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Glycymeridid bivalves from Japan and adjacent areas. Part II, Indo-Western Pacific species of *Melaxinaea* Iredale, 1930 (Pliocene to Recent)

ABSTRACT: The glycymeridid bivalve genus *Melaxinaea* (Pliocene to Recent) was originally based on a Recent Queensland, Australia, species *M. labyrintha* Iredale, 1930, which may be a junior synonym of *M. vitrea* (Lamarck, 1819). The genus *Melaxinaea* is characterized by its strongly compressed shell, two straight rows of hinge teeth meeting at an angle, and divided and intercalated nodulose ribs and inner ventral crenulations. It should be placed in *Tucetona* group rather than in *Glycymeris* s.s. group in the Glycymerididae, because shells of *Melaxinaea* and *Tucetona* are ornamented with well-defined radial ribs and are without a velvety periostracum and fine striations on the shell surface in which radial rows of well-developed periostracum are inserted. In addition, their ligamental areas are always incised by distinct ligamental grooves. The genus *Melaxinaea* is however more specialized than *Tucetona*, because the ribs and inner ventral crenulations become divided and intercalated in ontogeny. The type material of the following species of *Melaxinaea*, *Tucetona*, and *Glycymeris* are illustrated: *M. vitrea*, *T. pectiniformis*, *T. hanzawai*, *T. subpectiniformis*, and *G. capricornea*.

INTRODUCTION

Iredale (1930) proposed the genus *Melaxinaea* based on a Recent strongly compressed species *Melaxinaea labyrintha* Iredale, 1930, from north Queensland, Australia. Various investigators gave their attention to this peculiar genus which is characterized by its shell shape, flatness, sculpture, and especially by two straight rows of hinge teeth (Habe 1951, 1977; Newell 1969; Matsukuma 1979), and Habe (1977) proposed recently the subfamily Melaxinaeinae. Although characteristics of the hinge plate have been considered as a most important and distinctive feature, I believe that sculpture and inner ventral crenulations of the shell are also very important characters in determining the systematic relationships among the glycymeridids. This is so because crenulations at the inner margin of the valves in *Glycymeris*, *Tucetona*, and *Melaxinaea*

always occur at a position corresponding with interstices between radial ribs or their equivalent at the outer shell surface. In the juvenile shell of *Melaxinaea*, crenulations have two well-defined shoulders at the anterior and posterior margins, and shoulders with the same characteristics are also known in many species of *Tucetona* and *Glycymeris*. Although the ribs of *Tucetona* are not divided or intercalated, those of *Melaxinaea* are usually divided one or two times with age and secondary and tertiary ribs are intercalated. Corresponding to this bifurcation and intercalation of ribs, the inner ventral crenulations are also divided and intercalated. The combination of ribs and crenulations appears to be a characteristic in common to all species of the Glycymerididae except the Arcullaeinae of Newell (1969). Species of *Melaxinaea* are however more specialized than those of *Tucetona* and *Glycymeris*.

In this paper, the type species of *Melaxinaea* is redescribed, some taxonomic characters such as surface ornamentation and inner ventral crenulations are discussed, and the Indo-Western Pacific species which have been placed in this genus are reviewed.

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SYSTEMATIC DESCRIPTION

Genus *MELAXINAEA* Iredale, 1930

Type species. — *Melaxinaea labyrintha* Iredale, 1930 [=*M. vitrea* (Lamarck, 1819)], by original designation; Recent; Albany Passage, north Queensland, Australia.

Diagnosis: Shell strongly compressed, ratio of convexity of both valves to shell length approximating 0.3 to 0.5; dorsal margin long and straight, giving an eared appearance to the shell; surface ornamented with nodulose primary ribs and intercalated secondary ribs, occasionally having intercalated tertiary ribs; primary and secondary ribs sometimes divided; apparently lacking well-developed velvety periostracum and periostracal striations[1] at the shell surface; two straight rows of almost horizontal, weak hinge teeth on a large, flat hinge plate meeting at an angle; primary inner ventral crenulations divided, occasionally secondary and tertiary crenulations intercalated.

[1] The term periostracal striations is meant as fine striations in which radial rows of hairy-type periostracum are inserted, usually occurring on the outer surface of shells of *Glycymeris* s.s.; it is almost synonymous to the secondary striations of Nicol (1950).

Range. — Pliocene (Chapman & Singleton 1925) to Recent.
Distribution. — Australia, New Guinea, Andaman Isls, Sri Lanka, Mauritius(?), Philippines, and Taiwan (Text-fig. 1).

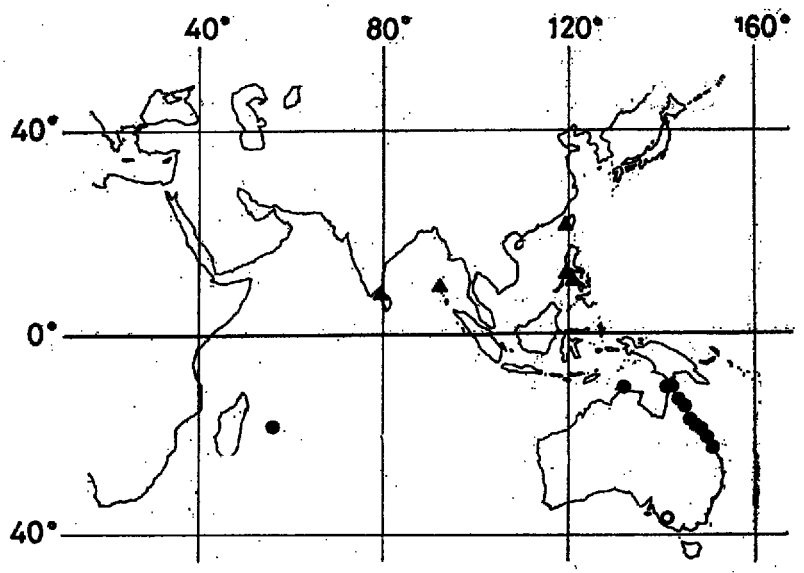

Fig. 1. Geographic distribution of fossil and Recent species of the genus *Melaxinaea*

Black spots denote — *M. vitrea* (Lamarck, 1819), Recent; black triangles — *M. planata* G. & H. Nevill, 1874), Recent; white circle — *M. planiuscula* (Chapman & Singleton, 1925), Pliocene

Melaxinaea vitrea (Lamarck, 1819)

(Text-fig. 2 and Pl. 1, Figs 1—3, Pl. 2, Fig. 6, Pl. 4, Fig. 2)

1819. *Pectunculus vitreus* Lamarck, p. 54.
1835. *Pectunculus vitreus* Lamarck; Deshayes & H. M. Edwards, p. 495.
1843. *Pectunculus vitreus* Lamarck; Reeve, *Pectunculus*, sp. 45, Pl. 8, Fig. 45*a-b* (Lamarcks's type material).
1879. *Pectunculus nova-guineensis* Angas, p. 420, Pl. 35, Fig. 10.
1880. *Pectunculus Angasi* Crosse, p. 272 [new name for Angas' species].
1885. *Pectunculus vitreus* Lamarck; E. A. Smith, p. 253.
1899. *Pectunculus vitreus* Lam.; Melvill & Standen, p. 187.
1912. *Pectunculus vitreus* Lamarck; Lamy, pp. 94—95.
non 1917. *Pectunculus vitreus* Lamarck; Odhner, p. 22, Pl. 1, Figs 12—13.
non 1925. *Glycymeris vitreus* (Lamarck); W. D. Smith, p. 315, Pl. 9, Fig. 15*a-l*
1930. *Melaxinaea labyrintha* Iredale, pp. 73—74, Pl. 9, Figs 1—4.
1931. *Melaxinaea litoralis* Iredale, p. 203.
non 1935. *Glycymeris vitrea* (Lamarck); Kuroda, app. p. 149.
1939. *Melaxinaea labyrintha* Iredale; Iredale, p. 303.
1939. *Melaxinaea litoralis* Iredale; Iredale, pp. 303—304, Pl. 4, Figs 13 and 13*a*.
1951. *Melanaxinaea labyrintha* Iredale; Habe, pp. 41—42, Figs 71—72.
non 1951. *Melanaxinaea vitrea* (Lamarck); Habe, p. 43.
1964. *Glycymeris (Melanaxinaea) labyrintha* (Iredale); Shikama, p. 41, Pl. 20, Fig. 9.
1966. *Melaxinaea labyrintha* Iredale, 1930; Habe & Kosuge, p. 129, Pl. 47, Fig. 15.
non 1973. *Melaxinaea vitrea* (Lamarck, 1818); Higo, p. 306.
1977. *Melaxinaea labyrintha* Iredale, 1930; Habe, pp. 44 and 48, Pl. 8, Figs 12—13.
non 1977. *Melaxinaea vitrea* (Lamarck, 1819); Habe, p. 48.

Diagnosis: Shell semi-orbicular, flattish, thin, a little oblique, somewhat eared in appearance; umbones small, pointed; ligamental area narrow and compressed, incised by ligamental

grooves; sculpture of well-defined radial ribs which become divided with age, and secondary and tertiary ribs intercalated; secondary ribs also divided; hinge teeth weak, almost horizontal; rows of anterior and posterior series of teeth meeting at an angle; inner ventral crenulations divided, secondary and tertiary crenulations intercalated; divided primary crenulations with only one shoulder, i.e. either anterior or posterior shoulder; secondary crenulations having no shoulder; inner striations corresponding to shoulders of crenulations. *Material: GK-M 10268 (77975)*, 2 conjoined specimens dredged in 1963 from Keppel Bay, central north Queensland, Australia, stored at the Department of Geology, Kyushu University; *NSMT 42030*, 3 conjoined specimens and a left valve, and *NSMT 50736*, 6 conjoined specimens and a right valve dredged all from Arafura Sea, stored in the National Science Museum, Tokyo.

Description. — Shell moderate in size, very compressed, thin. Dorsal margin straight, sometimes forming ear-like angles. Ventral margin rounded. Outer surface cream in color, with small irregular brown spots. Inner coloration white, somewhat transparent. Posterior half of the inner surface tinged with light brown, occasionally white inner striations. Hinge composed of two straight rows of teeth meeting at an angle; usually central part of the dental series obliterated with age by intrusion of the ligamental area. Hinge teeth weak, placed nearly parallel to the dorsal margin. 14—15 hinge teeth in anterior series, 12—13 in posterior series. Ligament with 4—5 sets of chevron-shaped lamellar and fibrous layers, amphidetic. Ligamental area narrow and compressed, incised by 4—5 ligamental grooves. Umbones small, pointed, located almost in the middle of dorsal margin, orthogyrate. Primary

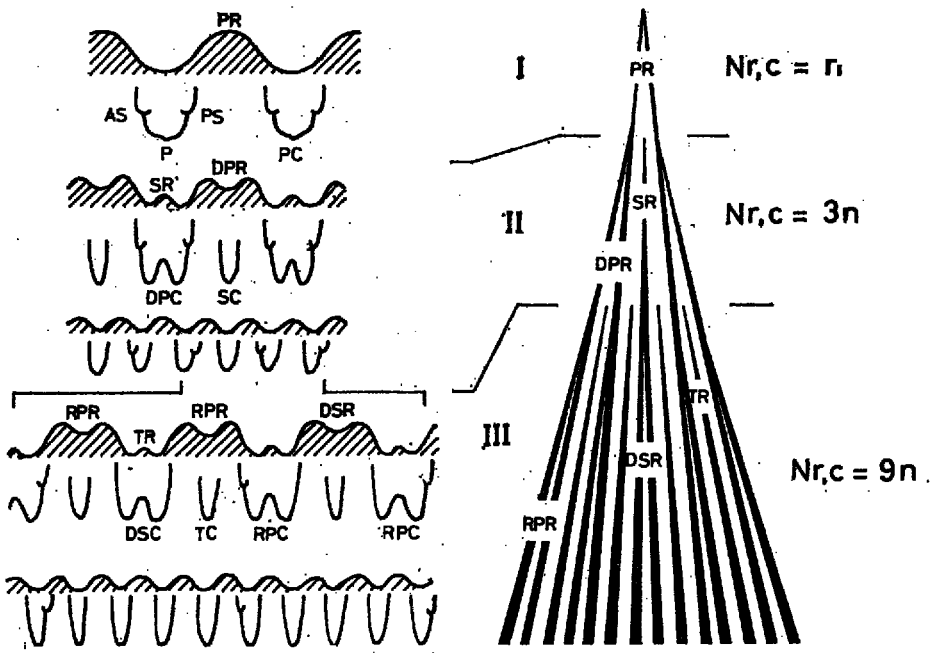

Fig. 2. Ribs and inner ventral crenulations in *Melaxinaea vitrea* (Lamarck, 1819); I, II, III successive ontogenetic stages

Nr, *c* number of ribs or crenulations, *AS* anterior shoulder, *DPC* divided primary crenulation, *DPR* divided primary rib, *DSC* divided secondary crenulation, *DSR* divided secondary rib, *P* peak of crenulation, *PC* primary crenulation, *PR* primary rib, *PS* posterior shoulder, RPC redivided primary crenulation, *RPR* redivided primary rib, *SC* secondary crenulation, *SR* secondary rib, *TC* tertiary crenulation, *TR* tertiary rib

inner ventral crenulations with anterior and posterior shoulders. Each divided primary crenulation and a half of each redivided primary crenulation with only one shoulder. The other half of each redivided primary crenulation, and all intercalated secondary and tertiary crenulations and divided secondary crenulations having no shoulder. Anterior adductor scar subtrigonal, slightly smaller than the ovate posterior scar with weak flange at its anterior side. Concentric surface ornamentation feeble. Radial ornamentation lacking fine striations and well-developed periostracum, split and intercalated with age. Primary ribs regularly split into two equal

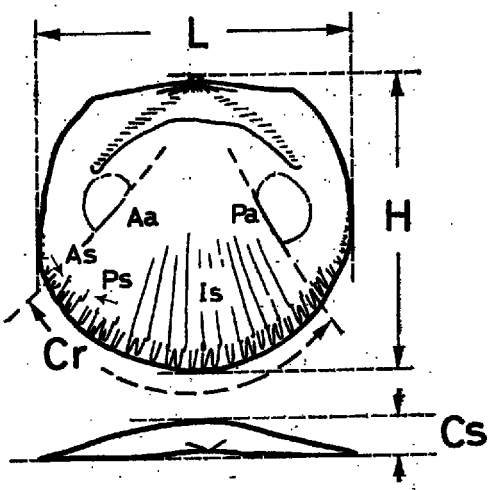

Fig. 3

Measurements and inner surface features of the *Melaxinaea* shell (right valve)

L shell length, *H* shell height, *Cs* convexity of single valve, *Cr* number of primary crenulations
Aa anterior adductor scar, *Pa* posterior adductor scar, *As* anterior shoulder, *Ps* posterior shoulder, *Is* inner striation

radials at 6—7 mm in shell length; small secondary ribs developed in interstices between an anterior, divided primary rib and a posterior, divided primary rib originated from another primary rib. At about 12 or more millimeters in length, secondary ribs develop at the same strength as divided primary ribs. At 25—30 mm in length, secondary ribs and divided primary ribs bifurcate and intercalated small tertiary ribs appear. Inner ventral crenulations always at a position corresponding with interstices between radial ribs of various kinds.

Measurements (in *mm*). — See Table 1 (for definition of the measurements *see* Text-fig. 3).

Discussion. — According to Iredale (1930), *M. labyrintha* was the correct name for the species previously identified as *Glycymeris vitrea* (Lamarck), and he emphasized that (*i*) the material described by Lamarck was collected by Péron, while *M. labyrintha* is only taken by dredging in Queensland, Australia, where Péron did not collect; (*ii*) Lamarck's species was a thin brittle shell, but *M. labyrintha* is not; and (*iii*) Reeve's figures of the holotype of *P. vitreus* presented a differently shaped shell with a more complex sculpture, the ears especially differing. Iredale (1930) concluded that Lamarck's material had probably come from Western Australia where Odhner (1917) subsequently recorded a small eared species called *Glycymeris vitreus* Lamarck (=*Tucetona odhneri* Iredale, 1939), and noted that Lamarck's species apparently bears a resemblance to Odhner's one. These two forms do however not appear to be conspecific. Odhner's shell is ornamented with rather strong radial ribs which are not divided or intercalated. Although the material from Mauritius has not been described or figured, *P. vitreus* and *M. labyrintha* are recorded not only in Queensland but also in Northern Territory (Australia), Arafura Sea, south of New Guinea, and Mauritius (Angas

1879; E. A. Smith 1885; Lamy 1912; Shikama 1964; Habe & Kosuge 1966; Dr. J. Kerslake, *pers. comm.* 1979). The anterior and posterior ears of the holotype of *P. vitreus* are broken, while the shell surface is ornamented with bifurcated, nodulose primary ribs and intercalated secondary ribs (Pl. 1, Fig. 1) which are the same as those in *M. labyrintha*. Although Iredale (1930) pointed out some discrepancies between both species based on Lamarck's original description and Reeve's figures of the type material, Reeve (1834) did not give detailed figures and one cannot find any substantial differences between *P. vitreus* and *M. labyrintha*.

Iredale (1931) proposed also another species of *Melaxinaea*, *M. litoralis*, from Innisfail, north Queensland, and the species has been described as follows: it is

Table 1

Material	valve	length	height	convexity of single v.	convexity of both v.	number of primary crenulations*
GK-M 10268 (77975)a	R	37.4	35.7	6.2	11.7	8
	L	37.3	35.7	6.1		
GK-M 10268 (77975)b	R	33.5	31.9	4.8	9.1	8
	L	33.5	31.9	4.7		
NSMT42030-1	R	33.7	32.2	5.3	10.1	8
	L	33.6	32.2	5.2		
NSMT42030-2	R	39.5	39.6	6.7	12.9	9
	L	39.5	39.5	6.6		
NSMT42030-3	R	47.7	46.5	9.3	18.1	—
	L	48.4	46.0	9.3		
NSMT42030-4	L	—	—	7.9	—	9
NSMT50736-1	R	20.8	19.9	3.6	—	—
NSMT50736-2	R	38.3	38.0	7.0	13.3	8
	L	38.6	38.2	7.0		
NSMT50736-3	R	33.0	32.4	5.2	10.1	8.5
	L	33.2	32.6	5.2		
NSMT50736-4	R	34.0	32.2	5.5	10.8	9
	L	33.9	32.2	5.8		
NSMT50736	R	42.0	(40.0)	8.0	15.0	9
	L	41.9	(40.1)	7.6		
NSMT50736-6	R	44.9	42.9	6.8	12.8	7
	L	44.9	42.9	6.7		
NSMT50736-7	R					
	L	52.3	50.7	—	17.4	—
type of P. vitreus	R	34.3	33.0	5.3	—	—
type of M. labyrintha	R					
	L	37	38	—	12	—

* Number of primary crenulations which occur at a position of the ventral margin between anterior side of the posterior adductor scar and posterior side of the anterior adductor scar

just as flat as *M. labyrintha* and has the same generic hinge line, but it differs at sight in lacking the pronounced ears, being nearly circular in outline, and the sculpture consists of closely packed radials with a fine lattice of threads. Iredale (1939) noted subsequently that some fine specimens of *M. litoralis* secured on the beach at Seaforth, north of Mackay, Australia, are not so very different from the reef shell (=*M. labyrintha*), being only a little less oblique, more circular in shell outline, and perhaps growing to a larger size. It is believed that *M. litoralis* is one of the morphological varieties or coastal representatives of *M. labyrintha*.

The species *P. novaguineensis* Angas, 1879, may also be conspecific with *P. vitreus*, because the sculpture is of the same nature as in *P. vitreus*. According to E. A. Smith (1885), *P. novaguineensis* and *P. vitreus* have the same generic hinge line. Angas (1879) gave the following measurements of his type material housed at the British Museum (Natural History) under the registration number *1879.9.6.2*: length 33.9 mm, height 31.8 mm, and convexity (of both valves?) 14.8 mm. If the measurements given by Angas are sufficiently reliable, the convexity is considerably greater than that of *P. vitreus*. The species *P. novaguineensis* should be treated as being conspecific wtih *P. vitreus* with some reservation until the type material is re-examined.

Habe (1951) and Higo (1973) advocated that *Glycymeris subpectiniformis* Nomura & Zinbo, 1934, is a junior synonym of *M. vitrea* (Lamarck). Nomura & Zinbo's species was originally described from the Pleistocene Ryukyu Limestone of Kikaijima, Kagoshima Prefecture, Japan, and has an arched strong dental series and strong radial ribs which are not bifurcated or intercalated; it should be placed in *Tucetona*.

Nomura & Zinbo (1934) also described a small species from the same strata of Kikaijima under the name *Glycymeris pectinata* (Lamarck) [error for (Gmelin)]. In turn, Kuroda (1935) and Habe (1977) considered that *T. pectinata* is a species from the eastern coasts of Central America, while Nomura & Zinbo's species is identical with *M. vitrea*. According to the re-examination of Nomura & Zinbo's material stored in the Tohoku University (registration number *IGPS 50195*), the shell is circular in shape, with an arched dental series and numerous hinge teeth set in radially; it has strong radial ribs which are not divided (Pl. 4, Fig. 5*a*). In the author's opinion, *Glycymeris pectinata* (Lamarck) *sensu* Nomura & Zinbo, 1934, *G. vitreus* (Lamarck) *sensu* W. D. Smith, 1925, and *Pectunculus pectiniformis* Lam. var. Martin, 1885, are identical with *Tucetona sindiensis* (Vredenburg, 1928).

Range. — Recent.

Distribution. — New Guinea (Angas 1879, E. A. Smith 1885); Arafura Sea (Shikama 1964, Habe & Kosuge 1966); Australia: Northern Territory (Australian Museum), Torres Straits (Melvill & Standen 1899, Lamy 1912, Iredale 1930), Queensland (E. A. Smith 1885; Lamy 1912; Iredale 1930, 1931, 1939; Australian Museum).

RIBS AND CRENULATIONS OF *MELAXINAEA*, *TUCETONA*, AND *GLYCYMERIS*

Historically, inner ventral crenulations have not been considered to be one of important distinctive characters of the Glycymerididae. For example, Nicol (1945) noted that the inner ventral border is nearly always crenulated. Lamarck (1805, 1819), Deshayes (1824—1837), Reeve (1843), Mayer (1868), and Rochebrune & Mobille (1889) put the following species without inner ventral crenulations into the Glycymerididae: *Pectunculus nuculatus* Lamarck, 1805; *Arca multistriata*

Forskaal, 1775; *Felicia jousseaumei* Mabille & Rochebrune *in* Rochebrune & Mabille, 1889 (= *Limopsis marionensis* E. A. Smith, 1885). Those species are now accepted as members of the Limopsidae. Although some Tertiary and Cretaceous species, e.g. *Arcullaea limopsiformis* H. E. Vokes, 1946, *Ewekoromeris ewekoroensis* (Adegoke, 1977), *Peruarca pectunculoides* Olsson, 1944, *Pettersia abnormalis* (Olsson, 1944), *Protarca obliqua* Stephenson, 1923, and *Trigonarca maconensis* (Conrad, 1860), also have a smooth inner ventral border, they have been placed in the Glycymerididae. In fact, they bear superficial resemblance to the Glycymerididae, Limopsidae, Cucullaeidae, and Arcidae. Their systematic position is not agreed upon among current systematic arrangements of fossil and Recent bivalves, and will be discussed separately.

The Glycymerididae excepting the Arcullaeinae of Newell (1969) consist of two broad groups, i.e. *Tucetona* group and *Glycymeris* s.s. group, and *Melaxinaea* should be placed in *Tucetona* group. In this paper, the name *Tucetona* is used for species with an incised ligamental area, strong radial ribs, and lacking well-developed velvety periostracum and fine periostracal striations at the outer shell surface. The name *Glycymeris* is used for species with an incised or smooth ligamental area, nearly smooth shell, well-developed pilose periostracum and periostracal striations. The specific name of the Recent European species *Glycymeris pilosa* (Linnaeus, 1767) is derived from its dense hairy-type periostracum.

Inner ventral crenulations of various species of *Tucetona* always occur at a position corresponding with interstices between strong primary ribs which are never divided or intercalated (Pl. 3, Figs 1—6; *see also* Nicol 1950); the crenulations have two fairly distinct shoulders at the anterior and posterior margins (Pl. 2, Fig. 1; Pl. 3, Figs 4—6). Although species of *Glycymeris* usually lack distinct radial ribs, some species such as *Glycymeris densilineata* Nagao, 1934, *G. reevei* (Mayer, 1868), and *G. capricornea* Hedley, 1906, have low, rounded, striated ribs or radial riblets with sharp crest (Pl. 2, Fig. 2 and Pl. 4, Fig. 3; *see also* Hayami 1965). Crenulations of these species also occur at a position corresponding with interstices between their radials and also have two shoulders. The ventral crenulations of the Pliocene New Zealand species *Glycymeris manaiaensis* Marwick, 1923, have very distinct anterior and posterior shoulders (Pl. 4, Fig. 1c). The shell surface of *G. manaiaensis* is ornamented with very fine radial grooves which correspond with peaks of the inner ventral crenulations. At the outer shell surface of *Glycymeris*, the crenulations sometimes appear as fine, radial white lines. The specific name of the Recent Japanese species *G. albolineata* (Lischke, 1872) is derived from these white lines (Pl. 4, Fig. 4). In the shell of *G. vestita* (Dunker, 1877) from Japanese coasts, the white lines occur at a position between very low, rounded radials with dense periostracal striations. The white lines and fine radial grooves at the shell surface of *G. manaiaensis*, *G. albolineata*, and *G. vestita* are never divided or intercalated. It is therefore believed that surface ornamentation and inner ventral crenulations in *Glycymeris* are hardly distinguishable from those in *Tucetona*.

In juvenile *Melaxinaea vitrea* (less than 6—7 mm in length), the outer shell surface is ornamented with strong radial ribs, while the inner ventral margin is roughly crenulated. According to the figure given by Iredale (1930), the crenulations appear to have anterior and posterior shoulders. These crenulations and radial ribs of the juvenile shells of *Melaxinaea* are similar to those of *Tucetona* and *Glycymeris* which are here named primary ribs and primary crenulations. With age, the primary ribs are divided in *M. vitrea* and secondary ribs are intercalated at a position between the primary ribs. Corresponding to the bifurcation of the primary ribs, the secondary crenulations without distinct

shoulders appear at a position between the primary ribs (Text-fig. 2). As a result of the secondary rib intercalation, each primary crenulation is divided into two smaller crenulations (*DPC* in Text-fig. 2) each with only one shoulder. The species *Glycymeris martini* Finlay, 1927 (= *Pectunculus orbicularis* Martin, 1885; *non* da Costa, 1778; *non* Angas, 1879), which was originally described from the Pliocene rocks of Java, also has regularly divided and intercalated riblets (Pl. 2, Fig. 3). Although its periostracum cannot be observed, it is thought that furrows between the fine riblets may be their periostracal striations, because they are smaller in size than interspaces between ribs of *Melaxinaea* and the ventral crenulations of *G. martini* do not occur at a position corresponding with the interstices between the riblets.

In large specimens of *M. vitrea* (more than 35—40 mm in length), the divided primary ribs and the secondary ribs are redivided or divided and small tertiary ribs are intercalated. At the ventral margin, the divided primary crenulations are redivided and the secondary crenulations are also divided. Occasionally, tertiary crenulations without distinct shoulders are intercalated. This evidence on the bifurcation and intercalation of ribs and crenulations suggests that *Melaxinaea* may be the most specialized form in *Tucetona* group.

REVIEW OF INDO-WESTERN PACIFIC SPECIES OF *MELAXINAEA*

A number of workers put the following Recent and fossil species in *Melaxinaea*: *M. labyrintha* Iredale, 1930; *M. litoralis* Iredale, 1931; *Axinactis (Melaxinaea) clarki* Nicol, 1951; *Pectunculus vitreus* Lamarck, 1819; *P. pectiniformis* Lamarck, 1819; *P. novaguineensis* Angas, 1879; *P. hoylei* Melvill & Standen, 1899; *Glycymeris planiuscula* Chapman & Singleton, 1925; *G. subpectiniformis* Nomura & Zinbo, 1934; *G. pectinata* (Lamarck) *sensu* Nomura & Zinbo, 1934; and *G. prashadi* Nicol, 1951 (*see* Iredale 1930, 1931, 1939; Kuroda 1935, 1960; Habe 1951, 1961, 1977; Nicol 1951; Darragh 1970; Shuto 1971; Muraoka 1972; Higo 1973). Of these species, *M. labyrintha, M. litoralis, P. vitreus, P. novaguineensis, G. subpectiniformis,* and *G. pectinata* are already described and discussed in the section on the type species of *Melaxinaea.*

It is believed that *P. pectiniformis, P. hoylei, G. subpectiniformis,* and *G. prashadi* are in fact referable to *Tucetona,* because their shells are ornamented with strong ribs which are not divided or intercalated, and their inner ventral crenulations always have two shoulders. Therefore, described here are only two species, *G. planiuscula* and *A. (M.) clarki* [= *M. planata* (G. & H. Nevill, 1874)]. Unfortunately, specimens of *G. planiuscula* have not been consulted by the author, and the diagnosis is an extract of the original description given by Chapman & Singleton (1925). The species *M. pectiniformis* (Lamarck, 1819) *sensu* Shuto, 1971, from the Pliocene Dingle Formation of Iloilo Basin, Panay Island, Philippines, has a strongly compressed shell and two straight rows of hinge teeth meeting at an angle. The material collected and

described by Shuto (1971) consists of young specimens only. Although these shells are ornamented with ribs which are not divided or intercalated, they belong to a species which is evidently not *P. pectiniformis* [= *P. pectunculus* (Linnaeus, 1758)] and may be a new species of *Melaxinaea*.

Melaxinaea planata (G. & H. Nevill, 1874)
(Pl. 2, Fig. 5)

1874. ***Pectunculus planatus*** G. & H. Nevill, p. 29, Pl. 1, Figs 16 and 16*a*.
1951. ***Axinactis (Melaxinaea) clarki*** Nicol, pp. 20—21, Figs 1—3.
1966. ***Melaxinaea subpectiniformis*** (Nomura et Zinbo, 1934); Habe & Kosuge, pp. 128—129, Pl. 47, Fig. 12.
1972. ***Melaxinaea dautzenbergi*** (Prashad); Muraoka, p. 143, Pl. 12, Fig. 2.

Diagnosis (after the original description): Shell flat, orbicular, with umbonal margin perfectly straight and much produced; color white, mottled and variegated with reddish-brown interior mottled with brown; 24 longitudinal ribs each one divided by a deep groove in the center, almost fimbriately decussated with crowded transverse striae throughout; hinge teeth 14 in number at the posterior and 11 at the anterior side; interior distinctly grooved; diam. (length ?) 14.5 mm, long. (height ?) 14 mm, alt. (convexity of single valve ?) 4 mm.
Material: ***NSMT 42015***, a right valve from Taiwan, stored in the National Science Museum, Tokyo; ***602-4-845***, 3 conjoined specimens, ***761-2139***, a conjoined specimens and 2 left valves, ***761-3966***, 3 conjoined specimens, all of them from Taiwan, stored in the Kanagawa Prefectural Museum (Natural History); and a conjoined specimen from Taiwan in Dr. Kuroda's collection (no number).

Description. — Shell flat, solid, with straight dorsal margin and rounded ventral margin. Ligamental area narrow and compressed, fairly incised by 4—5 ligamental grooves. Shell surface ornamented with straight-sided primary ribs with very shallow to rather deep central grooves. Anterior and posterior ends of shell have very weak secondary ribs intercalated, with very small secondary crenulations intercalated and occasionally primary crenulations weakly divided at the ventral margin.

Nicol (1951) gave a description of this species [as *A. (M.) clarki*] and the following is the essential characteristics: Ratio of convexity (of both valves) to shell height approximating 0.5; ribs in the central part of shell flat-topped, often with a shallow central groove, split into fine, slightly nodulose, crooked riblets at either end of shell; occasionally a small radial rib added in interspace.

Measurements (in *mm*). — See Table 2 (for definition of the measurements *see* Text-fig. 3).

Range. — Recent.

Distribution. — Andaman Isls (G. & H. Nevill 1974); Philippines (Nicol 1951); Taiwan (Habe & Kosuge 1966, Muraoka 1972); Palk Strait, Ceylon (Australian Museum).

Melaxinaea planiuscula (Chapman & Singleton, 1925)

1925. ***Glycymeris planiuscula*** Chapman & Singleton, p. 43, Pl. 3, Figs 26—28 and Pl. 4, Figs 17—18.
1951. ***Glycymeris planiuscula*** Chapman & Singleton; Nicol, p. 21.
1970. ***Melaxinaea planiuscula*** (Chapman & Singleton, 1925); Darragh, p. 144.

Diagnosis (after the original description): Ventral border evenly rounded, dorsal line straight and extensive, longer at the anterior side; umbo minute, acute, slightly opisthogyrate; costae about 34 in number, rounded and rather depressed, with linear interspaces, crossed by fine thread-like growth lines; hinge area comparatively deep and flat, the

entire internal margin having a strongly planated character; hinge teeth strong, oblique, numbering about 8 at each side; ligamental area small, incised; inner ventral margin denticulate and excavate in opposition to the external costae.

Measurements (in *mm*; after Chapman & Singleton 1925):

material	length	height	convexity of single valve
holotype	19.5	16.5	3.0
paratype	11.5	11.0	2.0
paratype	32.5	34.0	6.5

Table 2

Material	valve	length	height	convexity of single v.	convexity of both v.	number of primary crenulations
no. 602-4-845a	R	33.4	32.1	9.3	—	11
	L	33.3	32.2	9.1		11
602-4-845b	R	31.4	29.5	7.6	—	13
	L	31.3	29.5	7.6		13
602-4-845c	R	26.7	26.1	7.6	—	12
	L	26.8	25.7	7.5		12
761-2139a	R	25.4	25.3	7.3	—	12
	L	25.4	25.3	7.3		12
761-2139b	L	24.5	23.3	6.4	—	10
761-2139c	L	(24.3)	23.8	5.7	—	12
761-3966a	R	40.0	39.8	11.5	—	11
	L	39.7	39.8	11.3		11
761-3966b	R	41.0	39.3	10.4	20.0	13
	L	40.5	39.4	10.5		13
761-3966c	R	32.9	32.0	9.1	17.4	11
	L	32.6	32.1	9.2		11
NSMT 42015	R	(32.7)	(31.5)	8.9	—	11
Kuroda Coll.	R	28.8	27.7	—	14.1	11
				—		11
Nicol's material 236879 (holotype)	R+L	34.6	34.0	—	18.1	—
293039 (paratype)	R+L	20.6	20.0	—	10.0	—
293039a (do.)	R+L	17.0	16.8	—	8.0	—
293039b (do.)	R+L	17.0	16.6	—	8.4	—
293039c (do.)	R+L	16.4	16.4	—	8.6	—
293039d (do.)	R+L	15.9	15.8	—	7.8	—
293039e (do.)	R+L	15.0	14.4	—	7.8	—
293039f (do.)	R+L	15.4	15.4	—	7.6	—
293039g (do.)	R+L	11.6	12.3	—	6.4	—

Range. — Pliocene.

Distribution. — Australia: Hamilton, Victoria (Chapman & Singleton 1925).

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PLATE 1

Melaxinaea vitrea (Lamarck, 1819)

1 Outer (*1a*) and inner (*1b*) views of the holotype of *Pectunculus vitreus* Lamarck, 1819, ×2; Lamarck collection, Muséum National d'Histoire Naturelle in Paris; Recent; Australia (Photos courtesy of Mr. A. Foubert)

2 Outer view of the right valve (*2a*) and inner view of the left valve (*2b*) of the same specimen, ×1.5; Kyushu University, *GK-M 10268 (77975)a*; Recent; Keppel Bay, Queensland, Australia

3 Outer (*3a*) and inner (*3b*) views of a right valve, ×1.5; Kyushu University, *GK-M 10268 (77975)b*; Recent; Keppel Bay, Queensland, Australia

PLATE 2

1 *Tucetona subpectiniformis* (Nomura & Zinbo, 1934). Outer (*1a*) and inner (*1b*) views of the holotype of *Glycymeris subpectiniformis* Nomura & Zinbo, 1934, ×1.5; Tohoku University, *IGPS 50200*; Pleistocene Ryukyu Limestone; Kikaijima, Kagoshima Pref., Japan

2 *Glycymeris capricornea* Hedley, 1906. Outer view of the paratype, ×2.5; Kyushu University, *GK-M 10250*; Recent; Capricorn Group, Queensland, Australia

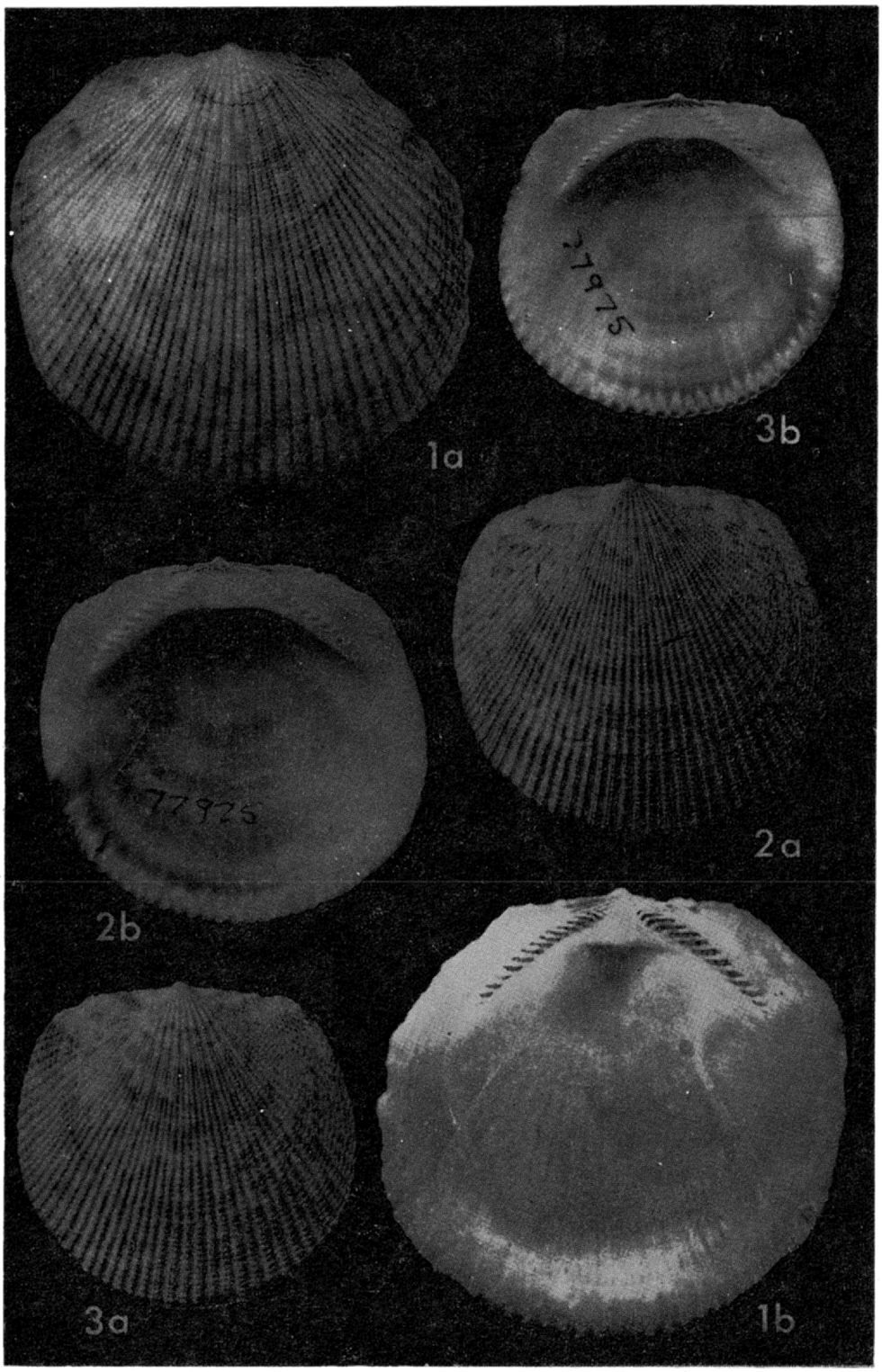
3 *Glycymeris martini* Finlay, 1927. Outer (*3a*) and inner (*3b*) views of a left valve, ×6; Kyushu University, *GK-M 10294*; Recent; Okinawa Pref., Japan

4 *Glycymeris pilsbryi* (Yokoyama, 1920). Periostracal striations at a right valve, ×1.5; Kyushu University, *GK-L 10300*; Pleistocene Narita Group; Ochi-Shimoshinden, Chiba Pref., Japan

5 *Melaxinaea planata* (G. & H. Nevill, 1874). Outer (*5a*) and inner (*5b*) views of a right valve, ×1.5; Kuroda collection; Recent; Kaohsiung, Taiwan

6 *Melaxinaea vitrea* (Lamarck, 1819). Inner ventral crenulations at the same specimen as in Pl. 1, Fig. 3; ×5.1

AS anterior shoulder, *DPC* divided primary crenulation with either anterior or posterior shoulder, *PS* posterior shoulder, *RPC* redivided primary crenulation, *SC* secondary crenulation without shoulder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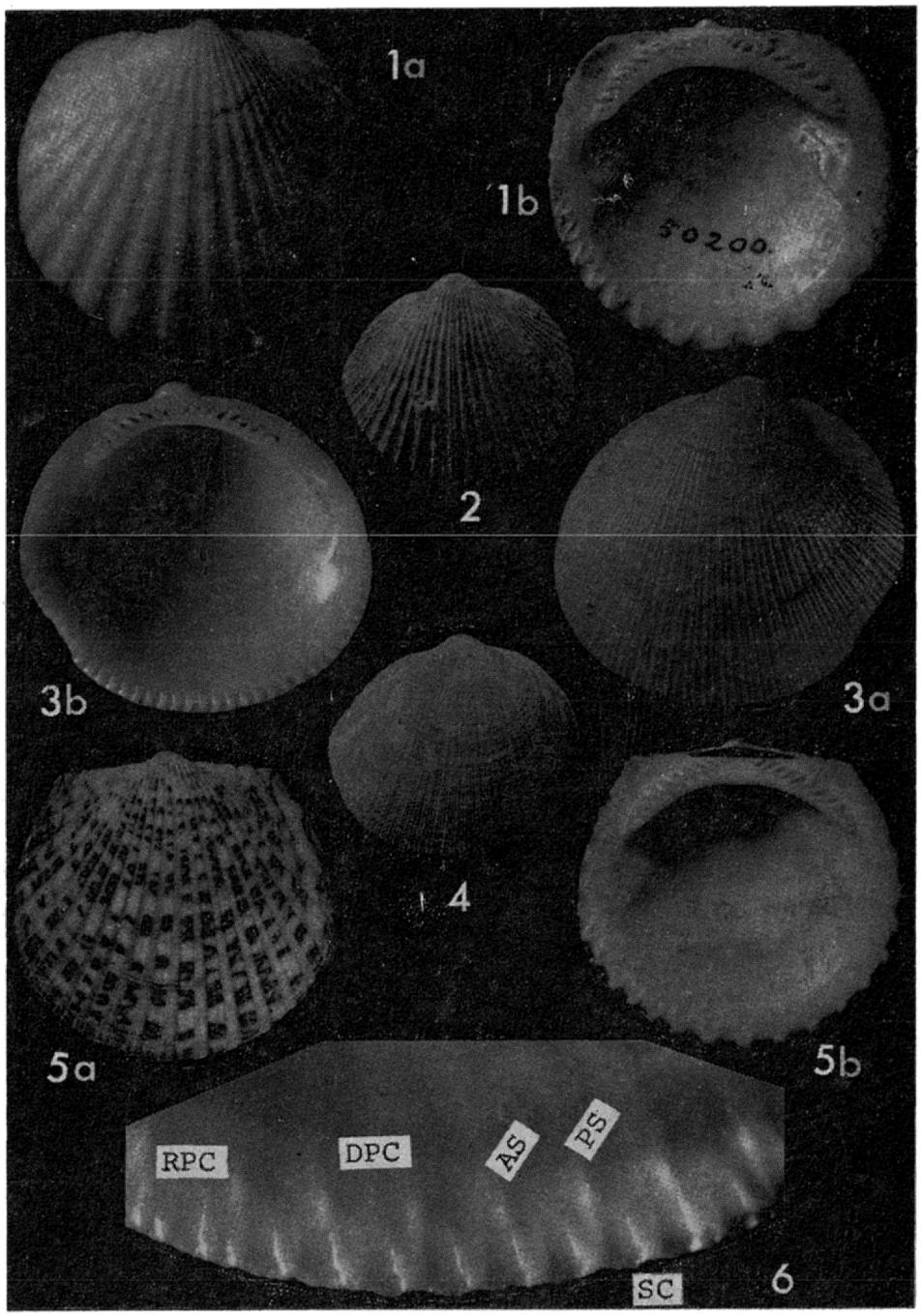
2a
77925
2b
3a
1b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5a
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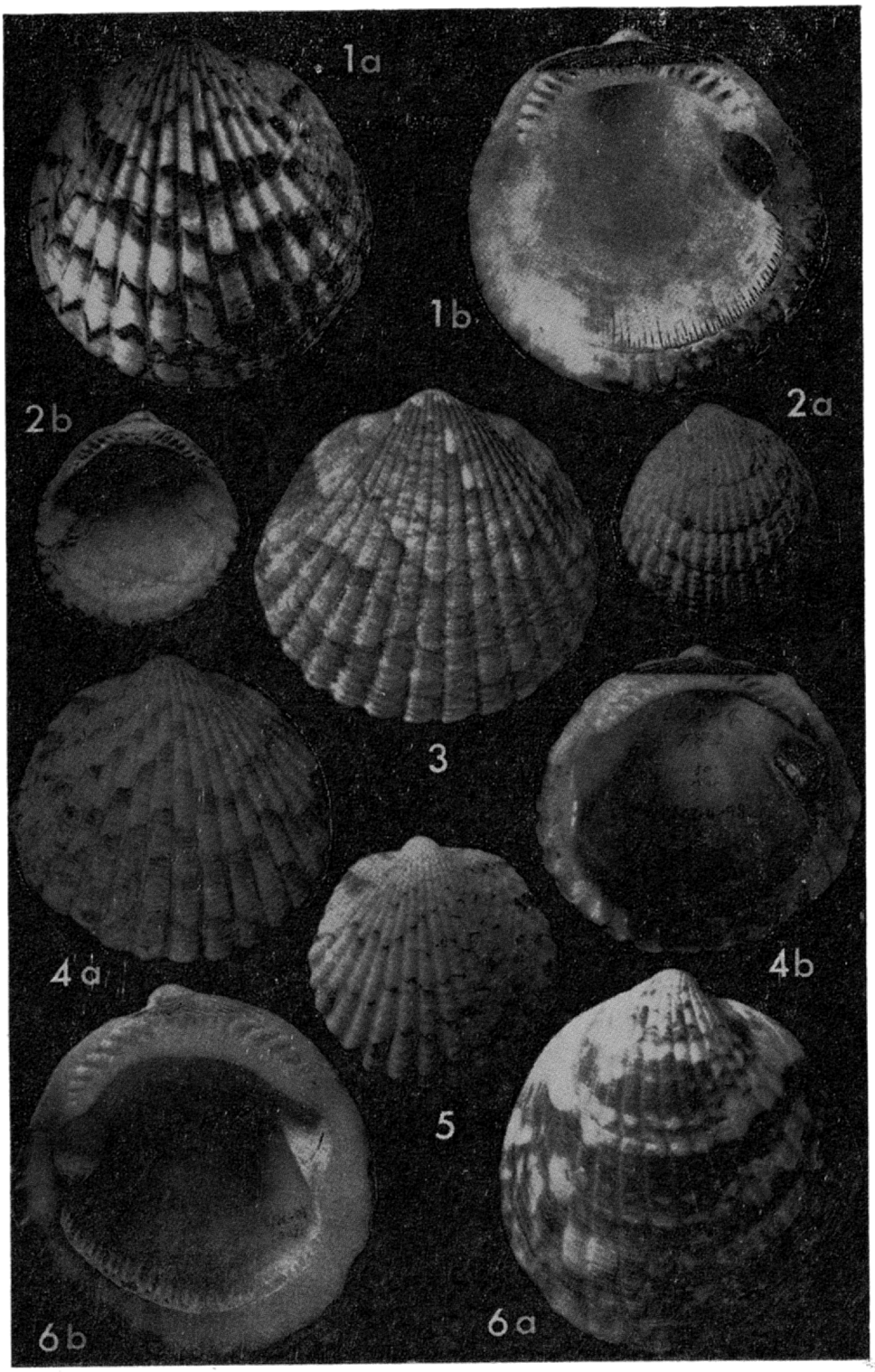
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3
4a
4b
5
6b
6a

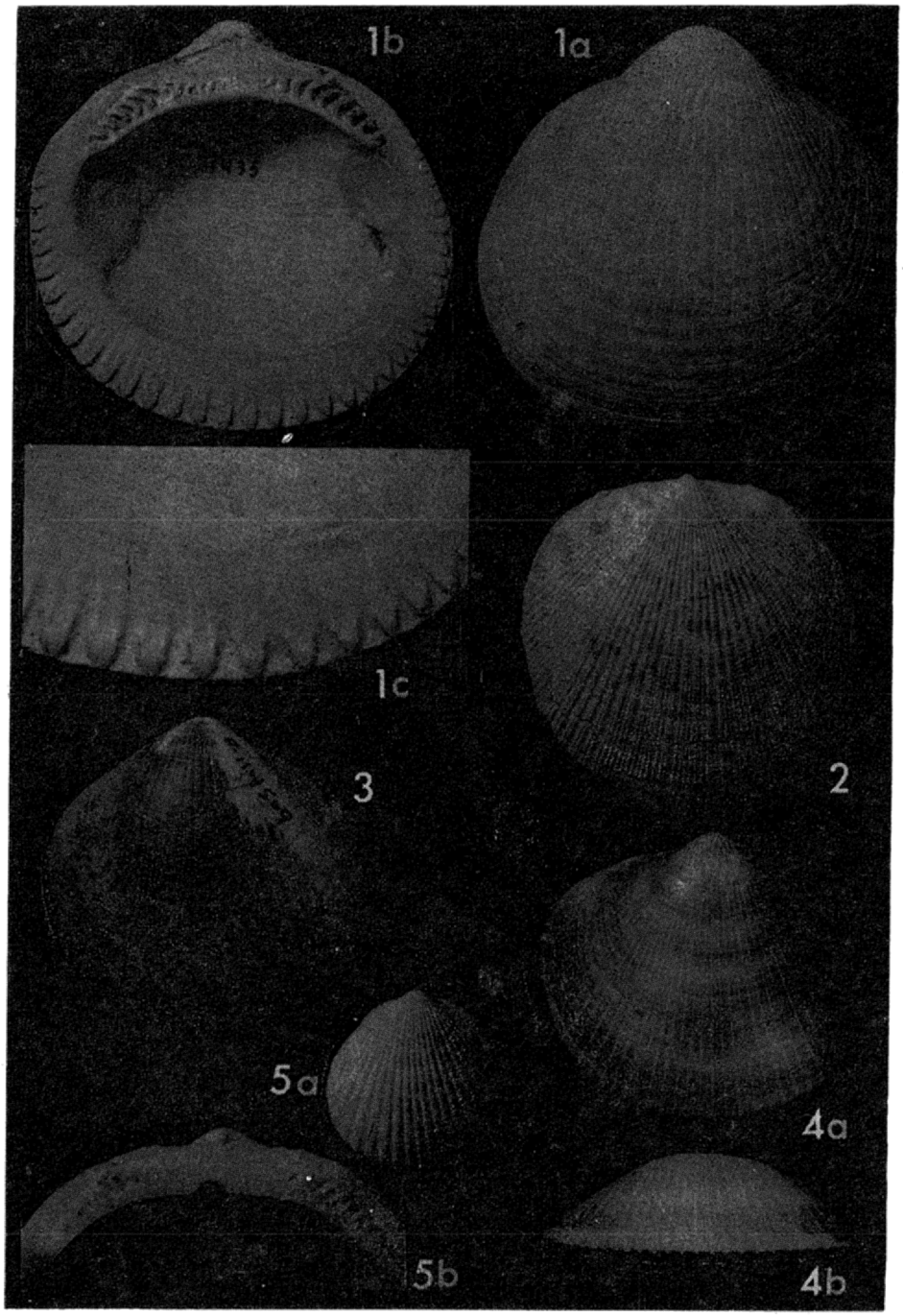
1b
1a
1c
3
2
5a
4a
5b
4b

PLATE 3

1 *Tucetona pectunculus* (Linnaeus, 1758). Outer view of the left valve (*1a*) and inner view of the right valve (*1b*) of the syntype of *Pectunculus pectiniformis* Lamarck, 1819, nat. size; Lamarck collection, Muséum National d'Histoire Naturelle in Paris; Recent; India (Photos courtesy of Mr. A. Foubert)

2 *Tucetona hanzawai* (Nomura & Zinbo, 1934). Outer (*2a*) and inner (*2b*) views of the holotype of *Glycymeris hanzawai* Nomura & Zinbo, 1934, ×2; Tohoku University, *IGPS 50196*; Pleistocene Ryukyu Limestone; Kikaijima, Kagoshima Pref., Japan

3 *Tucetona pectunculus muskatensis* (Melvill, 1897). Outer view of a right valve, ×1.6; Kyushu University, *GK-M 10296*; Recent; Oman

4—5 *Tucetona pectunculus* (Linnaeus, 1758).

4 Outer (*4a*) and inner (*4b*) views of a right valve, nat size; Kanagawa Prefectural Museum (Natural History), no. *602-4-782*; Recent; Bali Island, Indonesia

5 Outer view of a right valve, ×1.6; Kyushu University, *GK-M 10298*; Recent, north Queensland, Australia

6 *Tucetona auriflua* (Reeve, 1843). Outer (*6a*) and inner (*6b*) views of a left valve, nat size; Kyushu University, *GK-M 10291*; Recent; Kamiyamajima, Naha, Okinawa Pref., Japan

PLATE 4

1 *Glycymeris manaiaensis* Marwick, 1923. Outer (*1a*) and inner (*1b*) views of a right valve, nat. size, and shouldered crenulations (*1c*) at the posterior ventral margin of the same valve, ×2; Kyushu University, *GK-L 10303*; Pliocene Tangahoe Mudstone; Inaha Stream mouth, South Taranaki coast, New Zeland

2 *Melaxinaea vitrea* (Lamarck, 1819). Outer view of a right valve, nat. size; National Science Museum, Tokyo, *NSMT 50736-6*; Recent; Arafura Sea

3 *Glycymeris reevei* (Mayer, 1868). Outer view of a left valve, ×2; Australian Museum, *C. 114509*; Recent; south Noekori Island, West Irian

4 *Glycymeris albolineata* (Lischke, 1872). Outer (*4a*) and ventral (*4b*) views of a left valve, nat. size; Kyushu University, *GK-M 10301*; Recent; Tsuyazaki, Fukuoka Pref., Japan

5 *Tucetona sindiensis* (Vredenburg, 1928). Outer view (*5a*) of a left valve, nat. size, and cardinal area (*5b*) of the same valve, ×3; Tohoku University, *IGPS 50195*; Pleistocene Ryukyu Limestone; Kikaijima, Kagoshima Pref., Japan