

Results of the Rumphius Biohistorical Expedition to Ambon (1990)



Part 13. Mollusca, Bivalvia, Cardiidae

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31 Cardiidae species have been collected in Ambon, Indonesia by the Rumphius Biohistorical Expedition, comprising circa 40% of the known species of this family from the Indonesian archipelago. Seven of these could be traced to the figures given by Rumphius (1705) and an additional two, taking into account some reservations about the identity of Rumphius' depicted shells. This implies that all but one of Rumphius' species, viz. *Tridacna* (*Tridacna*) *gigas* (Linnaeus, 1758), have been reencountered by the present expedition. The expedition has yielded the first Indonesian published records of two species: *Fulvia* (*Laevifulvia*) *lineonotata* Vidal, 1994 and *Acrosterigma dianthinum* (Melvill & Standen, 1899). For the latter this implies a considerable range extension of the known distribution.

To the memory of Jacques Vidal (1926-2006)

Introduction

The Rumphius Biohistorical Expedition to Ambon, Indonesia took place in November-December 1990. The main objective was to investigate and collect marine invertebrates on the localities mentioned by Rumphius in his book 'D'Amboinsche Rariteitkamer' (1705), in order to get a better insight into Rumphius' marine biological work and to compare the present-day situation with the one described about 300 years ago (Strack, 1998). The material is deposited in the National Museum of Natural History (RMNH), Leiden, The Netherlands. Complementary material, not listed in this paper, has been deposited in the reference collection of the Oceanographic Institute of LIPI (Ambon). See Strack, 1993 for a general account, an overview of the sampling techniques, a list of stations and descriptions of the localities.

Rumphius (1705) treated seven species from the Moluccas that are currently classified in Cardiidae; an additional two with some reservations about their identity; and



Plate 1, 2. Reproduction of plates XLII and XLIV from a coloured copy of Rumphius' 'Amboinsche Rariteitkamer' (1705). The original numbering is erroneous: the first plate numbered XLIII represents plate 42 and a second (not with Cardiidae) is plate 43. The depicted tridacnids and cardiids are: XLII: A, *Tridacna* (*Chametrachea*) *squamosa* Lamarck; B, *Tridacna* (*C.*) *crocea* Lamarck; C, *Hippopus hippopus* (Linnaeus); E,



Corculum cardissa (Linnaeus); XLIV: E, ? *Vasticardium pectiniforme* (Born, 1780); F, *Fragum unedo* (Linnaeus); G, *Fragum fragum* (Linnaeus); H, *Lunulicardia hemicardium* (Linnaeus); N, ? *Fulvia aperta* (Bruguière). See also table 1. Strack & Goud (1996) give additional information regarding this coloured copy.

two supplementary ones, which are mentioned only, lacking an accompanying illustration. Fortunately, their descriptions allow for a positive identification. Rumphius' species are enumerated in table 1. All these species were rediscovered by the present expedition, except for *Tridacna (Tridacna) gigas* (Linnaeus, 1758), which is otherwise still known from Indonesian coastal waters, but has become locally extinct in a considerable part of its former distribution range due to overexploitation and environmental degradation (Rosewater, 1965; Lucas, 1988; Pasaribu, 1988; Mingo-Licuanan & Gomez, 2002). On the other hand, several Tridacninae species recently might have been intentionally reintroduced in Indonesia.

Rumphius' species are commented upon in the Systematic part under the current species name.

Table 1. Cardiidae species originating from Ambon illustrated and/or mentioned by Rumphius (1705), here reproduced on plate 1 and 2.

Plate / figure	Rumphius name, Dutch vernacular name [English translation]	Current name
Pl. 42 [43], fig. A	<i>Chama squammata</i> , Female <i>Littoralis</i> , Nageldoublet [Nail Doublet]	<i>Tridacna (Chametrachea) squamosa</i> Lamarck, 1819
Pl. 42 [43], fig. B	<i>Chama aspera & obtusa</i>	<i>Tridacna (Chametrachea) crocea</i> Lamarck, 1819
—	Male <i>Littoralis</i> [Rough and Dulled Clams]	<i>Tridacna (Chametrachea) maxima</i> Röding, 1798
—	<i>Chama decumanae</i> or <i>Pelagia</i> , Klipkousen	<i>Tridacna (Tridacna) gigas</i> (Linnaeus, 1758)
Pl. 42 [43], fig. C	<i>Chama striata</i> , Peerdevoetjes, Perspective Doublet [Furrowed clams]	<i>Hippopus hippopus</i> (Linnaeus, 1758)
Pl. 42 [43], fig. E	<i>Cartissae</i> , Venus Hertje [Little Venus heart]	<i>Corculum cardissa</i> (Linnaeus, 1758)
Pl. 44, fig. E	<i>Pectunculus vulgaris</i>	? <i>Vasticardium pectiniforme</i> (Born, 1780)
Pl. 44, fig. F	<i>Fragum</i> , een Aardbesie [Red Strawberry Doublet]	<i>Fragum unedo</i> (Linnaeus, 1758)
Pl. 44, fig. G	<i>Fragum album</i> , Witte Aardbesien [White or Yellow Strawberry Doublet]	<i>Fragum fragum</i> (Linnaeus, 1758)
Pl. 44, fig. H	Dubbelde Venushartje [Double Venus heart]	<i>Lunulicardia hemicardium</i> (Linnaeus, 1758)
Pl. 44, fig. N	<i>Pecten bullatus</i> [Kind of Bastard Ark]	? <i>Fulvia aperta</i> (Bruguière, 1789)

The cardiids sampled by the Rumphius Biohistorical Expedition constitute an incomplete representation of the fauna of this family of this part of the Indo-Pacific, considering the small size of Ambon, the limitations of the habitat diversity and the sampling methods, being restricted to the littoral and shallow coastal water zone, supplemented by dredge hauls up to a maximum depth of 28 m. This limited extent of coverage with regard to depth can explain the absence of several species normally present in deeper zones: no representatives of the genera *Frigidocardium* and *Microcardium*, absence of various *Acrosterigma* taxa (i.e. *transcendens*, *profundum*), etc.

In total 31 species of Cardiidae have been collected in Ambon, Indonesia by the Rumphius Biohistorical Expedition and during the preparations of this exhibition in October 1989. Four of these are assigned to Tridacninae, which is considered a specialized subfamily of the Cardiidae. By adopting this classification the results of the phylogenetic relationships as proposed by Schneider (1998) and the results of the biological research by Keys & Healy (2000) are followed. Of the 36 marine collecting stations, 28 yielded cardiids, comprising 130 samples (Table 2). Stations 30, 23 and 16 (all non sheltered Ambon Bay localities) were the most species-rich with regards to cardiids.

Altogether, a total of 15 species were collected alive. Five species were represented by only one single valve or specimen each.

Table 2 gives an overview of the Indonesian Cardiidae (sub)species, based on the samplings of the Rumphius expedition; various other Indonesian malacological expeditions of which the material is housed in the Zoological Museum Amsterdam (ZMA), The Netherlands, viz. the Siboga Expedition (1899-1900); the Teluk Jakarta ('Bay of Batavia') Expedition (1937); the RMNH/ZMA/Kalimantan/Pulau Berau Expedition (2003) and the RMNH/ZMA/Pulau Seribu Expedition (2005) and with material present in coll. TP. This results in a total number of 67 (sub)species, all based on personally examined samples.

Apart from the material mentioned above, I know the following supplementary Indonesian Cardiidae species from various other collections and literature sources:

<i>Acrosterigma abrollhense</i> Vidal, 1999	Moluccas (Vidal, 1999: 284, paratype 1, coll. WAM)
<i>Acrosterigma discus</i> Vidal, 1999	Ceram (Vidal, 1999: 290-291)
<i>Vasticardium lomboke</i> Vidal, 2003	Lombok Isl. (Vidal, 2003)
<i>Fulvia (Laevifulvia) imperfecta</i> Vidal & Kirkendale, 2007	Indonesia, West Papua, Padaido Isl. Osttheimer Orr, sta. 489 (coll. ANSP, nr. 206060)
<i>Frigidocardium n. sp.</i>	Aru Isl., Maikoor (coll. WAM, Huber & Ter Poorten, in press)
<i>Lyrocardium multipunctatum</i> (Sowerby, 1841)	Java Sea and Sunda Strait (Hylleberg, 2004, part 2, front endleaves, figs 7-10, coll. ZMUC); Samarinda, E. Kalimantan (Dharma, 2005, pl. 105, fig. 17); Java Sea (coll. ZMA), Banda Sea (coll. ZMA), West Papua, Raja Ampat Isles (Wells, 2002)
<i>Microcardium sakuraii</i> (Habe, 1961)	06°28'S-120°24'E, (coll. RMNH, Snellius II Expedition)
<i>Vepricardium incarnatum</i> (Reeve, 1844)	Nusa Tenggara Isles (Dharma, 2005, pl. 105, fig. 4, as <i>Bucardium asiaticum</i>)
<i>Hippopus porcellanus</i> Rosewater, 1982	Indonesia (Lucas, 1988; Pasaribu, 1988; Mingoal-Licuanan & Gomez, 2002), West Papua, Raja Ampat Isles (Wells, 2002)
<i>Tridacna (Persikima) derasa</i> (Röding, 1798)	West Papua, Auri Group, Pulau Rouw (Rosewater, 1965), Raja Ampat Isles (Wells, 2002), all Indonesian waters (Pasaribu, 1988)

Thus, the total number of cardiid (sub)species presently known from the Indonesian Archipelago, based upon material from the above-mentioned expeditions and collections, amounts up to 77, which comprises nearly one third of the total extant Cardiidae. Being the largest of the world's archipelagic systems, located in the tropics and bordering both the Indian Ocean and Pacific Ocean, it is clear that Indonesia forms one of the most diverse marine molluscan habitats. The Cardiidae species diversity appears to be of about the same order in comparison with the Philippine Archipelago, from which circa 75 species are known (Ter Poorten, in prep.), which however is of a considerably smaller size. Accordingly Crame, 2000 recorded the highest current documented regional bivalve diversity in the world in the Philippine-Indonesian-Malayan region. Be-

Table 2. Cardiidae recorded from Indonesia during various expeditions and from collection TP. + = present, - = absent, x = not sampled. Material of the Siboga Expedition (Leg. M. Weber et al.), Bay of Batavia (=Teluk Jakarta) Expedition (Leg. J. Hardenberg; ex coll. Lab. Onderzoek der Zee, The Netherlands), Kalimantan/Pulau Berau Expedition (Leg. R.G. Moolenbeek) and Pulau Seribu Expedition (Leg. R.G. Moolenbeek) is deposited in ZMA. Material from the Rumphius Biohistorical Expedition to Ambon in coll. RMNH. Only records of specimens are included that were personally examined.

	Ambon Rumphius 1705	Siboga Expedition 1899-1900	'Bay of Batavia' 1937	Ambon Expedition 1989/1990	Pulau Berau Expedition 2003	Pulau Seribu Expedition 2005	Indonesia Coll. TP
<i>Acrosterigma dianthinum</i>	-	-	-	+	-	-	+
<i>Acrosterigma hobbsae</i>	-	-	-	-	+	-	+
<i>Acrosterigma inpolitum</i>	-	+	+	-	+	+	+
<i>Acrosterigma maculosum</i>	-	+	-	+	+	+	+
<i>Acrosterigma profundum</i>	-	-	-	-	-	-	+
<i>Acrosterigma punctolineatum</i>	-	-	+	+	+	+	+
<i>Acrosterigma simplex</i>	-	+	-	+	+	+	+
<i>Acrosterigma transcendens</i>	-	+	-	-	-	+	+
<i>Acrosterigma variegatum</i>	-	+	-	-	+	-	+
<i>Vasticardium angulatum</i>	-	-	+	+	+	+	+
<i>Vasticardium elongatum elongatum</i>	-	-	-	+	-	-	+
<i>Vasticardium flavum flavum</i>	-	-	-	+	-	-	+
<i>Vasticardium flavum subrugosum</i>	-	+	+	-	+	+	+
<i>Vasticardium luteomarginatum luteomarginatum</i>	-	-	+	-	-	-	-
<i>Vasticardium orbita philippinense</i>	-	-	-	+	+	+	+
<i>Vasticardium papuanum</i>	-	+	-	-	-	+	+
<i>Vasticardium pectiniforme</i>	+?	+	+	+	-	+	+
<i>Vasticardium rubicundum kengaluorum</i>	-	-	+	+	+	+	+
<i>Vasticardium sewelli</i>	-	+	-	-	-	-	+
<i>Vasticardium vertebratum</i>	-	-	-	-	-	-	+
<i>Vepriocardium asiaticum</i>	-	-	+	-	-	-	+
<i>Vepriocardium coronatum</i>	-	-	+	-	-	-	+
<i>Vepriocardium multispinosum</i>	-	+	+	-	-	-	+
<i>Vepriocardium sinense</i>	-	-	+	-	-	-	+
<i>Afrocardium exochium</i>	-	-	+	-	-	-	+
<i>Afrocardium richardi</i>	-	+	+	-	+	+	+
<i>Corculum cardissa</i>	+	+	+	+	-	-	+



Where needed, additional taxonomic or ecological remarks have been added. Genera and species are arranged alphabetically. Of all cardiid species photographs have been included, all based on the Expedition material. These are supplemented by *in situ* photos of all encountered tridacnid species.

Indicated sizes refer to the mean length or height of adult specimens, followed by those of very large specimens.

Abbreviations: l.v. = left valve(s); p.v. = paired valve(s); r.v. = right valve(s); v. = valve(s).

ANSP	= Academy of Natural Sciences, Philadelphia, U.S.A.
BMNH	= The Natural History Museum, London, UK
MNHN	= Muséum national d'Histoire naturelle, Paris, France
RMNH	= Nationaal Natuurhistorisch Museum, Leiden, The Netherlands
TP	= Private collection J.J. ter Poorten, Hilversum, The Netherlands
WAM	= Western Australian Museum, Welshpool, Australia
ZMA	= Zoölogisch Museum Amsterdam, The Netherlands

Systematics

Family Cardiidae Lamarck, 1809
Subfamily Cardiinae Lamarck, 1809

Genus *Acrosterigma* Dall, 1900

Type species.— *Cardium dalli* Heilprin, 1887, by original designation.

Diagnosis.— Shell small to large, rather thin to medium thick shelled, elongated and pointed. Ribs generally rather low, on medium part poorly ornamented, posterior ones longitudinally divided. Ventral margin often uncoloured, regularly with two internal coloured rays. Internal umbonal ridge regularly present.

Remarks.— Vidal (1999a) reviewed the genus *Acrosterigma*. His taxonomic views are followed here.

Acrosterigma dianthinum (Melvill & Standen, 1899)
(figs 1-2)

Cardium (*Trachycardium*) *dianthinum* Melvill & Standen, 1899: 190.

Material.— Sta. 11 (1 v.).

Description.— Shell small (length 10-15 mm), rather thin, transversally ovoid and often very inequilateral, elongation variable; external colour uniformly white to cream,

◀ Figs 1-2, *Acrosterigma dianthinum* (Melvill & Standen), L 9.9 mm; sta. 11. 1-2, r.v. exterior and interior. 3-4, *A. maculosum* (Wood), H 21.6 mm; sta. 30. 3-4, l.v. exterior and interior. 5-6, *A. punctolineatum* Healy & Lamprell, H 21.4 mm; sta. 21. 5-6, l.v. exterior and interior. 7-8, *A. simplex* (Spengler), H 25.0 mm; sta. 20. 7, l.v., exterior; 8, r.v., interior. 9-10, *Vasticardium angulatum* (Lamarck), sta. 06. 9, r.v., interior, H 79.0 mm; 10, l.v., exterior, H. 91.0 mm.

posterior part often purple; ribs (42-50 in number) flat and low, with characteristic, regularly disposed, top granules, visible under magnification and skimming light.

Distribution.— Imperfectly known, until now confined to the central Indo-Pacific: recorded from Papua New Guinea (coll. TP), Queensland (Coral Sea, Torres Strait) and New Caledonia. Shallow water.

Remarks.— This record implies a considerable northwestward range extension of this poorly known and relatively rare species. Since the samplings of the Rumphius Expedition, additional Indonesian material has come to light originating from Sulawesi, Lembeh; E. coast of Seram Isl. and Banda Isl. Group, N. side of Van Rozengain Isl. (all leg. H. Morrison, 10.2005, coll. TP).

Acrosterigma maculosum (Wood, 1815)
(figs 3-4)

Cardium maculosum Wood, 1815: 218.

Cardium multistriatum Sowerby, 1840: sp. 47, fig. 59.

Cardium arenicolum Reeve, 1845: sp. 78, fig. 78.

Material.— Sta. 30 (1 v.).

Description.— Shell medium (height 30-50 mm), rather solid, ovoid, sub equilateral, rather elongated, umbos often pointed; external colour white or cream, brown or purple flecked, interior with two pink rays in umbonal cavity, occasionally completely purple; rib number highly variable (45-59) related to environment; ribs generally rounded, ornamented with scales variably disposed. Lunula small to indistinct, somewhat better developed on right valve.

Distribution.— Tropical Indo-West Pacific, from Madagascar, Red Sea to Japan, and Queensland. Littoral and shallow water. East of longitude 160°E replaced by *A. maculosum howense* Vidal, 1999.

Remarks.— Like many of its congeners, juveniles are generally more rounded than adult specimens due to allometric growth. These can easily be confused with the related *A. discus* Vidal, 1999, which is known from the Moluccas as well (coll. ZMA). For instance Steyn & Lussi (1998: 222, fig. 898), reporting *A. maculosum* from Kwazulu Natal, in all probability depict *A. discus*. Apart from being more rounded, this species is more flattened and has strongly oblique scales on the posterior part.

Acrosterigma punctolineatum Healy & Lamprell, 1992
(figs 5-6)

Acrosterigma punctolineata Healy & Lamprell, 1992: 87.

Cardium foveolatum Sowerby – Reeve, 1845: sp. 87, fig. 87.

Material.— Sta. 21 (1 juv. v.).

Description.— Shell small to medium (height 25-35 mm), rather thin, ovoid, equilateral to posteriorly expanded; moderately elongated; colouration white with very characteristic broken light brown lines and green-brown spots, nearly black on the posterior

side; rib number 42-56; ribs rounded with numerous transverse top ridges. Lunula small and elongated.

Distribution.— Central Indo-Pacific, from South Japan, Malaysia to Queensland, New Caledonia, Solomon Islands and Vanuatu, W of longitude 170°E. Littoral and shallow water.

Remarks.— The related *A. hobbsae* Vidal, 1999 is also known from the Moluccas (coll. BMNH, paratype), but is not present in the Rumphius Expedition material. Its larger size, a higher rib number, and more strongly developed lunula differentiate it. Besides, it lacks the clear dark brown spots on its posterior slope. Vidal (1999a) emended the incorrect original spelling of the species name in agreement with the gender of the generic name.

Acrosterigma simplex (Spengler, 1799)
(figs 7-8)

Cardium simplex Spengler, 1799: 17.

Cardium unicolor Sowerby, 1834: fig. 29.

Cardium nebulosum Reeve, 1845: sp. 99, fig. 99.

Laevicardium soyeri Fischer-Piette, 1977: 19.

Material.— Ambon, Pombo (1989) (2 p.v.); sta. 20 (2 p.v.).

Description.— Shell medium (height 30-50 mm), rather solid, inflated, umbo tumid, sub equilateral, variably elongated, posteriorly truncated; exterior uniform light greyish-cream or yellowish coloured, often darkened posteriorly, interior white, sometimes darker than interior with splashes of pink or purple; ribs numerous (42-59), rather flattened, poorly ornamented. Lunula large. Periostracum relatively well developed, principally on posterior slope.

Distribution.— Throughout the tropical Indo-West Pacific from Mozambique, Red Sea to Japan, Marshall Islands, Kiribati, North Australia and New Caledonia. Littoral and shallow water.

Genus *Vasticardium* Iredale, 1927

Type species.— *Cardium elongatum* Bruguière, 1789, by original designation.

Diagnosis.— Shell medium to very large, often rather thick shelled and elongated. Ribs generally high and well ornamented, posterior ones not longitudinally divided. Ventral margin often coloured, usually no internal coloured rays. Internal umbonal ridge normally lacking.

Remarks.— Vidal (1991; 1993; 1996; 1997a, b; 1999a, b) carried out extensive comparative diagnoses of the genera *Trachycardium*, *Vasticardium* and *Acrosterigma*. His taxonomic views are followed here.

Vasticardium angulatum (Lamarck, 1819)
(figs 9-10)

Cardium angulatum Lamarck, 1819: 9.

Cardium alternatum Sowerby, 1840: fig. 64.

Material.— Sta. 06 (2 v.).

Description.— Shell large to very large (height 60-90 mm), obliquely ovoid, rather flattened, very inequilateral, gaping posteriorly and anteriorly; exterior variable coloured with blotches of tan and occasionally yellow, purple or orange towards the margins, interior white; rib number about 25 to 32; ribs triangular and retro-ridged on posterior part of the shell, triangular and finely retro-ridged on median part, rounded and strongly rugose on anterior part; interstices often with a rounded regular riblet.

Distribution.— Tropical Indo-West Pacific, from Mozambique to Japan, Australia and Solomon Islands. Littoral and shallow water.

Remarks.— Salmon and beige coloured forms occur along the East coast of Africa, forms with yellow and purple margins seem to be mainly restricted to the Malaysia-Philippines-Solomon Islands region and Australian material commonly exhibits shades of orange. Fully white specimens, with blotches of tan, occur throughout the distribution range.

Some variation exists in the degree of development of twisted scales on the rib tops of the median posterior part of the shell; this is not geographically determined but occurs within populations.

Both Ambon valves are worn and discoloured. One of the valves has a height of 91.0 mm (fig. 10), which is nearly the maximum size the species can attain.

Vasticardium elongatum elongatum (Bruguière, 1789)
(figs 11-12)

Cardium elongatum Bruguière, 1789: 228.

Cardium serricostatum Melvill & Standen, 1899: 191.

Trachycardium okinawaense Kuroda, 1960: 82.

Material.— Ambon, exact locality unknown (1989) (1 p.v.), sta. 16 (1 ethanol).

Description.— Shell large to very large (height 75-130 mm), inflated, slightly inequilateral and generally more or less elongated; externally various shades of brown-yellow to purple; internally purple or pink near posterior margin; rib number 35 to 44; ribs sometimes square-sided and marginally serrated – forming overlapping teeth in closed paired valves –, sometimes flat and smooth, mainly on the median part of the shell. Interstices rather narrow to very narrow.

Distribution.— Throughout the tropical Indo-West Pacific up to Tonga Islands, with six geographic subspecies (see Vidal 1993 and 1999b). Yet not recorded from the N.W. Indian Ocean. Littoral and shallow water.

Remarks.— It is striking that *V. elongatum* s.l. appears to be largely absent from Western and Central Indonesian localities. The RMNH/ZMA Kalimantan/Pulau Berau (2003) and RMNH/ZMA Pulau Seribu (2005) expeditions subscribe this: not a single specimen was recorded, whereas it is common in neighbouring countries like Vietnam, Philippines, Papua New Guinea and Australia.

The morphologically related *V. papuanum* Vidal, 1996 proved to be present in the largest number of cardiid samples of the latter expedition, possibly locally replacing *V. elongatum*.

The concept of six geographic subspecies (Vidal, 1993) is not fully convincing as a relatively large percentage of specimens belong to ‘individual variants’ and because of

the rather common presence of specimens that occur far outside their supposed geographic boundaries. Further research is needed to solve this problem. The Ambon specimen sampled in 1989 (figs 11-12) is very fresh, still showing flesh remains on the adductor muscle scars; is close to the nominal subspecies and is of the uncommon tuberculated form.

From several Indo-West Pacific localities (Indonesia, Fiji and Tonga Islands) another large, very elongated 'form' is known with a thick periostracum, whitish coloured with a white interior and pale orange umbonal cavity. More material is needed to elucidate the status of this form.

Vasticardium flavum flavum (Linnaeus, 1758)
(figs 13-15)

Cardium flavum Linnaeus, 1758: 680.

Cardium fucatum Spengler, 1799: 30.

Cardium gratiosum Deshayes, 1855: 331.

Cardium tumidum Deshayes, 1855: 331.

Material.— Ambon, exact locality unknown (1989) (4 p.v.); Hitu, ca. 2 km W of Wakal (1989) (3 p.v.); Natsepa (1989) (6 p.v.), sta. 01 (7 p.v.), 02 (4 p.v.), 03 (1 p.v.; 2 ethanol), 04 (11 p.v.; 1 ethanol), 06 (2 v.), 16 (6 p.v.), 20 (9 p.v.; 3 ethanol), 21 (9 p.v.; 1 ethanol), 26 (1 p.v.), 30 (1 p.v.; 2 v.), 35 (2 p.v.).

Description.— Shell medium to large (height 40-65 mm), often nearly equilateral, little elongated; colour externally dull to diversely coloured, often yellowish or lilac on anterior part; interior white, almost always white to yellow or purple in the umbonal cavity. Rib number about 25 to 30, variable in structure and ornamentation. Lunula broad and well defined, deeply hollowed, larger in right valve than left valve. Vidal, 1997b defined three geographical subspecies: *flavum ss.*, with ribs smoothed, *subrugosum* (Sowerby, 1838) and *dupuchense* (Reeve, 1845), with stronger developed ribs, which are well ornamented. The specimens of Ambon are close to the nominal subspecies *flavum*, which can be differentiated by the ribbing on the median-postero part of the shell, becoming very flattened during ontogeny and by the generally stronger colouration of the anterior shell exterior.

Distribution.— Eastern part of Indian Ocean and tropical West Pacific from Thailand to Japan, N. Australia and Solomon Islands (see Vidal 1999a and 1999b). Littoral and shallow water.

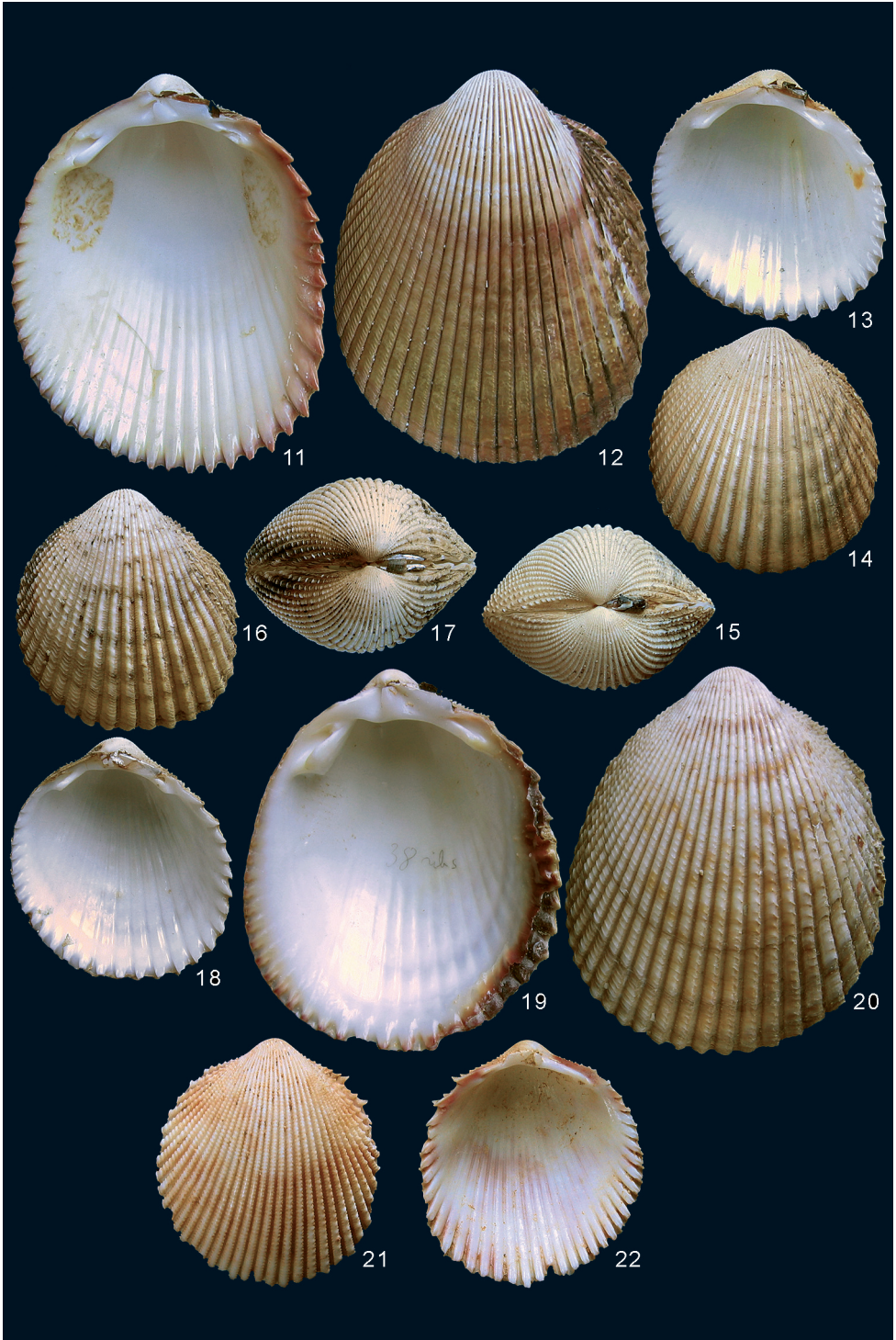
Remarks.— The specific denomination *flavum* has often erroneously been given to the following *Vasticardium pectiniforme*.

The Hitu (1989) sample (figs 13-15) shows intermediate characters between *flavum* and *pectiniforme*, which might be the result of hybridisation. For instance it is lacking any interior colouration and the periostracum has darker coloured blotches on the median and posterior side.

Vasticardium orbita philippinense (Hedley, 1899)
(figs 19-20)

Cardium philippinense Hedley, 1899: 503.

Cardium pseudoangulatum Bülow, 1905: 79.



Material.— Ambon, exact locality unknown (1989) (1 p.v.), 17 (1 p.v.).

Description.— Shell medium to large (height 70-110 mm), sub equilateral, thick and elongated; external colour with brownish-purple irregular splashes, more pronounced posteriorly; internally white to yellow with posterior margin strongly purple coloured; hinge with hooked basement of the anterior lateral on both valves; rib number 36-42; ribs squared to triangular, with top or flank oblique ridges. Vidal (1997a) defined four subspecies: *orbita* ss., *mendanaense* (Sowerby, 1897), *philippinense* and *hawaiensis* (Dall, Bartsch & Rehder, 1938).

Distribution.— Tropical western Pacific and South-eastern Indian Ocean, East of about longitudes 100-110°E. Littoral and shallow water.

Remarks.— *V. luteomarginatum* (Voskuil & Onverwagt, 1991) resembles *V. orbita*, but some constant characters (morphometry, rib number, coloration) allow their separation. In addition, the distribution patterns of both species are largely different, the former restricted to the Indian Ocean, the latter to the western Pacific (see Vidal 1999b) with an overlap zone in southwest Indonesia – Malaysia.

Vasticardium pectiniforme (Born, 1780)
(figs 16-18; pl. 2 E)

Cardium pectiniforme Born, 1780: 49.

Cardium regulare Bruguière, 1789: 227.

Cardium rugosum Lamarck, 1819: 10.

Trachycardium peregrinum Jousseau, 1888: 212.

Vasticardium nigropunctatum Habe & Kosuge, 1966: 324.

Material.— Sta. 01 (1 p.v.), 03 (2 p.v.; 1 v.), 04 (5 p.v.), 05 (1 p.v.), 16, 17 (1 p.v.), 18 (1 p.v.), 20 (12 p.v.; 5 ethanol), 21 (9 p.v.; 2 ethanol), 23 (1 p.v.; 1 juv. v.), 26 (7 p.v.; 1 v.), 27 (3 p.v.), 30 (4 p.v.; 1 v.), 34 (6 p.v.), 35, 37 (1 v.).

Description.— Shell medium to large (height 40-65 mm), often nearly equilateral, subelongated; colour externally and internally uniformly white to tan, sometimes yellow; umbonal cavity can be pale yellow. Rib number 25 to 30; ribs strong, squared to triangular, always strongly ridged. Lunula small to virtually absent, elongated. Periostracum olive-green to brownish, very often with darker coloured blotches on median and posterior side.

Distribution.— Throughout the tropical Indo-West Pacific, from South Africa (Kwazulu Natal), Red Sea, to Japan, Australia and West Pacific. A very common littoral species.

Rumphius, 1705 record.— '*Pectunculus vulgaris*', pl. 44, fig. E is a rather poor drawing but most probably refers to this species. In the description the following is men-

◀ Figs 11-12, *Vasticardium elongatum elongatum* (Bruguière), H 79.1 mm; Ambon, 1989. 11, r.v., interior; 12, l.v., exterior. 13-15, *V. flavum flavum* (Linnaeus), H 35.0 mm; Ambon, 1989. 13, r.v., interior; 14, l.v., exterior; 15, dorsal view. 16-18, *V. pectiniforme* (Born), H 37.6 mm; sta. 23. 16, l.v., exterior; 17, dorsal view; 18, r.v., interior. 19-20, *V. orbita philippinense* (Hedley), H 90.0 mm; sta. 17. 19, r.v., interior; 20, l.v., exterior. 21-22, *V. rubicundum kengaluorum* (Voskuil & Onverwagt), H 17.5 mm; sta. 05. 21-22, l.v. exterior and interior.

tioned about the colouration: 'a grayish or dirty white, with a few black speckles [...] a lemon yellow in the center of the shell' (Beekman, 1999: 198). The black speckles in all probability refer to the peculiarities of the periostracum, which locally consists of dark coloured blotches and which is very typical for *V. pectiniforme*. The lemon yellow represents the pale yellow colouration of the umbonal cavity, which is occasionally present. The reddish scales near the anterior margin on the coloured version of Rumphius' drawing (pl. 2 E) do not add to the clarity of the interpretation and probably result from some artistic freedom. The common occurrence is expressed in the name. Von Martens, 1902 calls it *Cardium rugosum* (Lamarck). Vidal, 1997b convincingly demonstrated that this name falls within the synonymy of *V. pectiniforme*.

Remarks.— *V. pectiniforme* has very often erroneously been named *V. flavum*. Both species differ by rib ornamentation and colouration. They are present in by far the largest number of Rumphius Expedition samples, reflecting their abundance in a wide range of littoral and shallow water Indo-West Pacific environments.

Vasticardium rubicundum kengaluorum (Voskuil & Onverwagt, 1993)
(figs 21-22)

Cardium mindanense Reeve, 1844: sp. 19, fig. 19.

Acrosterigma kengaluorum Voskuil & Onverwagt, 1993: 33.

Material.— Sta. 05 (1 juv. v.)

Description.— Shell medium (height 40-55 mm), regularly sub ovoid, solid and elongated, inflated, posterior margin slightly truncated; exterior colour variable, white to yellow or reddish, variably blotched orange to brown; posterior interior margin coloured; rib number 35-38; ribs squared to trapezoidal, with characteristic elaborate flank and top ornamentation.

Distribution.— Tropical Indo-West Pacific, from South Africa (Kwazulu Natal) to Japan and Solomon Islands. Littoral and shallow water.

Remarks.— *V. rubicundum* can have very different colorations: Western Indian Ocean material is generally more reddish coloured and the ribs are more coarsely sculptured; Japanese material is predominantly orange-yellow and specimens from Indonesia-Philippines tend to be paler coloured, consisting of splashes of brown or beige on a whitish background. Besides, it is less inflated, the rib sculpture of this material is finer, less elaborate and, on the median-postero part of the shell, more obliquely placed. A subdivision in three subspecies seems warranted, in which case the Ambon valve belongs to *V. rubicundum kengaluorum* (Voskuil & Onverwagt, 1993), described from material originating from the Solomon Islands.

Voskuil & Onverwagt (1993) designated one of the specimens of the type lot of *Cardium mindanense* Reeve, 1844 as 'holotype', thus making it a senior synonym of the Caribbean *C. egmontianum* Shuttleworth, 1856, and at the same time removed *C. mindanense* from usage for the Indo-Pacific species. Awaiting the outcome of a pending application by H. Lee & R.E. Petit (U.S.A.) to the I.C.Z.N. for a proposed conservation of the specific name *C. egmontianum* Shuttleworth, 1856, the usage of *C. rubicundum* is chosen here for this species. If this petition will be accepted by the I.C.Z.N., *C. mindanense* Reeve, 1844 is an available name that takes priority over *C. rubicundum* Reeve, 1844.

Subfamily Laevicardiinae Keen, 1951
Genus *Fulvia* Gray, 1853; subgenus *Fulvia*

Type species.— *Cardium apertum* Bruguière, 1789, by original designation.

Diagnosis.— Shell small to very large, predominantly rather thin shelled, occasionally translucent, rounded to obliquely ovate, posterior part often expanded. Ribs generally rather low to poorly defined on median part. Ribs bearing periostracal insertions. Posterior radial groove often present. Shell surface often partly covered with minute granulations.

Remarks.— Following Schneider (1995) *Fulvia* is placed in Laevicardiinae. The genus has been reviewed by Vidal (1994). Very recently, four additional taxa have been introduced by Vidal & Kirkendale (2007). Two of these, *Fulvia (Fulvia) colorata* Vidal & Kirkendale, 2007 and *F. (Laevifulvia) imperfecta* Vidal & Kirkendale, 2007, are known from Indonesia as well (table 2; introduction) but have not been found in the Rumphius Expedition material.

Fulvia (Fulvia) aperta (Bruguière, 1789)
(figs 23-25; pl. 2 N)

? *Solen bullatus* Linnaeus, 1758: 673.

Cardium apertum Chemnitz: Bruguière, 1789: 226.

Cardium hians Spengler, 1799: 39.

Cardium rugatum Gronovius; Dillwyn, 1817: 125.

Material.— Sta. 01 (6 p.v.; 2 v.; 1 ethanol), 05 (1 v.), 34 (5 juv. p.v.; 3 ethanol), 35 (4 p.v.), 41 (4 juv. p.v.; 1 ethanol).

Description.— Shell of medium size (length 35-45 mm), inflated, fragile, not elongated, posteriorly expanded and strongly gaping, highly diversely coloured, often with irregular concentric stripes or blotches on a white, yellowish or purple background; numerous flattened, cord like ribs, stronger and more distantly placed towards posterior part. Periostracal insertions rather prominent, situated on posterior side of the ribs.

Distribution.— Tropical Indo-West Pacific up to Japan, N. Australia and New Caledonia, however only scarcely reported from the Western Indian Ocean. Littoral to shallow water.

Rumphius, 1705 record.— '*Pecten bullatus*', pl. 44, fig. N. Linnaeus (1758: 673) described *Solen bullatus* with reference to Rumphius pl. 44, fig. N. Many subsequent authors have variously interpreted the status of Linnaeus' name. Von Martens (1902) refers to *Cardium rugatum* Gronovius, adding in brackets *C. apertum* Chemnitz and *S. bullatus* Linnaeus. Both Gronovius, 1781 and Chemnitz 1782 are rejected works. Bruguière, 1789, when referring to Chemnitz, validates the name *aperta*. Smith (1945) regards *S. bullatus* valid, places it in *Fulvia* and considers *C. apertum* Bruguière, 1789 a junior synonym. See also Dodge (1952: 37-38, 68-69) for a detailed overview. Other authors like Watters (2002), think that the figure of Rumphius represents an arcid. The drawing does not allow absolute certainty, but the description leaves little doubt that it does represent a *Fulvia*, most probably *F. aperta*: '[...] a very thin shell so that one can



easily press them to pieces; on the outside a light russet color of yellowish, with a few speckles [...], and the shells are loosely attached to each other with a little skin; on the inside it is a light red, very hollow and puffed up' (Beekman, 1999: 199).

All Rumphius Expedition records were found in Ambon Bay, suggesting a preference for protected habitats. Vidal, 1994 states that in New Caledonia it prefers littoral muddy organic environments.

Remarks.— Its most closely related congener, *F. (F.) papyracea* (Bruguère, 1789), lacks the gaping posterior margin and is almost perfectly equilateral. It is not uncommon in Indonesian waters and known from the Moluccas (coll. ZMA, TP), but has not been encountered in the expedition material. Two specimens from station 01 and one from station 35 (fig. 25) are of an atypical orange coloration, darker towards the umbo.

Fulvia (Fulvia) australis (Sowerby, 1834)
(figs 26-27)

Cardium australe Sowerby, 1834 fig. 12 and 1840: 35.

Cardium striatum Spengler, 1799: 45. [Never utilized].

Cardium varium Sowerby, 1834 fig. 19.

Cardium pulchrum Reeve, 1845: Sp. 98, fig. 98.

Material.— Sta. 05 (1 p.v.; 3 v.), 16 (8 p.v.), 17 (1 v.), 18 (1 p.v.), 35 (1 p.v.).

Description.— Shell of medium size (height 30-35 mm), slightly obliquely ovate, in majority longer than high, rather thin; colour variable, often whitish blotched with pink, purple or brown; numerous, flattened but well visible ribs, more pronounced on posterior third of the shell. Number of ribs extremely variable. Periostracal insertions present on posterior part of the ribs.

Distribution.— Throughout the tropical Indo-West Pacific, ranging from the Red Sea, Mozambique to Japan, Australia, Vanuatu and New Caledonia. Recently penetrated into the Eastern Mediterranean. Littoral to shallow water.

Remarks.— A common *Fulvia*, highly variable in shape and colour. Juveniles smaller than 5 mm can be difficult to separate from its congeners. A large, inflated, elongate-quadrangular form with a big, sharply bordered lunula with an elevated area in the right valve is known from Philippines, Papua New Guinea and the Solomon Isles (coll. TP). Whether this form falls within the intraspecific variability is still to be solved, awaiting examination of more material. The Ambon material does not match this morphology.

- ◀ Figs 23-25, *Fulvia (Fulvia) aperta* (Bruguère), sta. 35. 23, l.v., exterior, L 31.2 mm; 24, l.v., exterior, L. 26.4 mm; 25, l.v., exterior, L. 14.7 mm. 26-27, *F. (F.) australis* (Sowerby), L 24.0 mm; sta. 35. 26, r.v., interior; 27, l.v., exterior. 28-29, *F. (F.) scalata* (Vidal), H. 12.3 mm; sta. 23. 28-29, r.v., exterior and interior. 30-31, *F. (Laevifulvia) lineonotata* Vidal, H 10.8 mm; sta. 23. 30-31, r.v., exterior and interior. 32-39, *F. (L.) hungerfordi* (Sowerby), sta. 29. 32-33, r.v., exterior and interior, L 11.5 mm; 34-35, l.v., exterior and interior, L. 10.8 mm; 36-37, r.v., exterior and interior, L 10.5 mm; 38-39, l.v., exterior and interior, L. 9.6 mm. 40-41, *F. (L.) undatopicta* (Pilsbry), H 12.7 mm; sta. 16. 40, r.v., interior; 41, l.v., exterior. 42-43, *Laevicardium biradiatum* (Bruguère), H 39.7 mm; sta. 23. 42, l.v., exterior; 43, posterior view.

Fulvia (Fulvia) scalata Vidal, 1994
(figs 28-29)

Fulvia (Fulvia) scalata Vidal, 1994: 108.

Material.— Sta. 23 (3 v.).

Description.— Shell small (length 15-20 mm), rounded and inflated, roughly equilateral; generally regularly uniformly pale brown to pinkish coloured; ribs well delimited, particularly on posterior third of the shell; concentric aligned granules in the interstices, close-set and placed like steps of a ladder. Periostracal insertions present. Very large lunular heart.

Distribution.— Tropical Indo-West Pacific, predominantly from localities ranging from Philippines, North Australia to New Caledonia. Shallow water up to a depth of 72 m (Indonesia, Java Sea, coll. ZMA). Precise distribution limits are still poorly known.

Remarks.— The typical ladder-like sculpture allows for separation from its congeners. The sample originates from a grit sample, sand and occasional coral formation, depth 15 m.

Genus *Fulvia* Gray, 1853; subgenus *Laevifulvia* Vidal, 1994

Type species.— *Cardium hungerfordi undatopictum* Pilsbry, 1904, by original designation.

Diagnosis.— See general diagnosis of the genus *Fulvia*; periostracal insertions absent and shells relatively small.

Fulvia (Laevifulvia) hungerfordi (Sowerby, 1901)
(figs 32-39)

Cardium (Papyridea) hungerfordi Sowerby, 1901: 103.

Fulvia (Laevifulvia) prashadi Vidal, 1994: 111-112.

Material.— Sta. 28 (4 v.), 29 (16 v.), 32 (5 v; 1 ethanol), 33 (1 v.), 36 (1 p.v.).

Description.— Shell small (length 10-15 mm), well inflated, often subequilateral with posterior third expanded and posterior margin truncated, rather solid; interior and exterior colour uniform white to (reddish) brown, sometimes with concentric alignments; ribs strongly developed on the posterior third of the shell, less accentuated on anterior one, very weak to absent on the median part.

Distribution.— Central Indo-West Pacific, from Japan to New Caledonia. Littoral to shallow water up to depths of 100 m.

Remarks.— The differences between *F. (L.) hungerfordi* and *F. (L.) prashadi* as pointed out by Vidal, 1994 apparently fall within the intraspecific variety of the former: many intermediates were found in the numerous samples from Java, Teluk Jakarta ('Bay of Batavia') in the ZMA collection. Specimens with more marked, close-set growth stages near the margin generally tend to develop a more concave postero-ventral margin. The

Rumphius material is more in agreement with typical *hungerfordi* forms, lacking clearly marked growth interruptions, having a rather regular rounded outline and a faintly truncated posterior margin.

The finds of the Rumphius Expedition all originate from the protected, shallow inner part of Ambon Bay and Baguala Bay with one life-taken specimen from a depth of 12-17 m. Likewise, *F. (L.) hungerfordi* proved to be the dominant species in the protected, polluted, inshore embayment of Tolo Harbour, Hong Kong (Shin, 1985), which is partly related to the absence of two of its significant predators: species of the starfish *Luidia* (Reid & Shin, 1985).

Fulvia (Laevifulvia) lineonotata Vidal, 1994
(figs 30-31)

Fulvia (Laevifulvia) lineonotata Vidal, 1994: 110.

Material.— Sta. 05 (1 v.), 23 (4 p.v.; 11 v.; 2 ethanol), 32 (2 v.), 42 (2 p.v.; 1 ethanol).

Description.— Shell small (height 10-15 mm), rather elongated (juveniles more rounded), interior and exterior variably but often vividly coloured, shining, with often aligned spots or triangles along radial medio-posterior line; large smooth zone anteriorly and on median part. Posterior zone with well developed ribs. Minute granulations present on the whole shell exterior.

Distribution.— Tropical Indo-West Pacific, from Mauritius, India to Philippines, New Caledonia. Shallow water up to 60 m.

Remarks.— Not recorded before from Indonesia. Can easily be confused with juveniles of *Laevicardium lobulatum* (Deshayes, 1855). This species however lacks any granulations and the radiating ribbing pattern near the postero-dorsal margin is practically lacking.

Fulvia (Laevifulvia) undatopicta (Pilsbry, 1904)
(figs 40-41)

Cardium hungerfordi undatopictum Pilsbry, 1904: 556.

Cardium hungerfordi stigmaticum Pilsbry, 1904: 556.

Material.— Sta. 01 (16 v.), 16 (2 large p.v.), 23 (1 p.v.; 22 v.), 28 (1 v.), 34 (2 p.v.; 1 v.).

Description.— Shell small (height 10-15 mm), roughly equilateral and rounded, slightly truncated posteriorly; height often slightly exceeds length; colour extremely variable, often with four reddish spots which are cross disposed; a few strong ribs on posterior part of the shell, almost smooth elsewhere, with tiny commarginal aligned pustules, mainly near ventral margin.

Distribution.— Throughout the tropical Indo-West Pacific, recorded from Madagascar, Red Sea to Japan, N. Australia and New Caledonia. Shallow water, rarely littoral. The inclusion of the Red Sea and W. Indian Ocean by Vidal, 1994 is not confirmed by other authors.

Genus *Laevicardium* Swainson, 1840

Type species.— *Cardium oblongum* Gmelin, 1791, by subsequent designation, Stoliczka, 1871.

Diagnosis.— Shell small to very large, often elongated and rather inflated, radial ribbing pattern very superficial to indistinct, resulting in a smooth, often glossy appearance. Posterior margin relatively weakly crenulated. Hinge line long, arched.

Remarks.— Following the outcome of phylogenetic cladistic analyses by Schneider (1995), *Laevicardium* is placed in Laevicardiinae. Likewise has been done by Keen (1980).

Laevicardium biradiatum (Bruguère, 1789)
(figs 42-43)

Cardium biradiatum Bruguère, 1789: 231.

Laevicardium rubropictum Habe & Kosuge, 1966: 324.

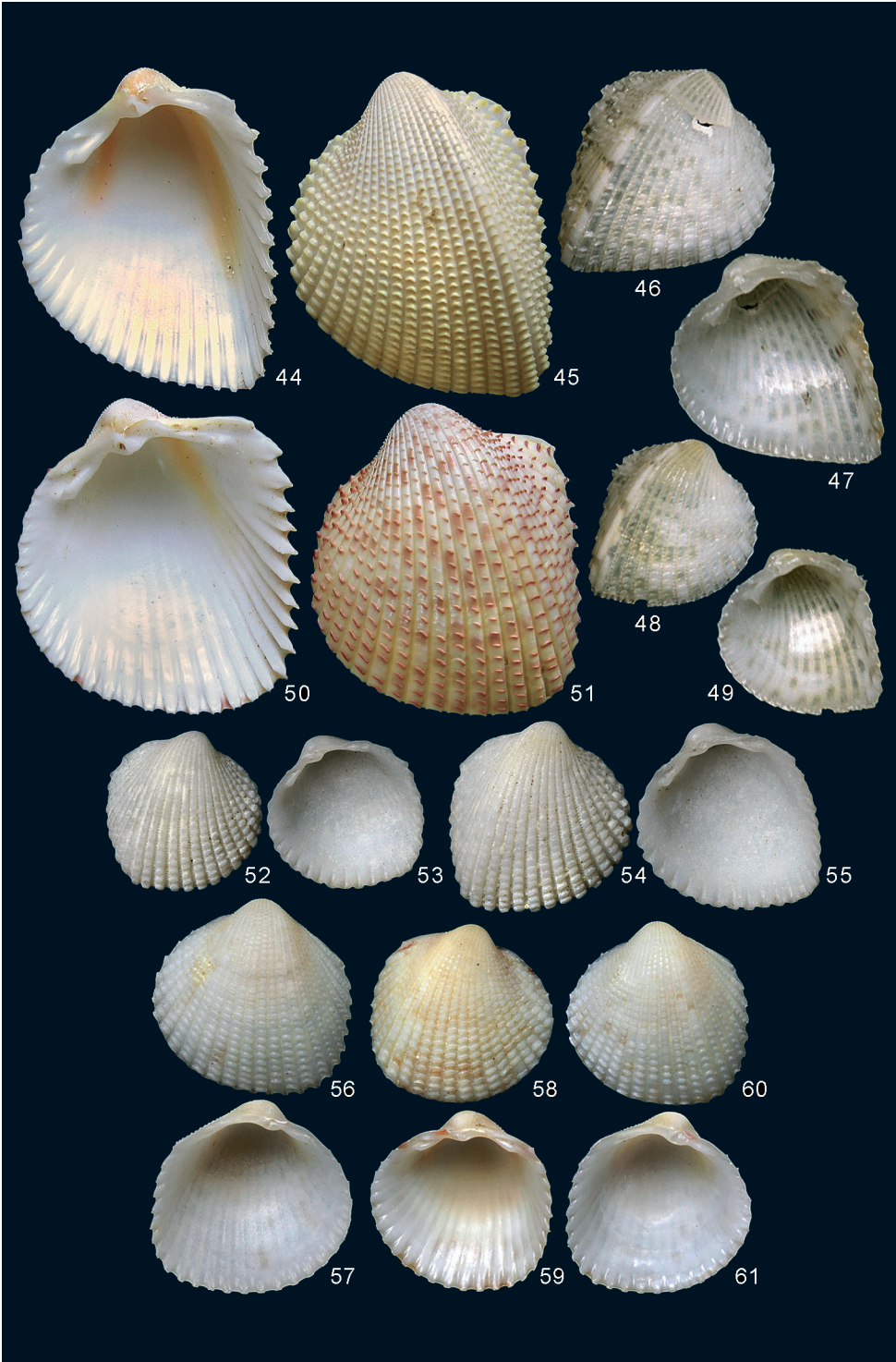
Material.— Sta. 23 (1 ethanol, in sand, 10 m).

Description.— Shell medium (height 30-50 mm), subequilateral, elongated and pear-shaped, umbos pointed, anterior margin rounded, posterior margin almost straight; colour variable, mottled brown and cream with splashes of purple brown, stronger near dorsal margins, interior white and yellowish with two radial rays of purple; rib number 40-50, ribs very weakly developed, lacking ornamentation.

Distribution.— Throughout the tropical Indo-West Pacific from South Africa (Kwa-zulu-Natal), Red Sea to South Japan, North Australia and Wallis and Futuna. Shallow water up to moderate depths.

Remarks.— Vidal (1999a) placed this taxon together with the related *L. attenuatum* (Sowerby, 1841) in *Acrosterigma*; based on the presence of tiny rib sculpture on the last few ribs near the postero-dorsal margin. This sculpture, if developed at all, tends to disappear soon during ontogeny. Because of the presence of many typical *Laevicardium* characteristics, this generic assignment is followed here. One of these features is formed by a weakly developed demarcation line, separating the anterior quarter from the median part of the shell. It runs not exactly parallel with the radial ribs. This element is clearly present on several Caribbean *Laevicardium* species too but can never be observed on *Acrosterigma*.

Figs 44-45, *Fragum fragum* (Linnaeus), H 27.2 mm; sta. 21. 44, r.v., interior; 45, l.v., exterior. 46-49, *F. mundum* (Reeve), sta. 30. 46-47, exterior and interior of r.v., H 4.5 mm; 48-49, exterior and interior of l.v., H 3.2 mm. 50-51, *F. unedo* (Linnaeus), H 34.5 mm; sta. 26. 50, r.v., interior; 51, l.v., exterior. 52-55, *F. scruposum* (Deshayes), sta. 17. 52-53, exterior and interior of r.v., H 6.4 mm; 54-55, exterior and interior of r.v., H 7.6 mm. 56-61, *F. sueziense* (Issel), sta. 23. 56-57, exterior and interior of l.v., L 5.9 mm; 58-59, exterior and interior of r.v., L 5.4 mm; 60-61, exterior and interior of l.v., L 5.5 mm. ►



Subfamily Fraginae Stewart, 1930
Genus *Corculum* Röding, 1798

Type species.— *Cardium cardissa* Linnaeus, 1758, by subsequent designation (Von Martens, 1870).

Diagnosis.— Shell medium to large, laterally heart-shaped, posterior slope highly flattened, bordered by a strong ridged to spinose radial keel. Sculpture of faint radial ribs. Posterior area of a glassy texture.

Remarks.— There is general agreement among taxonomists about placement of *Corculum* in Fraginae. The same is the case for the other genera here included.

Corculum cardissa (Linnaeus, 1758)
(figs 65-68; pl. 1 E)

- Cardium cardissa* Linnaeus, 1758: 678.
Cardium impressum Lightfoot in Solander, 1786: 155.
Cardium monstrosum Gmelin, 1791: 3253.
Corculum dolorosum Röding, 1798: 189.
Cardium replicatum Spengler, 1799: 52.
Cardium junoniae Lamarck, 1819: 17.
Cardium dionaeum Broderip & Sowerby, 1829: 367.
Cardium unimaculatum Broderip & Sowerby, 1833: 84-85.
Cardissa spinosa Swainson, 1840: 373.
Cardium aequale Deshayes, 1855: 332.
Cardium productum Deshayes, 1855: 333.
Corculum aselae Bartsch, 1947: 226.
Corculum levigatum Bartsch, 1947: 226.
Corculum obesum Bartsch, 1947: 224-225.
Corculum kirai Shikama, 1964: 75.
Corculum inexpectatum Crozier, 1966: 42-43.

Material.— Sta. 17 (2 p.v.), 20 (4 ethanol), 21 (1 p.v.; 1 ethanol).

Description.— Shell medium to large (height 35-65 mm), inequilateral with anterior slope more expanded than posterior which becomes ventrally concave; shell tumid and abnormally flattened, with an extremely reduced length; presence of an acute, ridged to spinose radial keel; laterally examined, the shell looks like a heart; about 12 ribs on each slope, flat, bearing sessile tubercles, sometimes slightly ridged; interstices smooth; anterior margin not touching umbo, slightly depressed in front of it; posterior part of hinge with an extremely short nymphal plate and ligament, but a long escutcheon zone. The colouration is extremely variable.

Distribution.— Tropical Indo-Pacific, excluding Red Sea (Mienis, 2000) and East Africa, up to longitude 130°. Shallow water.

Rumphius, 1705 record.— '*Little Venus heart*', pl. 42, fig. E. In his description Linnaeus (1758), among others, referred to this figure, which shows the anterior part of the two valves.

Remarks.— The distinct shell morphology is an adaptation to its epifaunal life habit: posteriorly byssally attached on the sandy sediment and feeding on symbiotic algae (zooxanthellae), which are present in the gills and the mantle tissues under the rather

thin, glassy shell. It probably also is a depth-limiting factor. This specific life habit probably adds to a high degree of variation in shell morphology, leading to a large number of synonymies that in all probability only reflect ecophenotypic forms of infra subspecific status, resulting in a monospecific genus. Rumphius, 1705 already enumerates three of these variations: the form in accordance with the normal form; one being in agreement with the *dionaeum* form and one with the *impressum* form, interpreted as *Cardium roseum* Chemnitz and *C. junoniae* Lamarck respectively by Von Martens, 1902.

The finds of the Rumphius expedition and the absence of records from Ambon Bay are well in accordance with the preferred sandy, coral reef habitat.

Genus *Ctenocardia* H. & A. Adams, 1858

Type species.— *Cardium hystrix* Reeve, 1844 (non Solander, 1786) [= *Fragum* (*Ctenocardia*) *symbolicum* Iredale, 1929], by subsequent designation (Dall, 1900).

Diagnosis.— Shell small to medium, outline subquadrate with clear medio-posterior angulation. Radial ribs with imbricating, tubular spines or lamellae. Interstices with imbricating scales. Right valve with second posterior lateral tooth.

Remarks.— The taxonomy of *Ctenocardia* is far from settled. Voskuil (1998) enumerates the Recent species belonging to this genus and considers *Americardia* a junior synonym of *Ctenocardia*. Vidal & Kirkendale (2007) describe two additional Indo-Pacific species and supply further generic comments. See also the remarks under the respective Ambonese species.

Ctenocardia virgo (Reeve, 1845) (figs 73-74)

Cardium imbricatum Sowerby, 1841: 110 (non Born, 1780).

Cardium hystrix Reeve, 1844: sp. 40, fig. 40a-b (non Solander, 1786).

Cardium virgo Reeve, 1845: sp. 120.

Fragum (*Ctenocardia*) *perornatum* Iredale, 1929: 264.

Fragum (*Ctenocardia*) *symbolicum* Iredale, 1929: 264.

Material.— Sta. 01 (2 juv. v.), 29 (1 juv. v.), 30 (1 juv. v.).

Description.— Shell small to medium (height 20-30 mm), very variable in shape, from inequilateral to almost equilateral and ovoid; angulation between posterior slope and the rest very variable, acute to very weak; colour white, occasionally with pink zones posteriorly and in umbonal cavity; rib number 28-34; ribs squared with double ornamentation on anterior part, i.e. top spiny tubercles and small spines on both sides; on posterior slope some ribs can bear only imbricated lamellae.

Distribution.— Eastern Indian Ocean from Thailand, Philippines, and Indonesia to N. Australia.

Remarks.— Philippine specimens tend to be much more strongly coloured: exterior having a yellow-orange appearance. There is some uncertainty as to the valid name of this species. The rib number ('about 38') mentioned in the original description of *Cardium virgo* Reeve, 1845 is much more in agreement with *C. fornicatum* Sowerby, 1840, although the colouration ('pure snowy white without, blood-red within) and Reeve's illustration shows clear characteristics of *C. perornatum* Iredale, 1929, which

was introduced as a replacement name for *C. imbricatum*. According to Bishop & Way, 1976 the type material of *C. virgo* is housed in the University Museum of Zoology, Cambridge (Jane Saul collection). Examination of this material will be needed to settle this issue, but is beyond the scope of this paper.

Ctenocardia translatum (Prashad, 1932)
(figs 69-72)

Cardium rigidum Reeve, 1845: sp. 105, fig. 105 (non Wood, 1815).

Cardium (Ctenocardia) translatum Prashad, 1932: 277.

Material.— Sta. 23 (2 p.v.; 12 v.), 28 (1 v.), 30 (2 v.).

Description.— Shell small (length 10-16 mm), almost perfectly equilateral and rounded; medio-posterior angulation not or hardly marked; colour exteriorly whitish with red-brown stains, interiorly variable, pink stained in the umbonal cavity; rib number 29-34; ribs squared, variably ornamented with imbricated scales, occasionally close-set, sometimes spatuliform and more tubercular near anterior margin. Interstices variable among specimens, ranging from as large as ribs to less than half the width of the ribs, thinly lamellated.

Distribution.— Tropical Indo-West Pacific from Maldives to Vietnam, Philippines to New Caledonia, West of longitude 180°.

Remarks.— Because of the small size a rather poorly known species, which however has been found in abundance in Thailand, Bight of Bangkok, Ko Lan in a reef environment at a depth of 3-6 m (coll. ZMA, leg. R.G. Moolenbeek). In coll. ANSP one sample from Maldives, Fadippolu Atoll, 05°18'20"N-73°29'E, depth 46-64 m, being the deepest record known to me.

The status of *Cardium robillardi* Sowerby, 1894 is still unclear: described from Mauritius, representing a *Ctenocardia* (Voskuil, 1998) and closely resembling *C. translatum*, both might in fact turn out to be conspecific, in which case *C. robillardi* would be a senior synonym of the latter, enlarging the western part of the distribution range. Examination of the type material is needed to solve this problem.

Genus *Fragum* Röding, 1798

Type species.— *Fragum flavum* Röding, 1798 [= *Cardium fragum* Linnaeus, 1758], by absolute tautonymy.

Diagnosis.— Shell small to large, triangular, with medio-posterior angulation. Ribs ornamented with scales or tubercles. Lunula and escutcheon poorly defined. Cardinal teeth joined in right valve.

Fragum fragum (Linnaeus, 1758)
(figs 44-45; pl. 2 G)

Cardium fragum Linnaeus, 1758: 679.

Cardium imbricatum Born, 1780.

Fragum flavum Röding, 1798.

Material.— Ambon, Pombo Isl., 1989 (5 p.v.); sta. 16 (5 p.v.; 1 v.), 20 (1 v.), 21 (3 p.v.; 1 ethanol), 26 (1 v.).

Description.— Shell medium (height 25-45 mm), inequilateral, trapezoidal in outline; posterior slope set off from the rest by a sharp radial angulation, steeply sloping; posterior margin almost straight; anterior margin convex and dilated; colour uniform white to cream-yellow, interior commonly with two yellow-orange stripes; rib number about 32 (20 anteriorly, 12 posteriorly); ribs flat with close set sessile transverse curved scales; interstices narrow, smooth; antero-dorsal margin erected and touching umbo.

Distribution.— Widely distributed throughout the tropical Indo-Pacific (except for the Red Sea) from S.E. Africa, up to Japan, N. Australia, and eastwards to Tuamotu Islands. Littoral and shallow water.

Rumphius, 1705 record.— '*Fragum album*', pl. 44, fig. G. In his description Linnaeus (1758), among others, referred to this figure, which is a clear representation of the species involved.

Remarks.— Like many Fraginae species *F. fragum* hosts symbiotic zooxanthellae, which may partly explain its restriction to mostly shallow water communities like inner reef habitats, consisting of moats and lagoons (Paulay, 1987). The close related congener *F. nivale* (Reeve, 1845) has a semi-infaunal life habit with the flattened postero-dorsal area at the surface of sand flats in lagoons and other sheltered sites (Zuschin & Oliver, 2003). It replaces *F. fragum* in the Red Sea, with which it lives sympatric in W. Indian Ocean localities. *F. fragum* proved to be extremely abundant in the shallow sandy borders of the lagoon of Anaa (Tuamotu Isles), a closed 25x5 km atoll with an estimated population of 600 million individuals and densities of up to 560 per m² (Richard, 1982).

On the basis of Linnaeus citation of the Rumphius' figure, Wilson & Stevenson, 1977 restrict the type locality to Ambon.

Fragum mundum (Reeve, 1845)
(figs 46-49)

Cardium mundum Reeve, 1845: sp. 125, fig. 125.

Cardium arcuatulum Sowerby, 1873: 721.

Fragum thurstoni Dall, Bartsch & Rehder, 1938: 154.

Material.— Sta. 05 (1 juv. v.), 23 (5 juv. v.), 30 (25 juv. v.).

Description.— Shell very small to small (height 5-12 mm), very inequilateral with posterior slope shorter separated from the rest by a longitudinal, sharp, curved angulation; exterior and interior colour cream to yellow with some greenish-blackish spots; rib number ca. 30 (of which 10 on posterior slope); ribs flat with more or less imbricate rather crowded scales on top, becoming spiny on the posterior slope; interstices narrow, finely striated; antero-dorsal margin not touching umbo, slightly depressed near it; on the hinge, hooked basement of the anterior lateral.

Distribution.— South Japan to the Central Pacific (Coral Sea, Melanesia, Polynesia, Hawaii, up to Tuamotu and Pitcairn Islands). Littoral and shallow water.

Remarks.— Due to its small size and relative rarity it has a patchy record and is sometimes overlooked or confused with juveniles of congeneric species, like *F. fragum*

(Linnaeus, 1758). According to Kay, 1979 this species is 'common in shallow water, occurring singly nestling in the algal-sand mat of tide pools and shoreward fringing reefs'.

Fragum scruposum (Deshayes, 1855)
(figs 52-55)

Cardium scruposum Deshayes, 1855: 333.

Hemicardium (*Fragum*) *fragum* var. *carinata* Lynge, 1909: 261.

Fragum whitleyi Iredale, 1929: 264.

Corculum (*Fragum*) *bannoi* Otuka, 1937: 138.

Fragum loochooanum Kira, 1955: 108.

Material.— Sta. 01 (1 juv. v.), 06 (2 v.), 16 (1 v.), 17 (2 v.), 23 (35 v.), 29 (1 juv. v.), 30 (5 v.).

Description.— Shell small (height 10-15 mm), resembling *Fragum fragum*, but smaller and with less sharpened (keeled) medio-posterior angulation; colour normally white, sometimes with patches of cream, juveniles occasionally pink or yellow with pinkish blotches; ribs about 20-25 in number, flatter, usually with less curved and coarser, more tubercular scales; interstices striated and rather broad, antero-dorsal hinge margin not touching umbo.

Distribution.— Tropical Indo-West Pacific, excluding Red Sea, up to Japan and N. Australia. Probably not far extending into the Pacific Ocean. Littoral and shallow water.

Remarks.— The intraspecific variability is expressed by the highly variable nature of the rib sculpture: ranging from rounded tubercles to elongated commarginal scales. Regularly found sympatrically with *F. fragum*.

Fragum sueziense (Issel, 1869)
(figs 56-61)

Cardium sueziensis Issel, 1869: 76.

Cardium (*Acanthocardia*) *omanense* Melvill in Melvill & Standen, 1906: 838.

Cardium transclathratum Viader, 1951: 143.

? *Cardium iranjanense* Fischer-Piette, 1977: 91.

Material.— Sta. 01 (6 p.v.; ca. 40 v.; 3 ethanol), 05 (8 p.v.; 10 v.; 1 ethanol), 06 (3 v.), 23 (30 v.), 29 (3 v.), 30 (35 v.), 31 (2 v.), 34 (22 v.), 37 (5 v.).

Description.— Shell very small to small (height 5-10 mm), outline variable, generally slightly inequilateral with posterior margin less convex, but sometimes equilateral and rounded; white to cream with occasionally pink spots or 2 purple-brown rays, visible inside and outside; rib number about 20-25; ribs squared with sessile top tubercles or scales; interstices striated, varying from close set to quite widely spaced; antero-dorsal margin not touching umbo, with most antero-dorsal part of the shell depressed beside umbo.

Distribution.— Throughout the tropical Indo-West Pacific, including Red Sea and South Africa (Kwazulu Natal). Littoral and shallow water.

Remarks.— This taxon has been placed in *Parvicardium* by several authors (Oliver, 1992, 1995; Hoenselaar & Dekker, 1998; Dekker & Orlin, 2000; Zuschin & Oliver, 2003). Placement in *Fragum* is more appropriate because of the broad and solid hinge plate, the strong hinge, and the depressed area just anterior of the umbo. *F. sueziense* proved to be one of the most important bivalve taxa in the quantitative bulk samples of the Northern Bay of Safaga, Red Sea, with bottom facies consisting of sand with coral patches, with sea grass and a mangrove channel (Zuschin & Oliver, 2003). Nearly all of the Rumphius Expedition finds are juveniles, originating from the more sheltered parts of Ambon Bay and Baguala Bay.

Fragum unedo (Linnaeus, 1758)
(figs 50-51; pl. 2 F)

Cardium unedo Linnaeus, 1758: 680.

Cardium cruentum Perry, 1811: pl. 57, fig. 1.

Hemicardium tegulatum Dautzenberg, 1900: 5.

Material.— Ambon, Pombo Isl., 1989 (4 p.v.), Ambon, Hitu, 1989 (1 p.v.), sta. 06, 16, 17, 21 (3 v.), 23, 26 (1 p.v.; 1 ethanol), 30 (1 v.; 1 juv. v.).

Description.— Shell medium to large (height 40-65 mm), inequilateral, subquadrate to trapezoidal, with rounded anterior and almost straight posterior margin; posterior slope separated from the rest by a non acute angulation (completely lacking or only weakly developed in juveniles); colour white to yellow-cream; about 25 ribs, flatly rounded with distantly spaced transverse scales, often dark red coloured and not covering full rib breadth; interstices narrow and smooth; antero-dorsal margin erected, touching umbo.

Distribution.— Tropical central Indo-West Pacific, from Thailand to Japan, N. Australia up to Tonga, W of longitude 170°W. Littoral and shallow water.

Rumphius, 1705 record.— '*Fragum*', pl. 44, fig. F. In his description Linnaeus (1758), among others, referred to this figure, which convincingly illustrates the shell morphology.

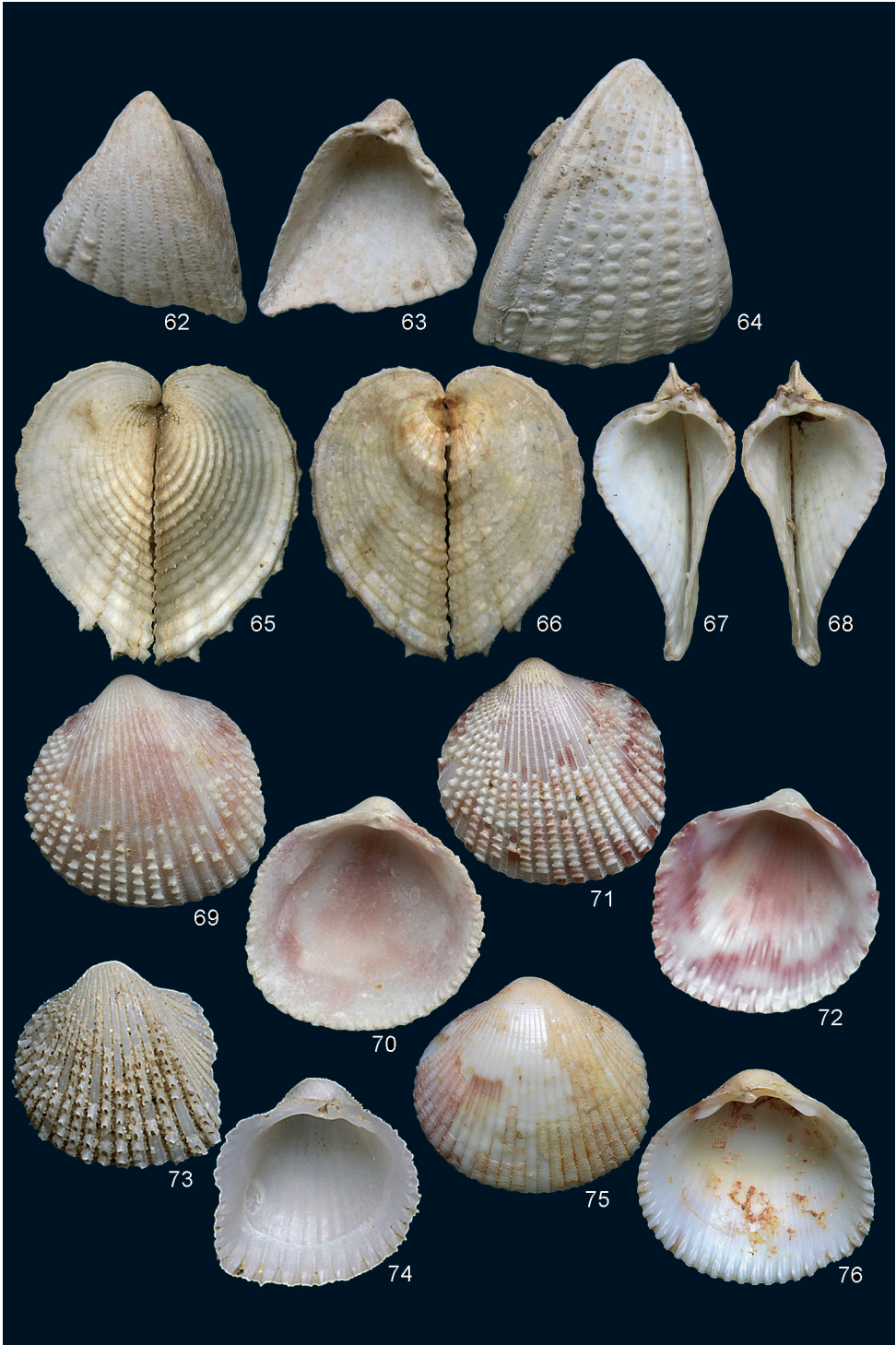
Remarks.— Rumphius, 1705 states that this species is common in Ambon Bay, which is not confirmed by the Rumphius Expedition records. Local pollution (Strack, 1993) could be a possible cause. Live specimens are found in abundance on intertidal sand flats in sheltered bays in N.W. Australia (Wilson & Stevenson, 1977). Rumphius, 1705 rightly notices that they are not deeply buried in the sand. The inclusion of South Australia and Mauritius in the distribution range by Germain, 1982 is clearly erroneous.

Genus *Lunulicardia* Gray, 1853

Type species.— *Cardium retusum* Linnaeus, 1767, by original designation.

Diagnosis.— Shell small to large, triangular, with acute medio-posterior angulation. Hinge strongly bent, sometimes distorted due to deeply impressed lunula. Ribs rather flattened, bearing nodules or transverse scales.

Remarks.— Like all Fraginae genera, *Lunulicardia* is in need of revision. The only



Ambonese representative, *L. hemicardium* (Linnaeus, 1758) has also been placed in *Hemicardium* Dall, 1900. Here the views of Wilson & Stevenson (1978), who point out the close affinities with *Lunulicardia*, are followed but ranked as a separate genus instead of a subgenus of *Fragum*.

Lunulicardia hemicardium (Linnaeus, 1758)
(figs 62-64; pl. 2 H)

Cardium hemicardium Linnaeus, 1758: 678.

Cardium tumoriferum Lamarck, 1819: 43.

Cardium guichardi Bernardi, 1857: 53-54.

Material.— Sta. 01 (4 juv. v.), 23 (10 juv. v.), 30 (1 juv. v.), 35 (1 v.).

Description.— Shell medium to large (height 35-60 mm), inequilateral, trapezoidal in outline, ventrally pointed; posterior margin less expanded than anterior, sometimes straight, even concave: sharp and prominent radial keel separating posterior slope from the rest; colour white to cream or pinkish, mainly on posterior slope, sometimes with reddish-brown spots; rib number variable (18-27): ribs flattened, bearing sessile rounded tubercles; interstices narrow, regularly notched; anterior margin not touching umbo, slightly depressed in front of it; posterior part of hinge very short; with broad flat lunula and very small nymphal plate and ligament.

Distribution.— Tropical Central Indo-West Pacific, from Japan, China to N. Australia and New Caledonia. Littoral and shallow water. In all probability, absent from Western Indian Ocean and Red Sea (see remarks).

Rumphius, 1705 record.— ‘Dubbelde Venushartje’ (no Latinized name given by Rumphius), pl. 44, fig. H. In his description Linnaeus (1758), among others, referred to this figure, which is a good representation of a sharply keeled specimen.

Remarks.— Rumphius, 1705 states that this species can be found in the inner part of Ambon Bay. Sta. 01 and 35 indeed refer to this shallow part of the bay and 30 to Baguala Bay. He already mentions the presence of a then greatly valued specimen showing the colour variation with red speckles or spots. A comparable example, with a certain degree of artistic freedom, can be seen in the coloured version of Rumphius’ plate. Live specimens are found in abundance on intertidal sand flats in sheltered bays in N.W. Australia (Wilson & Stevenson, 1977).

This species is exemplary for our poor state of knowledge of the distribution limits of many Indo-Pacific taxa. Although listed from the Red Sea (Oliver, 1992: pl. 22, fig. 4a-b – illustrated is indeed *L. hemicardium*, not necessarily originating from the Red Sea

◀ Figs 62-64, *Lunulicardia hemicardium* (Linnaeus), sta. 01. 62-63, exterior and interior of l.v., H 22.2 mm; sta. 35. 64, exterior of r.v., H 38.4 mm. 65-68, *Corculum cardissa* (Linnaeus), H 27.2 mm; sta. 17. 65, anterior view; 66, posterior view; 67, r.v., interior; 68, l.v., interior. 69-72, *Ctenocardia translutum* (Prashad), sta. 23. 69-70, exterior and interior of l.v., L 8.0 mm; 71-72, exterior and interior of l.v., L 7.6 mm 73-74, *C. virgo* (Reeve), L 4.1 mm; sta. 01. 73-74, exterior and interior of l.v.. 75-76, *Microfragum festivum* (Deshayes), L 9.2 mm; sta. 16. 75, l.v., exterior; 76, r.v., interior.

proper; Zuschin & Oliver, 2003: pl. 30, fig. 30.9 – illustrated is *F. nivale*), Eastern Arabia (Oliver, 1995: fig. 1082 – illustrated is *F. fragum*) East Africa (Fischer-Piette, 1977) and Thailand (Higo et al., 1999), I have never come across in any collection reliably documented material from these localities.

Genus *Microfragum* Habe, 1951

Type species.— *Cardium festivum* Deshayes, 1855, by original designation.

Diagnosis.— Shell small, flabelliform, weakly truncated posterior margin. Medio-posterior angulation rounded and not carinate. Ribs ornamented with dense, thin concentric scales. Interstices small.

Remarks.— Ranked by Vidal & Kirkendale, 2007 as a subgenus of *Ctenocardia* but here assigned generic rank, following Schneider (1998).

Microfragum festivum (Deshayes, 1855)
(figs 75-76)

Cardium festivum Deshayes, 1855: 332.

Material.— Sta. 16 (2 p.v.).

Description.— Shell small (height 10-15 mm), subequilateral, rounded quadrate, longer than high, posterior margin slightly truncated; exterior colour whitish to cream with brown-pinkish splashes, interior variable, ranging from white to orange in umbonal cavity or with brownish rays; rib number about 35-45; ribs flattened, rounded, covered with numerous thin imbricated very sessile lamellae that easily wear off, even in fresh material; interstices very narrow, finely punctuated.

Distribution.— Tropical West-Pacific, from Japan, Vietnam, Queensland, up to the Society Islands, longitude 150°.

Remarks.— *M. festivum* is the type species of *Microfragum*, a genus that is close related to *Ctenocardia* or even considered a subgenus of *Ctenocardia* (Keen, 1980). Here Schneider (1998) is followed, assigning full generic rank to *Microfragum*. The related *M. subfestivum* (Vidal & Kirkendale, 2007) was not encountered in the material. This species is differentiated by its smaller size, by being more asymmetrical and oblique, by a higher rib number and by the less numerous but more irregular lamellae (Vidal & Kirkendale, 2007).

Subfamily Tridacninae Lamarck, 1819
Genus *Hippopus* Lamarck, 1799

Type species.— *Chama hippopus* Linnaeus, 1758, by absolute tautonomy.

Diagnosis.— Shell very large, solid, elongated triangular. Only juveniles with small byssal gape that is bordered by interlocking teeth. 13-14 convex primary radial rib-like folds, bearing semi-tubular spines. Numerous riblets on primary ribs and interstices. Mantle not projecting laterally beyond shell margins.

Hippopus hippopus (Linnaeus, 1758)
(fig. 77; pl. 1 C)

Chama hippopus Linnaeus, 1758: 691.

Hippopus maculatus Lamarck, 1801: 117.

Material.— Sta. 20 (1 p.v.; 1 ethanol), 30 (2 p.v.).

Description.— Shell very large (length 250-350 mm), solid, strongly inflated, elongated triangular, inequilateral; exterior white with strawberry spots, interior white, often yellowish orange along margins and hinge; small byssal gape only in juvenile stage, bearing a row of tightly fitting teeth; 13-14 convex primary radial rib-like folds, bearing semi-tubular spines and numerous riblets on the principal ribs and interstices. The mantle is yellow-brown, dull green or grey and is rather dull in comparison to the *Tridacna* species. Contrary to *Tridacna*, the mantle of *Hippopus* does not project beyond the margins of the shells (Lucas, 1988).

Distribution.— Central Indo-Pacific from Thailand, South Japan to Tonga Islands. Shallow water.

Rumphius, 1705 record.— '*Chama striata*', pl. 42, fig. C. Although quoting a different Rumphius' name ('*Chama aspera obtusa*'), Linnaeus (1758) in his description, among others, referred to this figure, which clearly shows the nearly indistinct nature of the byssal gape.

Remarks.— The preferred habitat is sandy coral rock, generally not tied to a substratum (Pasaribu, 1988). Contrary to its congener *H. porcellanus* Rosewater, 1982, the incumbent aperture lacks tentacles (Lucas, 1988).

Genus *Tridacna* Bruguière, 1797

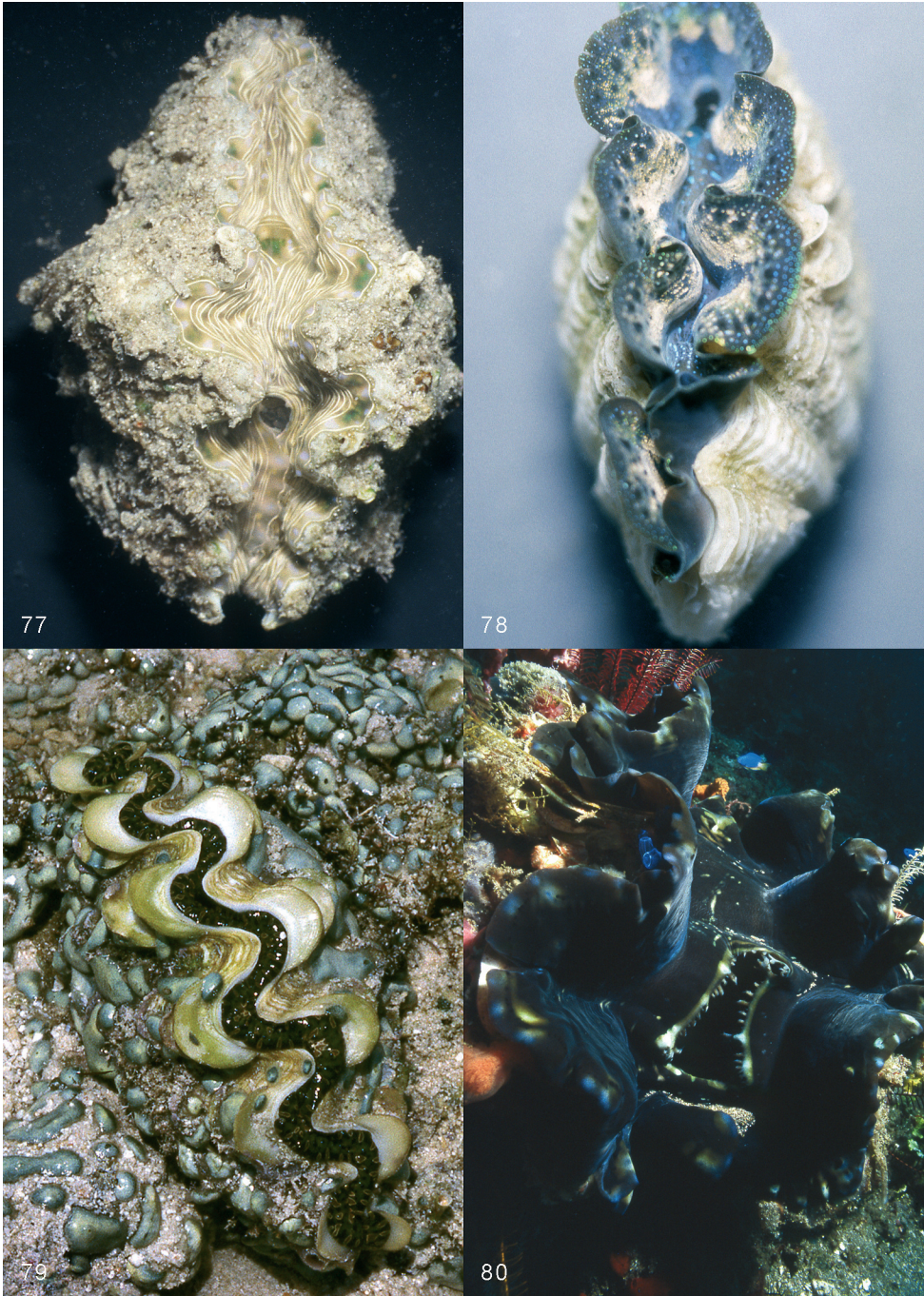
Type species.— *Chama gigas* Linnaeus, 1758, by subsequent monotypy.

Diagnosis.— Shell large to extremely large, solid, elongated triangular, inequilateral to nearly equilateral. Shell bearing prominent rib-like folds, unsculptured or ornamented with concentric ridges, scales or flutes. Well developed byssal gape that does not have interlocking teeth. Mantle colourful, projecting laterally beyond the shell margins when fully extended.

Subgenus *Chametrachea* Mörch, 1853

Type species.— *Tridacna crocea* Lamarck, 1819, by subsequent designation (Iredale, 1937).

Diagnosis.— Shell large to very large, solid, elongated triangular, strongly inequilateral to subequilateral with the umbos placed anteriorly. Rib-like folds ornamented with concentric ridges, scales or flutes. Often living byssally attached to coral rubble or embedded in coral.



Figs 77-80, Ventral views of life tridacnid species. 77, *Hippopus hippopus* (Linnaeus), sta. 20. 78, *Tridacna* (*Chametrachea*) *crocea* Lamarck, sta. 26. 79, *T. (C.) maxima* (Röding), sta. 17, *in situ*. 80, *T. (C.) squamosa* Lamarck, sta. 39, *in situ*. Photos figs 77-79: Marc Lavaleye; fig. 80: Willem Kolvoort.

Tridacna (Chametrachea) crocea Lamarck, 1819
(fig. 78; pl. 1 B)

Tridacna crocea Lamarck, 1819: 106.

Tridacna cumingii Reeve, 1862: pl. 7, fig. 7a (part).

Tridacna ferruginea Reeve, 1862: pl. 8, fig. 8a-b.

Material.— Sta. 20 (1 p.v.), 21 (2 ethanol), 26 (1 ethanol).

Description.— Shell large (length 125-150 mm), solid, inflated, triangular ovate, inequilateral; exterior dull white, sometimes with yellow, orange or pink tinge, interior same colouration, stronger towards the margins; very large broad byssal gape; 6-10 broad, low radial rib-like folds, largest on median part of the shell, bearing close-set undulating low scales and numerous riblets on the folds and interstices.

Distribution.— Central Indo-Pacific from Thailand, South Japan to Fiji Islands. Littoral and shallow water.

Rumphius, 1705 record.— '*Chama aspera & obtusa*', pl. 42, fig. B.

Remarks.— According to Von Martens, 1902 and Beekman, 1999 this species is involved too when Rumphius (1705: 128) describes 'another kind, thinner and flatter than the former *Littoralis*, having more the shape of a circle, with some trifling scales'.

As could be expected, all Rumphius Expedition records relate to exposed reef environments with coral boulders, in which it bores to the upper margin of its shells (Lucas, 1988).

Tridacna (Chametrachea) maxima (Röding, 1798)
(fig. 79)

Tridachnes maxima Röding, 1798: 171, no. 184.

Tridacna elongata Lamarck, 1819: 106.

Tridacna rudis Reeve, 1862: pl. 5, fig. 4a-c.

Tridacna compressa Reeve, 1862: pl. 6, fig. 5; pl. 7, fig. 5b.

Tridacna cumingii Reeve, 1862: pl. 7, fig. 7b (part).

Tridacna acuticostata Sowerby, 1912: 30-31, fig.

Material.— Sta. 11 (6 p.v.; 1 ethanol), 17 (2 p.v.; 2 ethanol), 20 (1 p.v.), 26 (1 p.v.) 27 (5 p.v.; 2 ethanol), 37 (1 ethanol), 39 (2 ethanol).

Description.— Shell very large (length 250-350 mm), solid, inflated, elongated, strongly inequilateral; exterior white or yellowish, sometimes orange or pink near margins, interior white, yellow, orange or pink near margins; very large elongated byssal gape; 5-6 broad, low radial rib-like folds, 5-6 flattened folds becoming obsolete near postero-ventral margin. Main folds bearing close-set scales or flutes and numerous riblets on the folds and interstices.

Distribution.— Widely distributed in the Indo-Pacific from South Africa (Kwazulu Natal), Red Sea, South Japan, North Australia deep into West-Pacific, West of longitude 130°. Littoral and shallow water.

Rumphius, 1705 record.— 'Male *Littoralis*', not depicted.

Remarks.— Occurs on hard substrates in a variety of reef environments, usually byssally attached. All Rumphius Expedition records refer to these habitats. It tends to bore into the reef, partially imbedded in the substrate (Lucas, 1988).

Tridacna (Chametrachea) squamosa Lamarck, 1819
(fig. 80; pl. 1 A)

Tridacna squamosa Lamarck, 1819: 106.

Material.— Sta. 11 (1 p.v.), 16 (5 p.v.), 18 (1 p.v.); 20 (3 p.v.; 1 juv.), 21 (5 p.v.); 27 (1 p.v.) 30 (1 p.v.); 39 (1 p.v., not sampled).

Description.— Shell very large (length 300-400 mm), solid, inflated, subequilateral; exterior white, yellow, orange or pink, rib ornamentation lighter coloured, interior white, margins often similar coloured as exterior; moderate byssal gape; 5-6 broad, well developed radial rib-like folds, 5-6 small ribs near postero-ventral margin. Strong, distantly placed scales or flutes on the folds, riblets on the interstices and even finer ones on the folds.

Distribution.— Widely distributed in the Indo-Pacific from South Africa (Kwazulu Natal), Red Sea, South Japan, North Australia, West-Pacific, West of longitude 130°. Littoral and shallow water.

Rumphius, 1705 record.— '*Chama squammata*; female *Littoralis*', pl. 42, fig. A.

Remarks.— *T. squamosa* occurs unattached or weakly attached by byssus as an adult and nestles in rubble or in reef pockets (Paulay, 1987), not imbedded in the substrate. In accordance, the species was completely absent in the more sheltered parts of Ambon Bay.

Rosewater, 1965 designates Rumphius' pl. 42, fig. A as lectotype of *Tridacna squamosa* Lamarck, 1819 and restricts the type locality to Ambon.

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