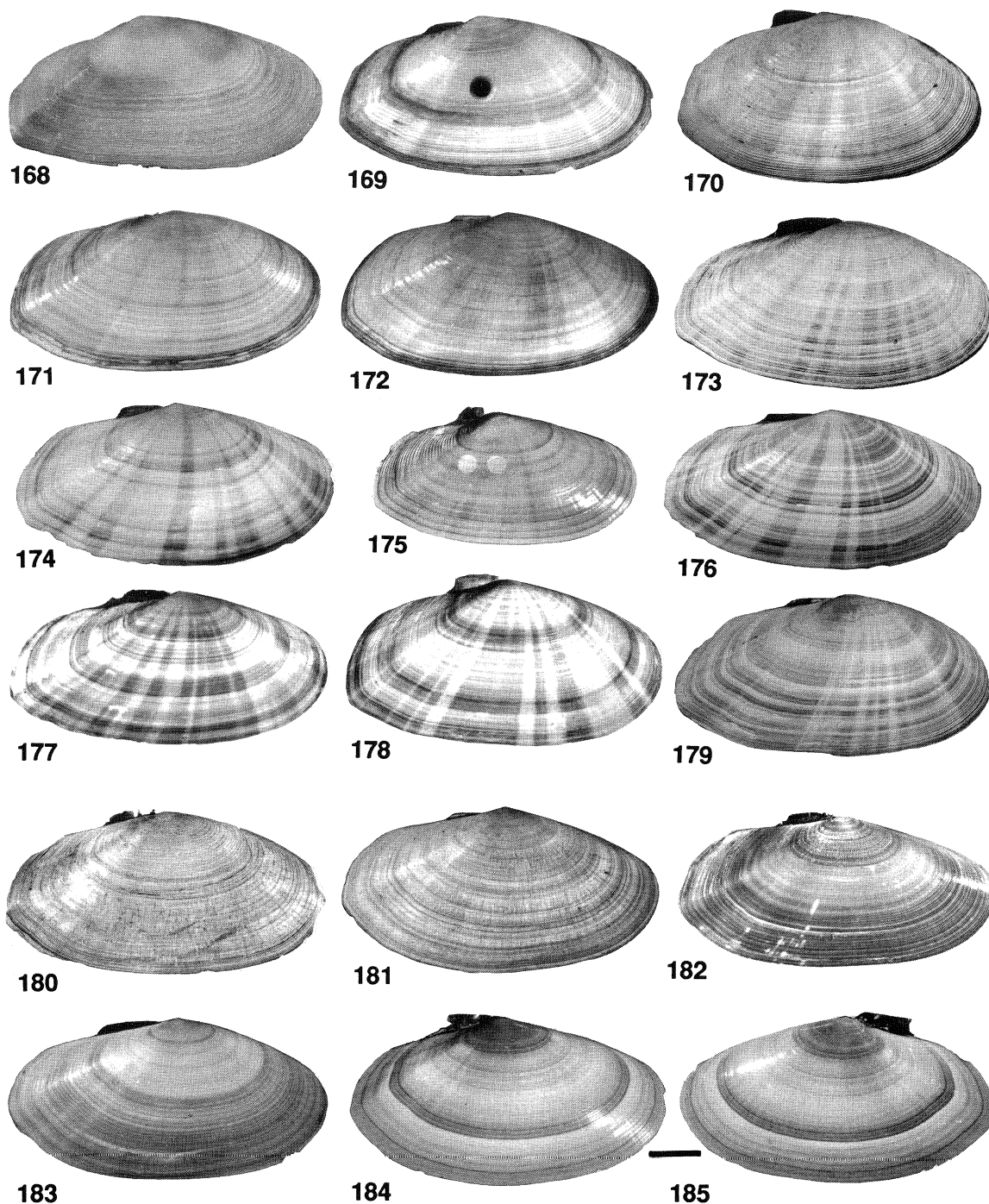
Figs 113-118. *Gari sibogai* Prashad: **113**, *Gari sibogai* Prashad, holotype, 20.2 mm, 9-45 m, south Ceram Island, Indonesia, ZMA 3.32.058; **114**, 21.3 mm, 64-73 m, 3 km north-east of west side Gillet Cay, Swain Reefs, Qld, AMS C149138; **115**, 15.4 mm, 55-91 m, east Agana Bay, Guam Island, Marianas Islands, Willan coll.; **116**, 12.5 mm, 75-90 m, Holtor Kombir, Indonesia, ZMUC; **117**, **118**, 17.0 mm, 62-67 m, Chesterfield-Bellona Plateau, Qld, MNHN. **Figs 119-130.** *Gari pennata* (Deshayes): **119**, *Psammobia pennata* Deshayes, holotype, 19.1 mm, Unknown locality, BMNH 1985169; **120**, *Psammobia dispar* Deshayes, lectotype, 18.9 mm, Philippine Islands, BMNH 1985170/1; **121**, *Heteroglypta kanaka* Pilsbry, holotype, 11.5 mm, 64-91 m, off Waikiki, Oahu Island, Hawaii, ANSP 47033; **122**, 28.4 mm, 10.5-12 m, Shag Rocks, North Stradbroke Island, Qld, Willan coll.; **123**, 19.5 mm, Darnley Island, Qld, AMS C51522; **124**, 19.3 mm, Cairns, Qld, AMS C143439; **125**, 21.0 mm, 18 m, Cobham Reef, Qld, Lamprell coll.; **126**, **127**, 12.6 mm, 21 m, south-west side Euston Reef, Qld, AMS C143438; **128**, 20.3 mm, Florida Group, Solomon Islands, NMV; **129**, 15.2 mm, 7-15 m, off Launiupoko Camp, Maui Island, Hawaii, USNM 337368; **130**, 29.6 mm, 35 m, Jolo Island, Philippine Islands, ZMUC.



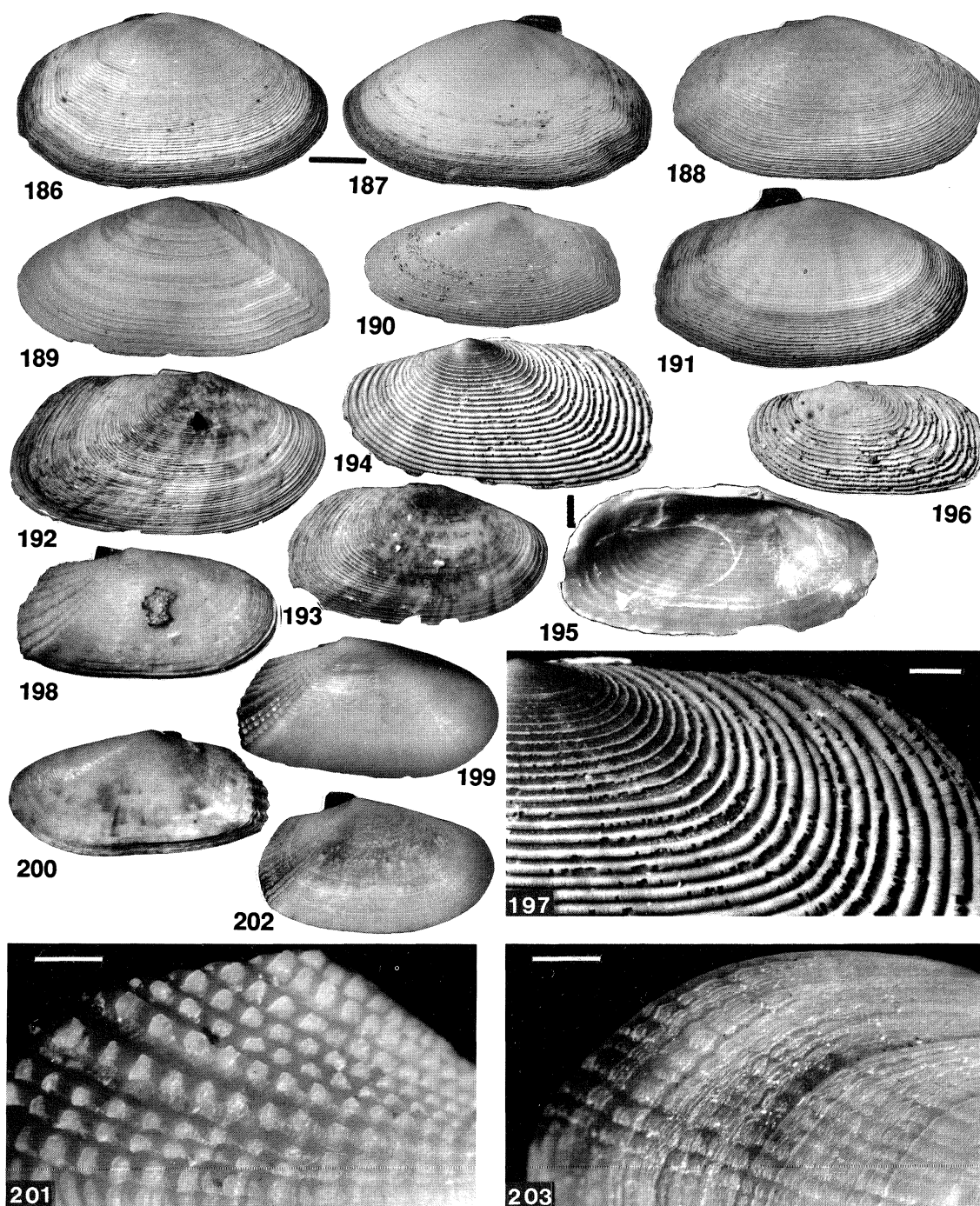
Figs 131-139. *Gari squamosa* (Lamarck): **131**, *Psammobia squamosa* Lamarck, lectotype, 31.3 mm, unknown locality, MHNG 1083/19/1; **132**, Specimen figured as *Psammobia rugulosa* A. Adams & Reeve by Reeve, 31.2 mm, "China Sea", BMNH 1985184/1; **133**, *Psammobia palmula* Deshayes, holotype, 21.5 mm, "New Holland, Sydney", BMNH 1985171; **134**, 25.0 mm, West Islet, Ashmore Reef, WA, WAM; **135**, 16.4 mm, Black Island, Whitsunday Group, Qld, Whitehead coll.; **136**, 21.6 mm, 14 m, south-east side Wheeler Reef, Qld, AMS C112049; **137**, 27.0 mm, Isle des Pins, New Caledonia, MNHN; **138**, 25.9 mm, 1 m, Malapoa Peninsula, Mele Bay, Efaté Island, Vanuatu, Willan coll.; **139**, 24.3 mm, Lekin lagoon, Ouvea Island, Loyalty Islands, Hole coll. **Figs 140-148**, *Gari pulcherrima* (Deshayes): **140**, *Gari pulcherrima* Deshayes, holotype, 17.9 mm, unknown locality, BMNH 1985168; **141**, *Psammobia abrupta* Deshayes, holotype, 10.5 mm, Philippine Islands, BMNH 1984300; **142**, *Psammobia pazi* Hidalgo, holotype, 33.8 mm, unknown locality, MNCN 15.07/0307; **143**, *Grammatomya kurodai* Habe, holotype, 26.8 mm, Off Cape Ashizuri, Kochi Prefecture, Japan, NSMT Mo58965; **144**, 25.2 mm, 27 m, Lizard Island, Qld, Willan coll.; **145**, 36.4 mm, 27 m, Lizard Island, Qld, Willan coll.; **146**, 20.8 mm, 4-7 m, south-east corner Dirk Hartog Island, WA, WAM 1307-68; **147**, 31.0 mm, 33 m, Nukualofa, Tongatabu Island, Tonga, BMNH 1887.2.9.2537; **148**, 31.7 mm, Tuléar, Madagascar, MNHN.



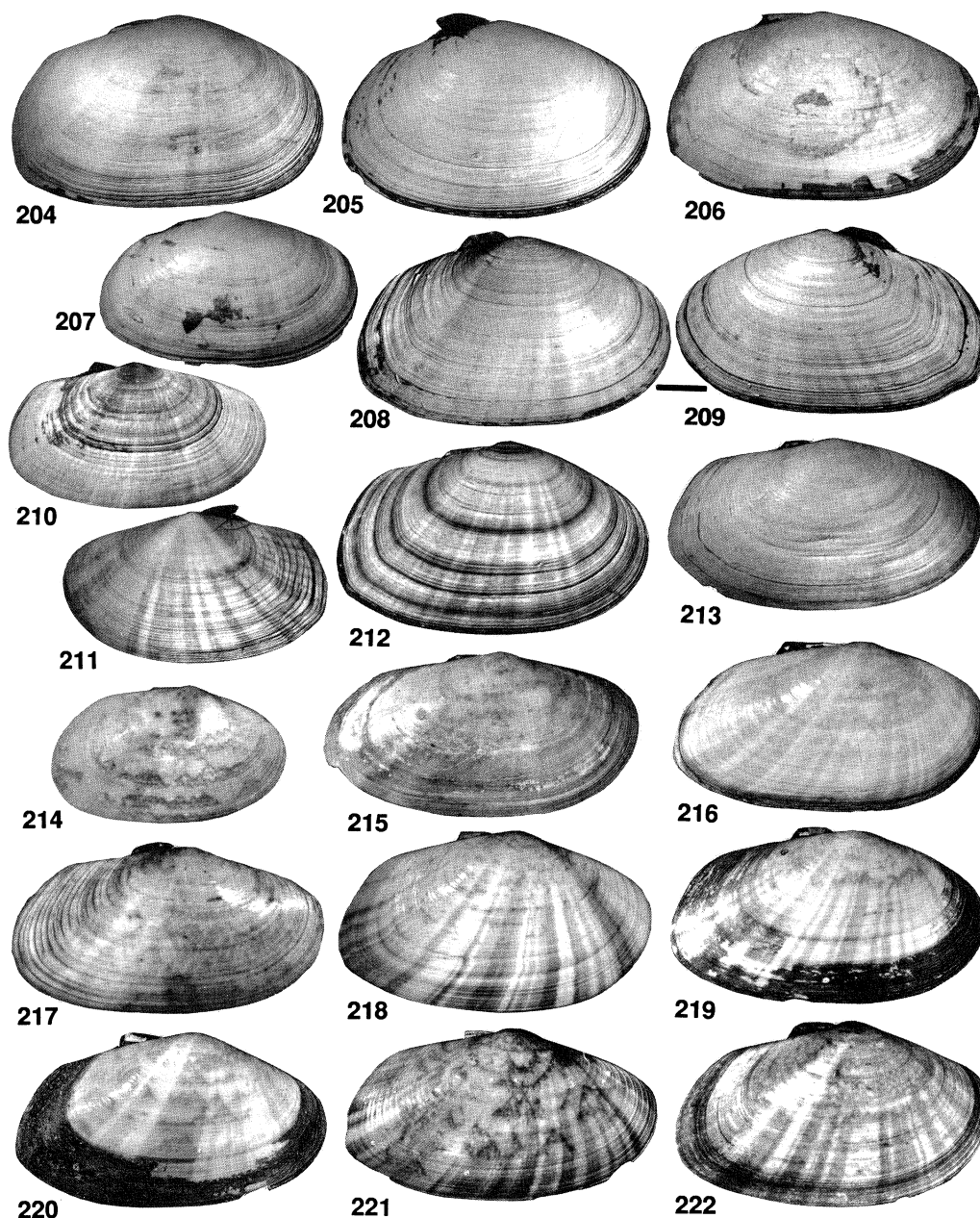
Figs 149-157. *Gari amethysta* (Wood): **149**, *Gari vulgaris* Schumacher, paralectotype, probable specimen figured by Schumacher, 51.3 mm, Unknown locality, ZMUC; **150**, specimen bearing MS name *Psammobia furcellata*, 69.3 mm, unknown locality, MNHN, Lamarck coll.; **151**, *Psammobia tripartitia* Deshayes, lectotype, San Nicholas Island, Philippine Islands, BMNH 196414; **152**, *Psammobia amoena* Deshayes, holotype, 47.9 mm, unknown locality, BMNH 1964010; **153**, *Gari mirabilis* Bertin, holotype, 55.0 mm, Madagascar, MNHN; **154**, 58.6 mm, 3.5-7.5 m, SE corner Dirk Hartog Island, WA, WAM 1716-68; **155**, 55.2 mm, Dampier, WA, Lamprell coll.; **156**, 28.8 mm, Philippine Islands, NMV; **157**, 50.5 mm, Manila, Philippine Islands, MNHN. **Figs 158-167.** *Gari livida* (Lamarck): **158**, *Psammobia livida* Lamarck, lectotype, 28.0 mm, "Nouvelle-Hollande, baie des Chiens Marins", MNHN; **159**, *Psammobia livida* Lamarck, paralectotype, 24.8 mm, "Nouvelle-Hollande, baie des Chiens Marins", MNHN; **160**, *Psammotaea zonalis* Lamarck, holotype, 42.5 mm, unknown locality, MHNG 1083/22; **161**, *Psammobia puella* Deshayes, holotype, 26.1 mm, Australia, BMNH 1984289; **162**, *Psammobia compta* Deshayes, lectotype, 35.4 mm, Tas., BMNH 1841.2.6.423; **163**, *Psammobia striata* Deshayes, possible syntype, 44.4 mm, Tas., BMNH 1842.11.2.8; **164**, *Psammobia tellinaeformis* Reeve, lectotype, 34.9 mm, Unknown locality, BMNH 1985182/1; **165**, *Psammobia hamiltonensis* Tate, lectotype, 30.8 mm, Grange Burn Formation, Muddy Creek, W Hamilton, Vic., SAM T1190A; **166**, 22.8 mm, Port Welshpool, Vic., Lamprell coll.; **167**, 21.8 mm, north-east Snake Island, Vic., Noonan coll.



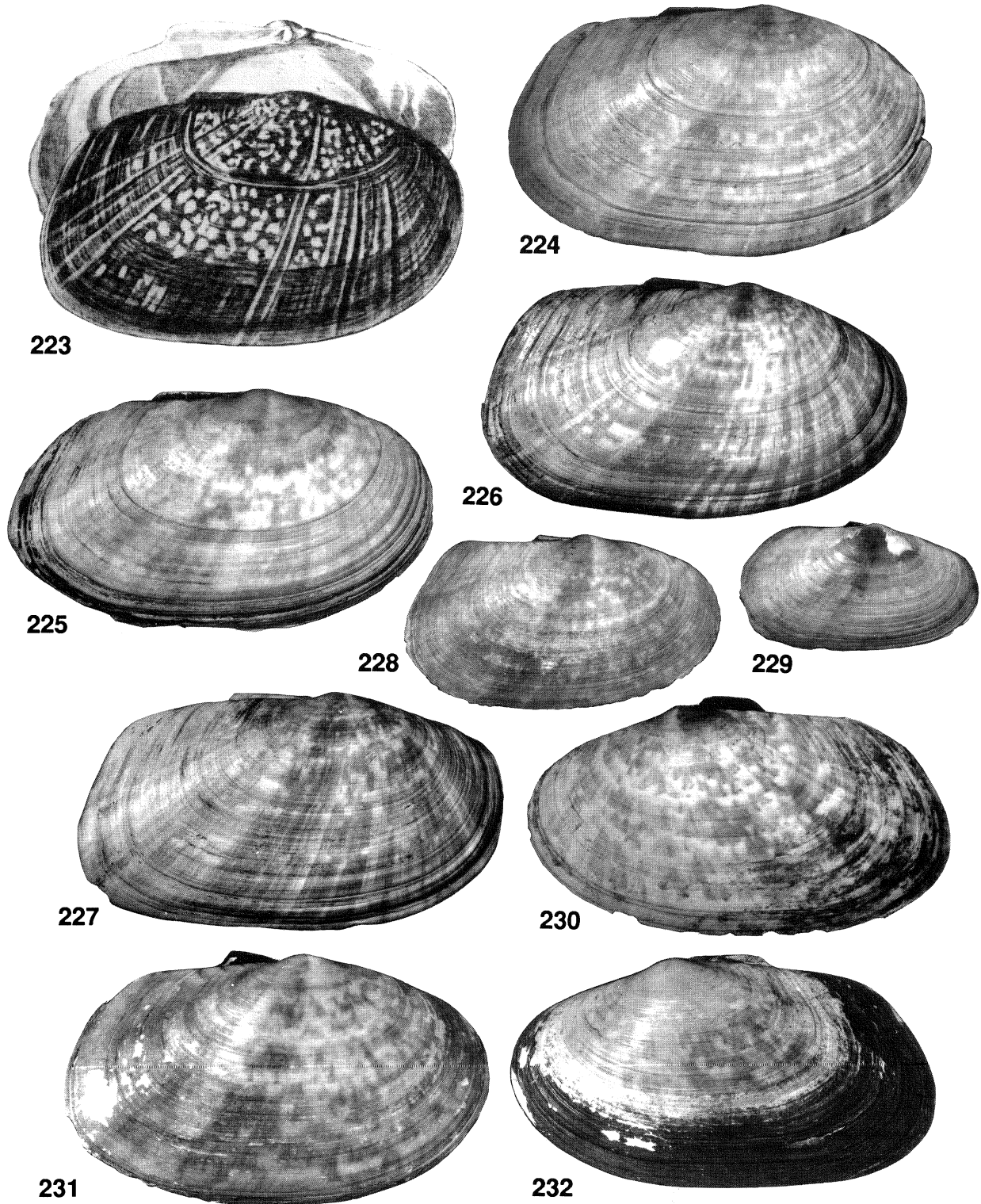
Figs 168-170. *Gari livida* (Lamarck): **168**, 33.4 mm, between Collaroy and Narrabeen beaches, NSW, Whitehead coll.; **169**, 36.0 mm, Southport, Tas., WAM 1051-70; **170**, 50.8 mm, Tas., WAM 1787-68. **Figs 171-179.** *Gari convexa* (Reeve): **171**, *Psammobia convexa* Reeve, lectotype, 50.5 mm, unknown locality, BMNH 1985185/2; **172**, *Psammobia convexa* Reeve, paralectotype, 46.9 mm, Unknown locality, BMNH 1985185/1; **173**, *Gari hodgci* Willan, holotype, 77.9 mm, Owenga, Chatham Islands, AIM TM-1360; **174**, 46.2 mm, Omaha Ocean Beach, Matakana, Auckland, Willan coll.; **175**, 24.3 mm, Sandy Point, Narrows Bend, Preservation Inlet, Fiordland, Willan coll.; **176**, 57.4 mm, Omaha Ocean Beach, Matakana, Auckland, Willan coll.; **177**, 39.2 mm, Baddleys Beach, Matakana, Auckland, Willan coll.; **178**, 54.2 mm, Smokehouse Bay, Great Barrier Island, Willan coll.; **179**, 81.2 mm, Aramoana Sandspit, Otago, Willan coll. **Figs 180-185.** *Gari lineolata* (Gray in Yate): **180**, *Psammobia lineolata* Gray in Yate, holotype, 41.4 mm, New Zealand, BMNH 1852.10.29.8; **181**, specimen figured by Reeve, 54.4 mm, "New Zealand", BMNH 196451; **182**, 37.4 mm, Baddleys Beach, Matakana, Auckland, Willan coll.; **183**, mm, 59.2 mm, Big Bay, Milford, Southland, Willan coll.; **184**, **185**, 35.8 mm, Bethells Beach, Auckland, Willan coll.



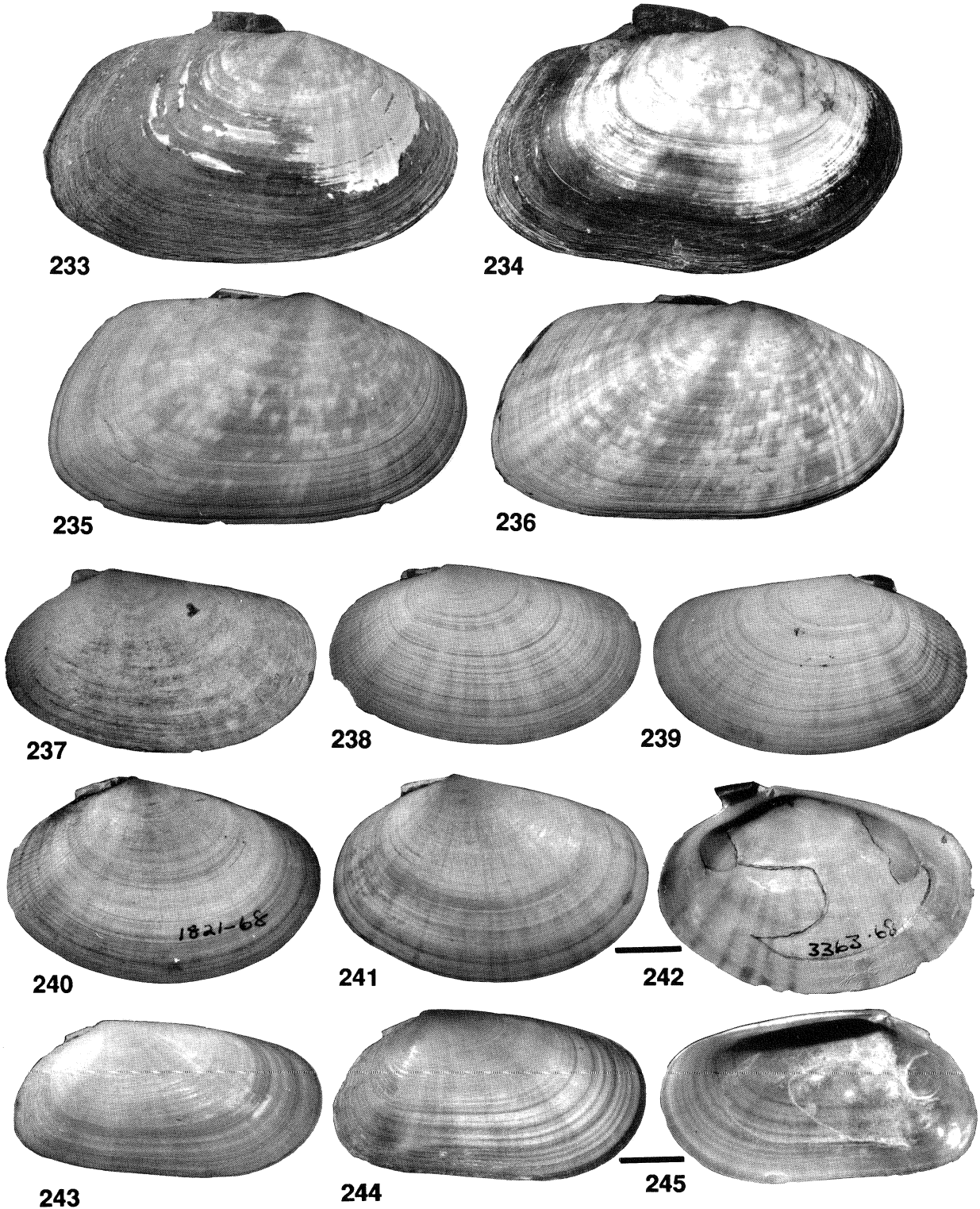
Figs 186-191. *Gari kenyoniana* (Pritchard & Gatliff): **186, 187**, *Tellina kenyoniana* Pritchard & Gatliff, holotype, 61.0 mm, near Split Point, Airey's Inlet, Vic., NMV F496; **188**, 67.5 mm, Flinders Island, Tas., NMV F52126; **189**, 74.1 mm, Pegg's Beach, Tas., NMV F52135; **190**, 30.3 mm, San Remo, Vic., NMV F52137; **191**, 50.6 mm, Stanley, Tas., Lamprell coll. **Figs 192, 193.** *Gari eos* n.sp.: **192**, *Gari eos* Willan, holotype, 60.7 mm, 69 m, Chesterfield-Bellona Plateau, MNHN; **193**, paratype, 34.2 mm, 62-65 m, east Yaté, New Caledonia, MNHN. **Figs 194-197.** *Gari galathea* (Powell): **194, 195**, 43.7 mm, 75 m, Réunion Island, MNHN; **196**, 37.3 mm, 165-195 m, Réunion Island, MNHN; **197**, detail of sculpture on posterior ridge and posterior slope of valve illustrated in Figure 194, scale = 3.0 mm. **Figs 198-203.** *Gari pusilla* Bertin: **198**, *Gari pusilla* Bertin, holotype, 11.4 mm, New Caledonia, MNHN; **199**, 10.6 mm, 8-13 m, reef no. 14-151, south Ribbon Reef, Qld, AMS C149154; **200**, 12.0 mm, 7 m, Matuku Island, Fiji, BMNH 1856.11.3.46; **201**, detail of sculpture on posterior slope of valve illustrated in Figure 199 (note scales), scale = 0.5 mm; **202**, 10.5 mm, Raoul Island, Kermadec Islands, AMS C30211; **203**, detail of sculpture on posterior slope of valve illustrated in Figure 202 (note lack of scales on radial ribs), scale = 0.5 mm.



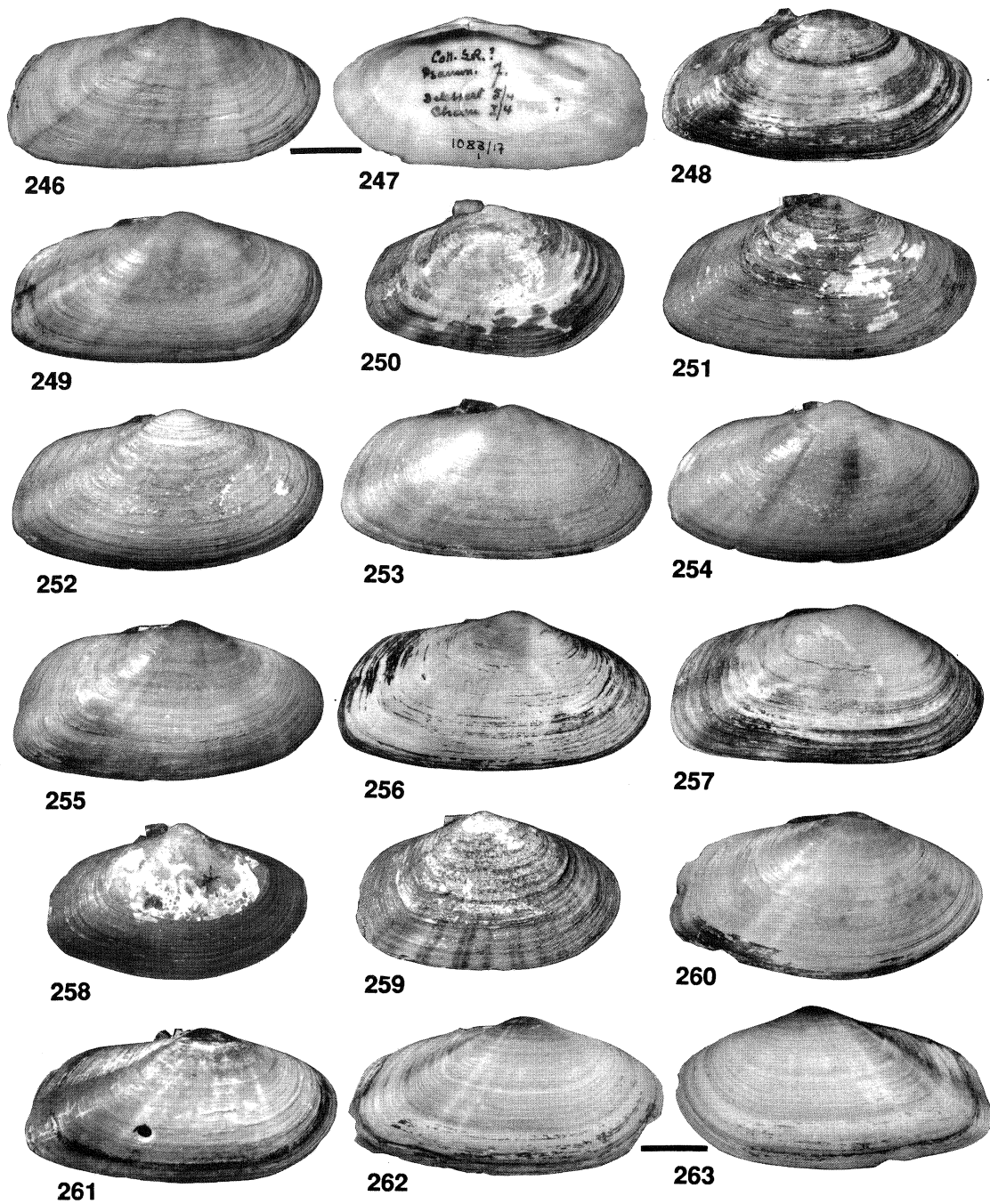
Figs 204-212. *Gari stangeri* (Gray in Dieffenbach): **204**, *Psammobia stangeri* Gray in Dieffenbach, lectotype, 60.0 mm, New Zealand, BMNH 1842.11.18.67/2; **205**, specimen figured by Reeve, 44.6 mm, New Zealand, BMNH 1985177/1; **206**, *Psammobia tristis* Deshayes, lectotype, 47.2 mm, "Amboina", BMNH 1984282/1; **207**, *Psammobia zelandica* Deshayes, lectotype, 34.0 mm, New Zealand, MNHN; **208**, **209**, 44.8 mm, 3-12 m, north end Narrows Bend, Long Sound, Fiordland, Willan coll.; **210**, 28.9 mm, 12 m, Goat Island, Leigh, Auckland, Willan coll.; **211**, 22.6 mm, 2.5 m, east end Waikato Bay, Matai Bay, Northland, Willan coll.; **212**, 56.0 mm, Smokehouse Bay, Great Barrier Island, Willan coll. **Fig.213.** *Gari depressa* (Pennant): *Psammobia affinis* Reeve, figured syntype, 53.7 mm, "New Zealand and the Philippine Is", BMNH 1985175/1. **Figs 214, 215.** *Gari castrensis castrensis* (Spengler): **214**, *Solen castrensis* Spengler, holotype, 37.7 mm, "Fra Kysten Guinea", ZMUC - Spengler coll.; **215**, specimen figured as *Psammobia castrensis* Chemnitz by Reeve, "Sorsogon, Island of Luzon, Philippines", BMNH 1985176. **Figs 216-222.** *Gari castrensis oriens* (Deshayes): **216**, *Psammobia oriens* Deshayes, lectotype, 63.2 mm, Sea of Japan, BMNH 1984278/1; **217**, *Psammobia rossiteri* Crosse, holotype, 38.5 mm, New Caledonia, AMS C30599; **218**, 59.6 mm, 18 m, Outer Rudder Reef, Qld, Lamprell coll.; **219**, 66.0 mm, 4 m, Watsons Bay, Lizard Island, Qld, AMS C147537; **220**, 60.1 mm, 15 m, off Granite Bluff, Lizard Island, Qld, AMS; **221**, 55.0 mm, 46 m, north-east side Pango Peninsula, Efaté Island, Vanuatu, Willan coll.; **222**, 59.2 mm, south-west Conducia Bay, Mozambique, NMSA H1442.



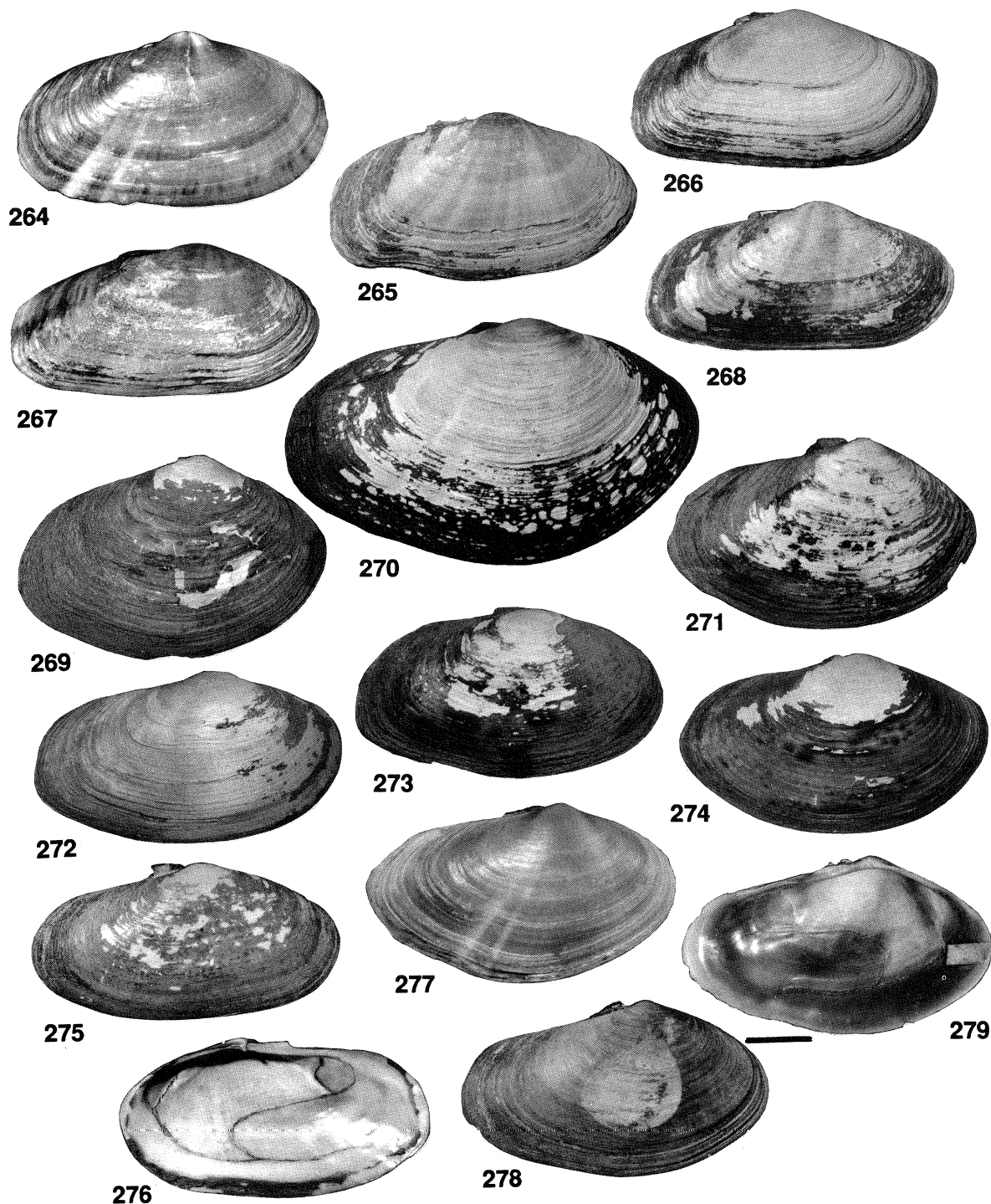
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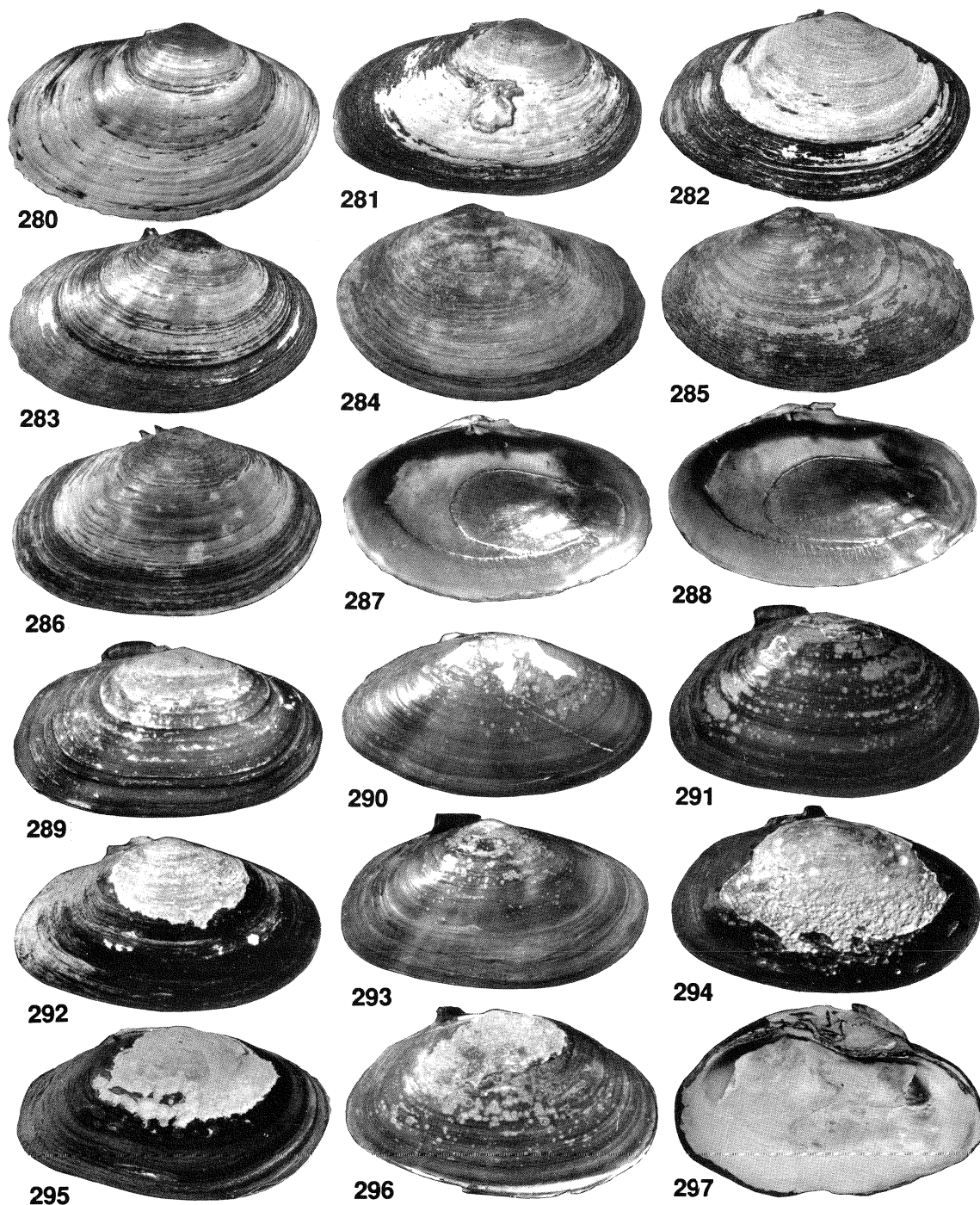
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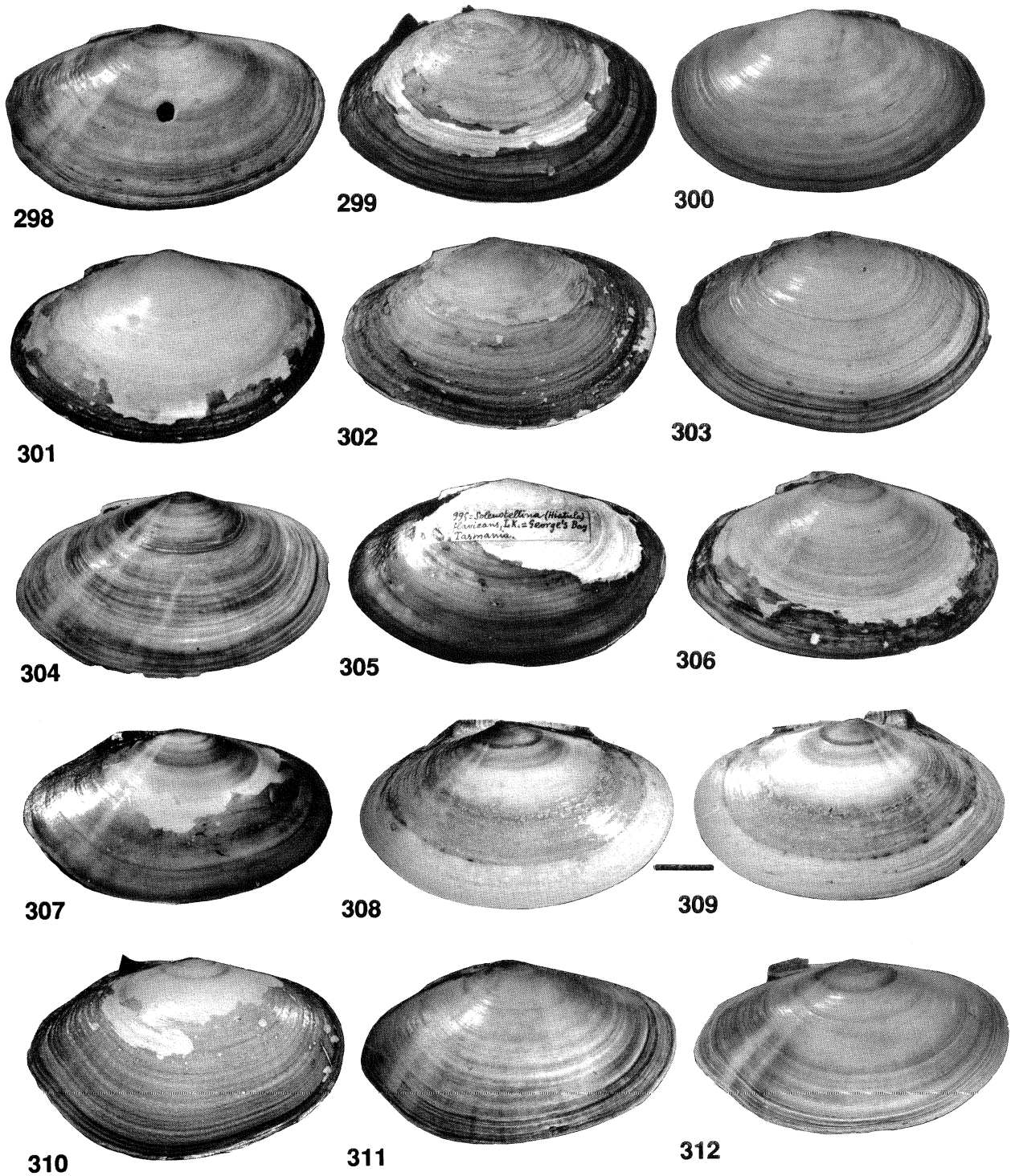
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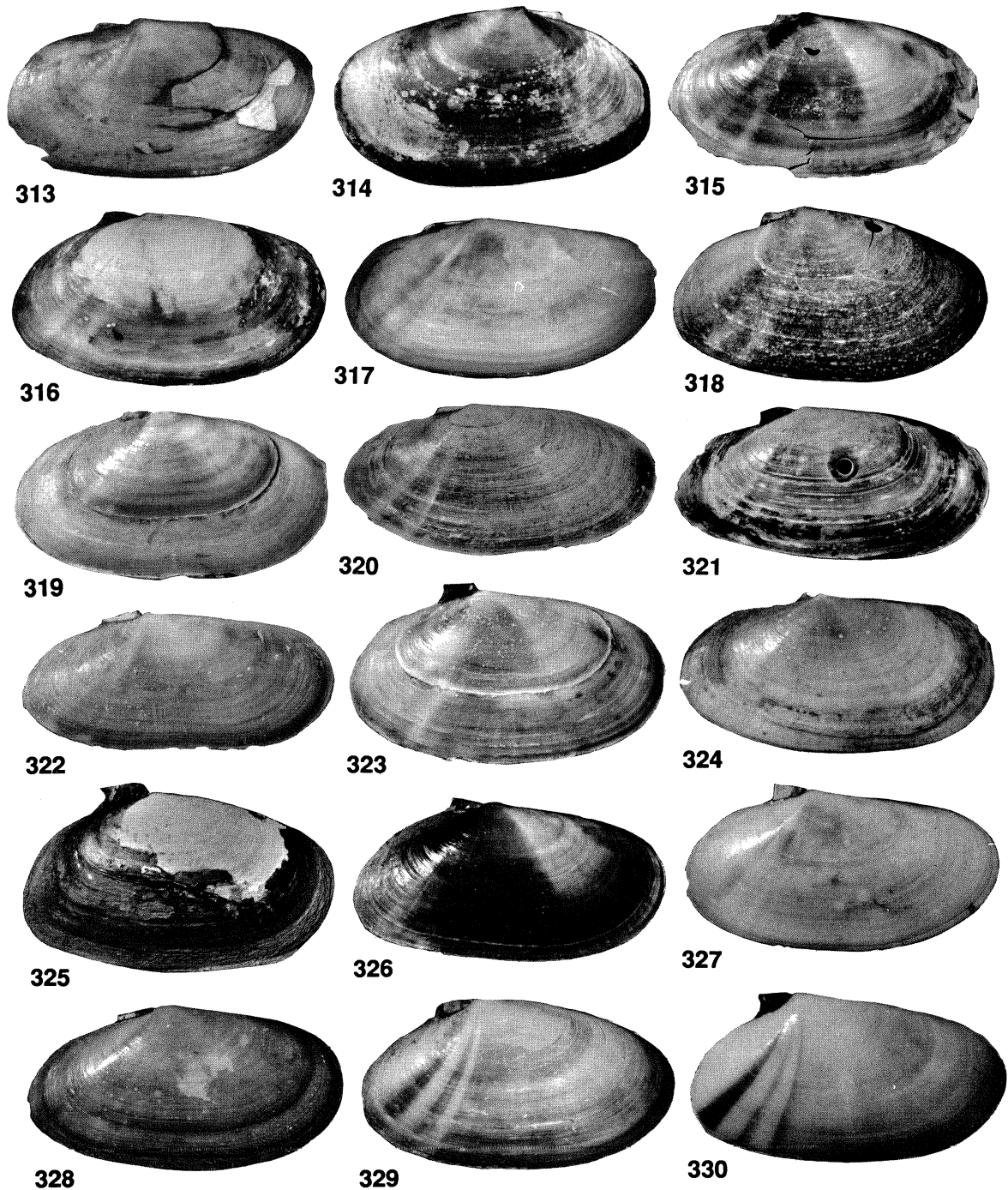
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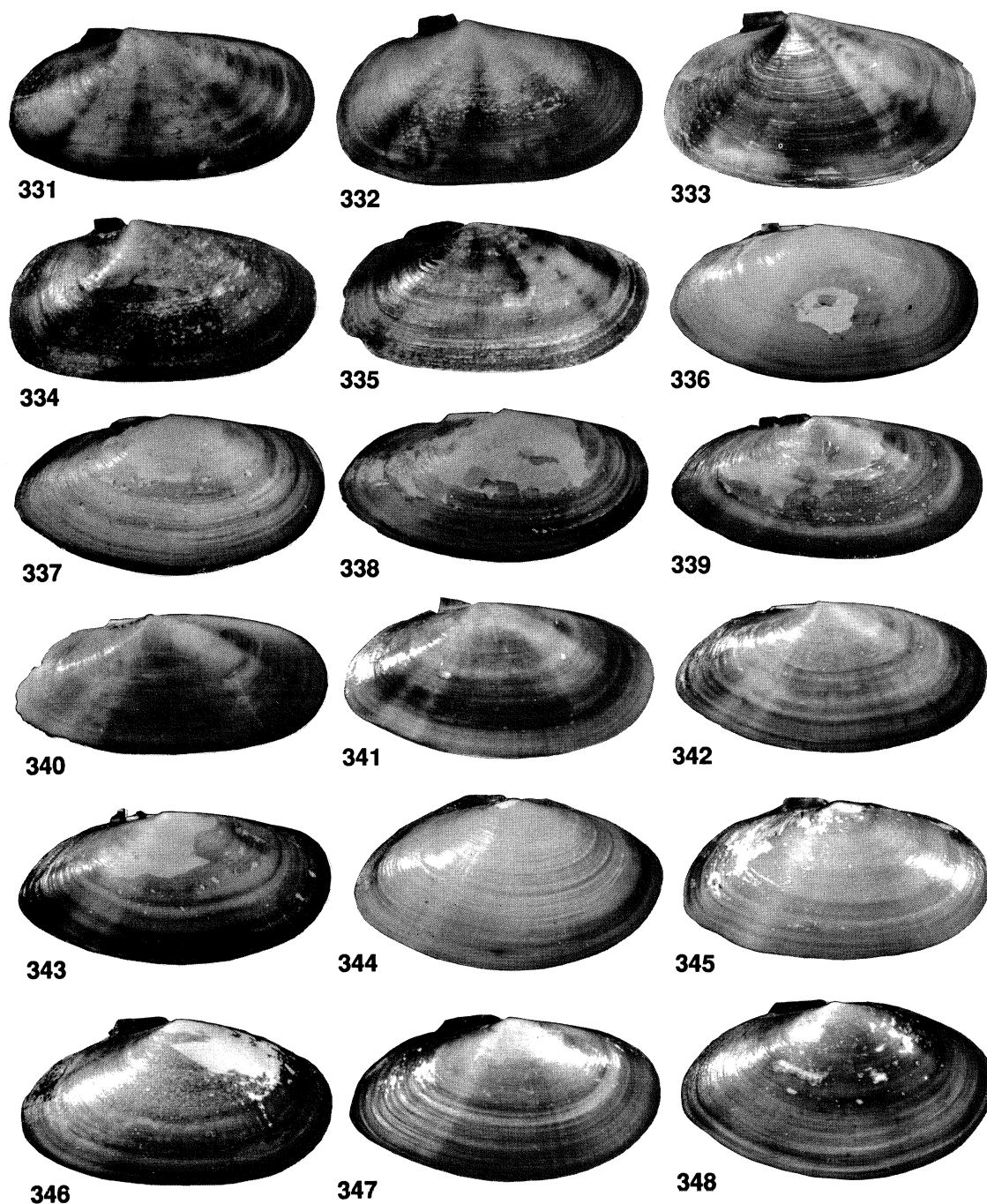
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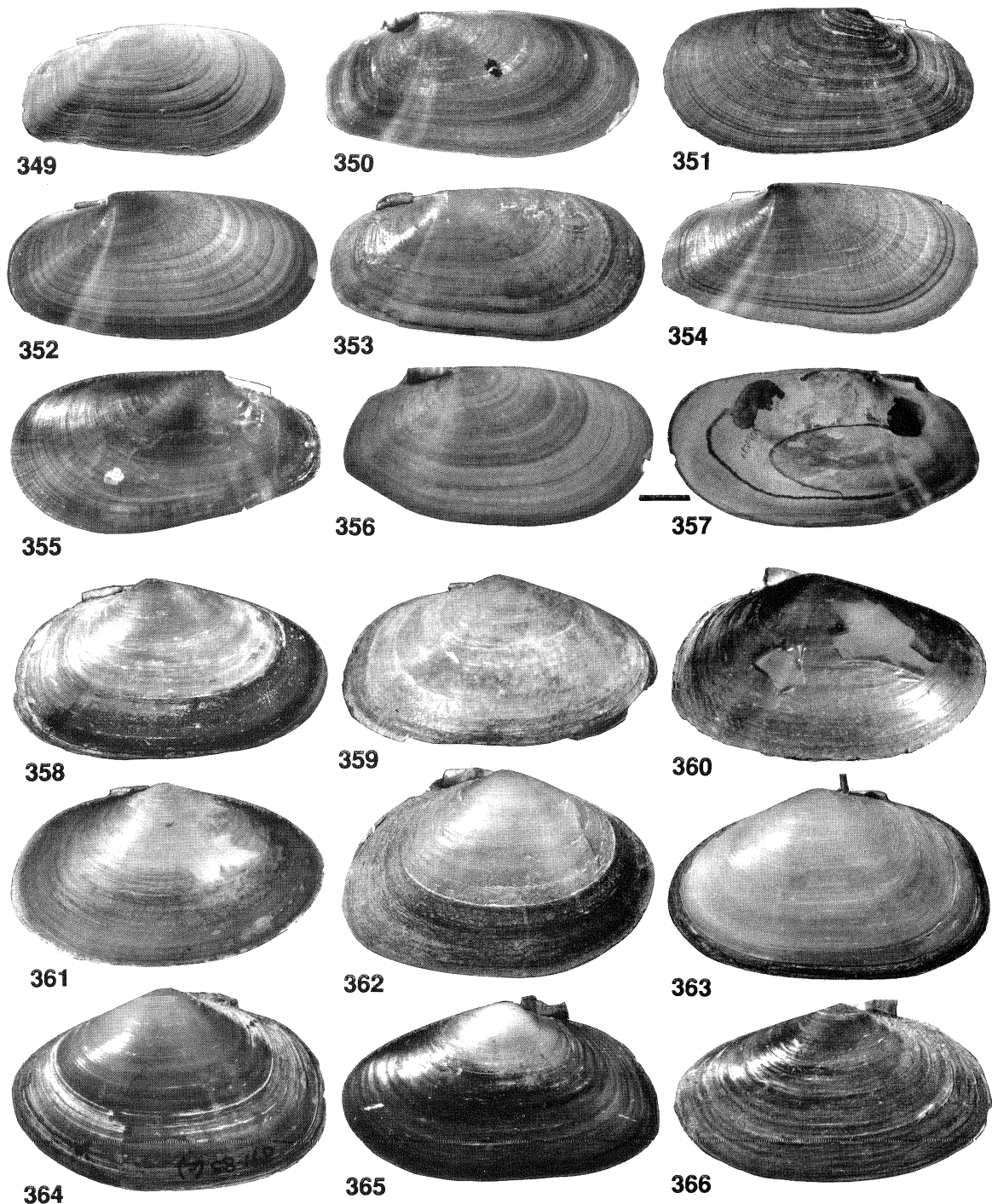
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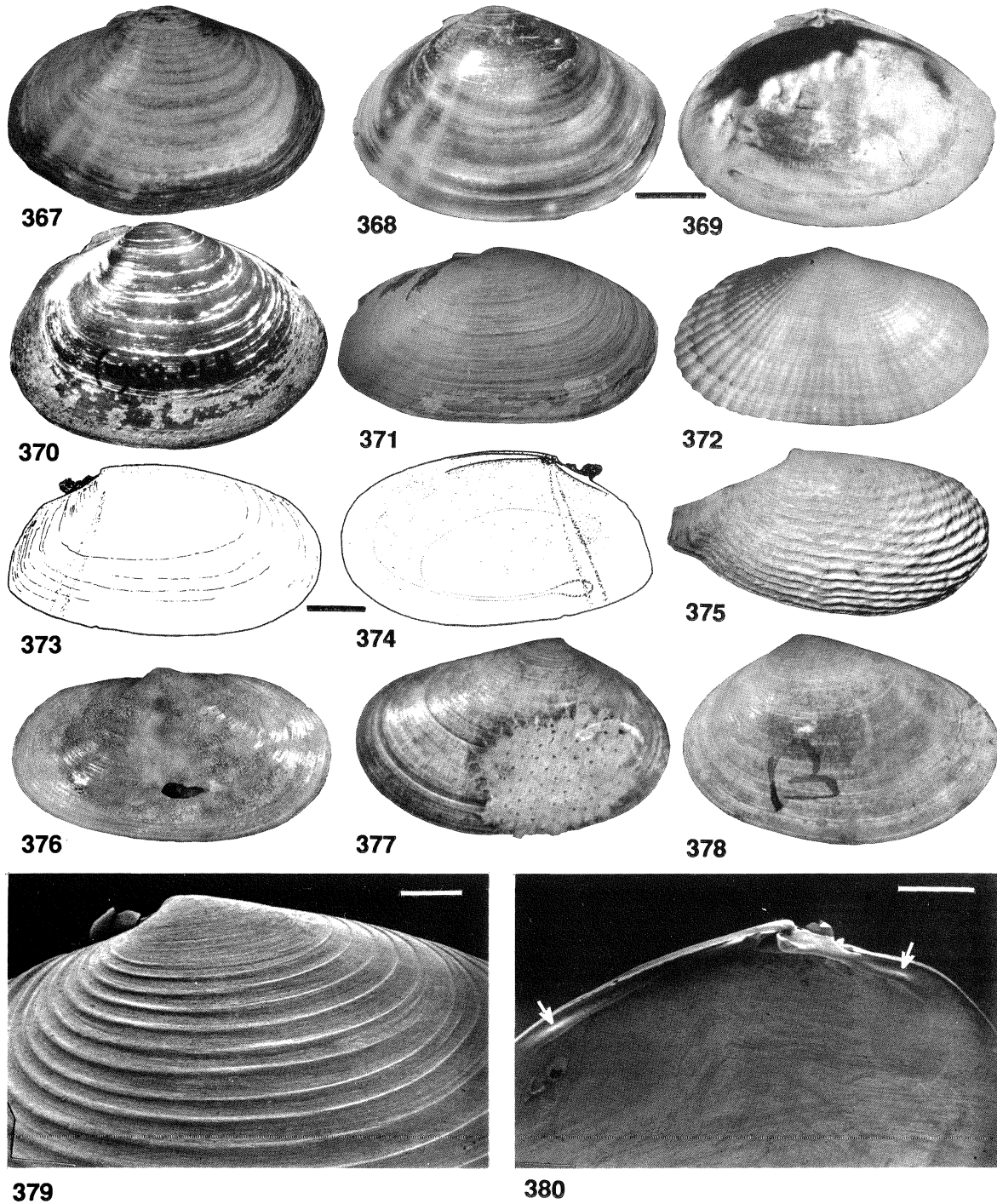
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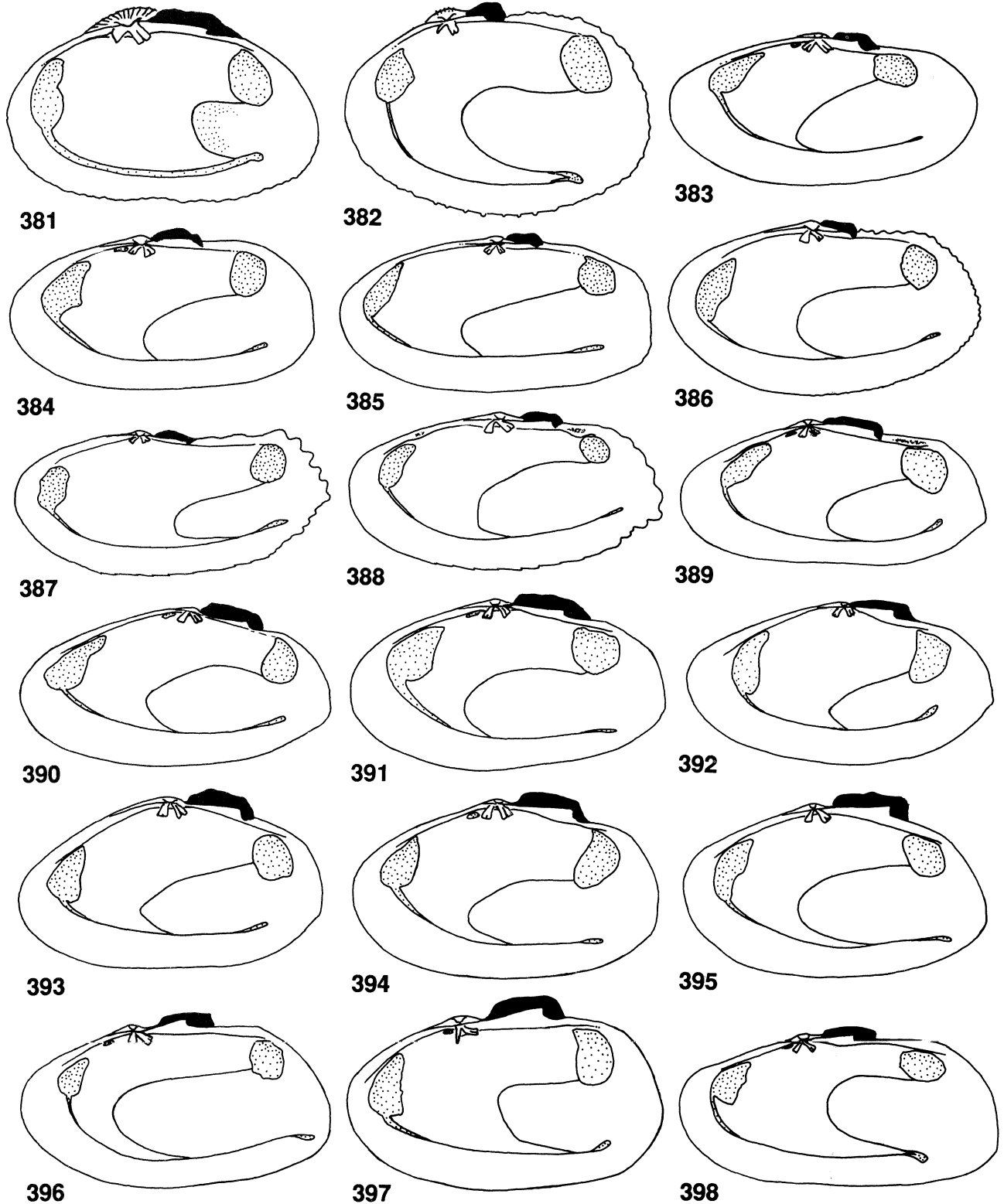
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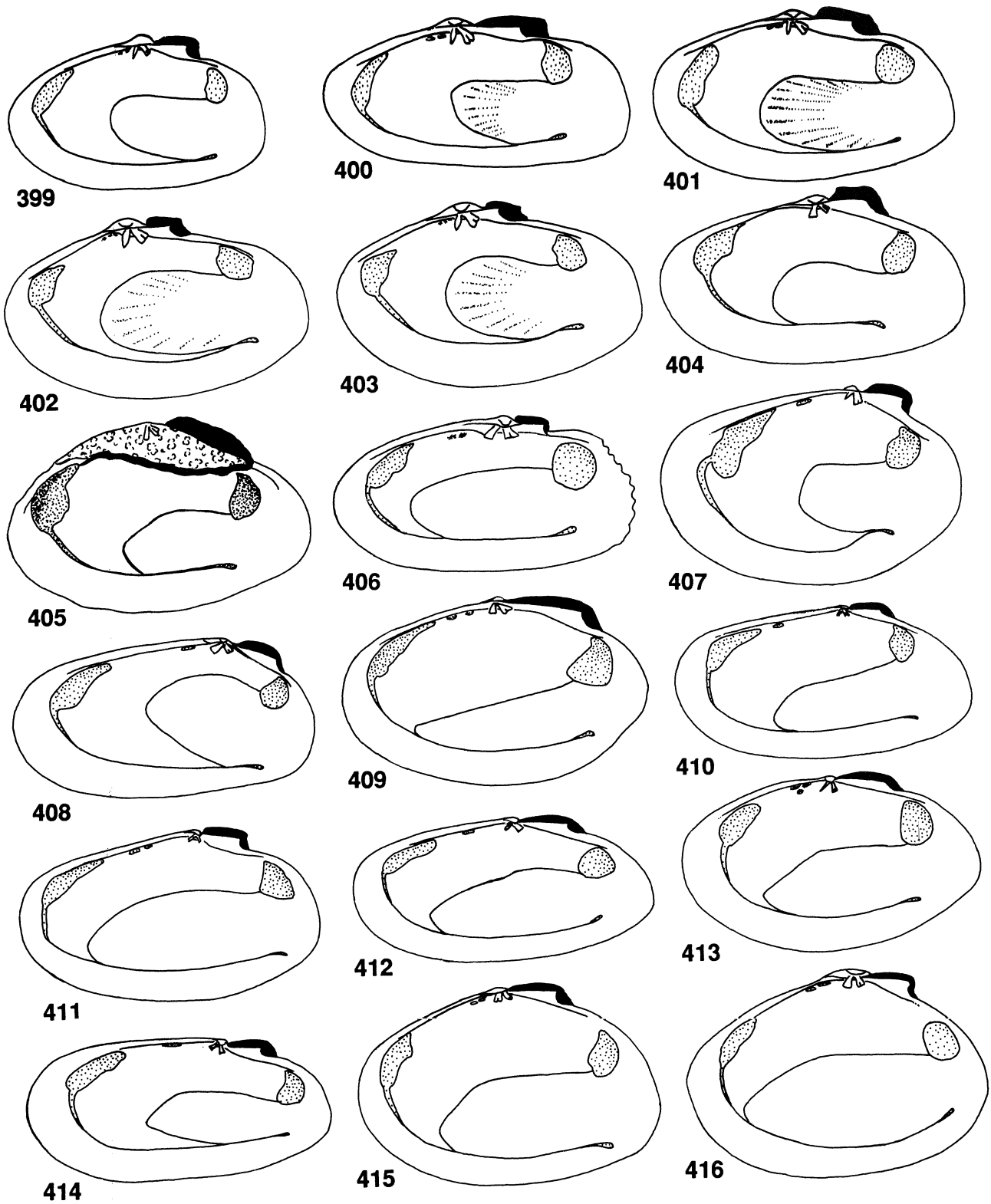
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