

**Systematic revision of living
species of *Meiocardia*, Glossidae
and *Glossocardia*, Trapezidae (Bivalvia)**

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ABSTRACT

Living species of *Meiocardia*, Glossidae, are reviewed on the basis of specimens stored in various museums and institutions, including the MUSORSTOM collection of Museum national d'Histoire naturelle, Paris. Six species, one of them new, are reported from the Indo-West Pacific. The type species, *M. moltkiana* (Gmelin, 1791), has been variously interpreted by authors, so we redescribe it and give a new diagnosis of the genus. Other species of *Meiocardia* are: *M. sanguineomaculata* (Dunker, 1882) (Philippines to Seychelles); *M. vulgaris* (Reeve, 1845) (China to Philippines); *M. globosa* sp. nov. (eastern Indian Ocean to Taiwan and Philippines); *M. samarangiae* Bernard, Cai & Morton, 1993 (Japan); and *M. hawaiiana* Dall, Bartsch & Rehder, 1938 (western Indian Ocean to Hawaii). *Meiocardia lamarckii* (Reeve, 1845) is synonymised with *M. moltkiana*. *Meiocardia lamarckii* of Japanese authors is not the same as *M. lamarckii* (Reeve), but is conspecific with *M. hawaiiana*. *Meiocardia samarangiae* Bernard, Cai & Morton, 1993 is a replacement name for *Isocardia tetragona* Adams & Reeve, 1850 non Koch & Dunker, 1837.

The genus *Glossocardia*, Trapezidae, is redescribed on the basis of the type-species, *Glossocardia obesa* (Reeve, 1843) (tropical West Pacific). It includes *Glossocardia stoliczkana* Prashad, 1932 (Philippines and New Caledonia) and the tropical western Atlantic *G. agassizii* (Dall, 1886), which was originally assigned to *Meiocardia*. There are no records of living or fossil species of *Meiocardia* from the western Atlantic or eastern Pacific.

RÉSUMÉ

Révision systématique des espèces actuelles de *Meiocardia* (Glossidae) et *Glossocardia* (Trapezidae) (Mollusca: Bivalvia).

Les espèces actuelles de *Meiocardia* (Glossidae) sont révisées sur la base du matériel conservé dans divers musées et instituts, y compris les collections constituées pendant les campagnes MUSORSTOM. Six espèces, dont une nouvelle, sont reconnues dans la région Indo-Ouest-Pacifique. L'espèce-type, *M. moltkiana* (Gmelin, 1791), a été diversement interprétée dans la littérature; nous la redécrivons donc, et donnons une diagnose révisée du genre. Les autres espèces de *Meiocardia* sont : *M. sanguineomaculata* (Dunker, 1882) (des Philippines aux Seychelles); *M. vulgaris* (Reeve, 1845) (de la Chine aux Philippines); *M. globosa* sp. nov. (de l'Est de l'océan Indien à Taiwan et aux Philippines); *M. samarangiae* Bernard, Cai & Morton, 1993 (du Japon); et *M. hawaiana* Dall, Bartsch & Rehder, 1938 (de l'ouest de l'océan Indien à Hawaï). *Meiocardia lamarckii* (Reeve, 1845) est mis en synonymie de *M. moltkiana*, mais *M. lamarckii* des auteurs japonais est un synonyme de *M. hawaiana*. *Meiocardia samarangiae* Bernard, Cai & Morton, 1993 est un nom de remplacement pour *Isocardia tetragona* Adams & Reeve, 1850, non Koch & Dunker, 1837.

Le genre *Glossocardia* (Trapezidae) est redécrit sur la base de son espèce-type, *G. obesa* (Reeve, 1843) (du Pacifique Ouest tropical). Ce genre comprend également *Glossocardia stoliczkana* Prashad, 1932 (des Philippines et de Nouvelle-Calédonie), et *G. agassizii* (Dall, 1886), de l'Atlantique tropical américain, décrite à l'origine comme *Meiocardia*. On ne connaît aucun *Meiocardia*, actuel ou fossile, dans le Pacifique oriental ou l'Atlantique américain.

INTRODUCTION

The bivalve family Glossidae is characterized by trapezoidal to cordiform shells with a cyprinoid hinge and conspicuous enrolled prosogyrous beaks. There are several living species belonging in two genera, *Glossus* and *Meiocardia*. Almost all living species of *Meiocardia* are restricted to the Indo-West Pacific. However, DALL (1886) described a living species from the tropical western Atlantic under the name *Meiocardia agassizii*.

Several fossil species from the Miocene of the Netherlands (JANSSEN, 1984), Tertiary of Piemonte, Italy (SACCO, 1900), and the Eocene of California (SQUIRES & ADVOCATE, 1986) and North Carolina (HARRIS, 1919a, b) have been included in *Meiocardia*. The taxonomic position of these fossil and living species from the Atlantic and the eastern Pacific is reassessed below.

Although several investigators, including REEVE (1845), ROEMER (1868), BUELOW (1906), LAMY (1920) and PRASHAD (1932), have reviewed the living species of *Meiocardia*, the taxonomy of Glossidae is still confused. For example, some authors have considered *Meiocardia moltkiana*, the type species of *Meiocardia*, to be strongly ribbed, with conspicuous nodules on the keel and a distinct sinuation just anterior to the keel (REEVE, 1845; ADAMS & REEVE, 1850; BUELOW, 1906), whereas Japanese authors have adopted the name for a species with an antero-posteriorly elongated, thick shell with a sharp keel lacking conspicuous nodules (OKUTANI & MATSUKUMA, 1982), and other authors have illustrated a shell with rounded postero-dorsal margin as this species (KEEN & CASEY, 1969; ABBOTT & DANCE, 1982).

We review living species of *Meiocardia*, Glossidae, based on the MUSORSTOM collection in Muséum national d'Histoire naturelle, Paris; National Science Museum, Tokyo; Institute of Systematics and Population biology, Universiteit van Amsterdam; Natural History Museum, London; Museum of Comparative Zoology, Harvard University; Academy of Natural Sciences, Philadelphia; Los Angeles County Museum, and others.

ABBREVIATIONS AND TEXT CONVENTIONS

Repositories

- ANSP : Academy of Natural Sciences, Philadelphia, Pennsylvania
 BMNH : The Natural History Museum, London
 IC : Mr Hiroshi Ito's private collection, Tokyo
 IMT : Institute of Malacology of Tokyo, Tanashi

- KPM : Kanagawa Prefectural Museum, Yokohama
 LACM : Los Angeles County Museum of Natural History, Los Angeles, California
 MCZ : Museum of Comparative Zoology, Harvard University, Cambridge, Massachusetts
 MNHN : Museum national d'Histoire naturelle, Paris
 NSMT : Department of Zoology, National Science Museum, Tokyo
 SBMNH : Santa Barbara Museum of Natural History, Santa Barbara, California
 USNM : National Museum of Natural History, Washington, DC
 YC : Mrs Yoshie Yamasaki's private collection, Nagoya
 ZMA : Institute of Systematics and Population Biology (Zoologisch Museum), Universiteit van Amsterdam, Amsterdam

Measurements (Fig. 1):

- Cb : Convexity of both valves
 Cs : Convexity of single valve
 H : Shell height
 L : Shell length
 lv : left valve
 rv : right valve
 V : valve.

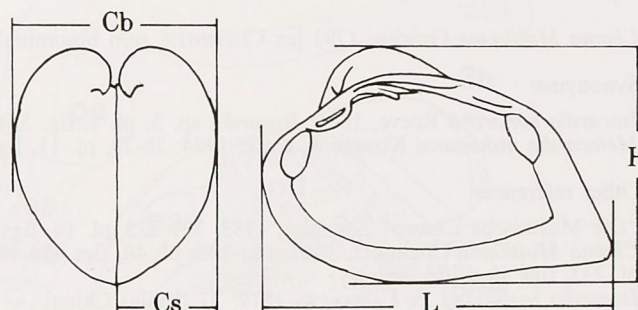


FIG. 1. — Shell measurements of *Meiocardia* and *Glossocardia*. Cb, convexity of both valves. Cs, convexity of single valve. H, shell height. L, shell length.

SYSTEMATIC ACCOUNT

Family GLOSSIDAE Gray, 1847

DIAGNOSIS. — *Shell* rounded to cordiform, strongly inequilateral, equivalve, with strongly enrolled, prosogyrous beaks. Ventral margin not gaping, smooth. Ligament external, opisthodetic, parivincular. *Hinge* with two lamellar cardinals and two laterals. Outer surface ornamented with commarginal sculpture. Dimyarian, with subequal adductor muscles. Pallial line simple, without sinus.

REMARKS. — The family Glossidae is apparently very close to the family Trapezidae, but differs from the latter by having a glossy shell and by lacking radial sculpture and microscopic scales on the outer surface.

Genus *MEIOCARDIA* H. & A. Adams, 1857

Meiocardia H. & A. Adams, 1857: 461. Type species: *Bucardia moltkiana*, Chem[nitz] [as listed by H. & A. Adams] = *Meiocardia moltkiana* Spengler [as cited by Stoliczka] = *Chama moltkiana* Gmelin, 1791, subsequently designated by STOLICZKA, 1870: 187.

DIAGNOSIS. — *Shell* small, usually less than 50 mm long, cordiform, strongly inflated, strongly inequilateral, equivalve. Beaks prominent, prosogyrous, strongly incurved. Larval ligament anterior to beaks. Outer surface glossy or polished, ornamented with commarginal sculpture. A strong primary keel from beak to lower posterior end separating posterior slope; weak secondary keel from beak to upper posterior end separating postero-dorsal margin. Cardinals (1, 3a, 3b) and laterals (LAI, LAIII, LPI, LPIII) in the right valve; cardinals (2a, 2b, 4b) and laterals (LAI, LPII) in the left valve. Posterior laterals (LPI, LPII, LPIII) finely striated or nodulated (Figs 1-2, 4-5).

REMARKS. — All living species of the Glossidae are placed in either *Glossus* Poli, 1795, or *Meiocardia*. *Meiocardia* clearly differs from *Glossus* in the having a smaller, subquadrate shell with very thin periostracum and a prominent primary keel separating the posterior slope. The genus *Glossus* includes only one living species, *G. humanus* (Linnaeus, 1758) of the Mediterranean to northeastern Atlantic, and is characterized by having a large, rounded shell with thick, reddish-brown periostracum and in lacking a dorsal keel. *Isocardia* Lamarck, 1799 is an objective junior synonym of *Glossus* Poli, 1795.

Meiocardia moltkiana (Gmelin, 1791)

Figs 3-4, 24-28

Chama Moltkiana Gmelin, 1791 [ex CHEMNITZ, non binominal]: 3303-3304.

Synonyms:

Isocardia lamareckii Reeve, 1845: *Isocardia* sp. 5, pl. 1, fig. 5 [China].

Meiocardia nishimurai Kosuge & Kase, 1994: 28-29, pl. 11, figs 1-5 [Bonin (= Ogasawara) Islands, Japan]. (**Syn. nov.**).

Other references:

“Die Moltkische *Chama*” Spengler, 1783: 321-325, pl. 14, figs 1-4 [South Seas; invalid, not latinized].

Chama Moltkiana Chemnitz, 1784: 105-108, pl. 48, figs 484-487 [Ostindien; appeared in invalid work]. — BRUGUIÈRE, 1797: pl. 233, figs 1a-d [fig. only].

Isocardia moltkiana — LAMARCK, 1819: 31 [India, China]. — BORY DE ST. VINCENT, 1827: 149.

Isocardia lamareckii — HANLEY, 1856: appendix, 370-371, app. pl. 18, f. 34 [China]. — BUELOW, 1906: 7-8, pl. 8, figs 6a-b. — LAMY, 1911: 132 [Mauritius].

Isocardia (Meiocardia) moltkiana — ROEMER, 1869: 8-9, pl. 1, figs 4-7 [Australia to Philippines]. — PRASHAD, 1932: 149-150 [pars] [Indonesia].

Isocardia (Meiocardia) Moltkeana var. *lamarecki* — LAMY, 1920: 298-300 [Mauritius].

Isocardia (sic) (Meiocardia) moltkiana — ABRARD, 1947: 39, pl. 3, fig. 11 [Miocene, New Hebrides].

Meiocardia moltkiana sanguinomaculata (sic) — KIRA, 1959: 194, pl. 71, fig. 5 [Japan]. — SHIKAMA, 1964: 67, pl. 41, fig. 13 [Mie Pref., central Japan].

Meiocardia moltkiana — KURODA et al., 1971: 673 (Japanese), 440 (English), pl. 97, figs 11-12 [Sagami Bay, central Japan].

— OKUTANI & MATSUKUMA, 1982: 175-176, pl. 10, fig. 5 [Izu Peninsula, central Japan]. — MATSUKUMA, 1986: 324-325 (f.)

[Okinawa]. — KOSUGE & KASE, 1994: pl. 10, fig. 10 [Spengler's type material].

Meiocardia tetragona — DRIVAS & JAY, 1988: 142, pl. 56, fig. 5 [Réunion & Mauritius].

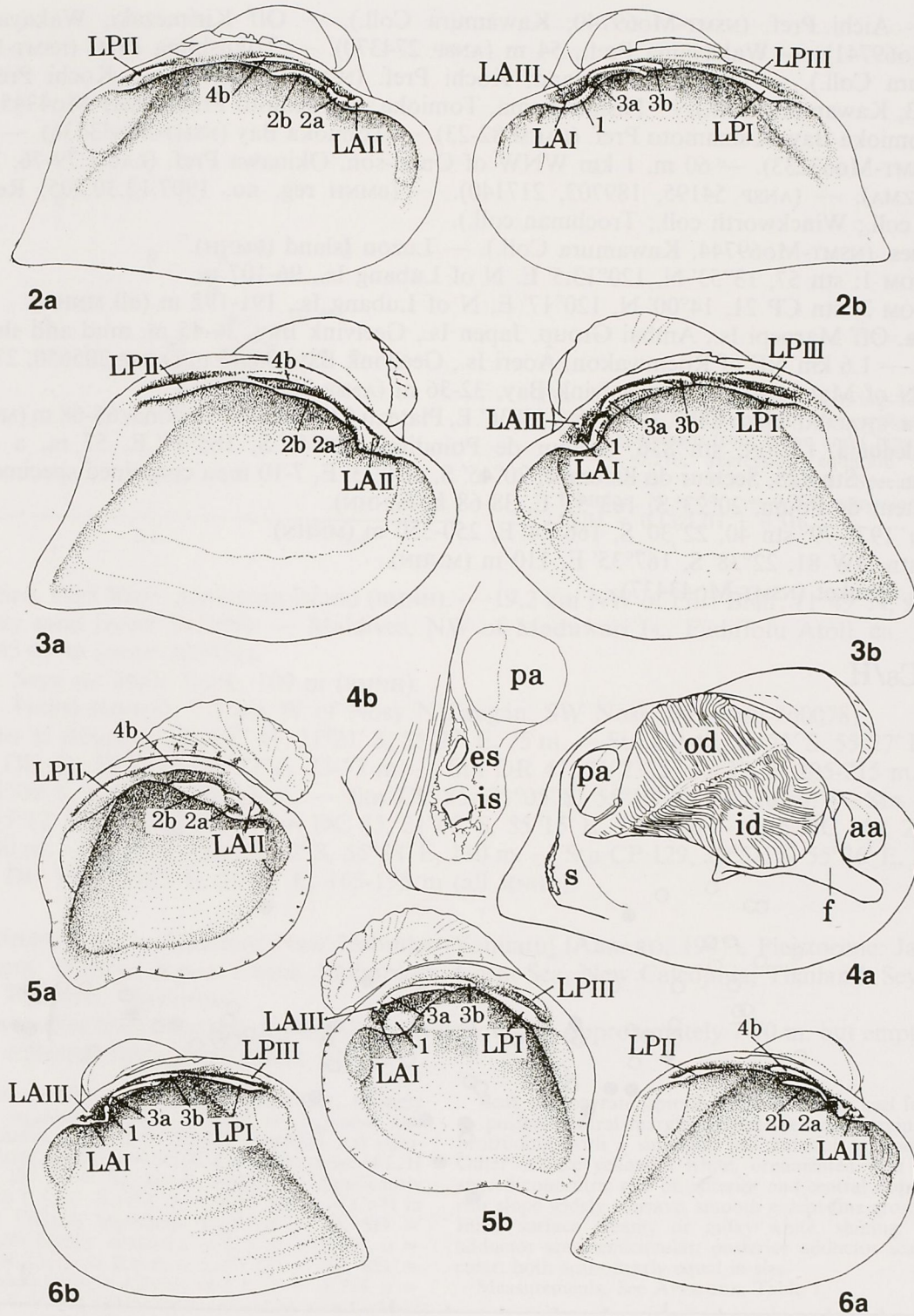
Meiocardia lamareckii — KOSUGE & KASE, 1994: pl. 10, fig. 12 [one of the syntypes].

TYPE MATERIAL. — “Die Moltkische *Chama*”: Spengler's illustrated specimens are stored in Zoologisk Museum, Copenhagen (not examined). — *Meiocardia lamareckii*: syntypes, Reeve collection, BMNH. — *Meiocardia nishimurai*: holotype, a conjoined specimen IMT-94-1.

TYPE LOCALITY. — “Die Moltkische *Chama*”: South seas [tropical Indo-West Pacific]. — *Meiocardia lamareckii*: China. — *Meiocardia nishimurai*: Ogasawara Islands, Japan.

MATERIAL EXAMINED. — Pleistocene: **Japan**. Ryukyu Limestone, Kikaijima Is., Kagoshima Pref. (NSMT-Mo69745).

Recent: **Japan**. Kameki-sho reef, Sagami Bay (NSMT-Mo43435). — 1.5 km SW of Jogashima, Sagami Bay, 70-75 m (NSMT-Mo69739). — Futami Bay, Chichijima Island, Bonin Islands, 27°04.5' N, 142°07.1' E, 115 m (NSMT-Mo59790). — Bonin Islands, holotype of *Meiocardia nishimurai* (IMT-



FIGS 2-6. — Dentition and gross anatomy of *Meiocardia*. — 2a-b, *Meiocardia samarangiae*. — 3a-b & 4a-b, *Meiocardia moltkiana*. — 5a-b, *Meiocardia sanguineomaculata*. — 6a-b, *Meiocardia hawaiana*. 1, 3a-3b, cardinals in the right valve. 2a-2b & 4b, cardinals in the left valve. LAI & LAIII: Anterior laterals in the right valve. LAII: Anterior lateral in the left valve. LPI & LPIII: Posterior laterals in the right valve. LPII: Posterior lateral in the left valve. aa: Anterior adductor. al: Adult ligament. es: Exhalant siphon. f: Foot. id: Inner demibranch. is: Inhalant siphon. od: Outer demibranch. pa: Posterior adductor. s: Siphons.

94-1). — Aichi Pref. (NSMT-Mo69740, Kawamura Coll.). — Off Kirimezaki, Wakayama Pref. (NSMT-Mo69741). — Wakayama Pref., 54 m (ANSP 274370). — Tokushima Pref. (NSMT-Mo69742, Kawamura Coll.). — Okinoshima Island, Kochi Pref. (NSMT-Mo42307). — Kochi Pref. (NSMT-Mo69743, Kawamura Coll.). — Nishinohama, Tomioka, Kumamoto Pref. (NSMT-Mo43455). — 20-40 m, Tomioka Bay, Kumamoto Pref. (LACM 82-23). — Tomioka Bay (NSMT-Mo43436). — Okinawa Pref. (NSMT-Mo63233). — 60 m, 1 km WNW of Onna-son, Okinawa Pref. (LACM 79-76, 78-101).

China. (ZMA). — (ANSP 54195, 189703, 217140). — (BMNH reg. no. 1907.12.30.505; Reeve coll.; Cuming coll.; Winckworth coll.; Trochman coll.).

Philippines. (NSMT-Mo69744, Kawamura Coll.). — Luzon Island (BMNH).

MUSORSTOM 1: stn 57, 13°53' N, 120°13.5' E, N of Lubang Is., 96-107 m.

MUSORSTOM 2: stn CP 21, 14°00' N, 120°17' E, N of Lubang Is., 191-192 m (all MNHN).

Indonesia. Off Maroepi Is., Ambai Group, Japen Is., Geelvink Bay, 36-45 m, mud and shells (ANSP 279722). — 1.6 km NE of Roemwakon, Aeri Is., Geelvink Bay, 36-45 m (ANSP 205650, 275802). — 3.6 km N of Matas, Aeri Is., Geelvink Bay, 32-36 m (ANSP 208922).

Coral Sea. CHALCAL 1: stn CP 7, 19°18' S, 158°36' E, Plateau Chesterfield-Bellona, 65-68 m (MNHN).

New Caledonia. LAGON: stn 836, Secteur de Poindimié, 20°46' S, 165°16' E, 57 m, a conjoined specimen. — Stn 928, Secteur de Koumac, 20°45' S, 164°23' E, 7-10 m, a conjoined specimen. — Stn 983, Secteur de Poum, 20°23' S, 163°57' E, 38-68 m (MNHN).

“Vauban”1978-79: stn 40, 22°30' S, 166°24' E, 250-350 m (MNHN).

SMB 5: stn DW 81, 22°38' S, 167°35' E, 110 m (MNHN).

Thailand. Phuket (NSMT-Mo43437).

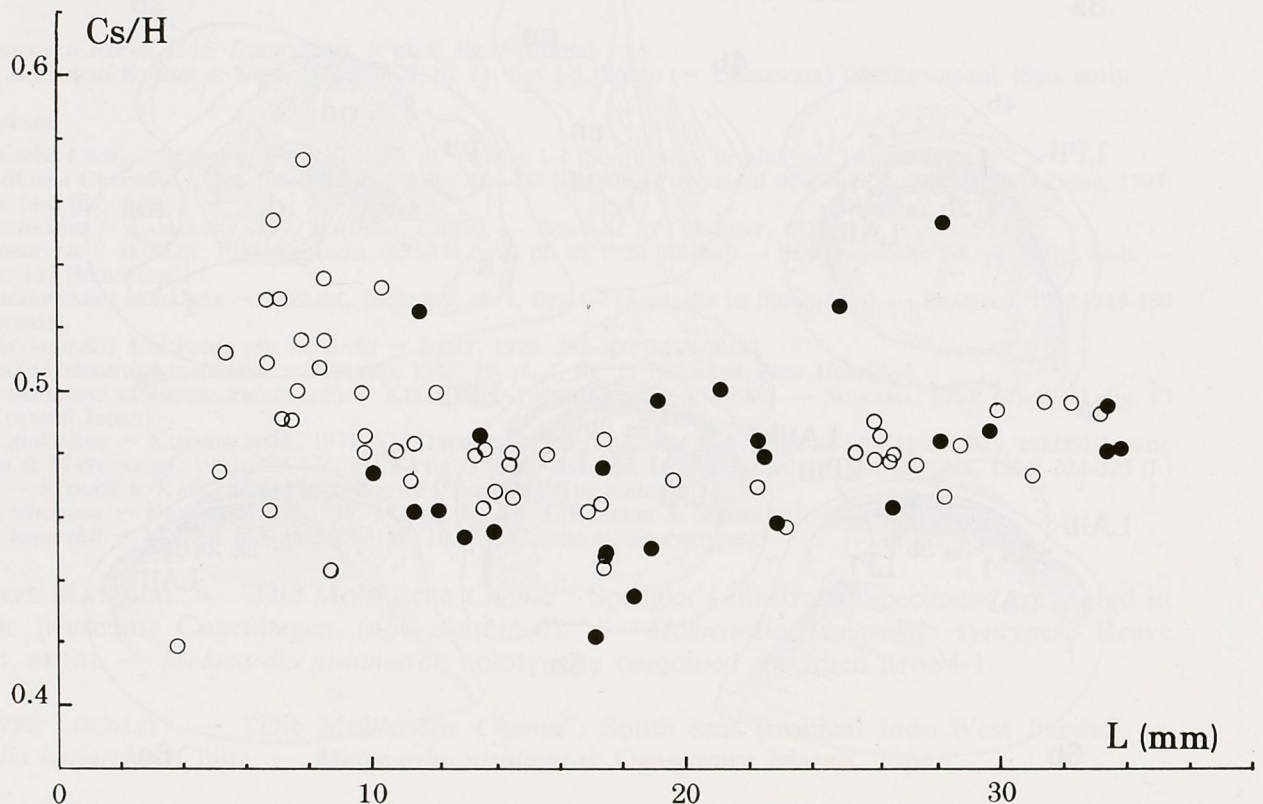


FIG. 7. — Scatter diagram showing relationship between L and Cs/H in *Meiocardia moltkiana*. Dots: Specimens from Japan and China. N = 25; $r = 0.325$; regression equation $Cs/H = 0.00129L + 0.451$. Circles: Specimens from Réunion. N = 55; $r = -0.258$; regression equation $Cs/H = -0.000818L + 0.500$.

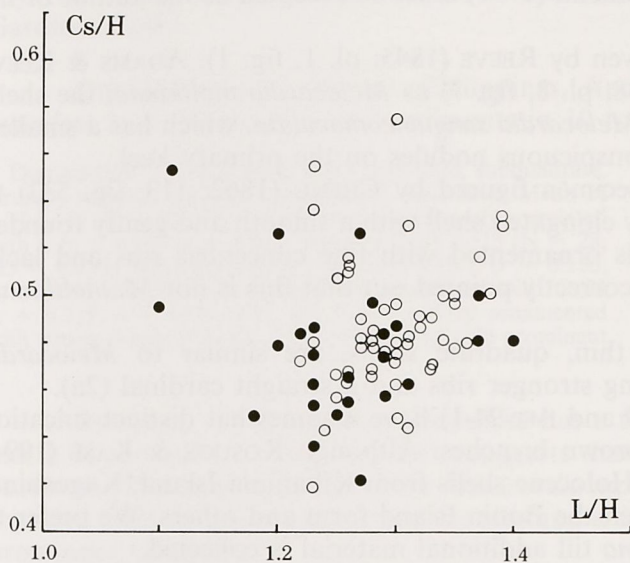


FIG. 8. — Scatter diagram showing relationship between Cs/H and L/H in *Meiocardia moltkiana*. Dots: Specimens from Japan and China. N = 25; $r = -0.210$; regression equation $Cs/H = -0.0874L/H + 0.587$. Circles: Specimens from Réunion. N = 55; $r = 0.207$; regression equation $Cs/H = 0.132L/H + 0.316$.

Andaman Sea. Port Blair, Andaman Island (BMNH). — 19.2 km NW of Port Blair, 11°49' N, 92°53' E, 90 m, shelly sand (ANSP 292189). — Maldives, NW of Maduvari Is., Fadiffolu Atoll, ca. 5°18' N, 73°29' E, 45-63 m (ANSP 325451).

Seychelles. Saya de Mala Bank, 100 m (BMNH).

Malagasy. Tuléar (MNHN); 7.2 km W of Nosy N'Tangan, SW Nossi Bé (ANSP 260078).

Réunion. MD 32 Réunion: stn DC 41, 21°21' S, 55°27' E, 75 m. — Stn CP 42, 21°21' S, 55°27' E, 74-77 m. — Stn DC 43, 21°21' S, 55°27' E, 73-77 m. — Stn DR 47, 21°23' S, 55°37' E, 205-215 m. — Stn DC 54, 21°06' S, 55°13' E, 80-83 m. — Stn CP 55, 21°05' S, 55°13' E, 97-110 m. — Stn DC 56, 21°05' S, 55°12' E, 170-225 m. — Stn DC 85, 21°00' S, 55°15' E, 58-70 m. — Stn DC 124, 20°52' S, 55°37' E, 40 m. — Stn DC 126, 20°52' S, 55°38' E, 110 m. — Stn CP 129, 20°51' S, 55°36' E, 290-300 m. — Stn DC 176, 21°02' S, 55°11' E, 165-195 m (all MNHN).

DISTRIBUTION. — Miocene: New Hebrides [Vanuatu] (ABRARD, 1947). Pleistocene: Japan.

Recent: Western Japan, China, Philippines, Coral Sea, New Caledonia, Thailand, Seychelles, Malagasy, Réunion, Mauritius.

This species lives in coarse sediments in shallow water, approximately 7-70 m, but empty shells have been collected from deeper than 300 m.

DESCRIPTION. — *Shell* small, thick, subcircular, strongly inequilateral, equivalve. Mean of L/H in Japanese and Chinese specimens 1.257 (N = 25, SD = 0.070), not significantly correlated with L ($r = 0.158$, $a = 0.05$); mean of L/H in Réunion 1.297 (N = 55, SD = 0.043), not significantly correlated with L ($r = -0.0418$, $a = 0.05$). Mean of Cs/H in Japanese and Chinese specimens 0.478 (N = 25, SD = 0.029), not significantly correlated with L ($r = 0.325$, $a = 0.05$); mean of Cs/H in Réunion 0.487 (N = 55, SD = 0.027), not significantly correlated with L ($r = -0.258$, $a = 0.05$) (Fig. 7); L/H not significantly correlated with Cs/H in both areas ($r = -0.210$ in Japan and China, $r = 0.207$ in Réunion, $a = 0.05$) (Fig. 8).

Beak prosogyrate, spirally twisted. Strong keel from beak to postero-ventral margin. Postero-ventral margin pointed, protruding, with a sinuation just anterior to smooth keel. Outer surface yellowish white, ornamented with regularly spaced concentric ribs on anterior and central slopes. Posterior slope widely concave, smooth except fine growth striae. Inner surface creamy or milky white, shining. Anterior adductor scar semicircular; posterior adductor scar subcircular; both scars nearly equal in size.

Measurements. See APPENDIX, Table 1.

REMARKS. — SPENGLER (1783) fully described the species, but did not give it a Latin name. Although the name, "die Moltkische *Chama*" of SPENGLER (1783), was latinized by CHEMNITZ (1784),

the work of MARTINI & CHEMNITZ (1769-1795) was placed by the Commission of Zoological Nomenclature on the List of Invalid Works, so Gmelin (1791) must be accepted as the author of the species.

Although PRASHAD (1932) cited figures given by REEVE (1845: pl. 1, fig. 1), ADAMS & REEVE (1850: 77, pl. 22, fig. 3) and BUELOW (1906: 37-38, pl. 8, fig. 7) as *Meiocardia moltkiana*, the shells illustrated by REEVE (1845) and others represent *Meiocardia sanguineomaculata*, which has a smaller, rounded shell with much coarser ribs and has conspicuous nodules on the primary keel. Although KEEN & CASEY (1969) assigned the specimen figured by CHENU (1862: 113, fig. 533) to *Meiocardia moltkiana*, it has an antero-posteriorly elongated shell with a smooth and gently rounded postero-dorsal area. The outer surface of shell is ornamented with fine concentric ribs and lacks nodules on the postero-dorsal keel. LAMY (1920) correctly pointed out that this is not *M. moltkiana*, but *M. vulgaris* (Reeve, 1845).

Juveniles of *M. moltkiana*, which have thin, quadrate shells, are similar to *Meiocardia hawaiana*, but they differ from the latter in having stronger ribs and a straight cardinal (2a).

Shells from Bonin Islands (NSMT-Mo59790 and IMT-94-1) have a somewhat distinct sulcation in front of a strong primary keel and reddish brown brotches. Although KOSUGE & KASE (1994) proposed for it the name *Meiocardia nishimurai*, Holocene shells from Kikaijima Island, Kagoshima Prefecture, present intermediate characters between the Bonin Island form and others. We prefer to treat *M. nishimurai* as a synonym of *M. moltkiana* till additional material is collected.

Although MATSUKUMA (1992) considered that *Meiocardia moltkiana* differs from *Meiocardia lamarckii* in having higher, thinner shells, with a weaker primary keel, a series of specimens from Réunion shows continuous variation between the two forms (Figs 25, 26a-d).

Meiocardia sanguineomaculata (Dunker, 1882)

Figs 5, 22-23

Isocardia moltkiana var. *sanguineomaculata* Dunker, 1882: 213 ["Korea"].

Other references:

Isocardia moltkiana — REEVE, 1845: *Isocardia* sp. 1, pl. 1, fig. 1 [Luzon, Philippines]. — ADAMS & REEVE, 1850: 77, pl. 22, fig. 3 ["Korea"]. — BUELOW, 1906: 37-38, pl. 8, fig. 7.

Isocardia (Meiocardia) moltkeana var. *sanguineomaculata* — LAMY, 1920: 298-299.

TYPE MATERIAL. — DUNKER based the name *sanguineomaculata* on the shell illustrated by ADAMS & REEVE (1850). This specimen was not found in BMNH.

TYPE LOCALITY. — Although ADAMS & REEVE (1850) noted the locality of their shell is "Corea" [= Korea], no additional specimens of this species have been rediscovered since their report. We think the shell came from tropical Indo-West Pacific, most probably from the Philippines.

MATERIAL EXAMINED. — Recent: **Philippines.** Luzon Island (BMNH 1989179). "Albatross": stn 5136, off Jolo, Jolo Is., 40 m, sand with shells (USNM 294545). — Stn D 5138, off Jolo, Jolo Is., 34 m, sand and coral (USNM 431190). — Stn 5139, off Jolo, Jolo Is., 36 m, coarse sand (USNM 294513). — Stn 5146, off Sulade Is., Sulu Archipelago, 43 m, coarse sand with shells (USNM 292393). — Stn 5148, off Sirun Is., Sulu Archipelago, 31 m, coarse sand (USNM 235929). — Stn 5149, W of Lapac, Tapul Is., 18 m, coarse sand with shells (USNM 235950). — Stn 5151, off Sirun Is., Tawitawi Is., Sulu Archipelago, 43 m, coarse sand with shells (USNM 292027). — Stn 5253, Pakiputan Strait, Mindanao, 50 m (USNM 237240).

Andaman Sea. Port Blair, Andaman Is. (BMNH 1989178).

Seychelles. REVES 2: stn 10, 05°02' S, 55°44' E, 45 m, a conjoined specimen. — Stn 16, 05°36' S, 56°56' E, 55 m, a conjoined specimen. — Stn 18, 05°45' S, 56°35' E, 50 m. — Stn 24, 05°09' S, 55°25' E, 35 m, a conjoined specimen. — Stn 30, 04°42' S, 54°24' E, 47 m, a conjoined specimen (all MNHN).

Farquar Group, 9°41' S, 51°03' E, 16 Dec. 1964 (USNM 718999).
 Saya de Malha Bank, Indian Ocean, 99 m, 2 conjoined specimens (BMNH 1910.8.31.688-689, J.S. Gardiner Coll.)

DISTRIBUTION. — Recent: Philippines, Andaman Islands, Seychelles. *Meiocardia sanguineomaculata* is a species of coarse sediments in 10 to 100 m.

DESCRIPTION. — *Shell* small, thick and solid, subquadrate, strongly inflated, strongly inequilateral, equivalve. Mean of L/H 1.145 (N = 28, SD = 0.073), not significantly correlated with L ($r = 0.159$, $a = 0.05$). Mean of Cs/H 0.515 (N = 28, SD = 0.034), not significantly correlated with L ($r = 0.155$, $a = 0.05$) (Fig. 9). L/H significantly correlated with Cs/H ($r = 0.519$, $a = 0.05$) (Fig. 10). Outer surface ornamented with strong concentric ribs. The primary keel with prominent

tubercles, wide, rounded. Postero-ventral margin with prominent sulcation just in front of the roundly protruded primary keel. Outer coloration whitish yellow with reddish brown triangular blotches. Beaks spirally enrolled. Inner surface creamy white, pale brown posteriorly. Anterior adductor scar elongated oval to semicircular; posterior adductor scar subcircular; both scars nearly equal in size.

Measurements. See APPENDIX, Table 2.

REMARKS. — *M. sanguineomaculata* has a thick, globular shell with Cs/H often exceeding 0.5 and L/H around 1.1. The shell form suggests that this species is most probably an inactive shallow burrower. This species differs from *Meiocardia moltkiana* by having an antero-posteriorly shortened, rounded shell with stronger concentric ribs and a distinct sinuation just anterior to the keel which has prominent tubercles.

Meiocardia vulgaris (Reeve, 1845)

Figs 12, 31-32

Isocardia vulgaris Reeve, 1845: *Isocardia* sp. 2, pl. 1, figs 2a-b [China].

Synonym:

Meiocardia delicata Kosuge & Kase, 1994: 29-30, pl. 11, figs 6-8, pl. 12, figs 1-3 [Okinawa, Japan]. (**Syn. nov.**).

Other references:

Isocardia moltkiana — SOWERBY, 1852: 82, pl. 6, fig. 126. — CHENU, 1862: 113, fig. 533. — ABBOTT & DANCE, 1982: 351, f.

Isocardia (Meiocardia) vulgaris — ROEMER, 1868: 9-10, pl. 1, figs 9-10 [China]. — PRASHAD, 1932: 150-151 [Indonesia].

Isocardia vulgaris — BUELOW, 1906: 37-38, pl. 8, fig. 5 [China].

Isocardia (Meiocardia) moltkeana var. *vulgaris* — LAMY, 1920: 297-298 [China, Poulo-Condor, India].

Meiocardia vulgaris — SHIKAMA, 1964: 67, pl. 41, fig. 14 [East China Sea]. — KOSUGE & KASE, 1994: pl. 10, fig. 11 [one of syntypes; China].

Glossus (Meiocardia) moltkiana — KEEN & CASEY, 1969: N657, fig. E134-7 [= CHENU, 1862, fig. 533].

TYPE MATERIAL. — *Isocardia vulgaris*: 5 syntypes in BMNH, without registration number. — *Meiocardia delicata*: holotype, a conjoined specimen IMT-94-2.

TYPE LOCALITY. — *Isocardia vulgaris*: China. — *Meiocardia delicata*: Okinawa, Japan.

MATERIAL EXAMINED. — Recent: **Japan**. Holotype of *Meiocardia delicata* (IMT-94-2).

China. 5 syntypes of *Isocardia vulgaris* (BMNH). — R. Winckworth Coll. (BMNH). — L. A. Reeve Coll. (BMNH). — (ZMA). — (ANSP 54063, 54064, 138495). — (USNM 17495, 32049 and 75912). — (LACM 13513, 48064, A1463, A5076). — Hong Kong (USNM 47939). — Taiwan (KPM 761-2357). — China Sea (USNM 186123).

Philippines. "Philippines" (NSMT-Mo69747, Kawamura Coll.). — "Philippines", sandy mud, 9 m, H. Cuming coll. (BMNH). — Nazasa Bay, Zambales Prov., W Luzon, 14°48.9' N, 120°05.5' E, 29 m (LACM 60-40). — NE Villa Carmen, Bataan Prov., W Luzon, 2-9 m (LACM 89954). — W of Boan Is., Turtle Is, SW Sulu Sea, 29-32 m (LACM 89904).

"Albatross" stn 5097, S of Corregidor Is., Manila Bay, 54 m, gray mud, sand and shells (USNM 283971). — Stn 5107, off Corregidor Is., Manila Bay, 50 m, gray mud (USNM 235242). — Stn 5131,

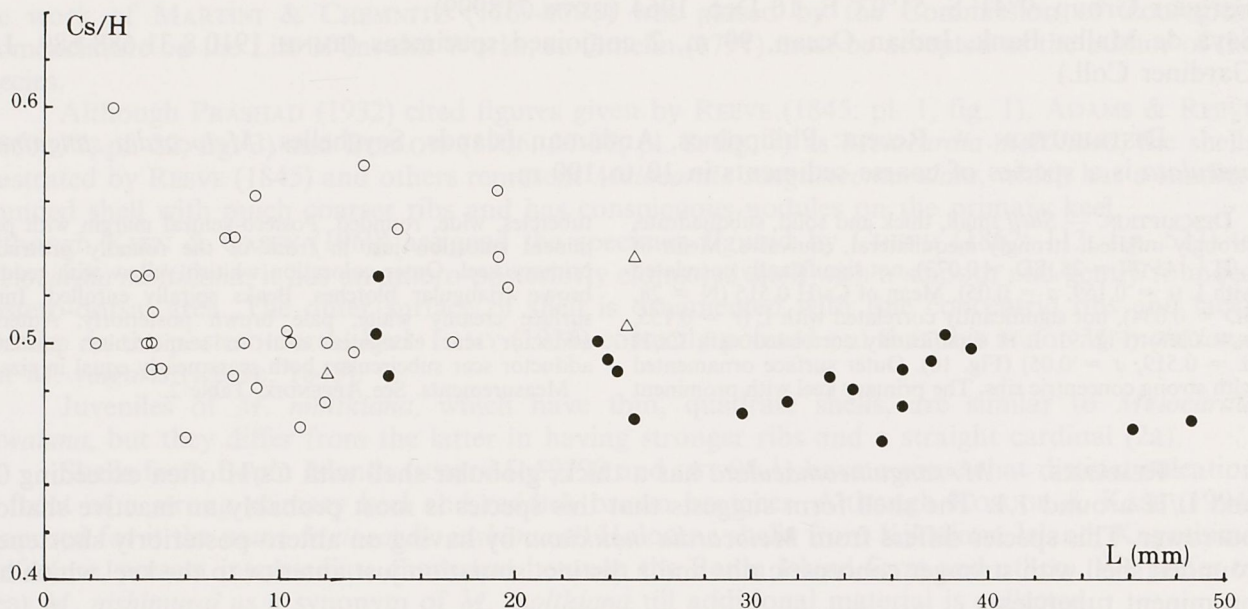


FIG. 9. — Scatter diagram showing relationship between L and Cs/H in *Meiocardia*. Dots: *Meiocardia vulgaris*. N = 19; $r = -0.541$; regression equation $Cs/H = -0.000934L + 0.514$. Circles: *Meiocardia sanguineomaculata*. N = 28; $r = 0.155$; regression equation $Cs/H = 0.00103L + 0.505$. Triangles: *Meiocardia globosa* sp. nov. N = 3.

off Panabutan Pt., W. Mindanao, 49 m, green mud and coarse sand (USNM 302604). — Stn 5156, off Tinakta Is., Tawitawi, SW Sulu Archipelago, 32 m, fine sand and shells (USNM 292117). — Stn 5157, off Tinakta Is., Tawitawi, SW Sulu Archipelago, 32 m, fine sand (USNM 236110). — Stn 5164, off SE Tawitawi, SW Sulu Archipelago, 32 m, green mud (USNM 283382). — Stn 5181, off Antonio Is., NE Panay, 47 m, fine muddy sand (USNM 248219, 293458). — Stn 5192, SE of Bantayan Is., NW of Cebu, 58 m, green sand (USNM 293088). — Stn 5210, N of Biliran Is., N of Leyte, 90 m, muddy sand (USNM 248221). — Stn 5220, N of Marinduque, 90 m, soft green mud (USNM 248376). — Stn 5235, off Magabao Is., E. Mindanao, 79 m, soft mud (USNM 294836). — Stn 5335, Linapacan Str., N of Palawan, 83 m, sandy mud (USNM 229229). — Stn 5336, Linapacan Str., off Observatory Is., N of Palawan, 83 m, sandy mud (USNM 297197). — Stn 5338, Palawan Pass, off Preservatory Is., 77 m, coarse sand and mud (USNM 237803, 297338). — Stn 5477, off Tacbac Pt., Leyte, 86 m, gray mud (USNM 238563). — Stn 5478, off Tacbac Pt., Leyte, 103 m (USNM 301132). — Stn 5480, off Tacbac Pt., Leyte, 112 m, fine sand (USNM 238581). E end of Corregidor Is., Manila Bay, 11-18 m (ANSP 247061). — SW of San Nicholas Shoals Light, Manila Bay (ANSP 246662, 246705). — Ragay Gulf, SE Luzon, 54 m (LACM 89903). — Ragay Gulf, SE Luzon (NSMT-Mo69746, Kawamura Coll.). — Hulagaan Is., Occidental Mindoro (ANSP 302071). — Borongan, Samar Prov. (LACM 89907). — Maqueda Bay, Samar Is. (MCZ). — N end of Cebu Is. (ANSP 245942). — Cebu (NSMT-Mo54938, 60557).

MUSORSTOM 3: stn DR 140, 11°43' N, 122°34' E, west of Panay Is., 93-99 m (MNHN). — Stn CP 141, 11°45' N, 122°45' E, west of Panay Is., 40-44 m (MNHN).

Malaysia. "Albatross": stn 5358, off Sandakan, north Borneo, 70 m, mud (USNM 297635).

Indonesia. CORINDON: stn CH 205, 1°08' S, 117°19' E, Makassar Strait, 49 m, a conjoined specimen (MNHN).

Welkmost Bay, Bantam, Java (USNM 261137). — Tjiganter, Bantam, Java (USNM 261138). — 3°54' S, 134°04' E, W of Babi Is., Wokam, NE Aru, 54-63 m, mud (USNM 747420).

Australia. (USNM 95524, Jeffrey coll.); 14.4 km SE of Double Is., Tin Can Bay, Queensland (USNM 681655). — Bundaberg, Queensland, 45 m (LACM 30008).

Andaman Sea. 08°29' N, 97°59' E, 40 km NNW of Phuket, Thailand, 42 m, sandy mud (ANSP 291729). — 4.8 km NE of Lighthouse Is., Phuket, 144 m (ANSP 286326). — 13°00' N, 97°41' E, 56 km W of Tavoy Is., Andaman Is., 68 m, mud with shells (ANSP 292935). — 13°28' N, 97°19' E, 91.2 km NW of Tavoy Is., 39 m, shelly sand (ANSP 293036). — 12°03' N, 92°57' E, 40 km NNW of Port Blair, Diligent Strait, Andaman Is. 38 m, shelly sand (ANSP 292612).

Bay of Bengal. 15°08' N, 94°04' E, 80 km SW of Irrawaddy River, Preparis North Channel, Burma, 53 m, gray mud (ANSP 293697). — 19°32' N, 92°52' E, 27.2 km SSE of Akyab, Burma, 55 m, muddy sand (ANSP 294080). — 17°35' N, 83°25' E, 28.8 km SW of Vizagapatnam, NE India, 79 m, shelly sand (ANSP 294702). — 17°35' N, 83°25' E, 16 km SE of Vizagapatnam, NE India, 58 m, shelly sand (ANSP 294183).

Oman. 25°50' N, 58°08' E, Oman Gulf (USNM 716879).

Zanzibar. 3.2 km W of Chango Is., 27 m, shelly sand (ANSP 214511).

Malagasy. 96 km NE of Cape St. André (USNM 719126).

DISTRIBUTION. — Recent: China, Taiwan, Philippines, Malaysia, Indonesia, Queensland, Andaman Is., Burma, NE India, Oman, Zanzibar; Malagasy. This species lives in mud in 2 to 50 m, and empty shells have been collected in approximately 110 m on a mud bottom with shells.

DESCRIPTION. — *Shell* large for genus, occasionally attaining 45 mm in length, yellowish white. L/H significantly correlated with L ($N = 19$, $r = 0.900$, $a = 0.05$). Cs/H significantly correlated with L ($N = 19$, $r = -0.541$, $a = 0.05$) (Fig. 9). L/H significantly correlated with Cs/H ($N = 19$, $r = -0.449$, $a = 0.05$) (Fig. 15). Keel running from beak to postero-ventral corner not prominent. Postero-dorsal area

smooth. Antero-ventral area ornamented with weak concentric ribs. Postero-dorsal margin rounded. Inner surface creamy white, umbonally yellowish, shining. Anterior adductor scar semicircular; posterior adductor scar subcircular; both scars nearly equal in size.

Measurements. See APPENDIX, Table 3.

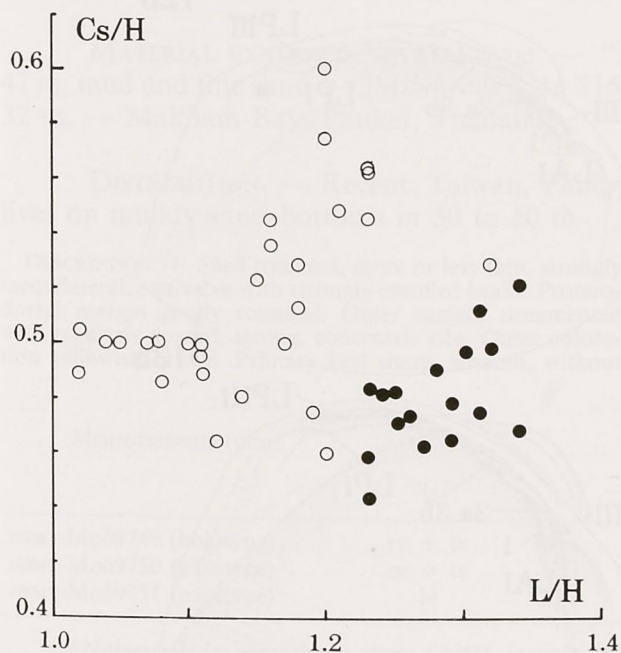
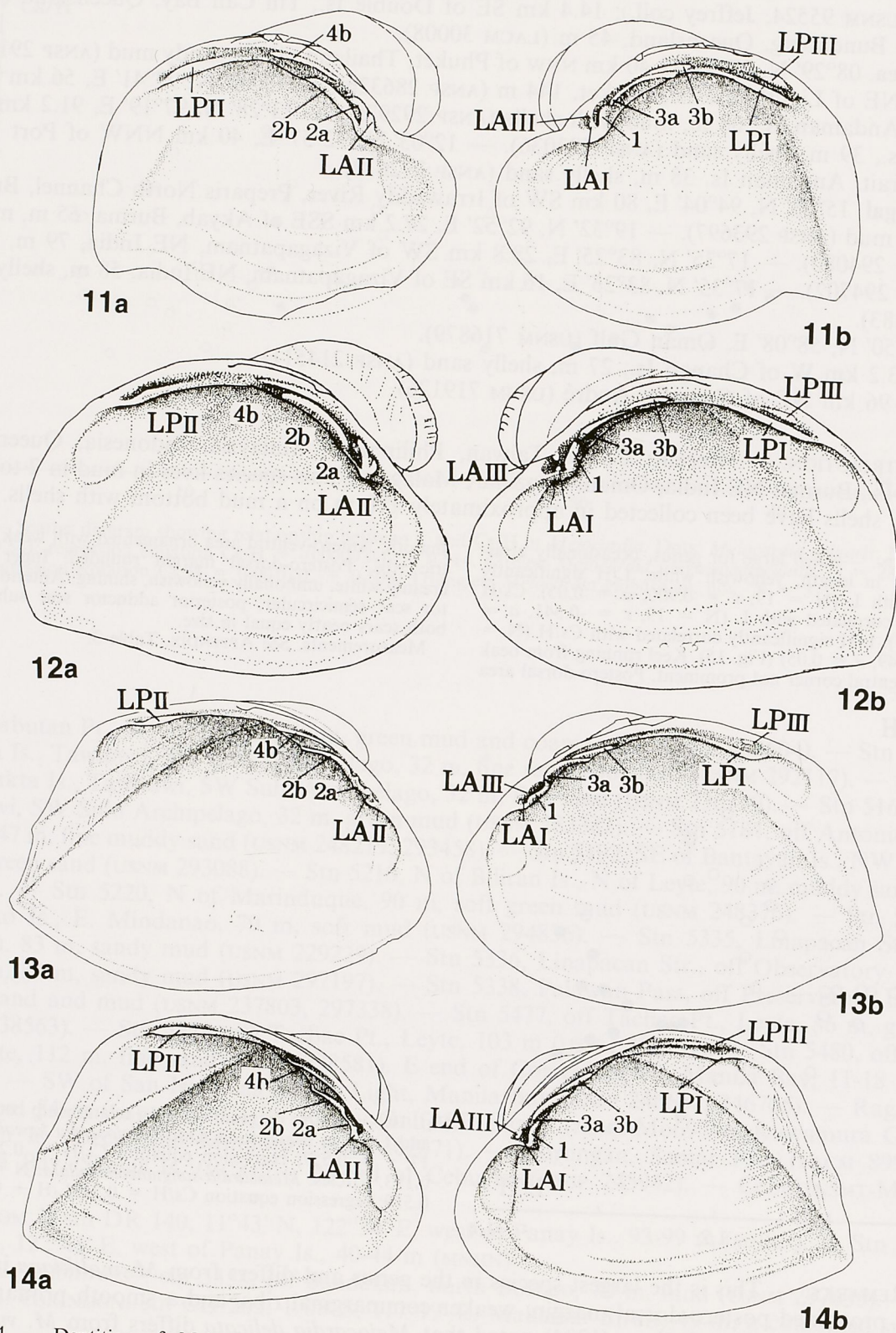


FIG. 10. — Scatter diagram showing relationship between L/H and Cs/H in *Meiocardia*. Dots: *Meiocardia hawaiana*. $N = 17$; $r = 0.557$; regression equation $Cs/H = 0.287L/H + 0.113$. Circles: *Meiocardia sanguineomaculata*. $N = 28$; $r = 0.519$; regression equation $Cs/H = 0.245L/H + 0.234$.

REMARKS. — This is the largest species in the genus and differs from *M. moltkiana* in having a gently protruded postero-dorsal margin, weaker commarginal ribs, and a smooth primary keel.

Although KOSUGE & KASE (1994) noted that *Meiocardia delicata* differs from *M. vulgaris* in having weaker commarginal sculptures and less globular shells, a gently arched postero-dorsal margin with delicate ornamentations is a characteristic of *M. vulgaris*.



FIGS 11-14. — Dentition of *Meiocardia* and *Glossocardia*. For the abbreviations see the explanation of Figs 2-6. — 11a-b, *Meiocardia globosa* sp. nov. — 12a-b, *Meiocardia vulgaris*. — 13a-b, *Glossocardia agassizii*. — 14a-b, *Glossocardia stoliczkana*.

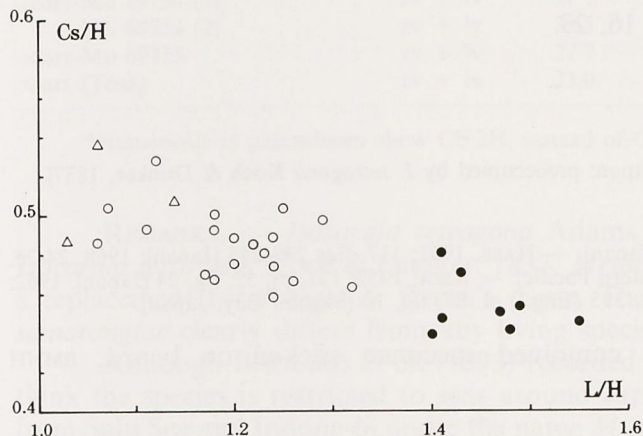


FIG. 15. — Scatter diagram showing relationship between L/H and Cs/H in *Meiocardia*. Dots: *Meiocardia samarangiae*. N = 8; $r = 0.701$; regression equation $Cs/H = 0.00380L/H + 0.347$. Circles: *Meiocardia vulgaris*. N = 19; $r = -0.541$; regression equation $Cs/H = -0.000934L/H + 0.514$. Triangles: *Meiocardia globosa* sp. nov. N = 3.

Meiocardia globosa sp. nov.

Figs 11, 30

TYPE MATERIAL. — Holotype: a conjoined specimen, NSMT-Mo69749. Paratypes: 1 conjoined specimen NSMT-Mo69750, 1 left valve NSMT-Mo69751; USNM 236796, 283380a.

TYPE LOCALITY. — Pescadores, Taiwan, coll. by K. Nakayasu.

MATERIAL EXAMINED. — Holotype. — “*Albatross*”, stn 5181, E of Gigante Is., Philippines, 47 m, mud and fine sand. — “*Albatross*”, stn 5164, SE of Tawitawi Is., Sulu Archipelago, Philippines, 32 m. — Makham Bay, Phuket, Thailand.

DISTRIBUTION. — Recent: Taiwan, Philippines, Indian Ocean coast of Thailand. This species lives on muddy sand bottoms in 30 to 50 m.

DESCRIPTION. — *Shell* rounded, more or less thin, strongly inequilateral, equivalve with strongly enrolled beaks. Postero-dorsal margin gently rounded. Outer surface ornamented with regularly spaced, strong, concentric ribs. Outer coloration yellowish brown. Primary keel sharp, smooth, without

nodules, separating smooth postero-dorsal area. Postero-ventral margin with prominent sulcation just in front of the pointed primary keel. Inner surface milky white, umbonally yellowish. Anterior adductor scar semicircular; posterior adductor scar subcircular; both scars nearly equal in size.

Measurements (mm):

	V	L	H	L/H	Cb	Cs	Cs/H
NSMT-Mo69749 (holotype)	rv + lv	24.8	21.8	1.14	22.1	-	(0.507)*
NSMT-Mo69750 (paratype)	rv + lv	12.1	11.7	1.03	11.4	-	(0.487)
NSMT-Mo69751 (paratype)	lv	25.1	23.7	1.06	-	12.7	0.536

*Numericals in parentheses show Cb/2H, instead of Cs/H.

REMARKS. — *Meiocardia globosa* is closest to *M. vulgaris* which is sympatric. *Meiocardia globosa* has a more rounded, antero-posteriorly shorter shell, with stronger commarginal ribs and a more prominent keel (Figs 30a-d).

Meiocardia samarangiae Bernard, Cai & Morton, 1993

Figs 2, 16, 29

Meiocardia samarangiae Bernard, Cai & Morton, 1993: 67.

Synonym:

Isocardia tetragona Adams & Reeve, 1850: 76, pl. 22, fig. 1 [Japan; preoccupied by *I. tetragona* Koch & Dunker, 1837].

Other references:

Meiocardia tetragona — HIRASE, 1934: 17, 117, pl. 31, fig. 3 [Japan]. — HABE, 1951: 117, figs 243-245 [Japan]; 1958: 24-25, pl. 1, figs 5-6 [Japan]; 1977: 236, pl. 49, figs 8-9 [Japan and western Pacific]. — KIRA, 1959: 131, pl. 52, fig. 24 [Japan]; 1962: 148, pl. 53, fig. 24 [Japan]. — KURODA *et al.*, 1971: 614 (Jap.), 395 (Eng.), pl. 87, fig. 10 [Sagami Bay, Japan].

TYPE MATERIAL. — Supposed syntype: a conjoined specimen stuck on board, BMNH 1874.12.11.270.

TYPE LOCALITY. — Japan.

MATERIAL EXAMINED. — Pleistocene: **Japan**. Moeshima Shell Bed, Moeshima Is., Kagoshima Pref. (NSMT-Mo59576). — Ryukyu Limestone, Kamikatetsu, Kikajima Is., Kagoshima Pref. (NSMT-Mo54638).Recent: **Japan**. Jogashima, Miura Peninsula, Kanagawa Pref. (NSMT-Mo43441, 43442). — Hayama, Kanagawa Pref. (NSMT-Mo43444). — "Sagami Bay" (NSMT-Mo45452, 45468, 69753, 69754, Kawamura Coll.). — Amadaiba, Sagami Bay (NSMT-Mo43443). — Off Isshiki, Aichi Pref. (NSMT-Mo43450). — "Wakayama Pref." (NSMT-Mo4412). — Minabe, Wakayama Pref. (NSMT-Mo50907). — Off Sakaihama, Tanabe Bay, Wakayama Pref. (NSMT-Mo69752). — Tatsugahama, Wakayama Pref. (NSMT-Mo43454). — "*Soyo-Maru*" stn 345, 33°15'10" N, 134°12'00" E, off Cape Muroto, 199-165 m, gravel, pebbles mud, rock (NSMT-Mo43447). — Tosa Bay (NSMT-Mo43451, 43452, 53902, 69756). — Amachi (YC), Shimizu (IC, Aug. 1972), Kochi Pref. — Kuriya, Echizen-cho, Fukui Pref. (NSMT-Mo43453, 69755). — "*Soyo-Maru*" stn 483, 34°44'50" N, 130°47'10" E, Tsushima Strait, 130 m, sand (NSMT-Mo43440). — "*Soyo-Maru*" stn 468, 34°25'40" N, 129°47'00" E, Tsushima Strait, 112 m, mud sand (NSMT-Mo43448). — "*Soyo-Maru*" stn 301, 31°13'10" N, 131°26'10" E, off Satamisaki, 181 m, gravel, sand, shells (NSMT-Mo43445). — "*Soyo-Maru*" stn 417, 31°10'15" N, 130°26'00" E, off Kaimondake, 192 m, sand (NSMT-Mo43446). — East China Sea (NSMT-Mo43449). — Miyakojima Island, Okinawa Pref. (NSMT-Mo51917).

DISTRIBUTION. — Japan, China. This species lives in muddy sand in approximately 110 to 190 m.

DESCRIPTION. — *Shell* antero-posteriorly elongate, subquadrate, thin but robust, inflated, strongly inequilateral, equi-valve. Mean of L/H 1.455 (N = 8, SD = 0.052), not significantly correlated with L ($r = 0.0435$, $a = 0.05$). Mean of Cs/H 0.453 (N = 8, SD = 0.015), not significantly correlated with L ($r = 0.701$, $a = 0.05$). L/H not significantly correlated with Cs/H (N = 9, $r = 0.548$, $a = 0.05$). Beakslow, prosogyrate. Primary keel running from beak to pointed postero-ventral margin. Secondary keel obscure. Outer surface with irregular commarginal ribs except on nearly smooth umbonal area. *Hinge* teeth thin; 1 long, parallel to dorsal margin; LPIII small. Inner surface creamy white. Anterior adductor scar semicircular; posterior adductor scar subcircular; both scars nearly equal in size.

Measurements (mm):

	V	L	H	L/H	Cb	Cs	Cs/H
NSMT-Mo 69752 (1)	rv + lv	29.9	20.1	1.49	18.2	-	(0.453)*
Mo 69752 (2)	rv + lv	29.7	21.1	1.41	20.3	-	(0.481)
Mo 69752 (3)	rv + lv	25.1	17.0	1.48	15.0	-	(0.441)
Mo 69752 (4)	rv + lv	20.0	15.4	1.30	(14.1)	-	-
NSMT-Mo 69753	rv + lv	28.0	18.1	1.55	16.1	-	(0.445)

	V	L	H	L/H	Cb	Cs	Cs/H
NSMT-Mo 69754 (1)	rv + lv	31.1	21.7	1.43	20.4	-	(0.470)
Mo 69754 (2)	rv + lv	29.5	20.9	1.41	18.7	-	(0.447)
NSMT-Mo 69755	rv + lv	27.7	18.9	1.47	17.0	-	(0.450)
NSMT (Tosa)	rv + lv	23.0	16.4	1.40	14.4	-	(0.439)

*Numericals in parentheses show Cb/2H, instead of Cs/H.

REMARKS. — *Isocardia tetragona* Adams & Reeve, 1850 is a primary junior homonym of *Isocardia tetragona* Koch & Dunker, 1837. *Meiocardia samarangiae* Bernard, Cai & Morton, 1993 is a replacement for ADAMS & REEVE's name. The scatter diagram of L/H — Cs/H shows that *M. samarangiae* clearly differs from any living species of *Meiocardia* (Figs 8, 10, 15).

Although BERNARD *et al.* (1993) recorded *M. samarangiae* from the Philippines to Japan, we think the species is restricted to seas around Japan. PRASHAD (1932) reported a *Meiocardia* species from Sulu Sea and Indonesia under the name *M. tetragona*. These specimens are an antero-posteriorly elongated form of *Meiocardia hawaiana*, because they have cardinals (1 and 2a) that are oblique to the dorsal margin (Fig. 35b).

Although HABE (1977) considered *Meiocardia hawaiana* to be a junior synonym of *M. tetragona*, the Hawaiian species differs from *M. tetragona* in having thinner, waxy white shells with oblique cardinals (1 and 2a).

The supposed life position of *M. samarangiae* which is suggested by attached animals, including bryozoans and sponges with siliceous spicules, is shown in Fig. 16. A specimen from Tosa Bay, Kochi Prefecture, has a muricid borehole at the ventral margin.

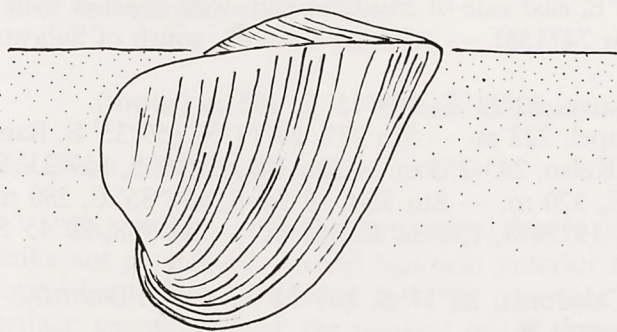


FIG. 16. — Supposed living position of *Meiocardia samarangiae*.

Meiocardia hawaiana Dall, Bartsch & Rehder, 1938

Figs 6, 33-37

Meiocardia hawaiana Dall, Bartsch & Rehder, 1938: 121-122, pl. 34, figs 17-18 [Hawaii].

Synonym?:

Bucardia (Meiocardia) cumingii Adams, 1864: 142.

Other references:

Isocardia (Meiocardia) tetragona — PRASHAD, 1932: 151-152, pl. 5, figs 3-4 [Sulu Archipelago].

Meiocardia lamarckii — HABE, 1951: 117 [western Japan]; 1977: 236 [western Japan]. — KIRA, 1959: 131, pl. 52, fig. 23 [Japan].

— MATSUKUMA, 1986: 324-325(f.) [Kochi Pref., western Japan].

Meiocardia hawaiana — WEAVER, 1963: 2, figs 1-2 [Oahu, Hawaii]. — KAY, 1979: 568, figs 184 A-B [Hawaii].

TYPE MATERIAL. — *Meiocardia hawaiana*: holotype, a right valve, USNM 173048 (Boss, ROSEWATER & RUHOFF, 1968). Paratypes, USNM 338242, 338243, 346246, 428546.

TYPE LOCALITY. — “*Albatross*”, stn 4133, near Kauai, Hawaii, 74-562 m.

MATERIAL EXAMINED. — Recent: **Hawaii**. 21°02.1' N, 156°47.25' W, off Oahu, 220 m, a conjoined specimen (USNM 807654).

Japan. Off Isshiki, Aichi Pref. (NSMT-Mo43438). — Kumanonada Sea (YC). — Off Wakayama (IC). — Kochi Pref. (NSMT-Mo63224, Kawamura Coll.). — Tosa Bay off Kochi Pref. (NSMT-Mo43439, Kawamura Coll.). — Off Amitori, Iriomote Is., Okinawa Pref. (NSMT-Mo69757, 69758).

Philippines. “*Albatross*” stn 5173, off Jolo, Jolo Is., 335 m, shelly coarse sand (USNM 236529). — Stn 5212, off Sibugay Is., east of Masbate, 194 m, gray sand and mud (USNM 292687). — Stn 5268, off Matocot Point, west of Luzon, 306 m (USNM 295937).

MUSORSTOM 1: stn 19, 13°56' N, 120°19' E, north of Lubang Is., 167-187 m, a conjoined specimen (MNHN).

MUSORSTOM 2: stn 17, 14°00' N, 120°17' E, north of Lubang Is., 174-193 m. — Stn 19, 14°01' N, 120°17' E, north of Lubang Is., 189-192 m. — Stn DR 33, 13°32' N, 121°07' E, north of Mindoro Is., 130-137 m, a conjoined specimen and many empty shells. (all MNHN).

MUSORSTOM 3: stn CP 88, 14°01' N, 120°17' E, north of Lubang Is., 183-187 m. — Stn CP 98, 14°00' N, 120°18' E, north of Lubang Is., 194-205 m. — Stn DR 102, 14°01' N, 120°18' E, north of Lubang Is., 192 m. — Stn CP 108, 14°01' N, 120°18' E, north of Lubang Is., 188-195 m. — Stn DR 126, 11°49' N, 121°22' E, west of Panay Is., 266 m. — Stn CP 131, 11°37' N, 121°43' E, west of Panay Is., 120-122 m. — Stn CP 143, 11°29' N, 124°11' E, northwest of Leyte Is., 205-214 m, a conjoined specimen and several empty shells. (all MNHN).

“*Siboga*”: stn 95, Sulu Archipelago, 2 conjoined specimens (ZMA). — Stn 105, Sulu Archipelago, 3 conjoined specimens (ZMA).

Indonesia. 6°07' S, 133°57' E, 12.8 km southwest of Tg Ratoe, Maikoor, Aru, Moluccas, 45 m, a conjoined specimen (USNM 755534). — 5°32' S, 133°E, east side of Mitduan reef, west coast of Nuhu Tjut, Kai Is., 54-56 m, 1 conjoined specimen (USNM 747158). — “*Siboga*”: stn 66, south of Salayar, Sulawesi, 1 conjoined specimen (ZMA).

Chesterfield Islands. CHALCAL 1: stn D 63, Banc Nova, 22°11' S, 159°15' E, 305 m (MNHN).

MUSORSTOM 5: stn 270, 24°49' S, 159°34' E, Banc Capel, 223 m. — Stn 277, 24°11' S, 159°35' E, Banc Kelso, 270 m. — Stn 285, 24°09' S, 159°34' E, Banc Kelso, 245-255 m. — Stn 309, 22°10' S, 159°23' E, Banc Nova, 340 m. — Stn 329, 20°23' S, 158°47' E, 320 m. — Stn 350, 19°34' S, 158°35' E, 280 m. — Stn 376, 19°51' S, 158°30' E, 280 m. — Stn 378, 19°54' S, 158°38' E, 355 m. — Stn 388, 20°45' S, 160°54' E, 500-510 m. (all MNHN).

New Caledonia. “*Vauban*” 1978-79: stn 3, S New Caledonia, 22°17' S, 167°12' E, 390 m (MNHN).

BIOCAL, stn DW 64, 24°48' S, 168°09' E, 250 m (MNHN).

BIOGEOCAL: stn KG 252b, 21°31' S, 166°21' E, 330 m. — Stn DW 253, 21°32' S, 166°29' E, Loyaute Bassin, 310-315 m (all MNHN).

CHALCAL 2: stn DW 71, 24°42' S, 168°10' E, 230 m, 1 conjoined specimen (MNHN).

SMIB 3: stn DW 9, 24°42' S, 168°08' E, 265 m, 1 conjoined specimen (MNHN).

SMIB 4: stn DW 44, S New Caledonia, 24°46' S, 168°08' E, 270-300 m. — Stn DW 47, S New Caledonia, 24°46' S, 168°08' E, 250-280 m (all MNHN).

Loyalty Islands. MUSORSTOM 6: stn DW 391, 20°47' S, 167°06' E, 390 m. — Stn DW 406, 20°41' S, 167°07' E, 373 m. — Stn DW 407, 20°41' S, 167°07' E, 360 m, 1 conjoined specimen. — Stn DW 416, 20°42' S, 167°00' E, 343 m. (all MNHN).

SMIB 5: stn DW 88, 22°19' S, 168°40' E, Ride des Loyaute, 350 m, 2 conjoined specimens. — Stn DW 90, 22°19' S, 168°42' E, Ride des Loyaute, 340 m. — Stn DW 97, 23°01' S, 168°18' E, 300 m, 1 conjoined specimen. — Stn DW 98, 23°02' S, 168°16' E, 335 m. (all MNHN).

New Hebrides Arc. VOLSMAR: stn DW 7, 22°27' S, 171°44' E, Ride des Loyauté, 325-400 m. — Stn DW 17, 22°23' S, 171°41' E, 260-300 m, 1 conjoined specimen, 6 rv, 6 lv. — Stn DW 38, 22°22' S,

168°44' E, 380-420 m. — Stn DW 42, 22°17' S, 168°42' E, 340-400 m. (all MNHN).

Réunion. MD32 Réunion: stn CP 129, 20°51' S, 55°36' E, 290-300 m (MNHN).

DISTRIBUTION. — Hawaii, Japan, Philippines, Indonesia, Coral Sea, New Caledonia; Indian Ocean side of Thailand, Réunion. This species lives on sand and mud bottoms in 45 to 220 m, and empty shells are occasionally recorded from 500 m or deeper.

DESCRIPTION. — *Shell* small to medium for genus, thin, subquadrate, glossy white. Mean of L/H 1.279 (N = 17, SD = 0.038), not significantly correlated with L ($r = 0.342$, $a = 0.05$). Mean of Cs/H 0.480 (N = 17, SD = 0.019), not significantly correlated with L ($r = 0.311$, $a = 0.05$). L/H significantly correlated with Cs/H (N = 17, $r = 0.557$, $a = 0.05$) (Fig. 10). Outer surface around keel and postero-dorsal area occasionally yellowish or reddish brown. Sharp, angular,

primary keel separating very smooth postero-dorsal area from antero-ventral area with irregular commarginal ribs. Anterior cardinal (1) oblique to dorsal margin; 2a dorsally deeply concave, oblique to dorsal margin. Inner surface creamy white, occasionally posteriorly pale brown, shining. Anterior adductor scar semicircular; posterior adductor scar subcircular; both scars nearly equal in size.

Measurements. See APPENDIX, Table 4.

REMARKS. — ADAMS (1864) described *Bucardia* (*Meiocardia*) *cumingii* on the basis of material from China. Although the species was said to have a waxy white shell, he only gave a brief description without any measurements. The type material was not found in BMNH during a visit by one of us (AM) in 1989. Instead of adopting a doubtful and obscure name for this species, we prefer to use *Meiocardia hawaiana*.

Family TRAPEZIDAE Lamy, 1920

DIAGNOSIS. — Shell trapezoidal, strongly inequilateral, equivalve, with prosogyrous beaks near anterior end. Ventral margin not gaping, smooth. Ligament external, opisthodontic, parivincular. Hinge with two lamellar cardinals and two laterals. Outer surface ornamented with commarginal and radial sculpture. Dimyarian, with subequal adductor muscles. Foot small, grooved, often byssate. Pallial line simple, without sinus.

Genus *GLOSSOCARDIA* Stoliczka, 1870

Type species: *Cypricardia obesa* Reeve, 1843.

DIAGNOSIS. — *Shell* subquadrate, thin in young, thick and solid in large specimens, yellowish. Beaks not prominent. Larval ligament anterior to beaks. Primary keel separating a flat posterior slope, sharp. Two additional keels on posterior slope, the secondary and tertiary keels weak but distinct; secondary keel, the weakest of the three, running from the beak to postero-dorsal corner, separating postero-dorsal margin. The stronger, tertiary keel located on the posterior slope near primary keel. Outer surface nearly smooth except for weak, irregular commarginal ribs and radial rows of microscopic scales. *Hinge* cyprinoid; teeth parallel to hinge margins; anterior cardinal in the right valve (1) lamellate in juvenile, nodulous in adult; posterior lateral in left valve (LPI) small, finely nodulated.

REMARKS. — Only three living species, *Glossocardia agassizii*, *G. obesa* and *G. stoliczkana*, belong to this genus. The Eocene *Meiocardia carolinae* Harris, 1919a, has a more or less prominent tertiary keel on the posterior slope near the primary keel (HARRIS, 1919b) and is safely placed in this genus. *Meiocardia suzukii* Squires & Advocate, 1986, from the Eocene Maniobra Formation of California, has shells that are not as inflated and lack strongly spirogyrate umbones. Although *M. suzukii* apparently lacks the tertiary keel on the posterior slope, it possibly belongs to *Glossocardia*.

Glossocardia obesa (Reeve, 1843)

Figs 18-19

Cypricardia obesa Reeve, 1843: *Cypricardia* sp. 10: pl. 2, fig. 10 [locality unknown].

Other references:

Glossocardia obesa - HABE, 1951: 118-119, figs 247-248 [Okinawa, Japan].*Trapezium (Glossocardia) obesa (pars)* - SOLEM, 1955: 73-74, pl. 6, figs 11-12 (holotype).

TYPE MATERIAL. — Holotype, a conjoined specimen, BMNH 1952.10.10.7.8.

TYPE LOCALITY. — Not given.

MATERIAL EXAMINED. — Recent: **Indonesia**. Silale, Ambon (NSMT-Mo69759).**Philippines**. Batangas Is., N of Cebu, coll. Poppe, 1 conjoined specimen (MNHN).**Chesterfield Islands**. CORAIL 2: stn DW 71, 19°15' S, 158°24' E, 55 m, 1 conjoined specimen. — Stn DW 138, 19°34' S, 158°18' E, 31 m, 1 rv (all MNHN).**New Caledonia**. LAGON: stn 612, 22°09' S, 167°01' E, 46-48 m, 1 rv (MNHN).

DISTRIBUTION. — Recent: Okinawa, Japan; Philippines; Ambon, Indonesia; New Caledonia; Chesterfield Islands.

DESCRIPTION. — *Shell* trapezoidal, thin in juveniles but thick and solid in full-grown specimens. Beaks prosogyrous, low, not strongly enrolled. Larval ligament small, anterior to beaks. Primary keel low, separating slightly concave postero-dorsal area. Outer surface ornamented with irregularly

spaced commarginal lamellae with numerous microscopic scales. Postero-ventral corner bluntly pointed. Inner surface creamy white. Anterior adductor scar semicircular, thickened ventrally; posterior adductor scar subcircular; both scars nearly equal in size.

Measurements (mm):

	V	L	H	L/H	Cb	Cs	Cs/H
NSMT-Mo69759-1	rv + lv	31.5	20.5	1.53	16.4	-	(0.400)*
Mo69759-2	rv	61.6	43.3	1.42	-	21.2	0.490

*Numericals in parentheses show Cb/2H, instead of Cs/H.

REMARKS. — Young specimens of *Glossocardia obesa* are apparently very close to *Meiocardia* species in having a more or less translucent shell with the larval ligament anterior to the beaks and in having lamellar cardinals, but they clearly differ from *Meiocardia* in having microscopic scales on the outer surface.*Glossocardia stoliczkana* (Prashad, 1932)

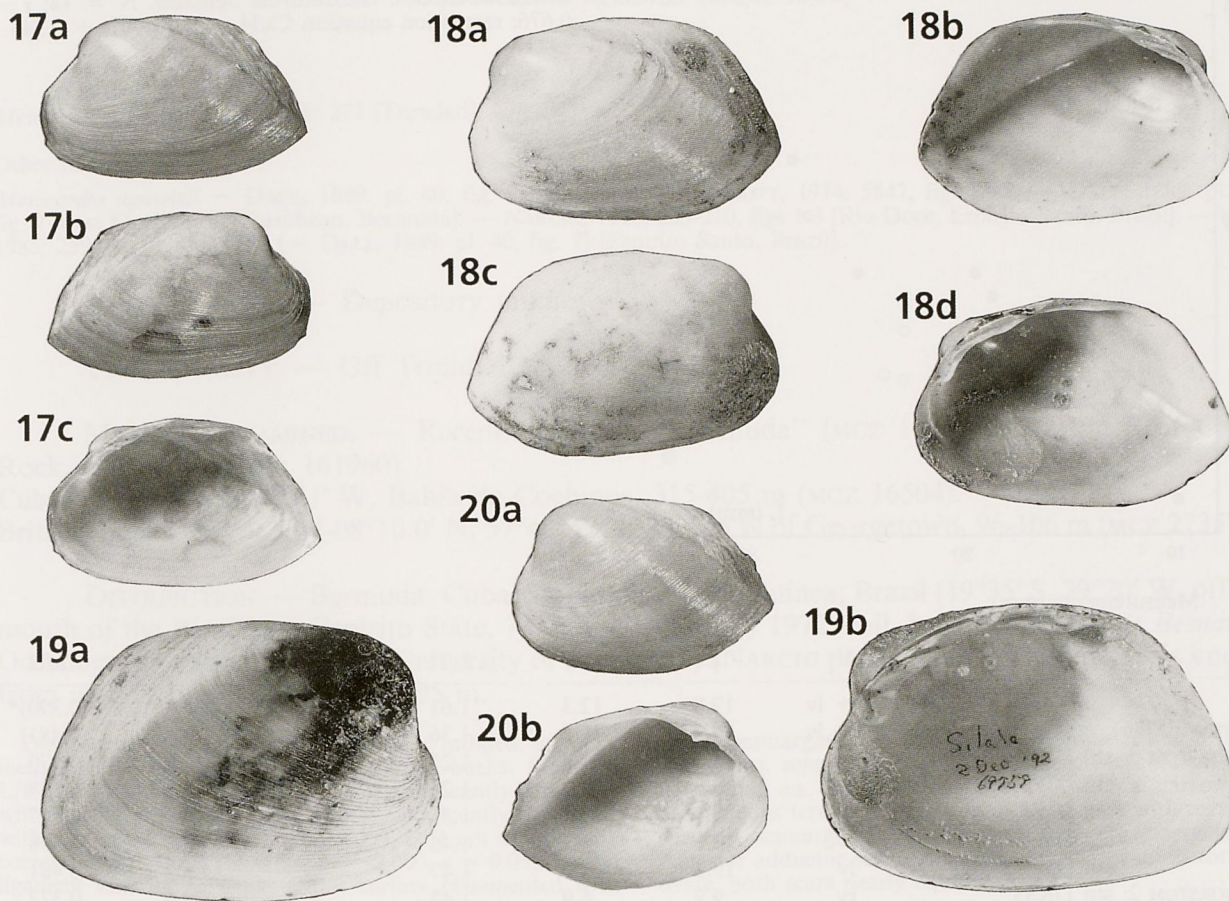
Figs 17, 20, 39

Glossocardia stoliczkana Prashad, 1932: 148-149, pl. 8, figs 15-18 [Sulu Archipelago, Philippines].

TYPE MATERIAL. — Holotype, a conjoined specimen, ZMA no registration number.

TYPE LOCALITY. — "Siboga", stn 97, 5°48.7' N, 119°49.6' E, Sulu Archipelago, Philippines, 564 m.

MATERIAL EXAMINED. — Pleistocene (?): Niue, a conjoined specimen, G. Paulay coll. (USNM). Recent: **Philippines**. Sulu Archipelago (holotype, ZMA). — Mactan Island, Cebu, a conjoined specimen (NSMT-Mo57861).



FIGS 17-20. — Shells of *Glossocardia*. — **17a-c**, *Glossocardia stoliczkana*. Sulu Archipelago, Philippines (holotype, ZMA). Shell length 19.8 mm. — **18a-d**, *Glossocardia obesa*. Ambon, Indonesia (NSMT-Mo69759). Shell length 31.5 mm. — **19a-b**, *Glossocardia obesa*. Ambon, Indonesia (NSMT-Mo69759). Shell length 61.6 mm. — **20a-b**, *Glossocardia stoliczkana*. Loyalty Ridge, New Caledonia (MNHN). Shell length 19.3 mm.

MUSORSTOM 2: stn DR 33, 13°32' N, 121°08' E, north of Mindoro Is., 130-137 m, 1 rv (MNHN).

MUSORSTOM 3: stn DR 137, 12°03' N, 122°06' E, north of Panay Is., 56 m, 1 lv (MNHN).

Loyalty Islands. MUSORSTOM 6: stn DW 391, 20°47' S, 167°06' E, 390 m, 1 rv. — Stn DW 398, 20°47' S, 167°06' E, 370 m, 1 rv. — Stn DW 418, 20°42' S, 167°03' E, 283 m, 1 rv. — Stn DW 439, 20°46' S, 167°17' E, 288 m, 1 rv. — Stn DW 440, 20°49' S, 167°17' E, 288 m, 1 lv. (all MNHN).

DISTRIBUTION. — Pleistocene: Niue. Recent: Cebu, Mindoro, Panay, Sulu Archipelago, Philippines; New Caledonia. This species is known from 56 to 564 m.

DESCRIPTION. — *Shell* small, thin, inflated, high, quadrangular, strongly inequilateral, equivalve. Mean of L/H 1.399 (N = 8, SD = 0.132), not significantly correlated with L ($r = -0.486$, $a = 0.05$). Cs/H significantly correlated with L ($r = 0.885$, $a = 0.05$) (Fig. 21). L/H not significantly correlated with Cs/H (N = 8, $r = -0.660$, $a = 0.05$). Umbones prosogyrous, low, not prominent, translucent. Outer surface white, ornamented with weak commarginal ribs and radial rows of fine scales; posterior area orange, smooth, with two narrow radial riblets (Fig. 39b, s and t) and fine growth striae, concave, separated from middle area by a

sharp keel. Postero-ventral margin pointed, without a sinuation like *M. sanguineomaculata*. Inner color white, orange posteriorly. *Hinge-teeth* thin; 1 thin and lamellar in young specimens, and solid, and rounded-lamellar in older specimens; 3a long, thin; 3b weakly bifid; LAI small; LAIII small but distinct; LPI long, strong; LPIII small, long and narrow; 2a small, thin; 2b rather long, thin; 4b long and narrow, thin; LAII very small, indistinct; semicircular, thickened ventrally; posterior adductor scar subcircular or ovate. Pallial scar entire, wide, integripalliate.

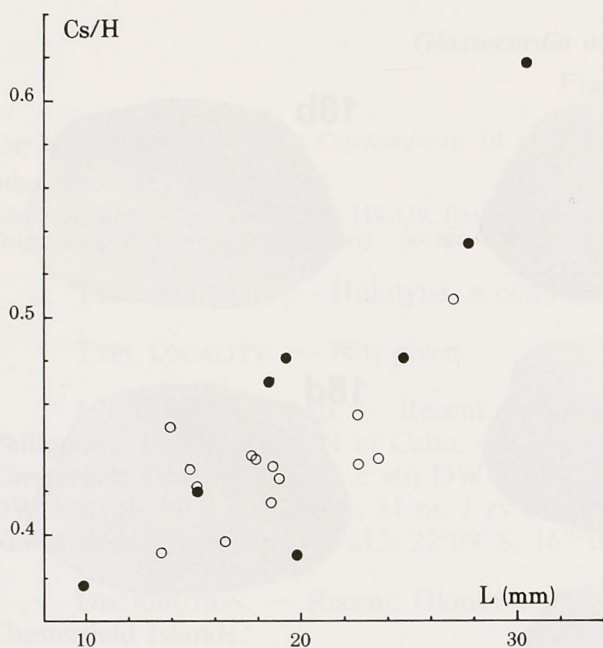


FIG. 21. — Scatter diagram showing relationship between L and Cs/H in *Glossocardia*. Dots: *Glossocardia stoliczkana*. N = 8; r = 0.885; regression equation Cs/H = 0.0103L + 0.258. Circles: *Glossocardia agassizii*. N = 14; r = 0.676; regression equation Cs/H = 0.00470L + 0.345.

Measurements (mm):

	V	L	H	L/H	Cb	Cs	Cs/H
NSMT-Mo57861	rv + lv	19.8	12.3	1.61	9.6	-	(0.390)*
	rv + lv	24.7	18.2	1.36	17.5	-	(0.481)
MUSORSTOM 6: stn DW391	rv	18.5	14.9	1.24	-	7.0	0.470
stn DW398	rv	27.8	22.3	1.25	-	11.9	0.534
stn DW418	rv	30.7	23.5	1.31	-	14.5	0.617
stn DW439	rv	12.1	8.3	1.46	-	3.3	0.398
stn DW440	lv	19.3	13.1	1.47	-	6.3	0.481
MUSORSTOM 2: stn DR33	rv	9.9	6.9	1.43	-	2.6	0.377
MUSORSTOM 3: stn DR137	lv	15.2	10.0	1.52	-	4.2	0.420

*Numericals in parentheses show Cb/2H, instead of Cs/H.

REMARKS. — Some shells from the Philippines (NSMT-Mo57861) and New Caledonia (stn DW 391, stn DW 398 and stn DW 418) are higher and more inflated than the type, and their umbonal regions are ornamented with weak and wide commarginal striae. Additional specimens are needed to determine whether or not this is a distinct species.

Glossocardia stoliczkana superficially resembles the tropical western Atlantic *G. agassizii* and young shells of *G. obesa* from the tropical West Pacific. These three species have radial rows of microscopic scales on the outer surface and a larval ligament at the anterior margin of beaks. *Glossocardia stoliczkana* differs from *G. agassizii* in having the higher and more strongly enrolled umbos, a shorter antero-dorsal margin and a wider postero-dorsal area. Commarginal striae in the postero-dorsal area of *G. agassizii* are finer and more regularly spaced than those of *G. stoliczkana*. *Glossocardia stoliczkana* clearly differs from *G. obesa* in having a distinct tertiary keel and fine commarginal lamellae on the posterior slope. The cardinal (1) in the right valve of *G. stoliczkana*, in both young and adult specimens, is lamellar and parallel to ventral margin, whereas the cardinal (1) of *G. obesa* is thin and lamellar in young shells, and is strong and triangular in adults.

Glossocardia stoliczkana is very similar to *M. hawaiiensis* and *M. samarangensis*, but differs from them in having a higher, thinner, shell with lower umbones, radial rows of microscopic scales on the outer surface, and a distinct tertiary keel on the yellow posterior slope (Fig. 21).

Glossocardia agassizii (Dall, 1886)

Fig. 38

Meiocardia agassizii Dall, 1886: 271 [Trinidad].

Other references:

Meiocardia agassizii — DALL, 1889: pl. 40, fig. 7) [Trinidad] . — ABBOTT, 1974: 5847, fig. 5848 (= DALL, 1889: pl. 40, fig. 7 [west Florida, the Caribbean, Bermuda]. — NARCHI, 1976: 205-210, figs 1-3 [Rio Doce, Espirito Santo, Brazil]. — RIOS, 1985: 259, pl. 91, fig. 1286 (= DALL, 1889: pl. 40, fig. 7) [Espirito Santo, Brazil].

TYPE MATERIAL. — Depository unknown.

TYPE LOCALITY. — Off Trinidad.

MATERIAL EXAMINED. — Recent: **Bermuda**. "Bermuda" (MCZ 152851); 1.2 km S of Castle Rock, 144-180 m (MCZ 161960).

Cuba. 22°09'30" N, 81°11' W, Bahia de Cochinos, 315-405 m (MCZ 16504).

British Guiana. 08°10.5' N-08°10.0' N, 57°48' W, 153.6 km N of Georgetown, 96-106 m (MCZ 273570).

DISTRIBUTION. — Bermuda; Cuba; Trinidad; British Guinea; Brazil (19°35' S, 39°20' W, off the mouth of the Rio Doce, Espirito State, 73 m, mud, January 1972, coll. by R.S. "Wladimir Besnard", Oceanographic Institute of the University of Sao Paulo) (NARCHI pers. comm.). This species is known from muddy bottoms in 73 to 405 m.

DESCRIPTION. — *Shell* cordiform, thin, inflated, strongly inequilateral, equivalve, with prosogyrous beaks. Mean of L/H 1.377 (N = 14, SD = 0.045), not significantly correlated with L ($r = -0.146$, $a = 0.05$). Cs/H significantly correlated with L ($r = 0.676$, $a = 0.05$) (Fig. 21). L/H not significantly correlated with Cs/H (N = 14, $r = -0.000$, $a = 0.05$). Larval ligament anterior to beak. Outer surface ornamented with

weak commarginal lamellae and microscopic scales. Primary keel sharp, separating slightly concave postero-dorsal area, which has an obscure secondary keel and a narrow but conspicuous tertiary keel. Postero-dorsal area with regularly spaced commarginal lamellae. Inner surface glossy white. Anterior adductor scar semicircular; posterior adductor scar ovate; both scars nearly equal in size.

Measurements (mm):

	V	L	H	L/H	Cb	Cs	Cs/H
MCZ 16504	-	13.9	10.0	1.39	-	4.5	0.450
MCZ 152851	rv + lv	13.7	9.3	1.47	7.3	-	(0.392)*
MCZ 161960	rl	23.6	17.7	1.33	-	7.7	0.435
MCZ 273570-1	rv	27.0	18.9	1.43	-	9.6	0.508
273570-2	rv	22.6	16.7	1.35	-	7.6	0.455
273570-3	rv	17.9	13.1	1.37	-	5.7	0.435
273570-4	rv	15.8	12	1.32	-	-	-
273570-5	rv	16.5	12.1	1.36	-	4.8	0.397
273570-6	lv	22.6	16.9	1.34	-	7.3	0.432
273570-7	lv	19.0	14.1	1.35	-	6.0	0.426
273570-8	lv	17.7	13.3	1.33	-	5.8	0.436
273570-9	lv	18.6	13.0	1.43	-	5.4	0.415
273570-10	lv	18.7	13.2	1.42	-	5.7	0.432
273570-11	lv	15.2	11.4	1.33	-	4.8	0.421
273570-12	lv	14.8	10.7	1.38	-	4.6	0.430

*Numericals in parentheses show Cb/2H, instead of Cs/H.

REMARKS. — DALL (1886, 1889) described this species as a member of the genus *Meiocardia*, and American authors have apparently followed this assignment (ABBOTT, 1974; NARCHI, 1976; RIOS, 1985). It has a thin, inflated, cordiform shell, with a sharp primary keel, a prominent tertiary keel, and a larval ligament anterior to the beaks. The hinge teeth of this species are also superficially close to *Meiocardia* species of the Indo-West Pacific. The outer surface of Dall's species is ornamented with weak commarginal lamellae and numerous microscopic scales, which is similar to the ornament on *Glossocardia obesa* of the Trapezidae but which is never found on shells of *Meiocardia*. This should be therefore transferred from the genus *Meiocardia*, Glossidae, to the genus *Glossocardia*, Trapezidae.

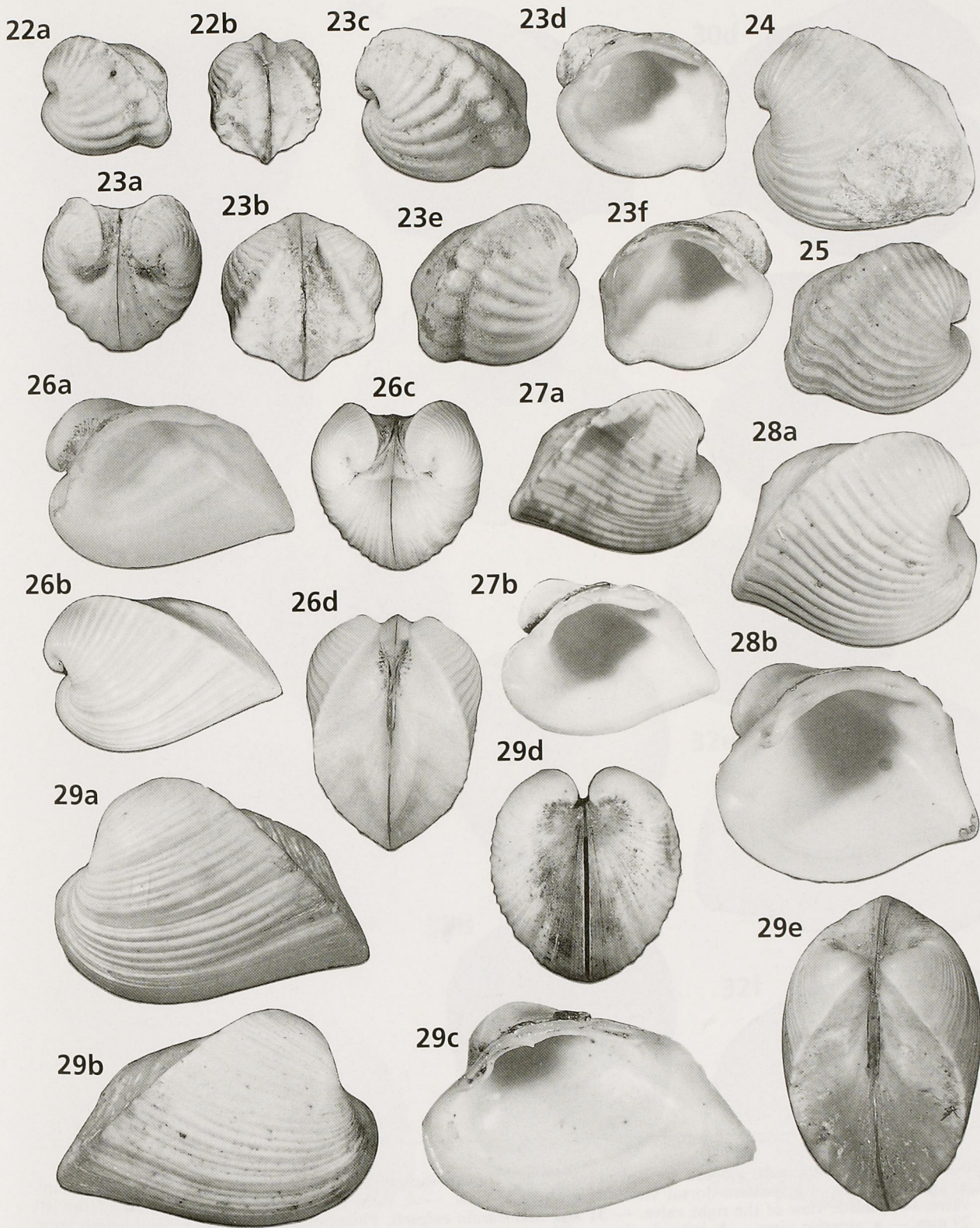
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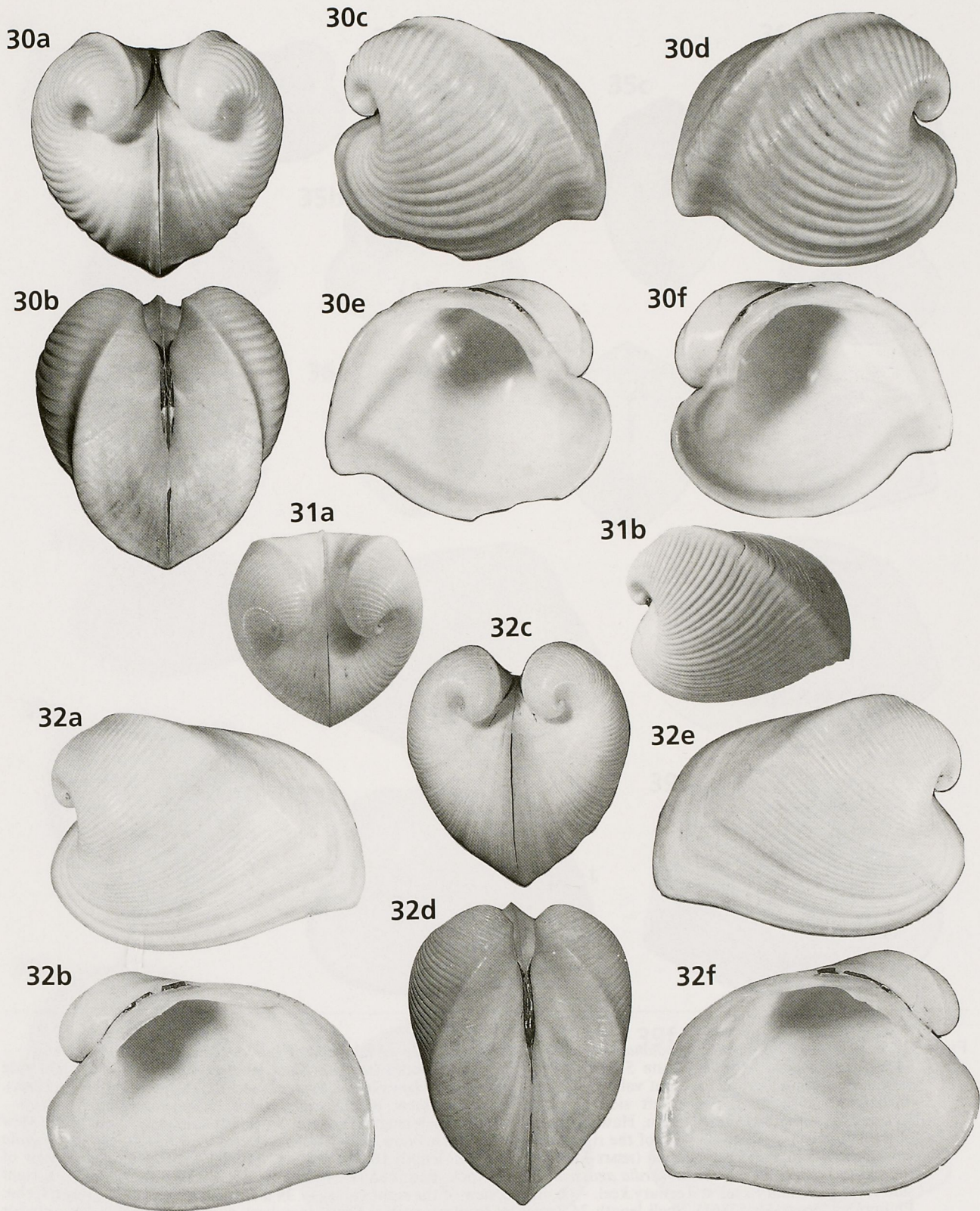
Some specimens stored in National Science Museum, Tokyo, were collected by members of the overseas research project "Diversity of marine organisms from Indonesian shallow waters" financially supported by Ministry of Education, Culture and Science, Japanese Government (project no. 04041103). This paper constitutes Contribution no. VII of Studies on the Kawamura Collection (Mollusca) stored in the National Science Museum, Tokyo.

FIGS 22-29. — **22 a-b**, *Meiocardia sanguineomaculata*. REVES 2: stn 10, Seychelles (MNHN). Shell length 11.9 mm. — **a**, left side view. — **b**, postero-dorsal view. — **23 a-f**, *Meiocardia sanguineomaculata*. REVES 2: stn 30, Seychelles (MNHN). Shell length 15.0 mm. — **a**, anterior view. — **b**, posterodorsal view. — **c**, left side view. — **d**, inside view of right valve. — **e**, right side view. — **f**, inside view of left valve. — **24**, *Meiocardia moltkiana*. Pleistocene Ryukyu Limestone, Kikaijima Is., Kagoshima Prefecture, Japan (NSMT-Mo69745). Shell length 33.4 mm. — **25**, *Meiocardia moltkiana*. Chichijima, Ogasawara Islands, Japan (NSMT-Mo59790). Shell length 28.2 mm. — **26 a-d**, *Meiocardia moltkiana*. China (ZMA). Shell length 33.4 mm. — **a**, inside view of right valve. — **b**, left side view. — **c**, anterior view. — **d**, postero-dorsal view. — **27 a-b**, *Meiocardia moltkiana*. MD 32: stn CP 43, Réunion (MNHN). Shell length 25.3 mm. — **a**, right side view. — **b**, inside view of the right valve. — **28 a-b**, *Meiocardia moltkiana*. SMIB 5: stn DW 81, New Caledonia (MNHN). Shell length 30.3 mm. — **a**, right side view. — **b**, inside view of the right valve. — **29 a-e**, *Meiocardia samarangiae*. Tanabe Bay, Wakayama Prefecture, Japan (NSMT-Mo69752). Shell length 29.7 mm. — **a**, left side view. — **b**, right side view. — **c**, inside view of the right valve. — **d**, anterior view. — **e**, postero-dorsal view.



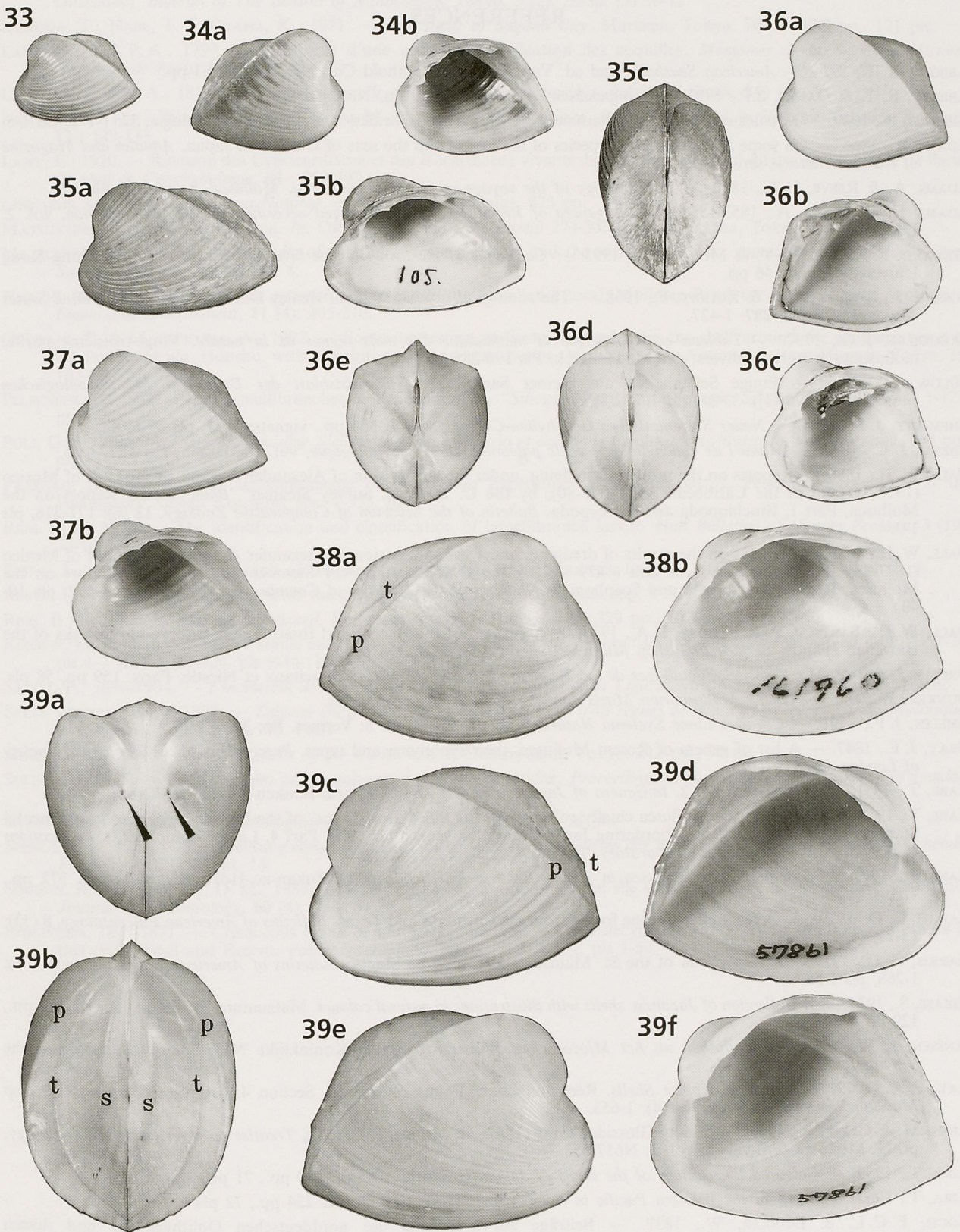


FIGS 30-32 — **30 a-f**, *Meiocardia globosa* sp. nov. Pescadores, Taiwan (holotype NSMT-Mo69749). Shell length 24.8 mm. **a**, anterior view. — **b**, postero-dorsal view. — **c**, left side view. — **d**, right side view. — **e**, inside view of the left valve. — **f**, inside view of the right valve. — **31 a-b**, *Meiocardia vulgaris*. Philippines (Habe Coll.). Shell length appr. 29 mm. — **a**, anterior view. — **b**, left side view. — **32 a-f**, *Meiocardia vulgaris*. Philippines (NSMT-Mo69747, Kawamura Coll.). Shell length 46.1 mm. — **a**, left side view. — **b**, inside view of the right valve. — **c**, anterior view. — **d**, postero-dorsal view. — **e**, right side view. **f**, inside view of the left valve.





FIGS 33-39. — **33**, *Meiocardia hawaiana*. "Siboga": stn 105, Sulu Archipelago (ZMA). Shell length 17.1 mm — **34 a-b**, *Meiocardia hawaiana*. SMIB 5: stn DW 90, New Caledonia (MNHN). Shell length 17.1 mm. — **a**, right side view. — **b**, inside view of the right valve. — **35 a-c**, *Meiocardia hawaiana*. "Siboga": stn 105, Sulu Archipelago (ZMA). Shell length 27.2 mm. — **a**, left side view. — **b**, inside view of the right valve. **c**, postero-dorsal view. — **36 a-e**, *Meiocardia hawaiana*. Oahu, Hawaii (USNM 807654). Shell length 14.4 mm. — **a**, left side view. — **b**, inside view of the left valve. — **c**, inside view of the right valve. — **d**, dorsal view. — **e**, postero-dorsal view. — **37 a-b**, *Meiocardia hawaiana*. Kochi Prefecture, Japan (NSMT-Mo43439-1). Shell length 16.9 mm. — **a**, left side view. — **b**, inside view of the right valve. — **38 a-b**, *Glossocardia agassizii*, Castle Rock, Bermuda (MCZ 161960). Shell length 23.6 mm. — **a**, right side view. **p**: Primary keel. **t**: Tertiary keel. — **b**, inside view of the right valve. — **39 a-f**, *Glossocardia stoliczкана*. Cebu, Philippines (NSMT-Mo57861). Shell length 24.7 mm. **p**: Primary keel. **s**: Secondary keel. **t**: Tertiary keel. — **a**, anterior view. Arrows indicate larval ligaments. — **b**, postero-dorsal view. — **c**, left side view. — **d**, inside view of the left valve. — **e**, right side view. — **f**, inside view of the right valve.



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APPENDIX: Tables of measurements.

TABLE 1. — *Meiocardia moltkiana*. Measurements (mm) of selected material.

	V	L	H	L/H	Cb	Cs	Cs/H
NSMT-Mo 42307	rv + lv	18.9	15.1	1.25	13.6	-	(0.450)*
NSMT-Mo 43435	rv + lv	18.4	14.9	1.23	13.0	-	(0.436)
NSMT-Mo 43436 (1)	lv	24.9	19.6	1.27	-	10.3	(0.526)
Mo 43436 (2)	lv	13.0	10.6	1.23	-	4.8	0.453
Mo 43436 (3)	lv	11.6	9.7	1.20	-	5.1	0.526
Mo 43436 (4)	rv	10.1	7.8	1.29	-	3.7	0.474
NSMT-Mo 43455 (1)	lv	21.1	15.4	1.37	-	7.7	0.500
Mo 43455 (2)	lv	17.4	14.1	1.23	-	6.7	0.475
Mo 43455 (3)	rv	13.9	11.0	1.26	-	5.0	0.455
Mo 43455 (4)	rv	13.7	11.1	1.23	-	5.4	0.486
Mo 43455 (5)	rv	12.2	9.3	1.31	-	4.3	0.462
Mo 43455 (6)	rv	11.4	9.3	1.23	-	4.3	0.462
NSMT-Mo 59790	rv	28.2	25.5	1.11	-	14.1	0.553
NSMT-Mo 63233	rv + lv	17.1	13.5	1.27	11.4	-	(0.422)
NSMT-Mo 69739	rv + lv	22.9	17.7	1.29	16.2	-	(0.458)
NSMT-Mo 69740	rv + lv	17.5	14.8	1.18	13.3	-	(0.449)
NSMT-Mo 69741	rv + lv	28.1	21.7	1.29	21.0	-	(0.484)
NSMT-Mo 69742	rv + lv	29.7	22.9	1.30	22.3	-	(0.487)
NSMT-Mo 69743	rv + lv	22.5	18.8	1.20	18.0	-	(0.479)
NSMT-Mo 69745 (1)	lv	33.4	30.1	1.11	-	14.9	0.495
Mo 69745 (2)	rv	22.1	20.3	1.09	-	-	-
Mo 69745 (3)	lv	19.1	14.9	1.28	-	7.4	0.497
ZMA China-1	rv + lv	33.4	24.3	1.37	23.4	-	(0.481)
China-2	rv + lv	33.8	24.2	1.40	23.3	-	(0.484)
MD32 DC41 (1)	rv	17.3	13.7	1.26	-	6.4	0.467
DC41 (2)	rv	17.4	13.3	1.31	-	5.9	0.444
DC41 (3)	rv	15.6	12.7	1.23	-	6.1	0.480
DC41 (4)	rv	14.0	10.9	1.28	-	5.1	0.468
DC41 (5)	rv	11.3	8.7	1.30	-	4.1	0.471
DC41 (6)	rv	5.4	4.3	1.26	-	2.2	0.512
DC41 (7)	lv	33.2	25.0	1.33	-	12.3	0.492
DC41 (8)	lv	26.0	20.4	1.27	-	10.0	0.490
DC41 (9)	lv	25.4	20.0	1.27	-	9.6	0.480
DC41 (10)	lv	17.4	13.6	1.28	-	6.6	0.485
DC41 (11)	lv	14.5	10.8	1.34	-	5.2	0.481
DC41 (12)	lv	13.6	10.6	1.28	-	5.1	0.481
DC41 (13)	lv	8.5	6.9	1.23	-	3.7	0.536
DC41 (14)	lv	7.8	6.2	1.26	-	3.2	0.516
MD32 DC43 (1)	rv	31.4	24.0	1.30	-	11.9	0.496
DC43 (2)	rv	31.0	23.1	1.34	-	10.9	0.472
DC43 (3)	rv	29.9	23.1	1.29	-	11.4	0.494
DC43 (4)	rv	26.6	20.4	1.30	-	9.8	0.480
DC43 (5)	rv	26.0	20.3	1.28	-	9.7	0.478
DC43 (6)	rv	22.3	16.8	1.33	-	7.9	0.470
DC43 (7)	lv	32.2	23.8	1.35	-	11.8	0.496
DC43 (8)	lv	28.7	22.6	1.27	-	10.9	0.482
DC43 (9)	lv	28.2	22.1	1.28	-	10.3	0.466
DC43 (10)	lv	27.3	21.2	1.29	-	10.1	0.476
DC43 (11)	lv	26.5	20.9	1.27	-	10.0	0.478
DC43 (12)	lv	26.2	20.4	1.28	-	9.9	0.485
MD32 DC126 (1)	rv	23.2	18.6	1.25	-	8.5	0.457
DC126 (2)	rv	19.6	16.1	1.22	-	7.6	0.472
DC126 (3)	rv	17.4	13.4	1.30	-	6.0	0.448
DC126 (4)	rv	13.6	10.8	1.26	-	5.0	0.463

	V	L	H	L/H	Cb	Cs	Cs/H
DC126 (5)	rv	11.4	8.7	1.31	-	4.2	0.483
DC126 (6)	rv	10.8	8.1	1.33	-	3.9	0.481
DC126 (7)	rv	9.8	7.5	1.31	-	3.6	0.480
DC126 (8)	rv	9.7	7.2	1.35	-	3.6	0.500
DC126 (9)	rv	8.4	6.7	1.25	-	3.4	0.507
DC126 (10)	rv	8.5	6.2	1.37	-	3.2	0.516
DC126 (11)	rv	7.7	5.6	1.38	-	2.8	0.500
DC126 (12)	rv	7.5	5.7	1.32	-	2.8	0.491
DC126 (13)	rv	7.3	5.5	1.33	-	2.7	0.491
DC126 (14)	rv	6.7	5.3	1.26	-	2.7	0.509
DC126 (15)	rv	5.2	4.0	1.30	-	1.9	0.475
DC126 (16)	rv	3.8	3.1	1.23	-	1.3	0.419
DC126 (17)	lv	16.9	13.0	1.30	-	6.0	0.462
DC126 (18)	lv	14.5	11.6	1.25	-	5.4	0.466
DC126 (19)	lv	14.4	10.7	1.35	-	5.1	0.477
DC126 (20)	lv	13.3	9.8	1.36	-	4.7	0.480
DC126 (21)	lv	12.1	9.0	1.34	-	4.5	0.500
DC126 (22)	lv	9.8	7.4	1.32	-	3.6	0.486
DC126 (23)	lv	8.7	7.0	1.24	-	3.1	0.443
DC126 (24)	lv	6.9	5.6	1.23	-	3.1	0.554
DC126 (25)	lv	7.1	5.1	1.39	-	2.7	0.529
DC126 (26)	lv	6.8	5.2	1.31	-	2.4	0.462
DC126 (27)	lv	5.9	4.7	1.26	-	-	-
MD32 DC176 (1)	rv	10.4	7.5	1.39	-	4.0	0.533
DC176 (2)	lv	7.9	6.1	1.30	-	3.5	0.574
DC176 (3)	lv	6.7	5.1	1.31	-	2.7	0.529

*Numericals in parentheses show Cb/2H, instead of Cs/H.

TABLE 2 — *Meiocardia sanguineomaculata*. Measurements (mm) of selected material.

	V	L	H	L/H	Cb	Cs	Cs/H
BMNH 1910.8.31.688	rv + lv	13.6	11.3	1.20	13.0	-	(0.575)*
1910.8.31.689	rv + lv	7.8	6.7	1.16	7.3	-	(0.545)
BMNH 1989178	rv + lv	17.4	14.9	1.17	14.9	-	(0.500)
1989179 (1)	rv + lv	19.3	15.7	1.23	17.7	-	(0.564)
1989179 (2)	rv + lv	19.7	17.2	1.15	18.0	-	(0.523)
1989179 (3)	rv + lv	6.0	5.0	1.20	4.6	-	(0.460)
USNM 235929	lv	10.3	10.1	1.02	-	5.1	0.505
USNM 235950	rv	10.5	9.8	1.07	-	4.9	0.500
USNM 237240	rv	(18)	15.4	-	-	7.0	0.455
USNM 294513 (1)	lv	9.0	7.9	1.14	-	3.8	0.481
294513 (2)	lv	5.0	4.5	1.11	-	2.2	0.489
294513 (3)	lv	3.0	2.5	1.20	-	1.5	0.600
294513 (4)	lv	2.2	2.0	1.10	-	1	0.500
294513 (5)	rv	4.6	3.9	1.18	-	2.0	0.513
294513 (6)	rv	4.0	3.4	1.18	-	1.8	0.529
USNM 294545 (1)	rv	4.5	3.4	1.18	-	1.8	0.529
294545 (2)	lv	9.0	7.3	1.23	-	4.1	0.562
USNM 431190 (1)	rv	8.0	7.4	1.08	-	3.6	0.486
431190 (2)	rv	8.1	6.6	1.23	-	3.6	0.545
431190 (3)	rv	4.6	4.4	1.05	-	2.2	0.500
431190 (4)	lv	12.0	10.8	1.11	-	5.4	0.500
431190 (5)	lv	8.5	8.2	1.04	-	4.1	0.500
431190 (6)	rv	4.0	3.4	1.18	-	1.18	0.529
REVES 2 Stn 30	rv + lv	15.0	12.4	1.21	13.6	-	(0.548)
Stn 24	rv + lv	13.2	11.9	1.11	11.8	-	(0.496)

	V	L	H	L/H	Cb	Cs	Cs/H
Stn 18	rv + lv	19.3	16.6	1.16	17.8	-	(0.536)
Stn 16	rv + lv	10.9	9.7	1.12	9.0	-	(0.464)
Stn 10	rv + lv	11.9	10.0	1.19	9.5	-	(0.475)

*Numericals in parentheses show Cb/2H, instead of Cs/H.

TABLE 3. — *Meiocardia vulgaris*. Measurements (mm) of selected material.

	V	L	H	L/H	Cb	Cs	Cs/H
BMNH syntypes 1	rv + lv	48.6	38.6	1.26	36.0	-	(0.466)*
2	rv + lv	37.6	31.9	1.18	31.4	-	(0.492)
3	rv + lv	38.2	30.5	1.25	30.7	-	(0.503)
4	rv + lv	36.4	29.3	1.24	28.6	-	(0.488)
MUSORSTOM 3 CP141	rv + lv	25.0	21.1	1.18	19.7	-	(0.467)
CORINDON Stn 205 (1)	rv + lv	14.6	13.8	1.06	13.4	-	(0.486)
Stn 205 (2)	rv + lv	14.1	13.2	1.07	13.3	-	(0.504)
Stn 205 (3)	lv	14.2	12.7	1.12	-	6.7	0.528
ZMA China (1)	rv + lv	34.3	27.8	1.23	26.7	-	(0.480)
China (2)	rv + lv	33.3	27.3	1.22	26.5	-	(0.485)
China (3)	rv + lv	23.9	21.5	1.11	21.2	-	(0.493)
China (4)	rv + lv	23.5	20.0	1.18	20.0	-	(0.500)
NSMT-Mo 54938	rv	24.3	20.3	1.20	-	9.9	0.488
NSMT-Mo 60557	rv + lv	31.5	26.2	1.20	24.9	-	(0.475)
NSMT-Mo69746	rv + lv	29.6	25.2	1.17	23.7	-	(0.470)
NSMT-Mo 69747 (1)	rv + lv	39.3	30.5	1.29	30.3	-	(0.497)
Mo 69747 (2)	rv + lv	36.4	29.3	1.24	27.7	-	(0.473)
NSMT-Mo 69748 (1)	rv + lv	46.1	35.0	1.32	32.4	-	(0.463)
Mo 69748 (2)	rv + lv	35.5	28.7	1.24	26.3	-	(0.458)

*Numericals in parentheses show Cb/2H, instead of Cs/H.

TABLE 4. — *Meiocardia hawaiiiana*. Measurements (mm) of selected material.

	V	L	H	L/H	Cb	Cs	Cs/H
NSMT-Mo 43439 (1)	rv + lv	16.9	13.0	1.30	12.0	-	(0.462)*
Mo 43439 (2)	rv + lv	19.1	14.8	1.29	14.5	-	(0.490)
MUSORSTOM 3 CP143 (1)	rv + lv	27.4	20.5	1.34	19.2	-	(0.468)
CP143 (2)	rv + lv	22.4	17.6	1.27	16.3	-	(0.463)
CP143 (3)	rv	28.9	21.9	1.32	-	10.9	0.498
CP143 (4)	rv	24.4	19.7	1.24	-	9.5	0.482
CP143 (5)	rv	23.7	18.4	1.29	-	8.8	0.478
CP143 (6)	rv	22.3	18.1	1.23	-	8.3	0.459
CP143 (7)	rv	20.9	16.0	1.31	-	7.6	0.475
CP143 (8)	rv	17.9	14.3	1.25	-	6.9	0.483
CP143 (9)	lv	27.7	22.1	1.25	-	10.4	0.471
CP143 (10)	lv	26.6	21.7	1.23	-	10.5	0.484
CP143 (11)	lv	26.4	20.1	1.31	-	10.3	0.512
CP143 (12)	lv	25.7	19.2	1.34	-	10.0	0.521
CP143 (13)	lv	25.4	19.5	1.30	-	9.7	0.497
CP143 (14)	lv	22.2	17.2	1.29	-	8.0	0.465
CP143 (15)	lv	21.9	17.8	1.23	-	7.9	0.444
CP143 (16)	lv	20.6	16.1	1.28	-	7.9	0.491
MUSORSTOM 1 Stn19	rv + lv	12.3	9.8	1.26	9.3	-	(0.474)

*Numericals in parentheses show Cb/2H, instead of Cs/H.