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Galeommatid bivalves from Phuket, Thailand

JØRGEN LÜTZEN[1]* and CLAUS NIELSEN FLS[2]

[1]*Department of Cell Biology and Comparative Zoology, Biological Institute, University of Copenhagen, Universitetsparken 15, DK-2100 Copenhagen, Denmark*
[2]*Zoological Museum, The Natural History Museum of Denmark, University of Copenhagen, Universitetsparken 15, DK-2100 Copenhagen, Denmark*

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Twenty-seven species of galeommatid bivalves from six genera have been collected at intertidal reef flats near Phuket Marine Biological Center, Thailand (Andaman Sea, Indian Ocean). Fourteen of the species are new to science and a new genus (***Nudiscintilla* gen. nov.**) has been established. The species are defined by full morphological descriptions, drawings of shells and soft parts, and photographs of shells, and for some of them, the live animals. The known geographical distribution and habitat of each species is also given. While one species is probably commensal with a thallasinidean crustacean, the remainder hide under shale, rocks and coral blocks, often in small intra- or interspecific family flocks. The behaviour was also noted for some of the species. It is presumed that galeommatid species go through a lengthy planktonic phase. *Zoological Journal of the Linnean Society*, 2005, **144**, 261–308.

ADDITIONAL KEYWORDS: behaviour – morphology – new taxa – reef flat – taxonomy – tropical.

INTRODUCTION

This paper documents 27 named species of the family Galeommatidae from Phuket Island, Thailand (Andaman Sea, Indian Ocean). Fourteen of the species are described as new. Most of the specimens were collected from the inner part of the intertidal zone of the coral reef in front of the Phuket Marine Biological Center (PMBC). Some were mentioned by Nielsen (1976) and by Tantanasiriwong (1979).

Identification of species of Galeommatidae is troublesome. Nearly a hundred were named in the 18th century, but the descriptions are brief and deal only with the shells; in addition, the illustrations are generally poor and give little or no details of hinge structures. Thus, most of the many species of *Galeomma* and *Scintilla* collected by H. Cuming (mostly in Indo-Pacific waters) and described by Deshayes (1856a, b) and Sowerby (1874) cannot be recognized unless the type material is studied. Unfortunately, the same is true for many of the Far Eastern species established in the 19th century, for which accurate illustrations of hinge characters are often wanting, while details of the soft parts are rare. In this study we show that the structure of the mantle, naked or with tentacles and/or papillae, which in the live animal is wrapped around the shell, provides very useful distinctive characters, to some extent even outdoing those of the shell.

*Corresponding author. E-mail: jlutzen@bi.ku.dk

MATERIAL AND METHODS

Galeommatids were collected during visits to Phuket Marine Biological Center (PMBC) in 1975 (February–March and December, CN), 1982 (February–March, CN), 1985 (January–March, CN), 2002 (February–March, CN, JL, Å. Jespersen), and 2003 (February, CN, JL, ÅJ). Most of the collections were made at low tide in the inner part of the reef flat on both sides of the pier at PMBC (7°48′N, 98°25′30″E). The nearby reef flat at the south side of Ao Tung Khen (7°48′30″N, 98°25′30″E) was visited three times, the reef flats of Ao Chalong (7°49′N, 98°21′E) and Nai Yang (Airport Beach, 8°05′N, 98°17′30′E) both once (Fig. 1). The

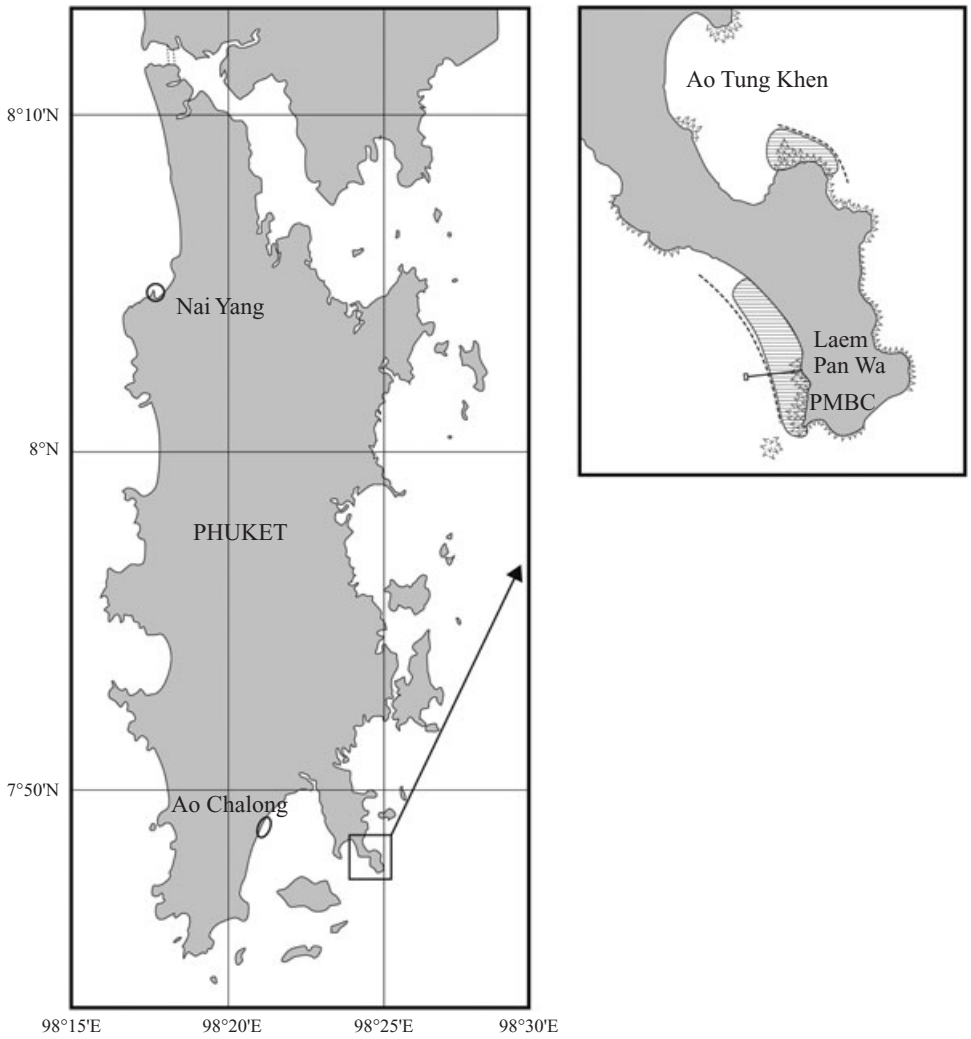

Figure 1. Map of Phuket Island with indication of collecting localities. The two localities covered more intensively are hatched in the inset map. The V-shaped signatures indicate shale exposed at low tide.

locality Koh Rok is a small island situated about 100 km SE of PMBC (7°15′N, 99°01′E). A few records from other sites include specimens deposited in the Reference Collection of PMBC.

The localities have a rather similar topography: a more or less extensive area with shales closest to the upper tide level, a zone with sandy or silty substrate with scattered coral blocks (mostly *Porites* spp.), wide at PMBC and Ao Chalong, but narrow at the two other localities, and a zone covered by large, flat *Porites* blocks interspersed with smaller areas with finer or coarser sand. At the southern side of the PMBC reef flat (just north of the pumphouse of the Center), many bivalves were found in the uppermost zone in coarse, well-oxygenated sand in wide crevices in the shale.

The bivalves were collected by examining the undersides of stones, slates and dead corals resting on sand or mud and by digging in the substrate beneath them. Many specimens were found attached to the base of live or dead *Porites* corals embedded in the substrate. The bivalves seemed to prefer the rust-brown areas of the coral skeleton (in contrast to its general grey or yellowish surface), indicating galleries with a more or less continuous flow of water along the underside of the coral (Fig. 2).

The living clams were brought to the laboratory and were maintained in small dishes for several days. A very few empty shells were also found. For each species we have endeavoured to illustrate both the living animal and details of the shell, although in a few instances this was not possible. Illustrations of the living animal

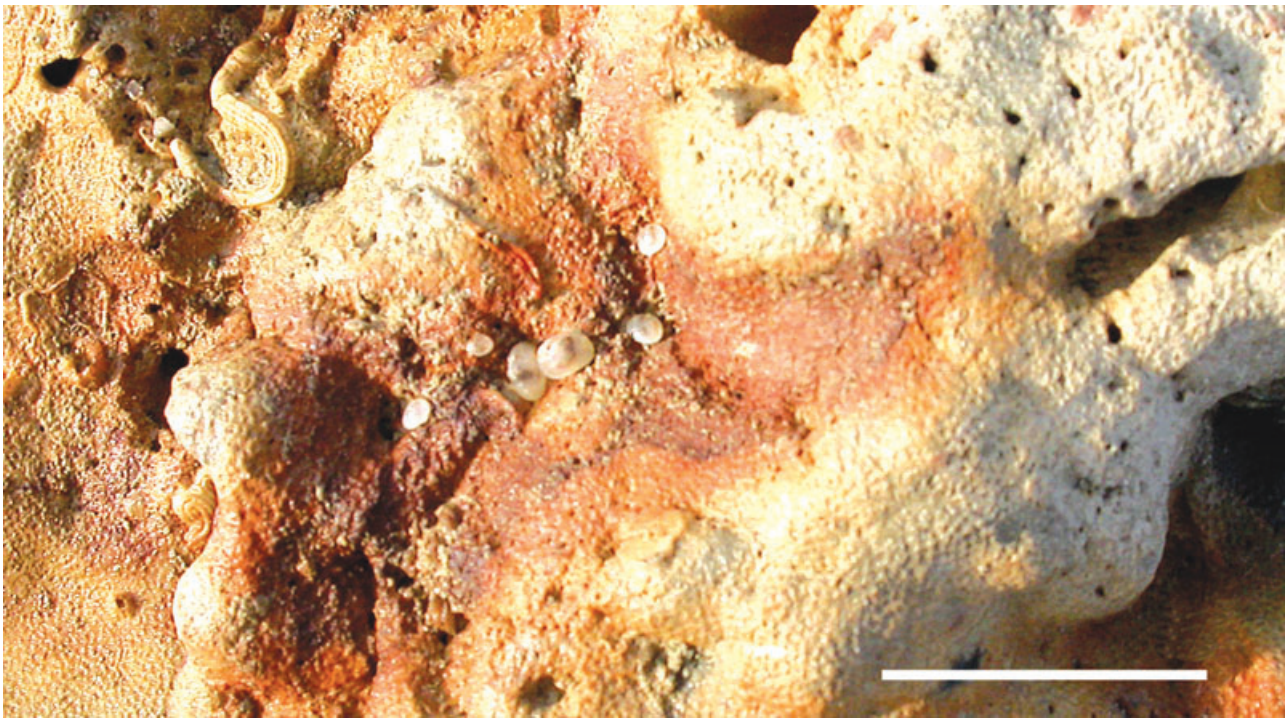

Figure 2. Photo of the underside of a dead *Porites* block showing the position of several *Scintilla anomala*. The dark brown zones indicate the passage of water currents and hence oxygenated areas, as opposed to the grey zones indicating stagnant water and low oxygen tension. Scale bar = 5 cm.

were made from sketches or from colour or black and white photos of specimens with maximum mantle coverage of the shell. Examination of shell morphology was made on material preserved in 70% ethanol and the illustrations based on photos of cleaned shells.

We have attempted for each species to illustrate: (1) the living animal, usually seen from the left; (2) the interior of the left valve; (3) the hinge plates of both valves, and (4) the exterior of a pair of cleaned and dried valves. Shell length (SL) and height (SH) to the nearest 0.1 mm are normally given for the smallest and largest individuals, and the width (when closed) is often given for a single specimen. Photos of cleaned shells of almost all species are presented in Figures 3–6. SL is generally given for all type specimens and the size of the prodissonch II has been measured for all species (based on one or two measurements).

In an effort to identify our material with already named species, we compared it with shells in the collections of other institutions, particularly those of The Natural History Museum, London (BMNH). We also studied a few shells in Santa Barbara Museum of Natural History, Santa Barbara, USA (SBMNH). The material is deposited in The Reference Collection of PMBC, Thailand and, when not otherwise indicated, in The Zoological Museum, Copenhagen, Denmark (ZMUC).

TAXONOMY

Family Galeommatidae Gray, 1840

Shell slightly convex or flattened, often gaping ventrally, umbones median or submedian. Hinge edentulous or with one tuberculiform cardinal in each valve, sometimes with a second and smaller cardinal present; a short posterior lateral is often present. Internal ligament opisthodetic, in a small pit or groove. The expanded mantle more or less covers the exterior of the shell.

The shells of the Galeommatidae are usually thin, brittle and featureless. The hinge is edentulous, irregular or often with one stout cardinal in each valve, sometimes with a second and smaller cardinal present in the left valve. The shell is more or less internalized by the profuse development of the mid-mantle folds, which are wrapped over the shell and, when fully extended, may cover both valves, sometimes permanently. In most species the mid-mantle folds can be withdrawn completely between the valves when the animal is disturbed. Inner folds of the mantle are fused posteroventrally to separate a wide anterior inhalant-pedal gape from a much smaller posterodorsal exhalant aperture, which is often raised on a short siphon. Anteriorly, the free and often frilled edges of the mantle folds normally extend beyond the shell

edges as an extensive cowl or hood. It forms a poorly defined inhalant siphon for the anterior-to-posterior water flow through the mantle cavity. When the mantle is fully extended over the shell, the shell is only exposed at a minute oval opening above the umbones or at a slit in the mid-lateral region.

The exposed parts of the mantle may be completely naked, but are normally ornamented with sensory tentacles or papillae, whose tips may be pointed or blunt and are sometimes pigmented (whitish, yellow or red). The distinction between papillae and tentacles is based on size and length rather than on histological criteria. Both can be extended by swelling of interior haemocoelic spaces and shortened or withdrawn by contraction of longitudinal muscle fibres (Morton, 1973; O'Foighil & Gibson, 1984; Mikkelsen & Bieler, 1989). Two fairly large unpaired tentacles arise dorsal to the anterior hood and to the exhalant aperture in many species and in some are the only tentacles present. They are called anterior and posterior siphonal tentacles. In some species (e.g. *Scintilla longitentaculata* sp. nov.) they can be everted suddenly from the normal retracted position and waved vigorously, probably to divert or dissuade potential predators, and are then known as dymantic tentacles (Morton, 1975).

In species of *Galeomma,* the papillae may have a terminal swelling which autotomizes and, it is believed, releases a noxious substance which may deter would-be predators (Morton, 1973). Preserved specimens are often more or less retracted into the shell, with the tentacles protruding only slightly beyond the edges of the gaping shell. Only *Aclistothyra* has the mantle edges fused along the dorsal mid-line and is unable to retract.

The muscular foot is adapted for active crawling, as described by several authors (e.g. Arakawa, 1960, 1961). A byssus gland is present and a few fine byssal threads attach the bivalves to the underside of stones, crevices, coral galleries and other protected substrates. A number of species are commensal with burrowing crustaceans or echinoderms. Some species are largely solitary, while others are gregarious, gathering in small groups that may sometimes consist of more than one species.

The eggs are incubated in the suprabranchial chamber, which includes both inner and outer demibranchs. Most of the species which have been studied are hermaphroditic.

The systematics of this family is in need of revision, with emphasis on both shell and soft part characters. Our studies indicate that several species have been named many times, probably as a result of the old habit of studying only cleaned shells. We have followed a conservative line and hope that additional information will emerge from molecular studies of the specimens that we have collected at Phuket.

GENUS *SCINTILLA* DESHAYES, 1856

Shell more or less inflated, rather thin, smooth, polished. Umbones moderately prominent, submedian or anterior to middle. Right valve with a single prominent cardinal, left valve with two somewhat divergent cardinals. Posterior laterals present.

Shell may be completely concealed by mid-mantle folds, which anteriorly extend beyond the shell to form a wide inhalant-pedal gape. The small posterior exhalant siphon is low and conical. Each opening is dorsally guarded by an unpaired siphonal tentacle, longer or stouter than any other tentacle present. The exposed mantle is provided with shorter papillae and/or longer tentacles, many of which are distinctly paired.

Type species: Scintilla philippinensis Deshayes, 1856 (subsequent designation by Stoliczka, 1871).

Remarks

Two species of *Scintilla* (***S. sannio* sp. nov.** and ***S. papillosa* sp. nov.**) are only provisionally referred to the genus since they do not entirely satisfy the above diagnosis.

SCINTILLA PHILIPPINENSIS DESHAYES, 1856 (FIGS 3A–C, 7, 8)

Scintilla philippinensis Deshayes, 1856b: 176. – Adams & Adams, 1857: 480, pl. 115, fig. 4. Sowerby, 1862: 179, pl. 235, figs 31, 32. Sowerby, 1874: species 5, pl. I, fig. 5a, b. Lynge, 1909: 186. Habe, 1977: 151. Morris & Purchon, 1981: 324. Higo, Callomon & Goto, 1999: 460. Higo, Callomon & Goto, 2001: 160, B667.
Scintilla reevei Deshayes, 1856b: 176 (**syn. nov.**). – Sowerby, 1874: species 4, pl. I, fig. 4a, b.

Material examined

Holotype: BMNH 196745/1, Island of Cebu, Philippines, SL = 14.1 mm.

Museum material: Holotype of *S. reevei*: BMNH 196770, Bais, Island of Negros, Philippines, SL = 16.2 mm. BMNH, unregistered: specimens from Port Blair, Andaman Islands; Pulau Bidang, N of Penang, and Pulau Perhentian, E coast of Malaysia; Pulau Blakang, Mati, Mindanao, Philippines; Trincomalee, Sri Lanka; Krusadai, Gulf of Manaar. ZMUC, unregistered: Koh Kahdat, Gulf of Thailand, one specimen.

New material: Reef off PMBC: 16 and 20 February 1982, eight specimens; 24 and 26 February 2002, five specimens; 6 and 9 February 2003, 11 specimens (one of them PMBC 20093, the other ten dissected or sectioned); Ao Tung Khen: 8 February 2003, one specimen.

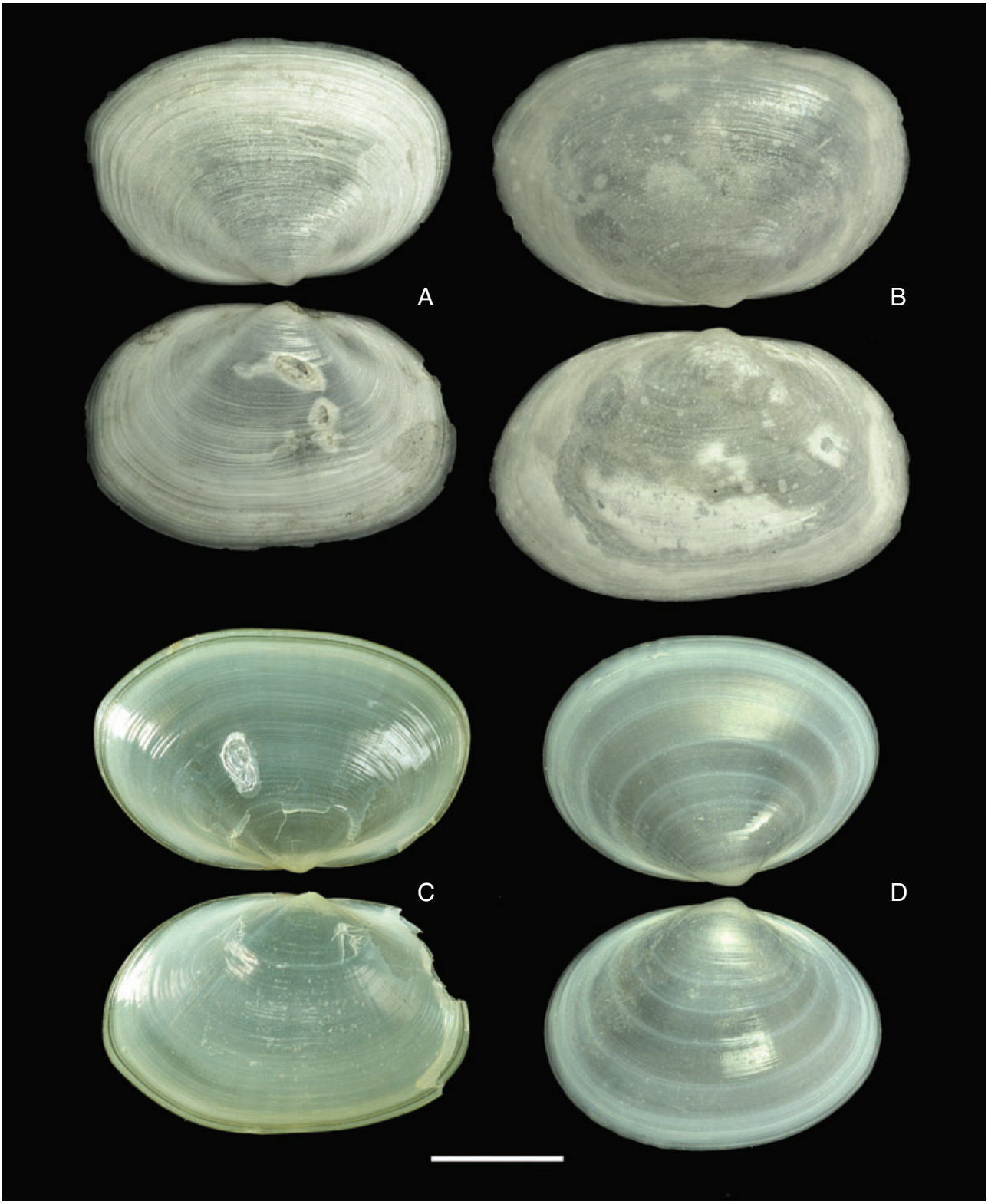

Figure 3. A, holotype of *Scintilla philippinensis*, Island of Cebu, Philippines, BMNH 196745/1. B, holotype of *S. reevei*, Island of Negros, Philippines, BMNH 196770. C, *S. philippinensis*, reef off PMBC, 9 February 2003, PMBC ref. coll. 20093. D, *S. cuvieri*, reef off PMBC, February 1975, PMBC ref. coll. 20094. Top: right valve; bottom: left valve. Scale bar = 5 mm.

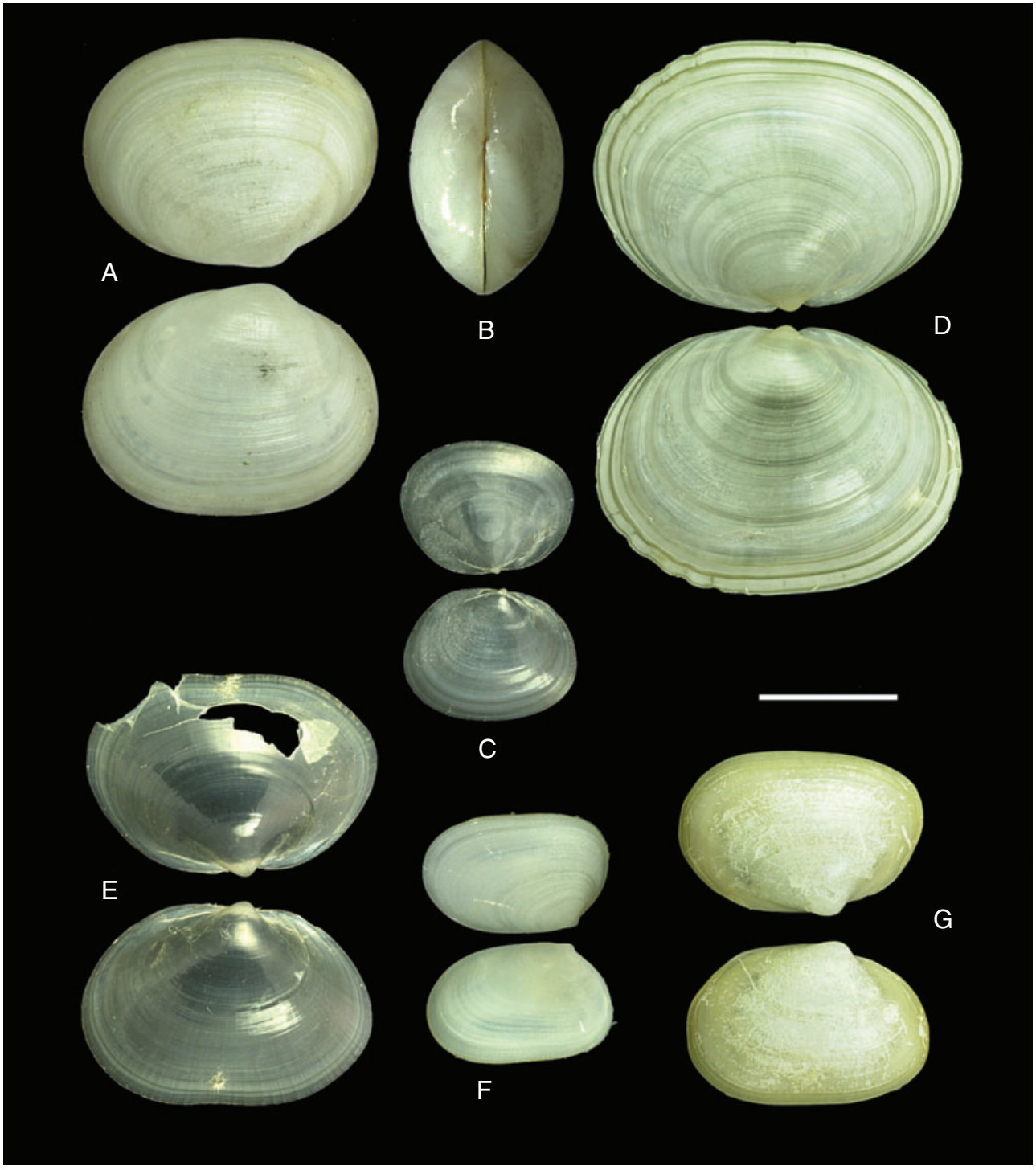

Figure 4. A, lectotype of *Scintilla ovulina*, Island of Samar, Philippines, BMNH 196764/1. B, syntype of *S. ovulina*, Island of Samar, Philippines, BMNH 196764/2. C, *S. anomala*, reef off PMBC, PMBC ref. coll. 20096. D, *S. nitidella*, reef off PMBC, 24 March 1975, PMBC ref. coll. 20099. E, *S. violescens*, reef off Nai Yang Beach, 9 February 2003, PMBC ref. coll. 20098. F, *S. dubia*, reef off PMBC, 24 March 1975, PMBC ref. coll. 20097. G, *S. imperatoris* **nom. nov.**, reef off PMBC, PMBC ref. coll. 20100. A & C–G, top: right valve; bottom: left valve. B, dorsal view. Scale bar = 5 mm.

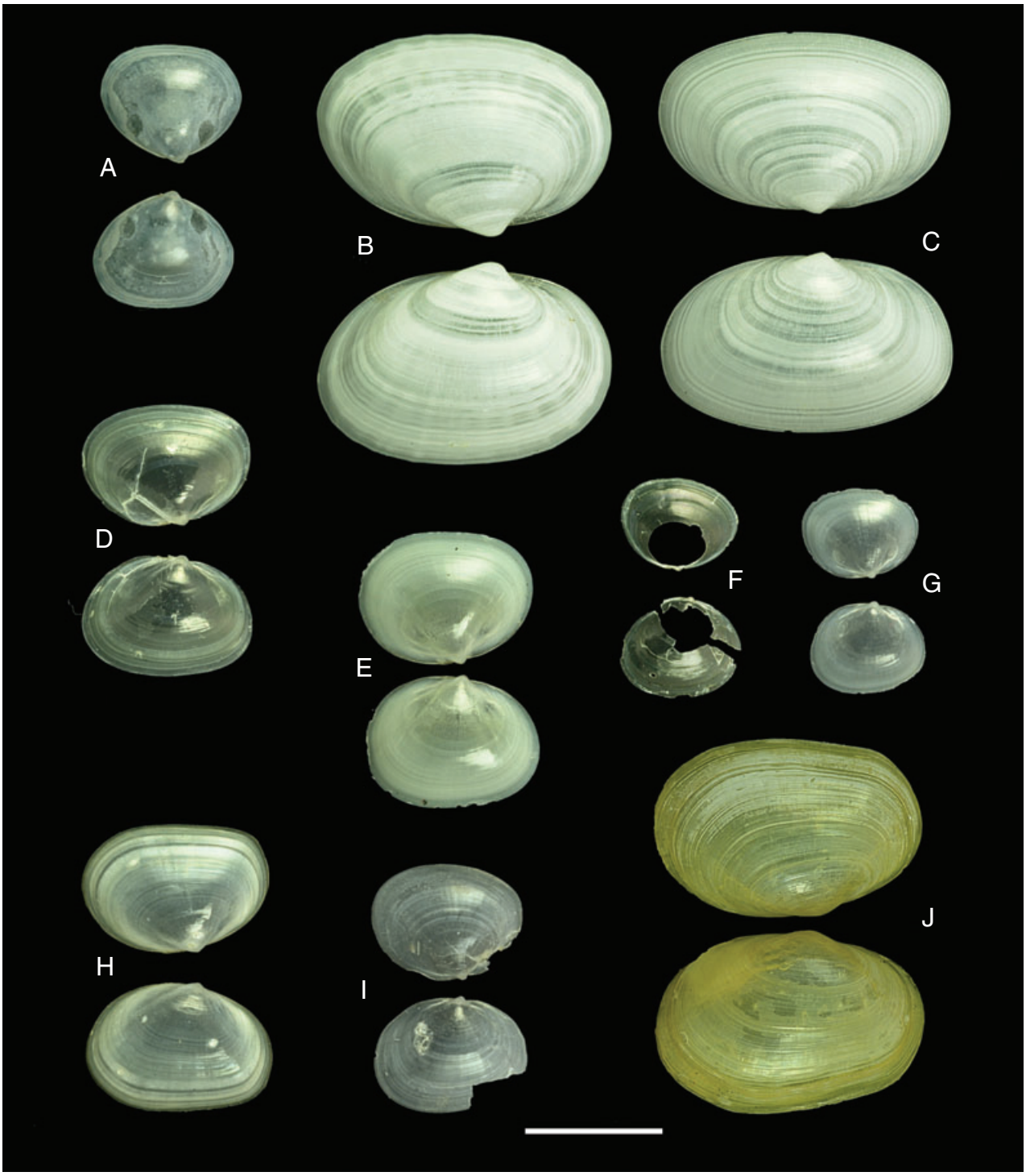

Figure 5. Holotypes. A, ***Scintilla agilis* sp. nov.**, reef off PMBC, March 1975, PMBC ref. coll. 20101. B, ***S. siamense* sp. nov.,** reef off PMBC, February 1975, PMBC ref. coll. 20107. C, **S. *sannio* sp. nov.**, reef off PMBC, February 1975, PMBC ref. coll. 20105. D, ***S. unicornia* sp. nov.**, reef off PMBC, 26 February 2002, PMBC ref. coll. 20108 E, ***S. mortoni* sp. nov.**, reef off PMBC, 5 February 2003, PMBC ref. coll. 20106. F, ***S. macrodactylus* sp. nov.**, reef off PMBC, 5 February 2003, PMBC ref. coll. 20103. G, ***S. minor* sp. nov.**, reef off PMBC, 26 February 2002, PMBC ref. coll. 20104. H, ***S. verrucosa* sp. nov.**, reef off PMBC, 3 March 2002, PMBC ref. coll. 20109. I, ***S. longitentaculata* sp. nov.**, reef off PMBC, 2 March 2002, PMBC ref. coll. 20102. J, ***S. papillosa* sp. nov.**, reef off Rawai Beach, no date, PMBC ref. coll. 20110. Top: right valve; bottom: left valve. Scale bar = 5 mm.

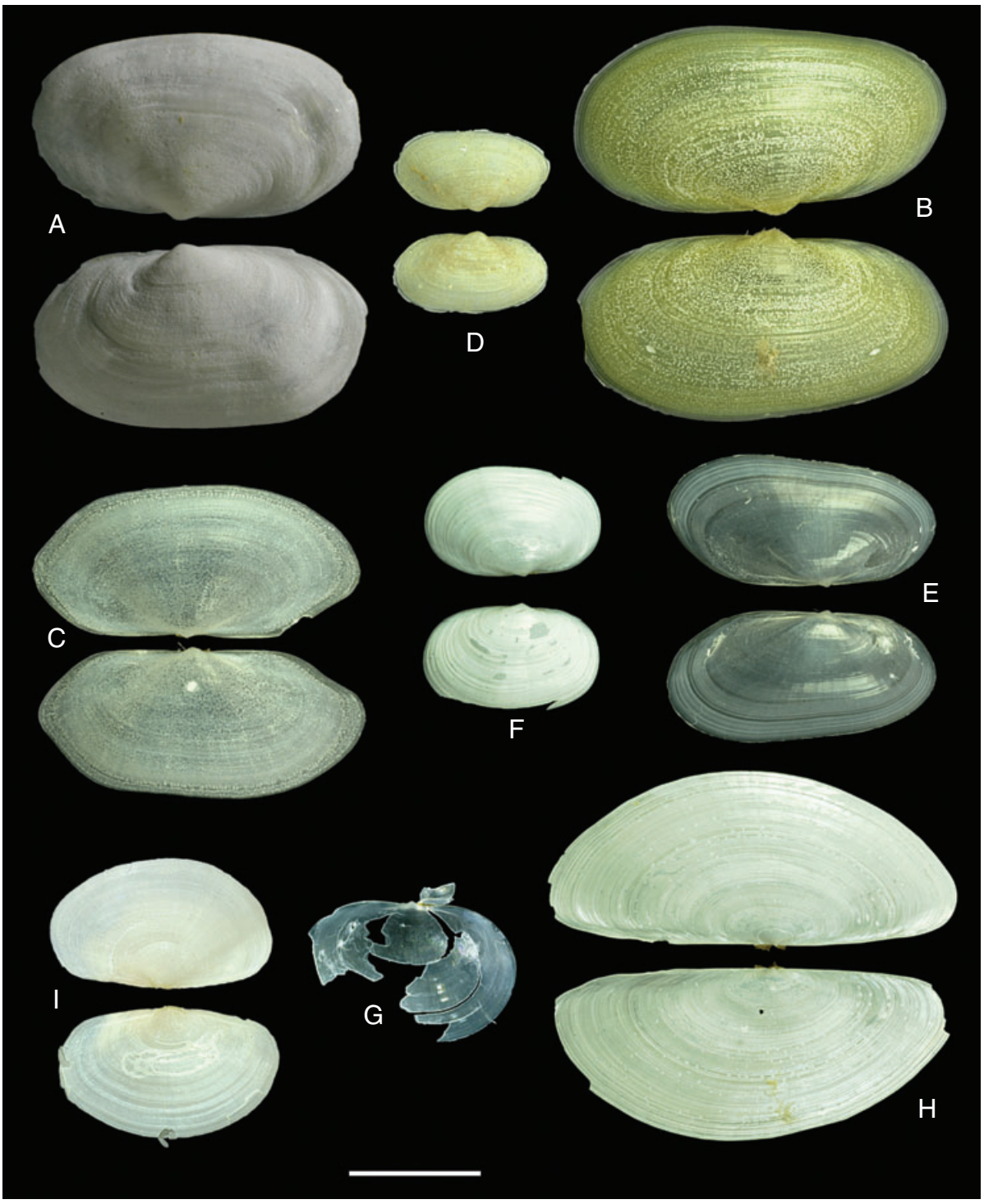

Figure 6. A, *Galeomma* (*Amphilepida) obockensis*, reef off Nai Yang, 7 July 1976, PMBC ref. coll. 916, M102. B, *G.* (*Galeomma) ambigua*, reef off PMBC, 9 February 2003, PMBC ref. coll. 20114. C, *G. layardi*, reef off PMBC, 3 February 2003, PMBC ref. coll. 20113. D, holotype of ***G. phuketi* sp. nov.**, reef off PMBC, 21 March 1975, PMBC ref. coll. 20115. E, *Pseudogaleomma japonica*, reef off PMBC, 3 March 2002, PMBC ref. coll. 20116. F, holotype of ***Nudiscintilla glabra* gen.** et **sp. nov.**, reef off PMBC, 8 February 1975, PMBC ref. coll. 20111. G, holotype of ***S. ovalis* sp. nov.**, reef off PMBC, 3 March 2002, PMBC ref. coll. 20112. H, *Ephippodonta gigas*, Koh Rok, Phuket Island, 7 March 1982, PMBC ref. coll. 20117. I, holotype of ***Aclistothyra orientalis* sp. nov.**, shells photographed with soft parts inside; reef off PMBC, PMBC ref. coll. 20118. Top: right valve; bottom: left valve, except G (left valve). Scale bar = 5 mm.

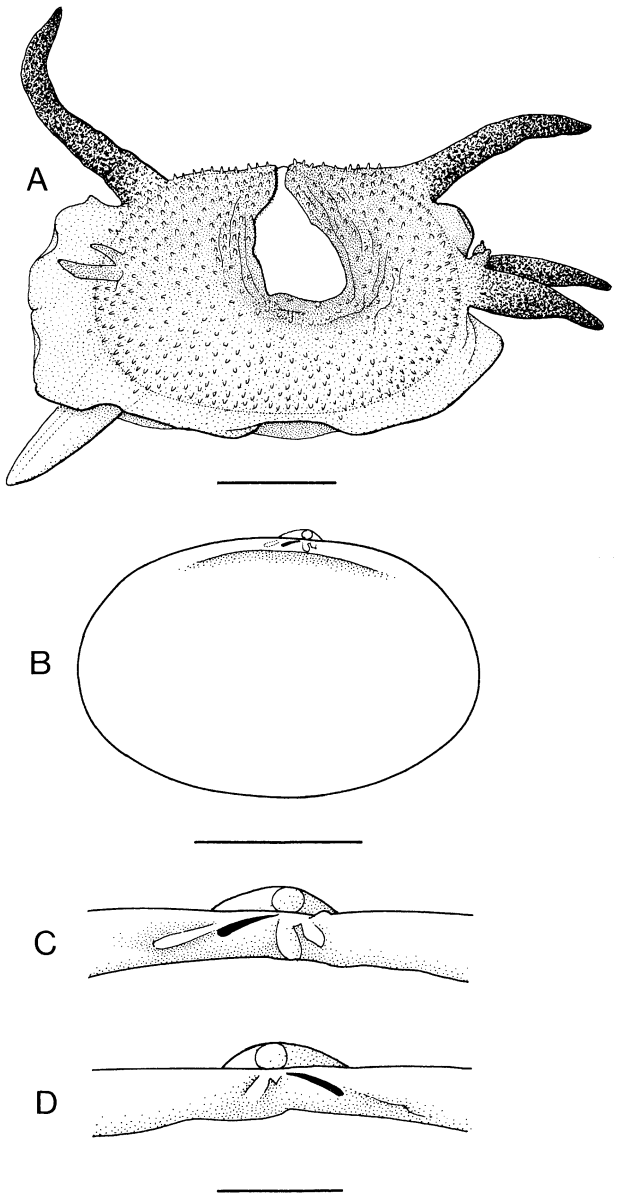

Figure 7. *Scintilla philippinensis.* A, living animal in left side view, dotted line indicating outline of shell. B, left valve in internal view. Left (C) and right valve hinge (D) showing prodissoconch II and resilifer of internal ligament (black). Scale bars: A, B = 5 mm, C, D = 1000 μm.

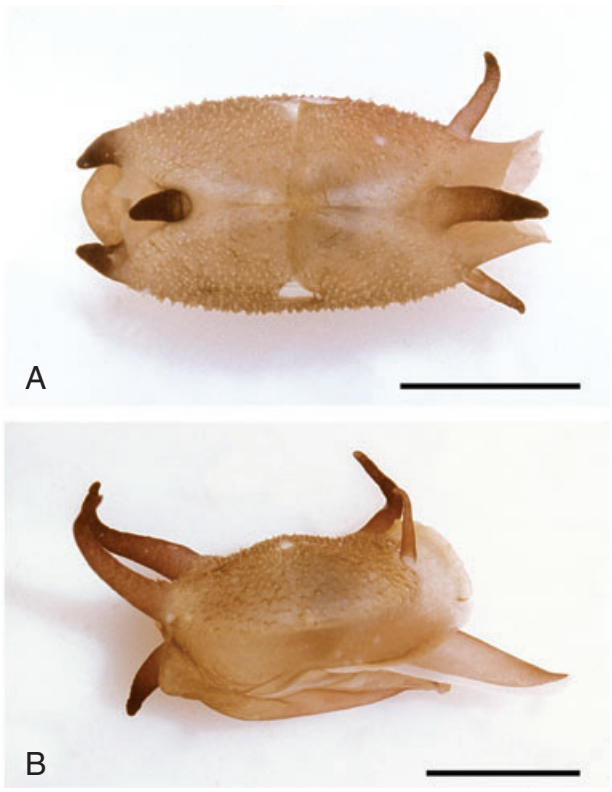

Figure 8. Live specimen of *Scintilla philippinensis* in dorsal (A) and right side view (B). Scale bars = 5 mm.

Description of material from Phuket

Shell: Ovate, somewhat inflated, uncoloured, relatively translucent, somewhat shiny, surface smooth with many irregular incremental lines (Fig. 3C). All margins perfectly rounded. Shell highest in the middle. SL ranges from 7.0 to 18.2 mm. A 14.5 × 9.5 mm shell was 6.0 mm wide. The prodissoconch II is 290 μm in diameter. Umbones fairly prominent, located slightly anterior of mid-shell. Hinge plate long and stout; right valve with an oblique cardinal slightly anterior of umbo, left valve with a large and a small rounded cardinal under and anterior of umbo. Inconspicuous posterior laterals are present in both valves. Some of the shells of live specimens were heavily corroded (Fig. 3C).

Soft parts: The reflected light brownish mantle is relatively thick, plicated and provided with minute rounded or pointed papillae, which are least abundant along the shell margins. There are two long and thick, gently tapering siphonal tentacles. Two pairs of smaller pointed tentacles arise anteriorly from the mantle and a pair of stout posteriorly directed tentacles issues from below the short, conical exhalant siphon. A minute mammiform protuberance is associated with the base of each of these tentacles. All tentacles are of a vivid purple which becomes darker towards the ends.

Habitat

At Phuket the species lives in sand on the underside of shale blocks and large pieces of coral, and in wide, sand-filled crevices in shale, in the upper to middle part of the tidal zone. It detaches easily from the rock

when the latter is turned over. The species has a patchy distribution, often occurring under stones very close to each other. It is often solitary, but two, three and five specimens were recorded from under the same rock.

Distribution

Island of Cebu, and Island of Negros, Philippines (Deshayes, 1856b); Koh Kahdat, Gulf of Thailand (Lynge, 1909); S. of Okinawa, Japan (Habe, 1977); E. coast of Malaysia (Morris & Purchon, 1981); S. China Sea and Beibu Gulf (Higo *et al*., 1999); Port Blair, Andaman Islands (BMNH); N. of Penang and Pulau Perhentian, E. coast of Malaysia (BMNH); Pulau Blakang, Mati, Mindanao, Philippines (BMNH); Trincomalee, Sri Lanka (BMNH); Krusadai, Gulf of Manaar (BMNH); Phuket Island, Thailand (present study).

Remarks

The holotype of *Scintilla reevei*, an empty shell, strongly resembles both the holotype of *S. philippinensis* (Fig. 3A, B) and the material from Phuket (Fig. 3C) in shell and hinge characters, so we consider them conspecific. We have also compared the holotype of *S. striatina* Deshayes (BMNH 196772) with *S. philippinenesis*, but although the shells are very similar, the hinge plate in the former is more slender. Six alcohol-preserved specimens identified as *S. philippinensis* from Pulau Bidang (BMNH) all exhibit the typical stout and dark-coloured tentacles, which greatly helps to distinguish the species from any other galeommatid.

Scintilla cuvieri Deshayes, 1856 (Figs 3D, 9, 10)

Scintilla cuvieri Deshayes, 1856b: 174. – Sowerby, 1874: species 15, pl. 2, fig. 15a, b. Lamprell & Healy, 1998: 152, fig. 394.

Material examined

Lectotype: BMNH 196761/1, designated by Morton & Scott (1989), Island of Bohol, Philippines, SL = 18.6 mm.

New material: Reef off PMBC: February 1975, two dried shells (one of them PMBC 20094); 3 March 1975, one specimen; 10 February 1985, three specimens; 2 March 2002, one specimen and a valve.

Description of material from Phuket

Shell: Roundly ovate, moderately compressed, whitish, semitransparent, rather thin, outer surface smooth and shiny, commarginally striate with fine lines of growth. A large species, the specimens ranging from 11.3×8.8 mm to 16.8×12.3 mm, and even 19 mm in SL (Lamprell & Healy, 1998). A 13.9×10.5 mm shell measured 6.5 mm in width. The prodissoconch II is circular and *c*. 275 μm in diameter. Umbones moderately prominent, located slightly anterior of the middle. Hinge plate stout, right valve with a single blunt cardinal tooth, left valve with a large and a small cardinal tooth. Both valves with an elongate posterior lateral.

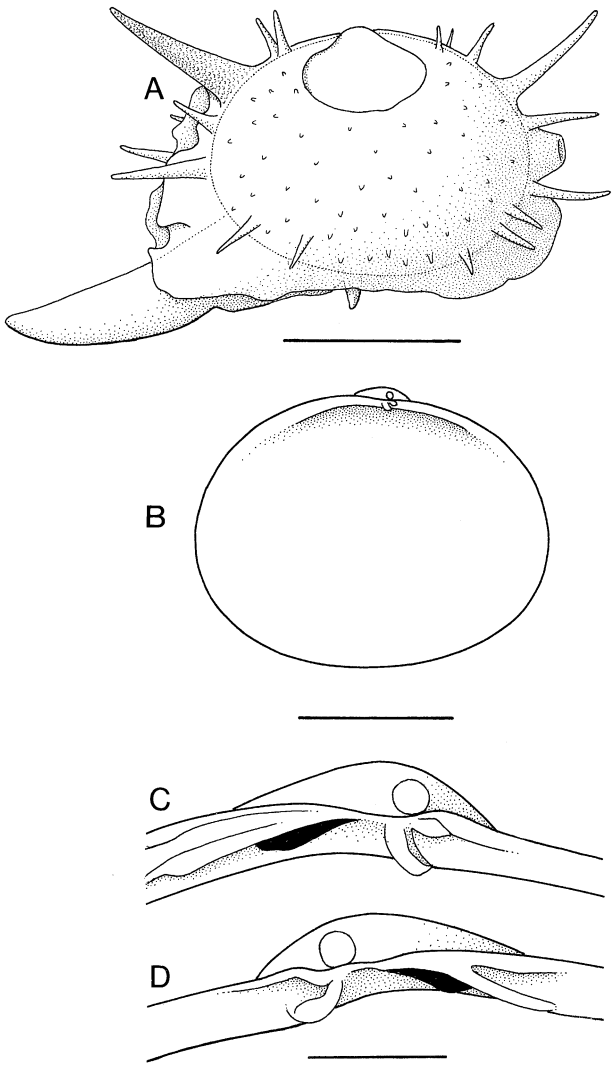

Figure 9. *Scintilla cuvieri.* A, living animal in left side view, dotted line indicating outline of shell. B, left valve in internal view. Left (C) and right valve hinge (D) showing prodissoconch II and resilifer of internal ligament (black). Scale bars: A, B = 5 mm, C, D = 1000 μm.

Soft parts: The anterior frilled edges of the extended mantle form a wide inhalant region, which continues into a narrow pedal opening. The posteroventral fusion of the mantle is usually moderately swollen.

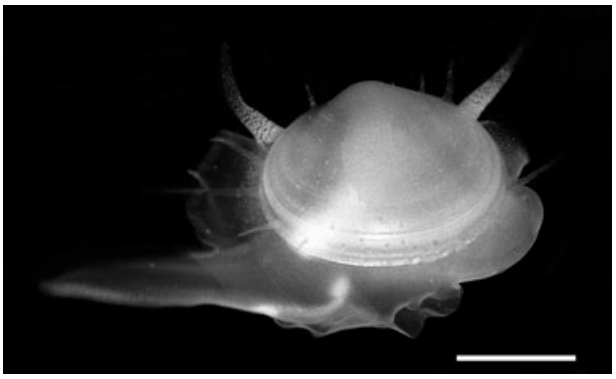

Figure 10. Live specimen of *Scintilla cuvieri* seen from the left. Scale bar = 5 mm.

There is a relatively small conical exhalant siphon. Minute papillae are scattered over the part of the mantle normally covering the shell, while a few longer paired tentacles arise from the area along the shell margins. In addition there are 3–4 unpaired tentacles above and below the exhalant siphon and a long and stout anterior tentacle above the inhalant region. The latter is provided with a rich whitish pigmentation. Foot and mantle can be completely withdrawn between the closed valves.

Habitat

At Phuket, the bivalves attach to the undersides of stones covered by, or lying on, coarse sand or gravel containing coral fragments in the middle and inner parts of the tidal zone. A specimen of *S. minor* sp. nov. was attached to the reflected mantle of one of the bivalves.

Distribution

Island of Bohol, Philippines (Deshayes, 1856b); Northern Queensland, Australia (Lamprell & Healy, 1998); Phuket Island, Thailand (present study).

Remarks

Three syntypes of *S. flavida* Deshayes, 1856 (from Samar Island, Philippines, BMNH 196769) bear a striking overall similarity to *S. cuvieri*, but the small cardinal tooth in the left valve is absent. The species is, furthermore, very similar to *S. translucida* Preston, 1908 from the Andaman Islands, but there is no information on the dentition and soft parts of that species and the type could not be located.

Having compared our material with a Hong Kong specimen identified as *Scintilla* cf. *cuvieri* (SBMNH 35064), figured by Morton & Scott (1989: pl. I, o, fig. 19C) and Valentich-Scott (2003: pl. 8B), we do not feel convinced of this identification. The Hong Kong specimens were originally identified as *S. nitidella* by Dudgeon & Morton (1982).

Scintilla ovulina Deshayes, 1856 (Figs 4A, B, 11)

Scintilla ovulina Deshayes, 1856b: 174. – Sowerby, 1874: species 44, pl. V, fig. 44. Shopland, 1902: 178.

Material examined

Lectotype (here designated): BMNH 196764/1, Basay, Island of Samar, Philippines, SL = 10.7 mm.

Paralectotypes: BMNH 196764/2–8, Basay, Island of Samar, Philippines, six specimens and one valve.

New material: Reef off PMBC: without date, one specimen (PMBC 20095); February 2002, one specimen.

Description of material from Phuket

Shell: Ovate, inflated, nearly as wide as high, dull to shining, whitish, semitransparent, surface smooth with many fine growth lines. All margins broadly rounded, slightly truncated anteriorly. Size of the two Phuket specimens 6.3×5.1 mm (width 4.7 mm) and 7.8×6.5 mm (width 5.7 mm). SL of the largest shell is 10.7 mm (lectotype). The prodissoconch II is 240 μm in diameter. Umbones moderately prominent, hinge plate relatively narrow. Right valve has a single stout, oblong and rounded subumbonal cardinal and a short protruding posterior lateral. Left valve with two small cardinals, the posterior pointed, the anterior rounded, plus a short posterior lateral.

Soft parts: Even when observed for many hours in a dish, only a small part of the mantle lobes was reflected over the margins of the shell. The inhalant aperture is small and anteroventral, the circular exhalant opening raised on a small siphon directed more or less backwards. Besides short and slender anterior and posterior siphonal tentacles, there are numerous small pointed papillae posterodorsally and anteriorly on the mantle lobes.

Habitat

There were only two specimens from Phuket. These were found solitarily in water-filled galleries between the sediment and the underside of *Porites*, in the lower intertidal zone.

Distribution

Basay, Island of Samar, Philippines (Deshayes, 1856b); Aden, South Yemen (Shopland, 1902); Phuket Island, Thailand (present study).

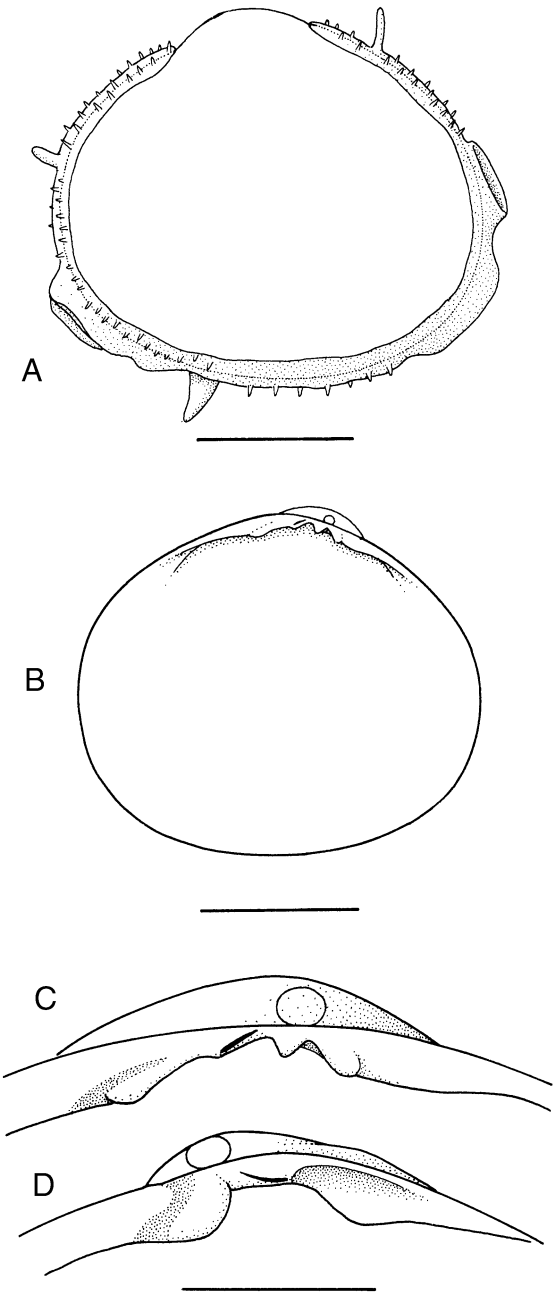

Figure 11. *Scintilla ovulina.* A, living animal in left side view, dotted line indicating outline of shell. B, left valve in internal view. Left (C) and right valve hinge (D) showing prodissoconch II and resilifer of internal ligament (black). Scale bars: A, B = 3 mm, C, D = 1000 μm.

Remarks

The globular shape of the shell serves to distinguish this species from all other described species of *Scintilla*. Although its affiliation to this genus may be provisional, the sperm of one of our specimens, when examined with TEM, had exactly the same, characteristic structure as that of four other genera (including *Scintilla*) of Galeommatidae studied by Eckelbarger, Bieler & Mikkelsen (1990) and by one of us (JL).

SCINTILLA ANOMALA DESHAYES, 1856 (FIGS 2, 4C, 12–14)

Scintilla anomala Deshayes, 1856b: 181. – Sowerby, 1862: 179, pl. 234, figs 25, 26. Angas, 1867: 928. Sowerby, 1874: species 37, pl. V, fig. 37a, b. Lynge, 1909: 185.
Solecardia cryptozoica Hedley, 1917: 684, pl. XLVI, fig. 1, pl. LI, fig. 40 (**syn. nov.**).
Varotoga cryptozoica Iredale, 1930–33: 206 (**syn. nov.**).

Material examined

Syntypes: BMNH 196793, Island of Samar, Philippines, six specimens.

New material: Reef off PMBC: February 1975, nine specimens; 26 February and 3 March 2002, 12 specimens; 1–9 February 2003, *c.* 12 specimens (one of them PMBC 20096); Reef at Ao Tung Khen: 1 March 2002, two specimens.

Description of material from Phuket

Shell: Roundly ovate, rather compressed, thin and brittle, transparent, polished, surface smooth with faint commarginal striae, slightly gaping posteriorly. Hinge line concave. Antero- and posterodorsal margins gently curved, crenulate corresponding to many short radial ribs on the exterior surface (Figs 13, 14), other margins broadly rounded, mostly without ribs. The crenelations at the growing edge are the tips of oval, calcareous rods, which are connected by a thin sheet (Fig. 13C). On the exterior side, the rods can be followed as ribs, which then fuse to form the smooth outer surface of the shell (Fig. 13A). On the interior side, the ribs soon become thicker, contact each other and finally fuse to a smooth surface, which becomes covered by additional layers of shell material (Fig. 13B). The ribs thus become concealed on both sides of the shell, but their hidden, original structure can be seen in both transmitted (Fig. 13D) and incident light from certain angles (Fig. 14). Maximum size to 9.0 mm long and 6.5 mm high (width 3.0 mm). Diameter of prodissoconch II 250 μm. Umbones rather small, almost central, maximum height occurs posterior to umbones. Right valve with a single rounded cardinal directly under umbo, left valve with a smaller, narrow cardinal under umbo. Posterior laterals small and short.

Soft parts: The expanded anterior part of the reflected mid-mantle folds forms a hood-like inhalant

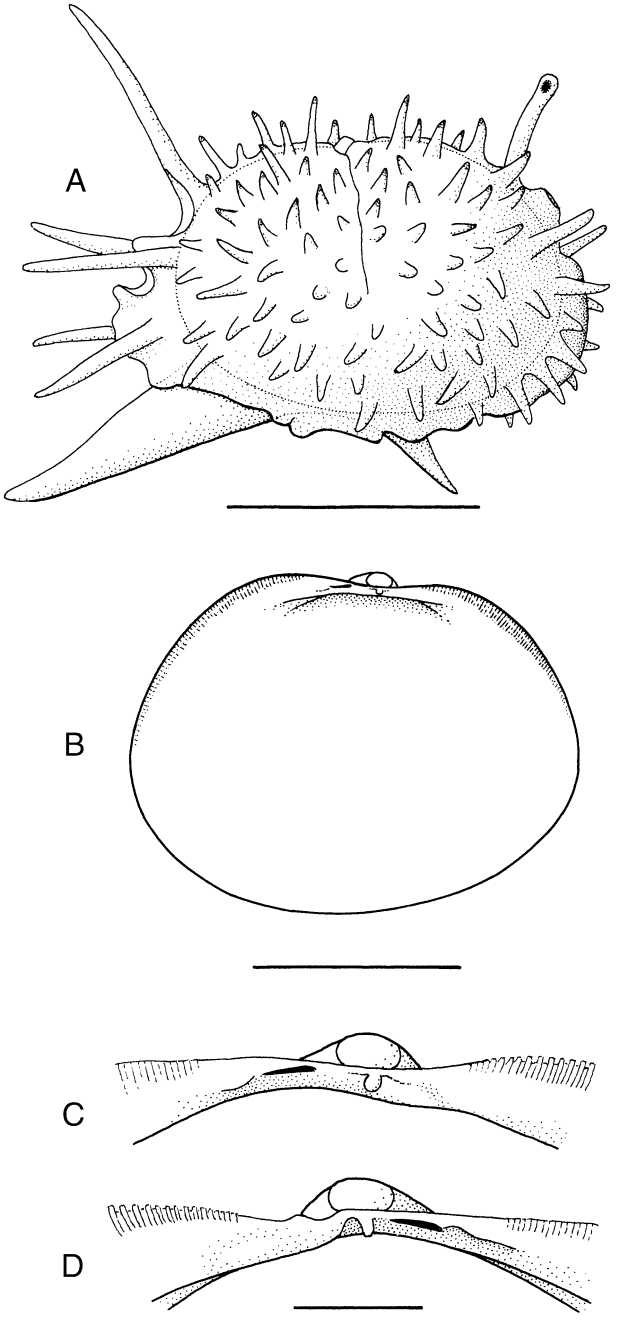

Figure 12. *Scintilla anomala.* A, living animal in left side view, dotted line indicating outline of shell. B, left valve in internal view. Left (C) and right valve hinge (D) showing prodissoconch II and resilifer of internal ligament (black). Scale bars: A = 5 mm, B = 3 mm, C, D = 500 μm.

region; its dorsal edge is confluent with a long, slender pointed tentacle, while two pairs of shorter forward directed tentacles guard the lateral edges. The exhalant siphon is a short cone, above which rises a bluntly ending tentacle whose tip bears a distinct red or orange knob. The mantle is covered with many pointed tentacles of varying length, with lemon-coloured tips. The posterior margin of the fused left and right inner mantle lobes is also coloured yellow.

Habitat

At Phuket, *S. anomala* is one of the commonest species, found on the undersides of *Porites* and of stones and flat coral boulders resting on sand in the middle and inner tidal zone. It often occurs in groups of 3–8 individuals (Fig. 2) and was once found together with *Pseudoscintilla ovalis* gen. et sp. nov.

Distribution

Island of Samar, Philippines (Deshayes, 1856b); Port Jackson (Sydney Harbour), New South Wales, Australia (Angas, 1867; Hedley, 1917); Lem Ngob, Gulf of Thailand (Lynge, 1909); Phuket Island, Thailand (present study).

Remarks

There is only one cardinal in the left shell, but the arrangement of papillae and tentacles is typical of *Scintilla*. The radiating ribbed sculpture of the dorsal shell margins (Fig. 13), so typical of this species and also present in the syntypes, the terminally reddish posterior tentacle and yellow ornamentation of the other tentacles easily distinguish *S. anomala* from other species of the genus. The arrangement and coloration of the tentacles of our material perfectly match Hedley's (1917) specimens from Sydney, whose shells, moreover, show the same characteristic ribbed – or in Hedley's terminology, vermiculate – dorsal margins as ours. It is therefore difficult to understand why H. B. Preston (cited and followed by Hedley), on comparing the Sydney specimens with the syntypes of *S. anomala*, found them to be distinct. Since the type species of *Varotoga* is a junior synonym of *S. anomala*, *Varotoga* is not valid.

SCINTILLA DUBIA (DESHAYES, 1856) (FIGS 4F, 15, 16)

Erycina dubia Deshayes, 1856c: 183.
Scintilla obliqua Sowerby, 1862: species 32, fig. 35 (**syn. nov.**). – Sowerby, 1874: species 34, pl. IV, fig. 34.
Cymatioa dubia Keen, 1971: 133, fig. 303 (**syn. nov.**).

Material examined

Holotype of *Erycina dubia:* BMNH 196756, Bay of Guayaquil, Ecuador, SL = 7.3 mm.

Museum material: Holotype of *Scintilla obliqua*, BMNH, Ecuador, SL = 7 mm.

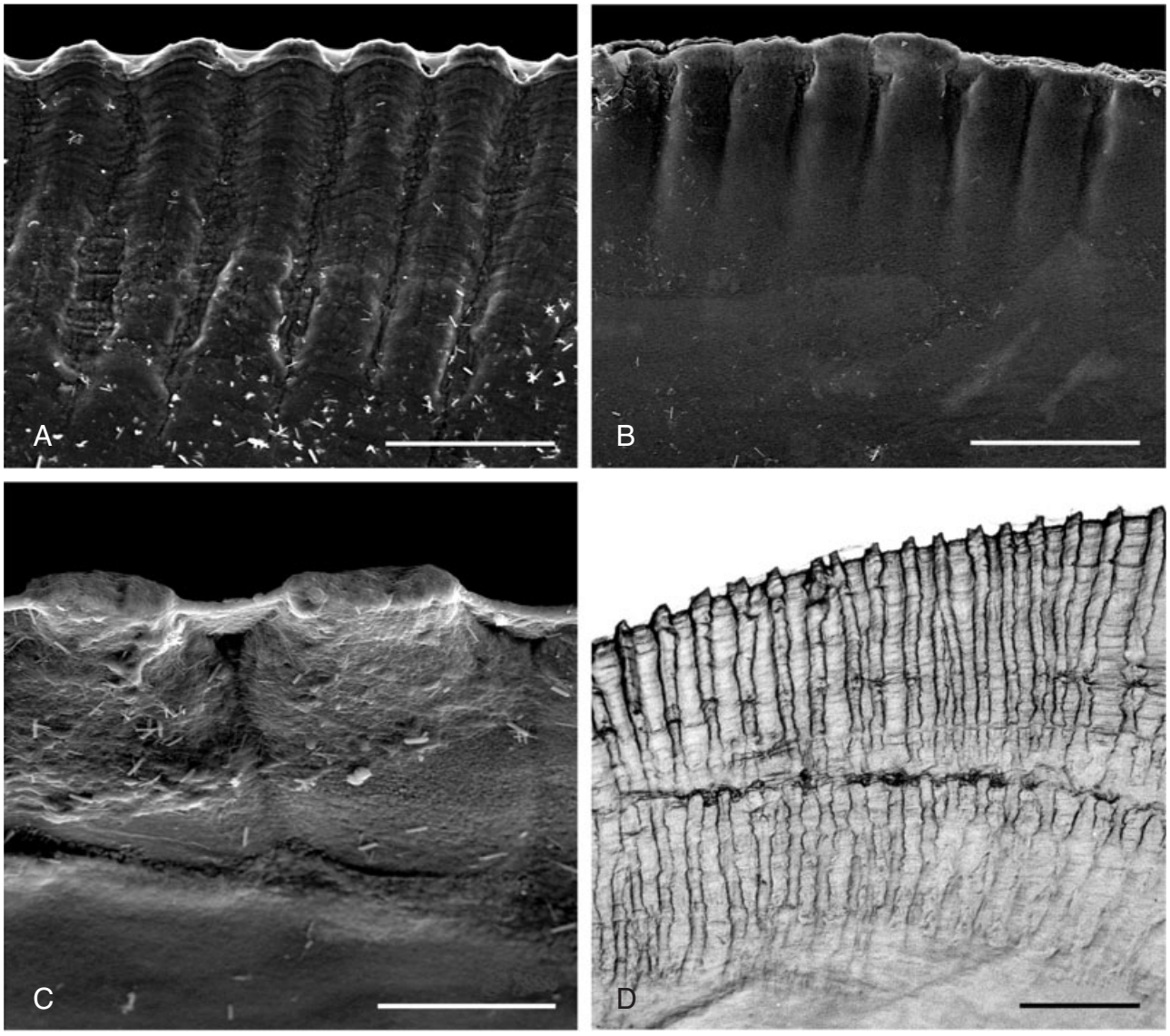

Figure 13. *Scintilla anomala.* A–C, SEM of toothed dorsal shell margin and radial ribs of exterior side (A) and interior side (B); (C) shows the edge of the shell and the periphery of the interior side. D, light micrograph of shell margin seen from the exterior in transmitted light. Scale bars: A, B = 100 μm; C = 50 μm; D = 200 μm.

New material: Reef off PMBC: 23 February 1975, two specimens; 24 March 1975, five specimens (one of them PMBC 20097); 2 March 2002, one specimen; 4 February 2003, two specimens.

Description of material from Phuket

Shell: Elongate-ovate and distinctly inequilateral, rather compressed, pale whitish, semitranslucent, thin, surface smooth and dull. Anterior and posterior sides sloping dorsally, otherwise evenly rounded, ventral margin straight. Anterior part of ventral shell margin slightly crenulated. The size of 11 specimens ranges from 5.0×2.9 mm to 6.9×4.3 mm. A 6.4×3.9 mm shell measures 2.3 mm in width. The prodissoconch is II 215 μm across. Umbones small, the posterior region 3.5 times longer than the anterior. Hinge plate narrow, right valve with a single large and rounded cardinal, left valve with a stout subquadrate cardinal and, separate from it, a smaller, inconspicuous anterior cardinal. The posterior lateral in both valves is rather elongate.

Soft parts: The free anterior edge of the reflected mantle forms a wide inhalant siphon and continues dorsally in a single straight tentacle, which has a lon-

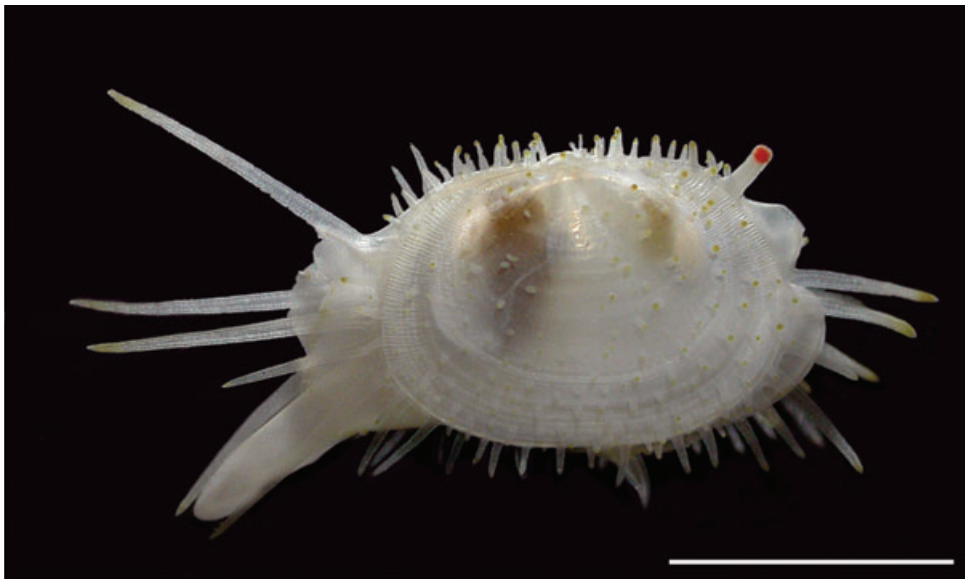

Figure 14. Live specimen of *Scintilla anomala* seen from the left. Scale bar = 5 mm.

gitudinal ventral groove. The exhalant mantle opening is raised on a low conical siphon. The posterior unpaired siphonal tentacle is always directed dorsally. The mantle, which may cover the entire shell, is provided with a few pointed paired tentacles along the anteroventral margin of the shell and below the exhalant siphon. In addition, there are scattered and evenly spaced blunt papillae all over its surface. The foot is pointed both anteriorly and posteriorly, and its front part adorned with a longitudinal whitish stripe.

Habitat

At Phuket, specimens were found solitarily (three), in two pairs, or three together. Two specimens were attached to the underside of *Porites*, the remainder to the underside of slates resting on coarse sand in the middle or upper tidal zone.

Distribution

Bay of Guayaquil, Ecuador (Deshayes, 1856c); Phuket Island, Thailand (present study).

Remarks

In spite of the wide geographical distance separating the location of the holotypes of *E. dubia* and *S. obliqua* from our specimens, the former match the shell dimensions and dentition of our material down to the last detail. We could not compare the soft parts as these are not present in the Ecuadorian specimens. Keen's (1971) transfer of the species to *Cymatioa* Berry, 1964 (= *Crenimargo* Berry, 1963) is hard to defend, as the relative position of the ligament to the umbo and the shape and size of the cardinals differ in *S. dubia* and the type species of *Cymatoia*, *C. electilis* (Berry, 1963).

SCINTILLA VIOLESCENS KURODA & TAKI, 1961 (FIGS 4E, 17)

Scintilla violescens Kuroda & Taki, 1961: 141. – Arakawa, 1961: 143, figs 1–5. Habe, 1981: 105. Higo *et al*., 1999: 460, B668. Okutani, 2000: 937, pl. 466, fig. 7. Higo *et al*. 2001: 162, B672.
Scintilla ione: Kuroda *et al*., 1971: 411, pl. 120, figs 5, 6 (non *Scintilla ione* Habe, 1951).

Material examined

New material: Reef off PMBC: without date, two specimens; 8 March 1982, three specimens. Reef off Nai Yang Beach: 9 February 2003, seven specimens (one of them PMBC 20098).

Description of material from Phuket

Shell: Shortly oblong-ovate, moderately inflated, whitish, opaque, very glossy, surface smooth with many fine incremental lines. Hinge line concave, anterodorsal and posterodorsal margins slightly sloping, front, hind and ventral margins regularly rounded. Slightly gaping posteriorly. The size ranges

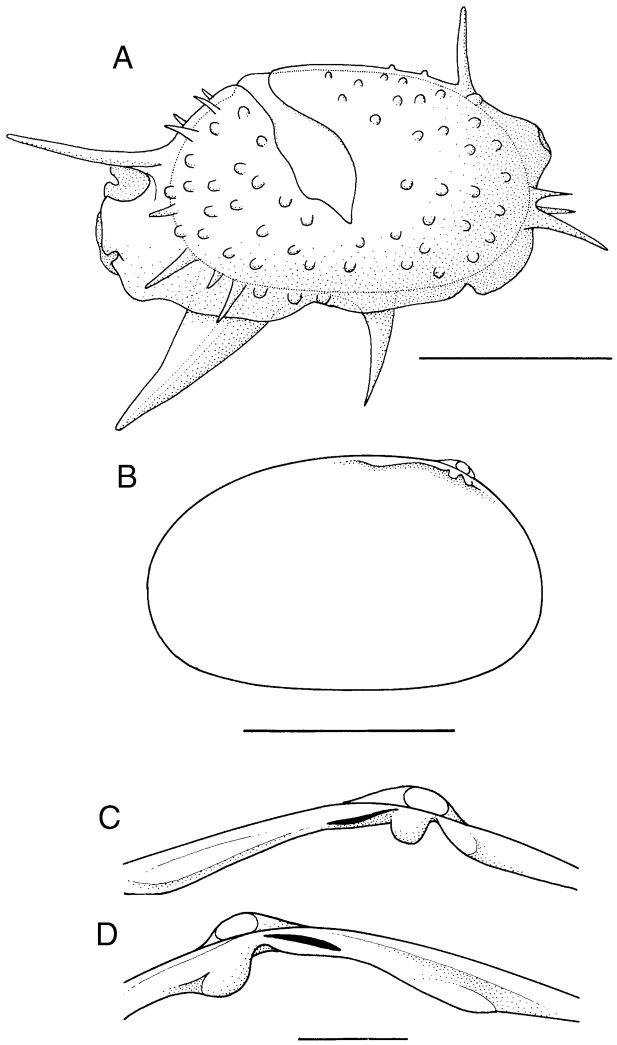

Figure 15. *Scintilla dubia.* A, living animal in left side view, dotted line indicating outline of shell. B, left valve in internal view. Left (C) and right valve hinge (D) showing prodissoconch II and resilifer of internal ligament (black). Scale bars: A, B = 3 mm, C, D = 500 μm.

from 4.1×3.3 mm to 10.5×7.5 mm. The prodissoconch II measures 295 μm in diameter. Umbones prominent, placed slightly in front of the middle. The right valve bears a stout rounded cardinal under the umbo. The left valve has a large, pointed and a slightly smaller cardinal. Elongated laterals are present behind the narrow and rather long resilifer in both valves.

Soft parts: Two rather large and thick pointed unpaired tentacles emerge anteriorly from the dorsal edge of the inhalant siphon, and posteriorly from above the exhalant siphon. The anterior tentacle is reddish terminally while the posterior tentacle is whitish at the tip. Moderately long paired pointed tentacles occur anteriorly and posteriorly on the mantle, especially ventral to the siphon. Fairly large rounded papillae, rather few in number, are scattered over the central part of the reflected mantle surface.

Figure 16. Live specimen of *Scintilla dubia* in left side view. Scale bar = 5 mm.

Habitat

At the reefs off PMBC and Nai Yang Beach, the species occurs in the middle intertidal zone. In Japan it is found subtidally to a depth of 100 m (Higo *et al*., 1999).

Distribution

Shirahama, Kii Peninsula and Akiya, Miura Peninsula, Honshû, Japan; Hakata Bay, Kyûshû, Japan (Kuroda & Taki, 1961); Sagami Bay and southwards, Japan; Noto Peninsula, Japan Sea (Higo *et al*., 1999); Phuket Island, Thailand (present study).

Remarks

Our specimens fit the original description by Kuroda & Taki (1961) very well. The dimensions and outline of the shell match the shell illustrated by Kuroda, Habe & Oyama (1971) as *Scintilla ione* perfectly and are also reasonably similar to *S. violescens* as illustrated by Arakawa (1961). However, Japanese specimens may have violet rather than whitish shells and an uncoloured anterior siphonal tentacle (Okutani, 2000). In the animal illustrated by Arakawa, the paired tentacles are much longer, and the papillae both longer and more numerous than in our specimens. Kuroda *et al*.'s quotation of Kuroda & Taki (1961) as the authors of *S. ione* is erroneous, as Kuroda & Taki in the said paper established

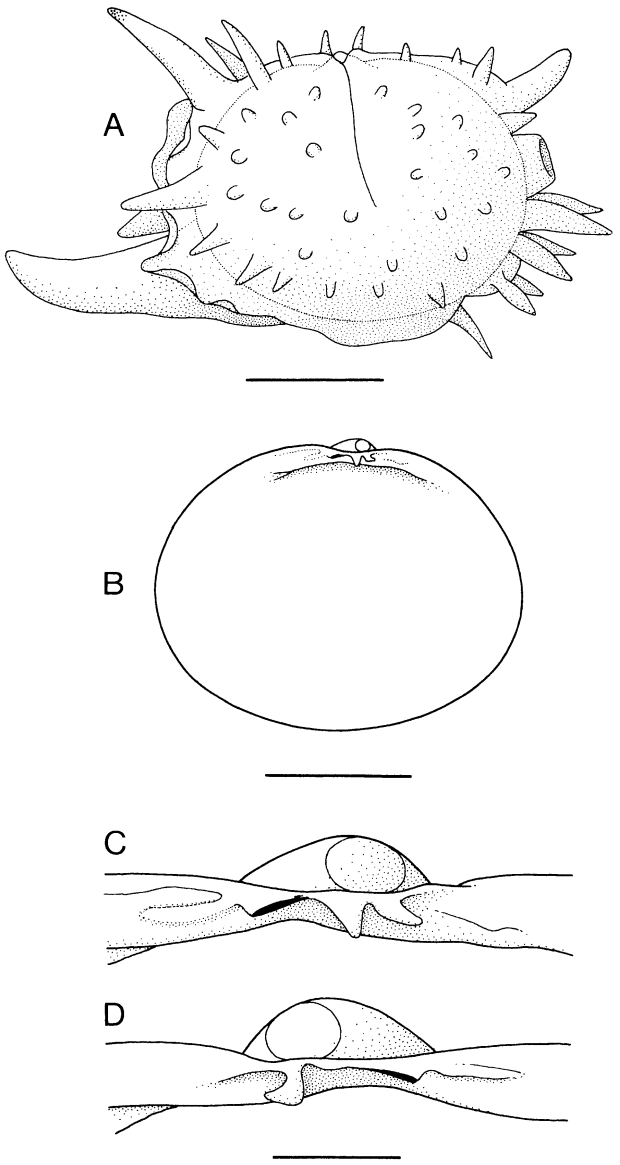

Figure 17. *Scintilla violescens.* A, living animal in left side view, dotted line indicating outline of shell. B, left valve in internal view. Left (C) and right valve hinge (D) showing prodissoconch II and resilifer of internal ligament (black). Scale bars: A, B = 3 mm, C, D = 500 μm.

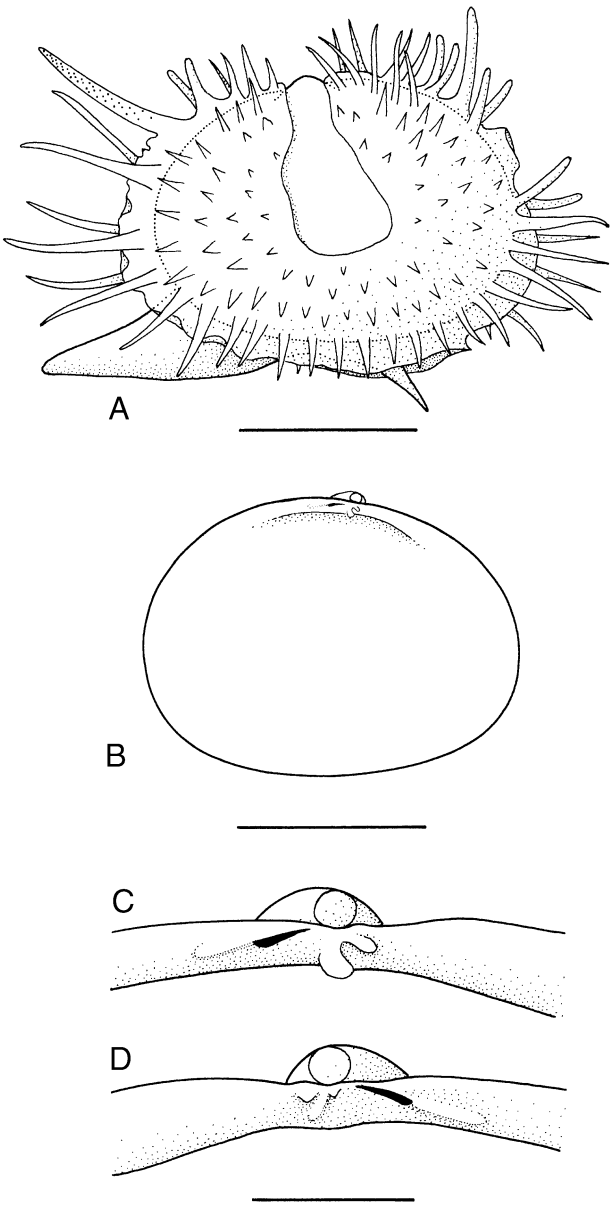

Figure 18. *Scintilla nitidella.* A, living animal in left side view, dotted line indicating outline of shell. B, left valve in internal view. Left (C) and right valve hinge (D) showing prodissoconch II and resilifer of internal ligament (black). Scale bars: A, B = 5 mm, C, D = 1000 μm.

S. violescens, not *S. ione*, the latter name being introduced by Habe (1951) for another species.

Two specimens (SL = 4.1 and 7.2 mm) were brooding larvae (9 February and unknown date). The prodissoconch I (D-shell) measured 135–140 × 95 μm.

SCINTILLA NITIDELLA HABE, 1962
(FIGS 4D, 18, 19)

Scintilla vitrea Habe, 1961: 127, pl. 57, fig. 14.

Scintilla nitidella Habe, 1962: 46, pl. 57, fig. 14 (new name for *Scintilla vitrea* Habe, preoccupied by *Scintilla vitrea* Quoy & Gaimard, 1832). – Habe, 1964: 185, pl. 57, fig. 14. Kuroda *et al*., 1971: 411, pl. 120, fig. 7. Habe, 1977: 152, pl. 27, figs 14, 15. Habe, 1981: 105. Morton & Scott, 1989: 147, figs 18, 19A, pl. I, m. Higo *et al*., 1999: 461, B674. Valentich-Scott, 2003: 279, pl. 8C. Okutani, 2000: 937, pl. 466, fig. 6. Higo *et al*. 2001: 162, B 674.

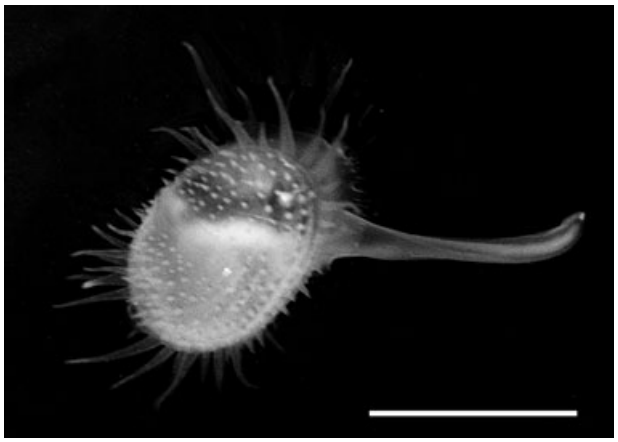

Figure 19. Live specimen of *Scintilla nitidella* in right side view. Scale bar = 5 mm.

Paraborniola matsumotoi Dudgeon & Morton, 1982: 633, 635 (fide Morton & Scott, 1989).

Material examined
New material: Reef off PMBC: 13 March 1975, one specimen; 24 March 1975, one specimen (PMBC 20099); 11 March 1982, five specimens; 5 February 2003, two specimens.

Description of material from Phuket
Shell: Subquadrate to subovate, thin and semitransparent, somewhat inflated. Surface smooth with commarginal striae. Valves slightly longer posteriorly with gently rounded margins. The largest of our specimens measured 10.0 mm in SL. The prodissoconch II is 290 μm across. Beaks small but prominent. Right valve with a low oblique cardinal, left valve with a small and a large rounded cardinal. Both valves with ridge-shaped posterior laterals.

Soft parts: The unpaired anterior siphonal tentacle is long, pointed and terminally sprinkled with whitish pigment. The reflected mid-mantle fold bears numerous tentacles which are longest anteriorly, dorsally, and along the ventral shell margin and is everywhere else provided with many papillae. Tentacles and papillae are pointed except for a pair of tentacles immediately behind the anterior siphonal tentacle and seven tentacles, including the comparatively longer posterior siphonal one nearest to the exhalant aperture, which are all blunt.

Habitat
At Phuket, the specimens, comparatively few in number, were found in the lower part of the intertidal zone under coral blocks and shales; five were found under one rock. Morton & Scott (1989) maintain that in Hong Kong this species occupies coral galleries in association with a range of other invertebrates such as ophiuroids and alpheid shrimps. In Japanese waters the species may descend to 100 m.

Distribution
Tanabe Bay, Honshû, Japan (Habe, 1961); Sagami Bay, Honshû to the W coast of Kyûshû, Japan (Habe, 1964); Jogashima WSW 4 km, Japan (Kuroda *et al*., 1971); Tolo Harbour, Hong Kong (Morton & Scott, 1989); Phuket Island, Thailand (present study).

Remarks
Our specimens match those described from Hong Kong by Morton & Scott (1989) in shell characters. Their illustration of the living animal also agrees quite well with our specimens. In contrast to Phuket specimens, the soft parts of Japanese specimens of *S. nitidella* illustrated by Okutani (2000) have reddish to orange tentacles. If this is not simply a geographical colour variation, Phuket and Hong Kong specimens might represent a different species. From their shell characters, *S. nitidella*, *S. violescens* and *S. imperatoris* nom. nov. are difficult to distinguish. However, the length and the number and arrangement of the pallial tentacles and papillae are sufficient to separate the three species. A Phuket specimen released D-Larvae (162 × 140 μm) 11 March 1982.

SCINTILLA IMPERATORIS NOM. NOV.
(FIGS 4G, 20, 21)

Scintillorbis opalinus Kuroda *et al*., 1971: 412, pl. 120, fig. 9.
Sagamiscintilla opalinus: Habe, 1977: 152.
Scintilla cf. *opalinus*: Morton & Scott, 1989: 148, fig. 19B, pl. I, n. Valentich-Scott, 2003: 279.
Sagamiscintilla opalina: Higo *et al*., 1999: 461, B678.
non *Scintilla opalina* Deshayes, 1856b: 177.

Material examined
Museum material: Syntypes of *Scintilla crocea* Deshayes, 1856, Island of Negros, Philippines, two specimens (BMNH 196768). Holotype of *Scintilla hydrophana* Deshayes, 1856, Balanas, Island of Luzon, Philippines (BMNH 196780). Holotype/syntype of *Scintilla hydatina* Deshayes, 1856, Island of Bohol, Philippines (BMNH).

New material: Reef off PMBC: February 1975, six specimens (one of them PMBC 20100); March 1975,

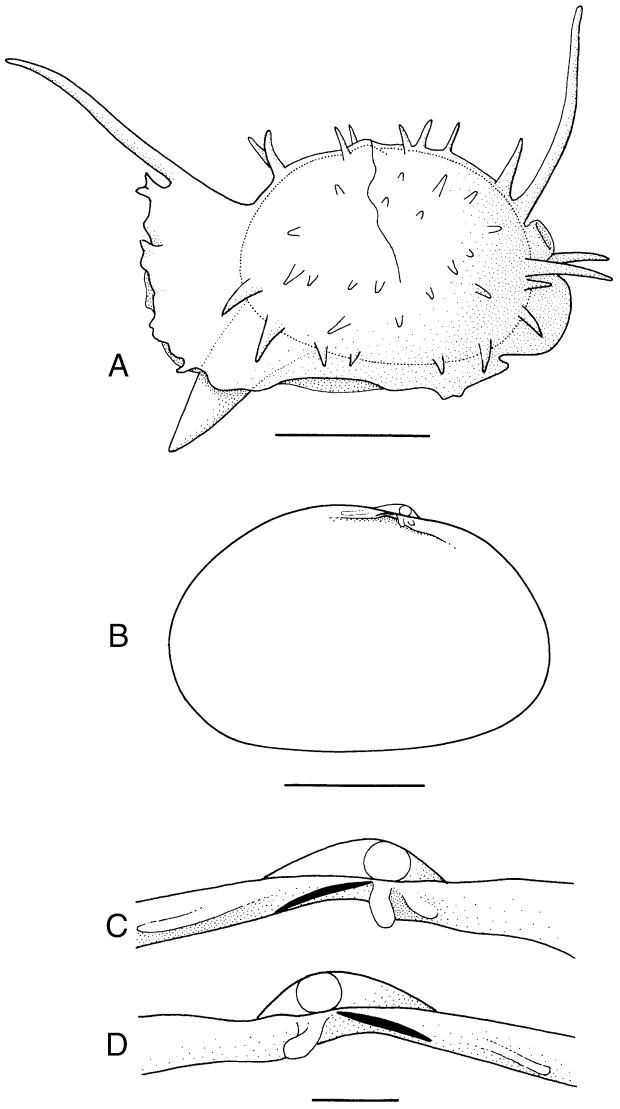

Figure 20. ***Scintilla imperatoris*** **nom. nov.** A, living animal in left side view, dotted line indicating outline of shell. B, left valve in internal view. Left (C) and right valve hinge (D) showing prodissoconch II and resilifer of internal ligament (black). Scale bars: A = 5 mm, B = 3 mm, C, D = 500 μm.

two specimens; 11 March 1982, five specimens; 25 February 2002, two specimens. Tai Tam Bay, Hong Kong: March 2002, several specimens.

Description of material from Phuket

Shell: Subovate, moderately inflated, whitish to pale pink or pale reddish-brown, relatively thin, semi-transparent, faintly glossy, surface smooth with many inconspicuous incremental lines. Anterodorsal and posterodorsal margins sloping, ventral parts of front and hind margins regularly rounded, ventral margin straight along the middle third. Size ranges

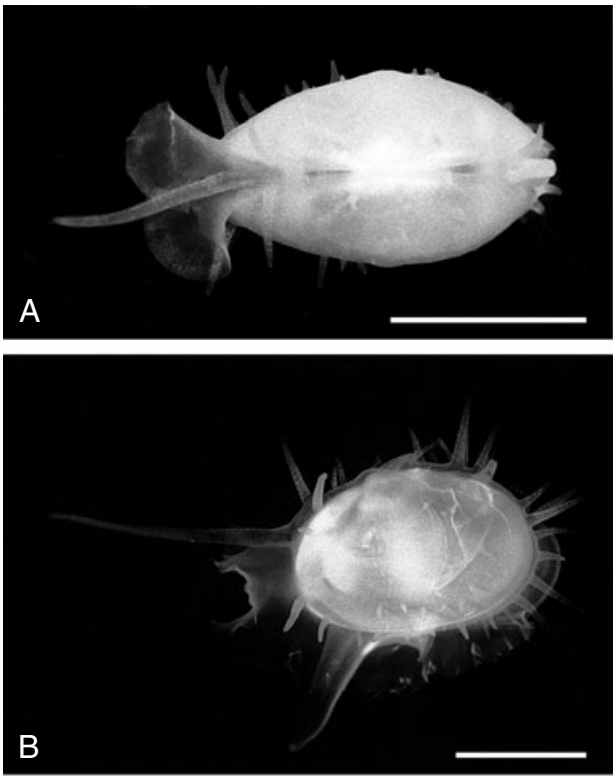

Figure 21. Live specimen of ***Scintilla imperatoris*** **nom. nov.** In dorsal (A) and left side view (B). Scale bars = 5 mm.

from 2.0 × 1.8 mm to 11.4 × 7.8 mm. An 8.2 × 5.5 mm large shell was 3.1 mm wide. The prodissoconch II is 270 μm in diameter. Umbones anterior to the middle. Hinge plate with one tuberculate rounded cardinal in the right valve and a large rounded plus a smaller cardinal in the left valve. Resilifer quite narrow and long. Both valves with a ridge-shaped posterior lateral.

Soft parts: A long slender anterior tentacle issues from the dorsal edge of the large inhalant region. Another equally long unpaired tentacle is placed immediately above the relatively small exhalant siphon. Smaller and larger, sometimes very extensible, tentacles or pointed papillae are dispersed over the part of the mantle lobes reflected over the shell.

Habitat

At Phuket, several (up to six) bivalves have been found together on the underside of large pieces of dead coral.

Distribution

Sagami Bay, Honshû, Japan (Kuroda *et al*., 1971); Hong Kong (Morton & Scott, 1989); Phuket Island, Thailand (present study).

Remarks
Kuroda *et al*. (1971) described this species as new under the name *Scintillorbis opalinus* without discussing Deshayes' *Scintilla opalina*, which is obviously another species. When Kuroda *et al*.'s species is transferred to the genus *Scintilla* their name becomes a junior synonym and a replacement name is needed. We agree with Morton & Scott (1989) that there is absolutely no reason to distinguish between *Scintilla* and the genera *Scintillorbis* Kuroda *et al*., 1971 or *Sagamiscintilla* Habe, 1975, both established to accommodate *S. opalinus*.

The shells of *Scintilla crocea*, *S. hydrophana*, and *S. hydatina* cannot be distinguished from that of *S. imperatoris*. If Lynge's (1909) identification of *S. hydatina* is correct, however, it is nevertheless a separate species, as the number, position and colour of the tentacles differ significantly from *S. imperatoris*, and we have refrained from synonymizing the species. See 'Remarks' in *S. nitidella*.

The shell and living animal have been compared to and found identical with Hong Kong specimens identified as *S.* cf. *opalinus* by Morton & Scott (1989). They reported the prodissoconch to be 0.2 mm in diameter, but illustrated a *c*. 0.3 mm larval shell comparable to those of the Thai specimens.

Etymology
For the replacement name we have chosen *S. imperatoris*, after its collector, the Japanese Emperor Hirohito.

SCINTILLA AGILIS SP. NOV.
(FIGS 5A, 22, 23)

Material examined
Holotype: PMBC 20101, reef off PMBC, Thailand, March 1975, SL = 5.2 mm.

Paratypes: Reef off PMBC: March 1975, two specimens; 26 February 2002, two specimens; 4 February 2003, two specimens.

Description of material from Phuket
Shell: Subtriangular, margins rounded or slightly angular, rather inflated, milky white, semitransparent, thin, surface smooth, dull, with fine commarginal lines. Posteriorly, the surface is very finely and regularly punctured. Seven specimens range in size from $5.2 \times 4.4 \times 2.9$ mm to $6.1 \times 4.9 \times 3.2$ mm. The prodissoconch II is 450 μm across. Beaks prominent, slightly anterior to the middle. Hinge line slightly curved. Hinge plate narrow, right valve with a single conical cardinal, left valve with a pointed posterior and a slightly smaller rounded anterior cardinal. The left posterior lateral fits into a longitudinal groove bordered ventrally by an elongated right lateral.

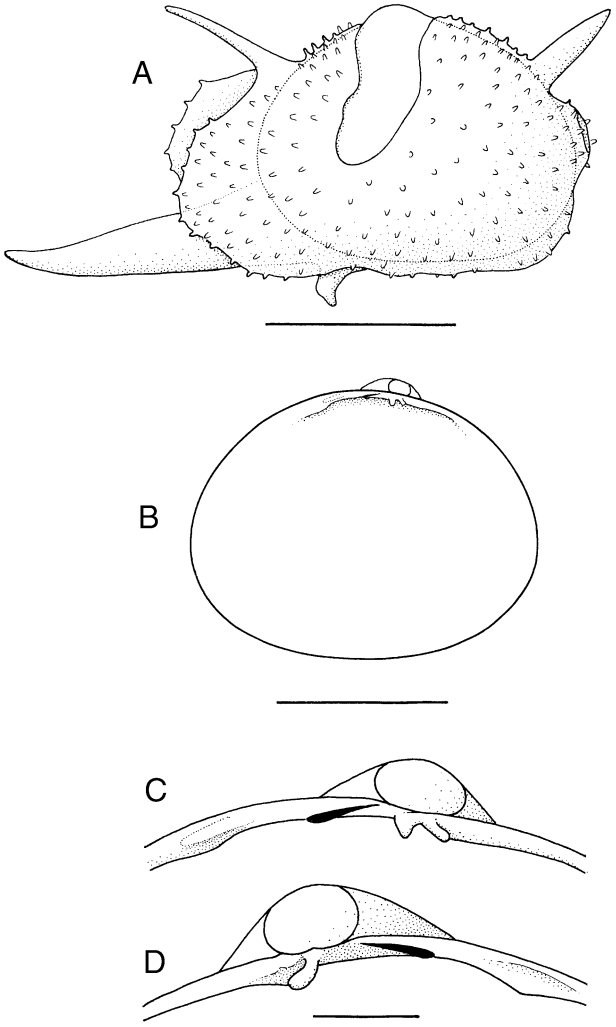

Figure 22. ***Scintilla agilis*** **sp. nov.** A, living animal in left side view, dotted line indicating outline of shell. B, left valve in internal view. Left (C) and right valve hinge (D) showing prodissoconch II and resilifer of internal ligament (black). Scale bars: A, B = 3 mm, C, D = 500 μm.

Soft parts: When undisturbed, the mantle edge and foot extend beyond the valves, but both can be withdrawn completely into the shell. The free edges of the mantle extend in front of the shell forming a wide combined inhalant siphon and pedal gape. The posteriorly directed exhalant aperture is borne on a low siphon. The mantle surface is provided with minute and irregularly widely spaced conical papillae. There are two elongate pointed siphonal tentacles; the anterior is longer and more slender, the posterior extends just above the exhalant siphon. The foot is slender and when fully extended may exceed the length of the

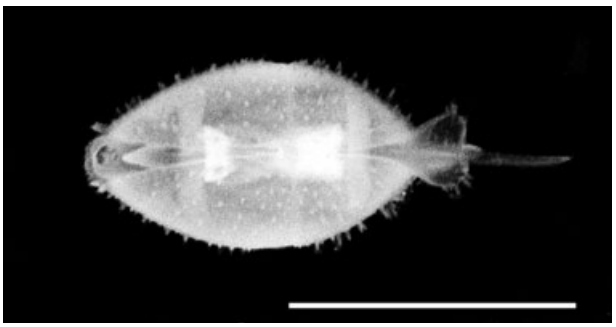

Figure 23. ***Scintilla agilis*** **sp. nov.** Dorsal view of live specimen. Scale bar = 5 mm.

shell. When placed in a dish, the animal can jump by squirting water through the exhalant siphon. It may hang suspended from a water surface by a byssus thread.

Habitat
All specimens were found in water-filled galleries on the underside of *Porites* in the middle and lower part of the littoral zone.

Distribution
Phuket Island, Thailand (present study).

Remarks
The absence of tentacles (other than the two siphonal ones) is only shared with other Phuket species of *Scintilla* such as *S. minor* sp. nov., *S. siamense* sp. nov., and *S. verrucosa* sp. nov. However, in contrast to these species, the shell of *S. agilis* is subtriangular and the prodissoconch II extraordinarily large.

Etymology
From the Latin *agilis* (agile), referring to the species' jumping behaviour.

SCINTILLA LONGITENTACULATA SP. NOV.
(FIGS 5I, 24)

Material examined
Holotype: PMBC 20102, reef off PMBC, Thailand, 2 March 2002, SL = 5.5 mm.

Description of material from Phuket
*Shell: S*ubovate, compressed, transparent, very thin, glassy, surface smooth and polished. Anterior margin sloping above, rounded below, other margins evenly rounded. Size of the only shell 5.5 × 4.2 mm, diameter of prodissoconch II 230 μm. Umbones moderately prominent, placed slightly anterior of mid-shell. Right valve with an oblique low and rounded cardinal anterior to umbo, left valve with two unequally large rounded cardinals. Posterior laterals short and small. Resilifer oblique and short.

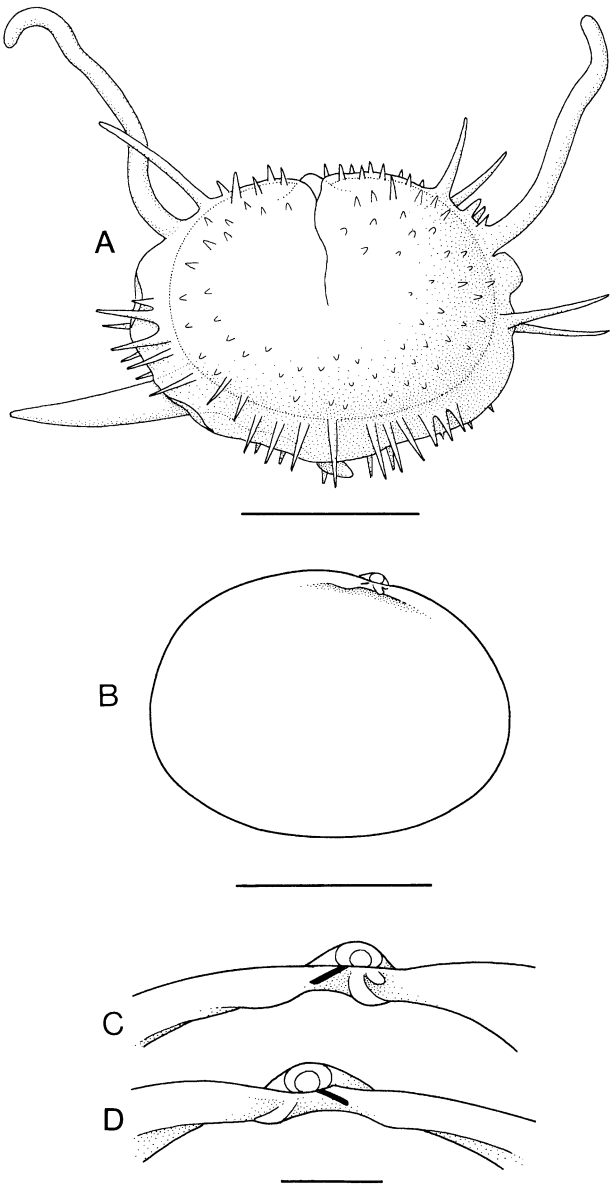

Figure 24. ***Scintilla longitentaculata*** **sp. nov.** Holotype. A, living animal in left side view, dotted line indicating outline of shell. B, left valve in internal view. Left (C) and right valve hinge (D) showing prodissoconch II and resilifer of internal ligament (black). Scale bars: A, B = 3 mm, C, D = 500 μm.

Soft parts: Three long, slender but rigid tentacles occur dorsally near the anterior (one) and the poste-

rior siphonal tentacle (two). A pair of similar tentacles issues ventral to the small exhalant siphon. Even when only slightly stimulated, the two siphonal dymantic tentacles may be extended to the length of the shell and are extremely mobile. On the part of the reflected mantle normally lying along the anterior and ventral shell margin there is a fringe of slender serially arranged medium-sized tentacles. Short pointed papillae occur dorsally and peripherally on the reflected mantle. The foot is relatively long and tapering.

Habitat
The specimen was collected from under a flat stone on a gravel bottom in the upper intertidal zone. It had two very small, and supposedly juvenile, bivalves attached to the mantle.

Distribution
Phuket Island, Thailand (present study).

Remarks
Although the shell and its dentition are very similar to those of *S. unicornia* sp. nov., the very different arrangement and size of the tentacles are sufficient to separate the two species (compare Figs 24A and 34 A). It also resembles *S. nitidella* in most shell characters, but differs from that species in the absence of tentacles posteroventrally on the reflected mantle, and in particular in the size of the siphonal tentacles (compare Figs 18A and 24A).

Etymology
From Latin *longus* (long) and *tentataculum* (feeler), alluding to the two extensible siphonal tentacles.

SCINTILLA MACRODACTYLUS SP. NOV.
(FIGS 5F, 25, 26)

Material examined
Holotype: PMBC 20103, reef off PMBC, Thailand, 5 February 2003, SL = 4.2 mm, SH = 3.3 mm.

Additional new material: Reef off PMBC: 13 March 1975, one specimen; 5 February 2003, one specimen.

Description of material from Phuket
Shell: Subovate, only slightly longer than high, rather compressed, thin, fragile and transparent, surface smooth and glossy. Size up to 4.6 × 3.7 mm. The prodissoconch II is 285 μm in diameter. All margins gently curved, umbones small, slightly anterior to middle, maximum height occurring posterior to umbones. Right valve with a single stout cardinal in front of umbo, left valve with two cardinals below and in front of umbo, the larger one hook-shaped, the smaller one triangular. Both valves with posterior laterals.

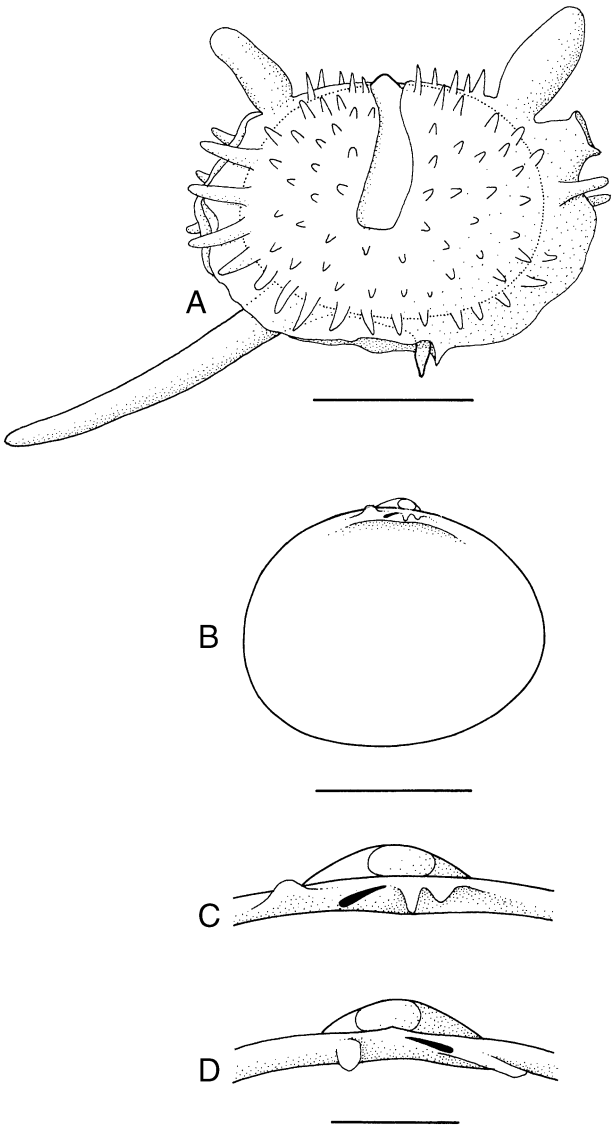

Figure 25. ***Scintilla macrodactylus*** **sp. nov.** A, living animal in left side view, dotted line indicating outline of shell. B, left valve in internal view. Left (C) and right valve hinge (D) showing prodissoconch II and resilifer of internal ligament (black). Scale bars: A, B = 2 mm, C, D = 500 μm.

Soft parts: The two equally large siphonal tentacles are unusually thick and mobile and, when fully expanded, may reach the length of the shell. A series of bluntly ending tentacles occurs on the reflected mantle along the shell margin, decreasing in length posteriorly. A pair of similar tentacles issues ventral to

Figure 26. ***Scintilla macrodactylus*** **sp. nov.** Left side view of live animal. Scale bar = 5 mm.

the exhalant siphon. Short papillae occur all over the rest of the reflected mantle, becoming longer and more pointed dorsally. Tentacles and papillae are brighter at the tip. The foot is very long and slender.

Habitat
All three specimens were attached to the underside of *Porites*.

Distribution
Phuket Island, Thailand (present study).

Remarks
The living animal and the outline of the shell show some resemblance to *S. longitentaculata*. However, the dentition in the two species differs considerably, and the tentacles of *S. longitentaculata* are much thinner and can be extended much farther than those of the present species.

Etymology
From Greek *makros* (long) and *daktylos* (finger), referring to the long, finger-shaped siphonal tentacles.

SCINTILLA MINOR SP. NOV.
(FIGS 5G, 27)

Material examined
Holotype: PMBC 20104, reef off PMBC, Thailand, 26 February 2002, SL = 4.2 mm.

Paratypes: Reef off PMBC: 26 and 28 February 2002, 11 specimens; 5 February 2003, seven specimens. Reef at Ao Tung Khen: 1 March 2002, two specimens.

Description of material from Phuket
Shell: Subovate to subquadrate, rather compressed, very thin, uncoloured, transparent and moderately glossy, slightly opaque at the periphery, surface smooth. All margins gently curved, maximum height immediately posterior to umbones, which are small, located slightly anterior to the middle. The size ranges from 2.5×1.85 mm to 4.3×3.2 mm. The prodissoconch II is 250 μm in diameter. The hinge consists of an obliquely placed cardinal in the right valve and a

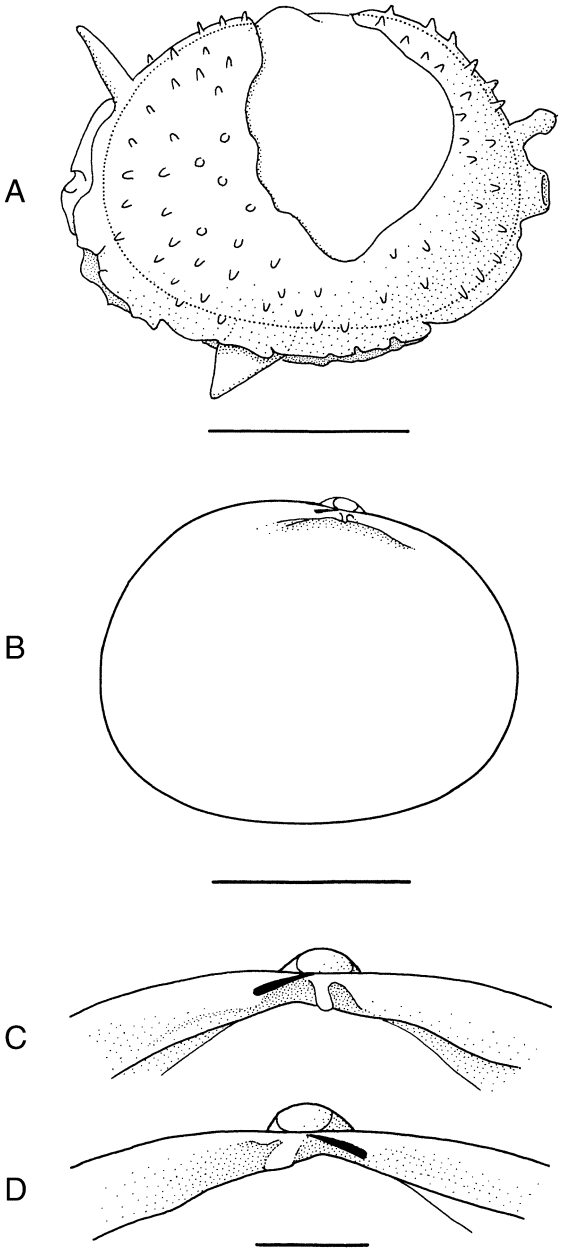

Figure 27. ***Scintilla minor*** **sp. nov.** A, living animal in left side view, dotted line indicating outline of shell. B, left valve in internal view. Left (C) and right valve hinge (D) showing prodissoconch II and resilifer of internal ligament (black). Scale bars: A, B = 2 mm, C, D = 500 μm.

vertical cardinal under the umbo in the left valve. A second, anterior left cardinal is probably represented by a low oblique ridge. Posterior laterals short and narrow.

Soft parts: A relatively short, pointed siphonal tentacle, whitish at the tip, issues above the inhalant region and a very short posterior terminally rounded tentacle occurs dorsal to the small exhalant siphon. There are no other tentacles, but numerous short pointed papillae are evenly distributed all over the mantle's surface. They may be extended to a size twice that shown in Figure 27A. The foot is rarely extended and seems to be rather short.

Habitat
Most of the specimens were found on the underside of *Porites*. They sometimes occurred together with *S. mortoni*.

Distribution
Phuket Island, Thailand (present study).

Remarks
Always a small species, the shell of which is very variable in shape. The soft parts show some resemblance to those of *S. agilis* sp. nov. (Fig. 22A), but the two species are easily distinguished by the widely different size of the prodissoconch II (compare Figs 22C, D and 27C, D).

Etymology
From Latin *minor* (less), referring to the species' small size.

SCINTILLA MORTONI SP. NOV.
(FIGS 5E, 28)

Material examined
Holotype: PMBC 20106, reef off PMBC, Thailand, 5 February 2003, SL = 6.3 mm.

Paratypes: Reef off PMBC: 26–28 February and 2 March 2002, 15 specimens; 5 February 2003, 21 specimens.

Description of material from Phuket
Shell: Obliquely ovate, inflated, width *c.* 1/2 of length; thin, semitransparent, whitish turning yellowish with size, shiny except in a broad lustreless and opaque peripheral zone. Anterior and posterior sides gently sloping dorsally, rounded ventrally, ventral margin moderately rounded. Most shells range from 4.0×3.0 mm to 5.3×4.0 mm (width 2.8 mm), but three specimens were distinctly larger ($8.8 \times 6.4 \times 4.3$ mm to $8.5 \times 5.9 \times 4.0$ mm). Prodissoconch II is 250 μm in diameter. Beaks rather prominent, located slightly anterior to the middle. Dentition comprises a single stout angular cardinal and a low posterior lateral in the right valve, and a large and a small rounded cardinal plus a slightly pointed lateral in the left valve.

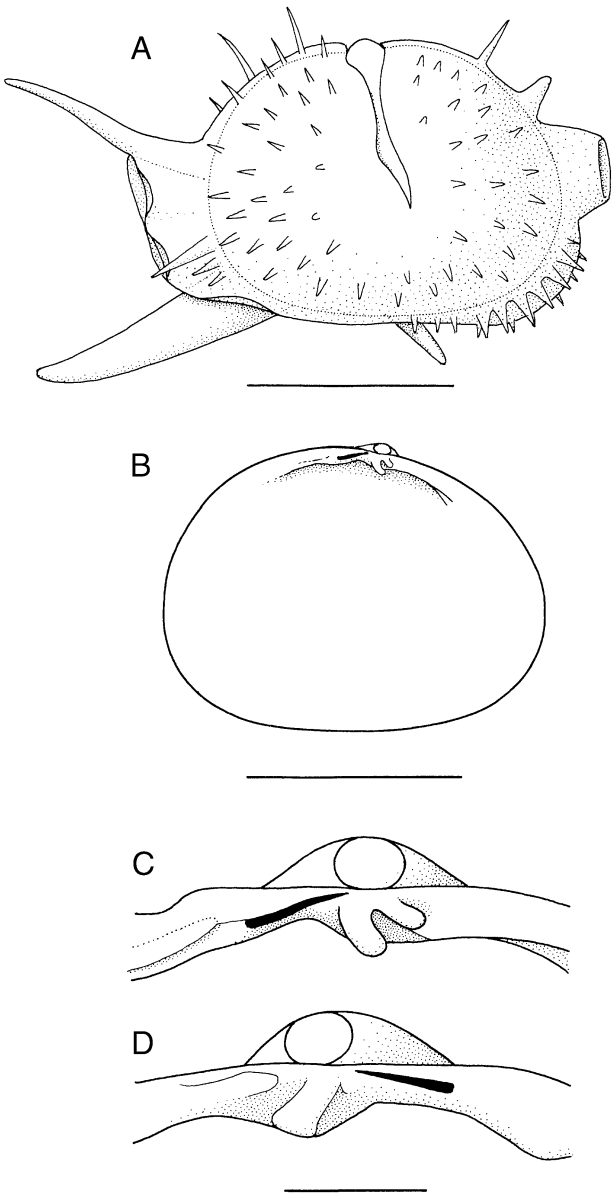

Figure 28. *Scintilla mortoni* sp. nov. A, living animal in left side view, dotted line indicating outline of shell. B, left valve in internal view. Left (C) and right valve hinge (D) showing prodissoconch II and resilifer of internal ligament (black). Scale bars: A, B = 3 mm, C, D = 500 μm.

Soft parts: The anterior unpaired pointed tentacle exits from the dorsal edge of the funnel-shaped inhalant siphon and may be whitish terminally. Another much shorter unpaired tentacle is located immediately above the broadly conical exhalant siphon. Three small and slender unpaired tentacles issue from the dorsal part of the fused mantle. Along the ventral shell margin, the mantle bears an anterior group of three smaller slender paired tentacles and a series of 5–6 close-set posterior paired tentacles. In addition, there are numerous minute pointed papillae on the whole surface of the mantle. The number of papillae and tentacles increases with size and may be much more numerous than in the illustrated specimen.

Habitat
Many specimens were found on the underside of *Porites* in the lower part of tidal zone. Three to five specimens often occurred together, sometimes accompanied by *S. unicornia* sp. nov.

Distribution
Phuket Island, Thailand (present study).

Remarks
Comparison between numerous specimens of both *S. mortoni* sp. nov. and *S. imperatoris* shows that although they somewhat resemble each other in shell and mantle characters, they are separate species. The tentacles in *S. mortoni* are more numerous and the posterior siphonal tentacles always much shorter than in *S. imperatoris*. The outline of the shell is less oval in S. *mortoni* and the opaque peripheral zone of the shell is invariably present, enabling prompt identification of the species.

Etymology
Named in honour of the notable malacologist, Professor Brian Morton, now at the Natural History Museum, London.

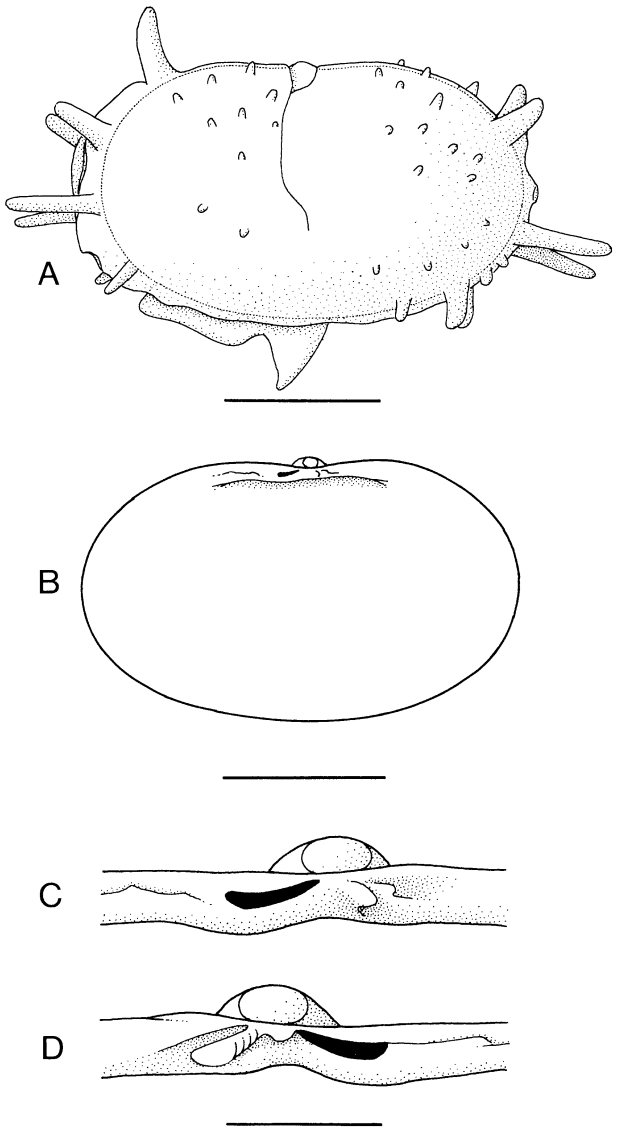

Figure 29. *Scintilla ovalis* sp. nov. A, living animal in left side view, dotted line indicating outline of shell. B, left valve in internal view. Left (C) and right valve hinge (D) showing prodissoconch II and resilifer of internal ligament (black). Scale bars: A, B = 3 mm, C, D = 500 μm.

SCINTILLA OVALIS SP. NOV.
(FIGS 6G, 29)

Material examined
Holotype: PMBC 20112, reef off PMBC, Thailand, 3 March 2002, SL = 8.2 mm.

Description of material from Phuket
Shell: Regularly ovate, moderately inflated, very thin and fragile, glassy and translucent, uncoloured, surface smooth. Hinge margin slightly concave, other margins regularly rounded. Size 8.2 × 4.7 mm, diameter of prodissoconch II 225 μm. Umbones small, submedian, slightly longer posteriorly. Hinge plate of right valve with a single large oblique cardinal in its narrow part with pectinate incisions, and a low ridge-shaped posterior lateral. Left valve with two subtriangular cardinals, one larger than the other, and a posterior lateral.

Soft parts: The narrow inhalant region terminates dorsally in an unpaired finger-shaped siphonal tentacle, whereas there are two, shorter (or a single

branched) posterior siphonal tentacles above the very small exhalant siphon. The siphonal tentacles may extend to one-third of the length of the shell. In addition there are three anterior and two posterior pairs of relatively short and thick, terminally rounded tentacles. All tentacles have small white speckles and whitish tips. A few minute subconical papillae issue from the part of the mantle overlying the posterior and anterodorsal part of the shell. The foot is short and thick.

Habitat
The single specimen was found under a flat rock, together with eight specimens of *S. anomala*.

Distribution
Phuket Island, Thailand (present study).

Remarks
The small number of rather short, strictly paired and blunt tentacles and the highly unusual presence of two posterior siphonal tentacles make this species easy to distinguish from others of the genus.

Etymology
From Latin *oval* (egg-shaped), referring to the oval outline of the shell.

SCINTILLA SANNIO SP. NOV.
(FIGS 5C, 30, 31)

Material examined
Holotype: PMBC 20105, reef off PMBC, Thailand, February 1975, SL = 10.6 mm.

Paratype: Reef off PMBC: February 1975, one specimen.

Description of material from Phuket
Shell: Subovate, moderately inflated, almost opaque, whitish with distinct yellowish commarginal growth lines and extremely fine radial striae. Surface smooth. Size $9.0 \times 6.0 \times 3.6$ mm and $10.6 \times 6.3 \times 4.1$ mm. The prodissoconch is oval with a maximum diameter of 395 μm. Umbones prominent, slightly in front of middle. Hinge line arched, margins somewhat angulated antero- and posteroventrally, otherwise rounded, ventral margin only slightly curved. Right valve with a prominent triangular tooth posterior to centre of umbo. In the left valve it fits between a single, stout and hook-like tooth directly below the umbo and a small ridge, perhaps representing a secondary but rudimentary cardinal. Ligaments long, left posterior lateral a small shelf, right one hardly discernible.

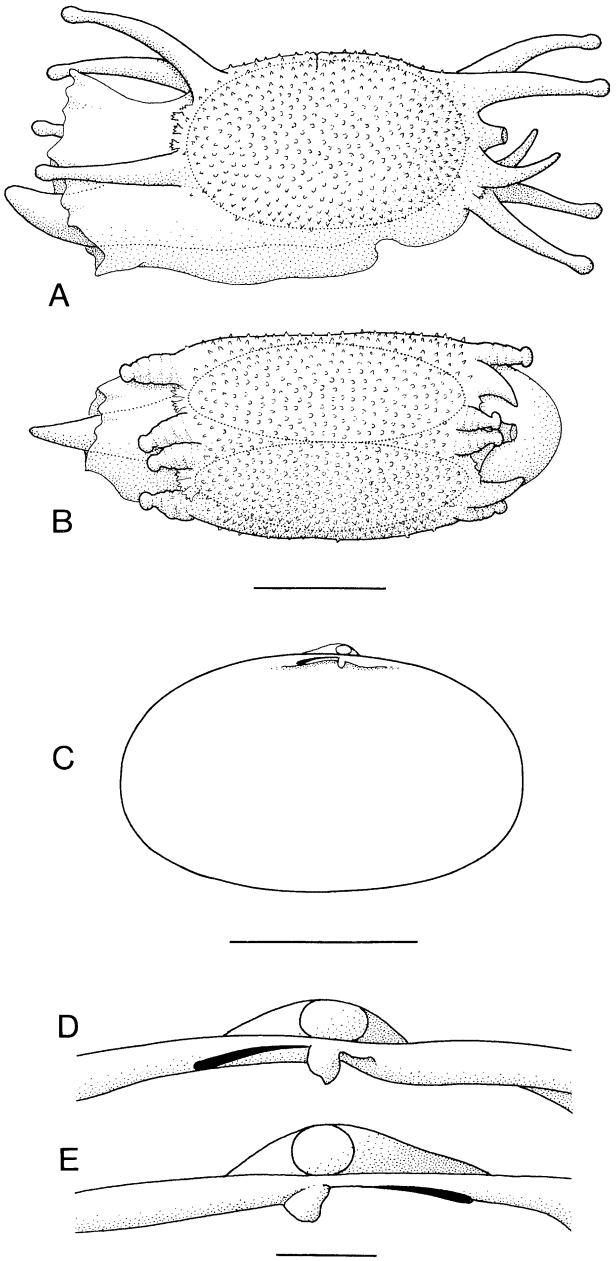

Figure 30. ***Scintilla sannio*** **sp. nov.** A, living animal in left side view with extended tentacles, dotted line indicating outline of shell; B, same seen in dorsal view with tentacles partly retracted. C, left valve of larger specimen in internal view; left (D) and right valve hinge (E) showing prodissoconch II and resilifer of internal ligament (black). Scale bars: A–C = 5 mm. D, E = 500 μm.

Soft parts: The large hood-like inhalant siphon has very frilled edges, while the exhalant siphon is small and funnel-shaped. The posteroventral fused part of

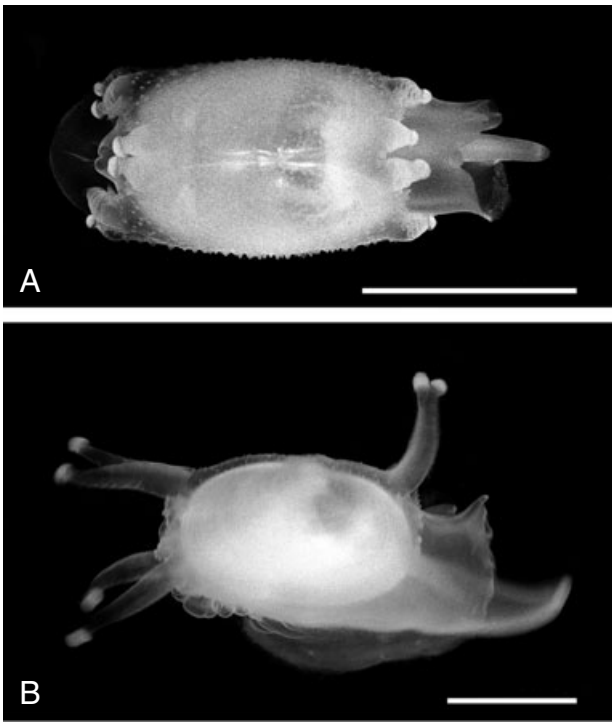

Figure 31. ***Scintilla sannio*** **sp. nov.** Live animal seen from the dorsal side with partially retracted tentacles (A) and from the right side (B). Scale bars = 5 mm.

the mantle is smooth-walled. There are no unpaired siphonal tentacles. Arising from the base of the inhalant aperture there are four paired anteriorly directed equally sized stout and tapering tentacles, all with a terminal rounded whitish swelling. Four similar but posteriorly directed tentacles plus two smaller and pointed ones surround the exhalant siphon. Small and short irregular protuberances arise from the base of some of the tentacles at both ends. The part of the mantle covering the shell is provided with numerous close-set minute pointed papillae. When disturbed, the animal extends the tentacles and waves them to and fro for a few seconds and then retracts. The mantle can be completely withdrawn into the shell.

Habitat
The two specimens were found together under the same rock.

Distribution
Phuket Island, Thailand (present study).

Remarks
The two specimens differ somewhat in proportions between SL and SH, the smaller having relatively greater height than the larger, illustrated specimen. However, the unique appearance of the exposed mantle and its appendages make live animals of this species easy to recognize. The outline of the shell resembles *S. forbesi* Deshayes, 1856, but the hinge is quite different. The complete absence of laterals makes the species a dubious member of *Scintilla*.

Etymology
From Latin *sannio* (jester), referring to the agitated animal's resemblance to the hat of a jester.

SCINTILLA SIAMENSE SP. NOV.
(FIGS 5B, 32, 33)

Material examined
Holotype: PMBC 20107, reef off PMBC, Thailand, February 1975, SL = 11.0 mm.

Description
Shell: Subovate, polished, cream-coloured, surface smooth except for incremental lines. Posterior side sloping dorsally, margins otherwise rounded. Size of the only shell 11.0 × 7.3 × 4.9 mm, diameter of prodissoconch II 330 μm. Umbones prominent, the posterior region three times longer than the anterior. The right valve with a single rounded cardinal below the larval shell, the left valve with a similar-sized, flat cardinal slightly posterior to the larval shell and in front of its base a tiny triangular tooth. Both valves with posterior laterals.

Soft parts: Inhalant-pedal gape long, but transversely narrow, margins richly pleated. Siphonal tentacles absent unless the raised dorsal margin of the inhalant opening represents an anterior one. Exhalant opening small and circular, raised on a low siphon. The mantle is wrapped over the entire shell and adorned by numerous minute papillae that are especially common on the part covering the shell.

Distribution
Phuket Island, Thailand (present study).

Remarks
The finely papillose mantle resembles very much that of *Scintilla papillosa* sp. nov., but the outline of the shell, the position of the umbo and the hinge of the two species differ considerably (compare Figs 32A and 36A). The shell bears some resemblance to that of *S. blaesei* Dautzenberg & Fischer, which is described as having a single tooth only beyond the umbo in both valves, but apparently no laterals. We have referred

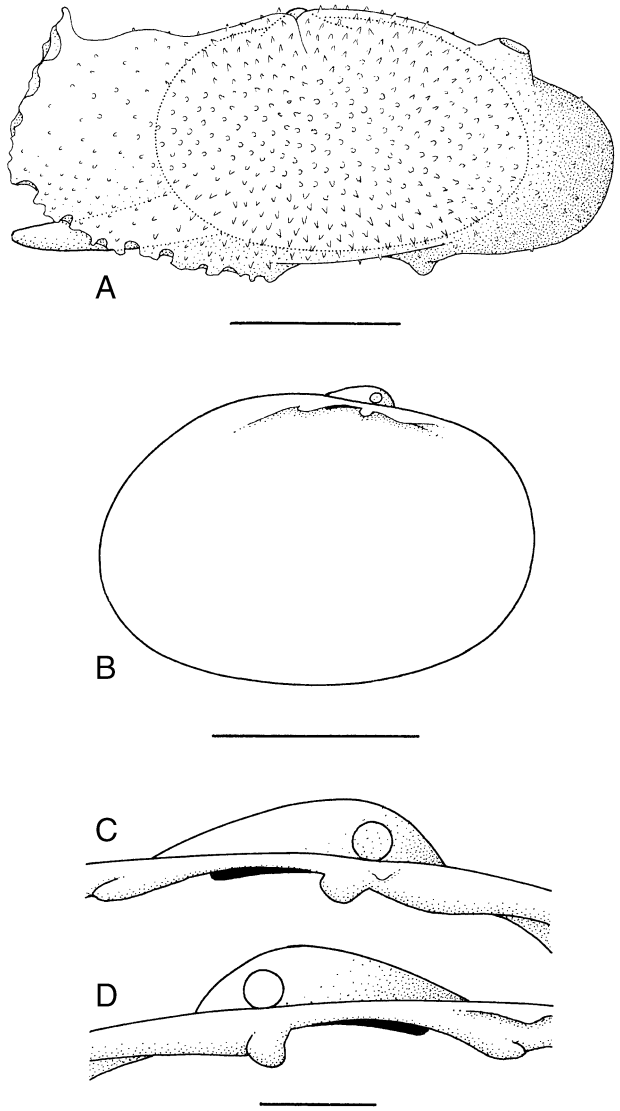

Figure 32. ***Scintilla siamense*** **sp. nov.** Holotype. A, living animal in left side view, dotted line indicating outline of shell. B, left valve in internal view. Left (C) and right valve hinge (D) showing prodissoconch II and resilifer of internal ligament (black). Scale bars: A, B = 5 mm, C, D = 1000 μm.

the species to *Scintilla* assuming the obsolete tooth of the left shell to represent a rudimentary cardinal.

Etymology
Named after Thailand, formerly Siam, where the species was discovered.

SCINTILLA UNICORNIA SP. NOV.
(FIGS 5D, 34)

Material examined
Holotype: PMBC 20108, reef off PMBC, Thailand, 26 February 2002, SL = 6.1 mm.

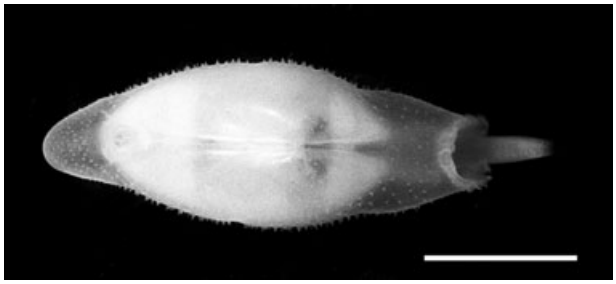

Figure 33. ***Scintilla siamense*** **sp. nov.** Live specimen in dorsal view. Scale bar = 5 mm.

Paratypes: Reef off PMBC: 26–28 February 2002, 12 specimens; 5 February 2003, three specimens.

Description of material from Phuket
Shell: Subovate, narrowing towards the anterior side, colourless, transparent, thin, glossy, surface smooth. Size up to 7.4 × 5.0 mm. A 4.6 × 3.2 mm specimen was 1.8 mm in width. The prodissoconch II measures 225 μm in diameter. Umbones moderately prominent, anterior to the middle. Hinge plate narrow; right valve with a single rounded cardinal, left valve with a large keeled and a smaller knob-shaped cardinal. Posterior laterals present on both valves.

Soft parts: A large siphonal tentacle arises above the dorsal edge of the wide anterior inhalant aperture. Another tentacle is located above the low conical exhalant siphon. The anterior tentacle is irregularly coloured whitish to pale green, while the posterior one is whitish only terminally. Both may be extended to almost 2/3 the length of the shell and then assume a conical shape, pointed at the end. Bluntly ending tentacles or papillae of many sizes arise from the posterior and anterior mantle surface. A posteroventral group of 4–5 such tentacles tends to be serially arranged. The foot is prominent, its posterior tip pointed.

Habitat
Almost all of the specimens were attached to the underside of *Porites*.

Distribution
Phuket Island, Thailand (present study).

Remarks
Although the siphonal tentacles may be extended to a considerable degree, they never reach the length of

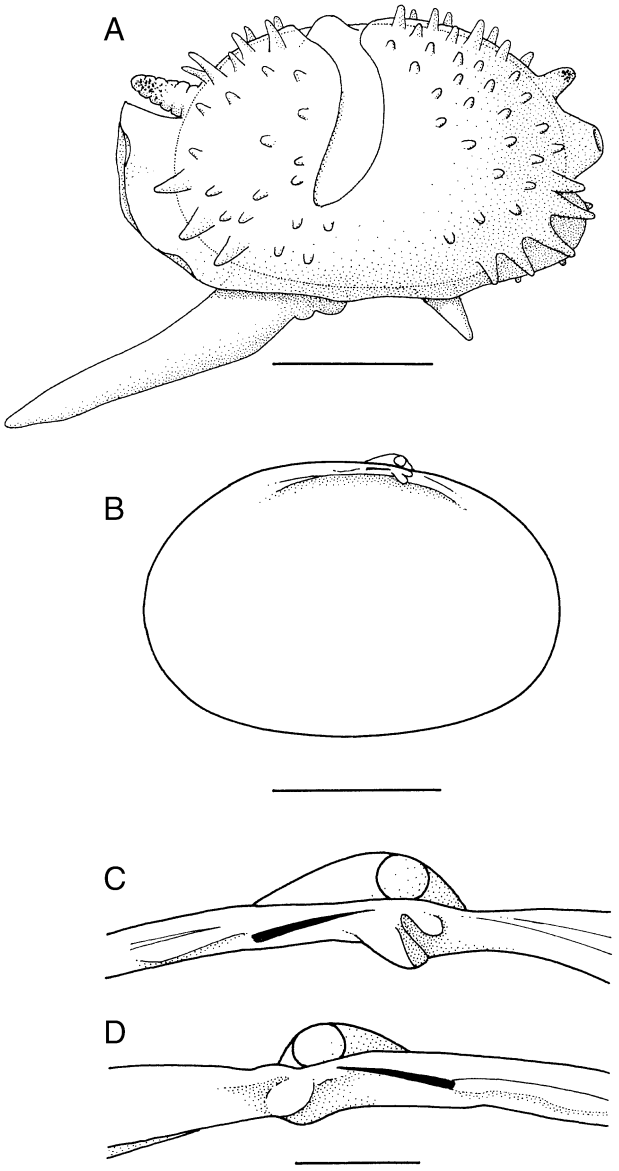

Figure 34. ***Scintilla unicornia*** **sp. nov.** A, living animal in left side view, dotted line indicating outline of shell. B, left valve in internal view. Left (C) and right valve hinge (D) showing prodissoconch II and resilifer of internal ligament (black). Scale bars: A, B = 3 mm, C, D = 500 μm.

those of *S. longitentaculata* sp. nov. and when fully stretched are conical, not of similar diameter throughout, and invariably more or less whitish.

Etymology

From Latin *unus* (one) and *cornu* (horn), in allusion to the prominent anterior siphonal tentacle.

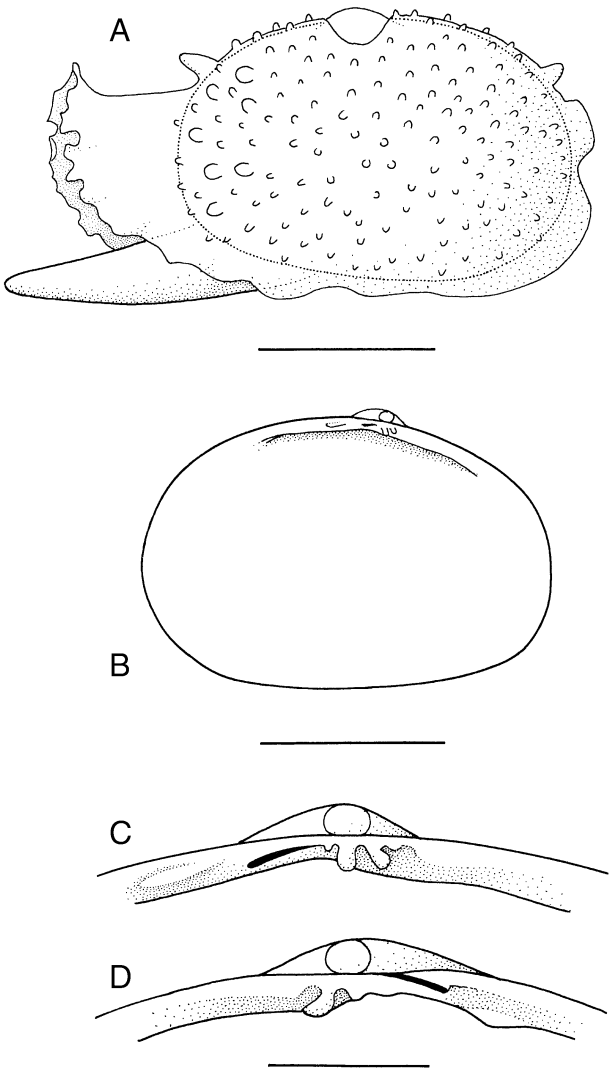

Figure 35. ***Scintilla verrucosa*** **sp. nov.** holotype. A, living animal in left side view, dotted line indicating outline of shell. B, left valve in internal view. Left (C) and right valve hinge (D) showing prodissoconch II and resilifer of internal ligament (black). Scale bars: A, B = 3 mm, C, D = 1000 μm.

SCINTILLA VERRUCOSA SP. NOV.

(FIGS 5H, 35)

Material examined

Holotype: PMBC 20109, reef off PMBC, Thailand, 3 March 2002, SL = 6.8 mm.

Description of material from Phuket

Shell: Subovate, relatively thick, uncoloured, partially transparent and shiny except along a few peripherally opaque and dull commarginal bands. Surface smooth with many fine incremental lines. Dorsal margin arched, anterior margin sloping dorsally, otherwise

subtruncate, ventral margin almost straight, posterior margin regularly rounded. Maximum height occurs well behind the umbo. The only shell measured 6.8 × 4.7 mm, with a prodissoconch II of 265 μm in diameter. Umbones moderately prominent, located in front of the middle. Hinge plate with a single subtriangular, rounded cardinal in front of umbo in the right valve and with two equally large rounded cardinals below and in front of umbo in the left valve. Posterior laterals of medium length.

Soft parts: The front edges of the inhalant region are richly pleated. Anterior and posterior siphonal tentacles are short and thick, the exhalant aperture borne on a low subconical siphon. Numerous small, rounded papillae are spread all over the part of the mantle lobes which is reflected over the shell and anteriorly a small number of larger, spherical warts occur in between them.

Habitat
The single bivalve was found under a flat rock in the upper intertidal zone.

Distribution
Phuket Island, Thailand (present study).

Remarks
The animal bears a certain resemblance to *Scintilla papillosa* sp. nov., but the papillae are far fewer in number, smaller and less crowded than in that species. The hinge bears very distinct cardinals in contrast to the obsolete ones in *S. papillosa*.

Etymology
From Latin *verrucosus* (warty), referring to the many wart-like papillae on the mantle.

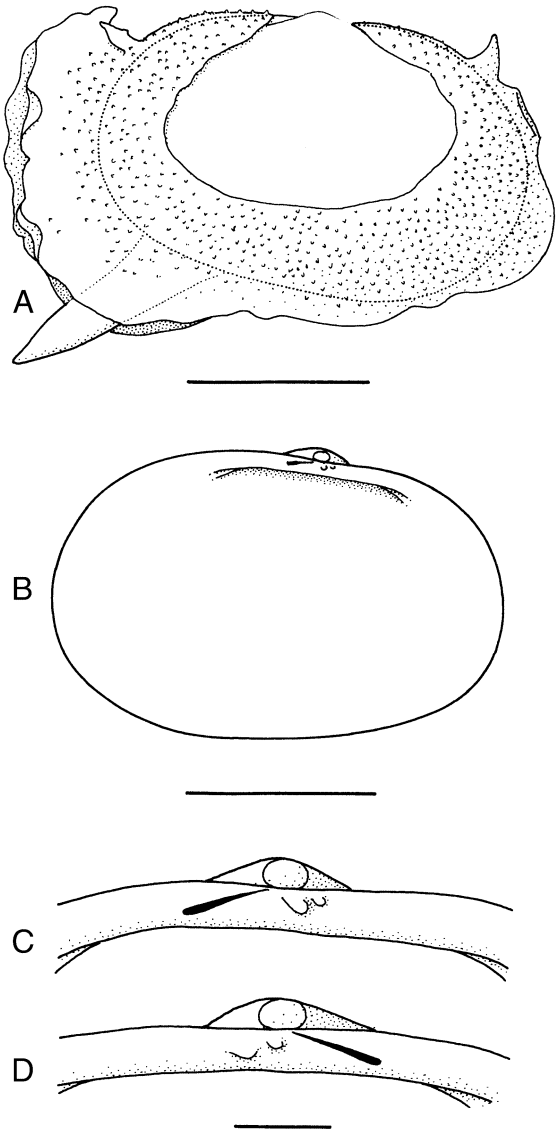

Figure 36. ***Scintilla papillosa*** **sp. nov.** A, living animal in left side view, dotted line indicating outline of shell. B, left valve in internal view. Left (C) and right valve hinge (D) showing prodissoconch II and resilifer of internal ligament (black). Scale bars: A, B = 3 mm, C, D = 500 μm.

SCINTILLA PAPILLOSA SP. NOV.
(FIGS 5J, 36, 37)

Material examined
Holotype: PMBC 20110, reef off Rawai Beach, no date, SL = 9.5 mm.

Paratypes: Reef off PMBC: 13 March 1975, one specimen; 21 December 1975, two specimens. Reef off Rawai Beach, no date, two specimens.

Description of material from Phuket
Shell: Subovate, highest behind umbo, relatively thick, opaque, pale yellow in smaller, yellow in larger specimens. Surface smooth except for distinct commarginal growth lines. Hinge line straight, anteriorly slightly truncate, ventral margin straight or slightly arched, posterior margin rounded. Size of six bivalves ranged from 6.5 × 4.0 mm to 9.8 × 6.8 mm. A 9.5 × 7.0 mm large specimen was 4.3 mm in width. The prodissoconch II is 240 μm in diameter. Umbo moderately prominent, slightly longer posteriorly. Right valve with two low rounded cardinal nodules, left valve with a small oblique cardinal nodule under the umbo and an even smaller one in front of the umbo. Laterals absent.

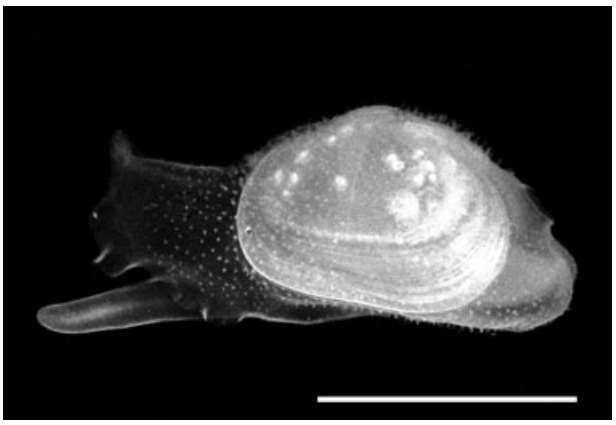

Figure 37. *Scintilla papillosa* sp. nov. Live animal seen from the left. Scale bar = 5 mm.

Soft parts: A very small anterior siphonal tentacle occurs dorsal to the large inhalant region and an equally small posterior tentacle is placed above the exhalant siphon. Numerous small pointed papillae are scattered all over the reflected mantle lobes, less commonly near the two mantle openings. When maximally extended, the papillae may be longer than illustrated.

Habitat
All specimens were attached to grooves or crevices on the underside of *Porites*, in the lower part of the tidal zone.

Distribution
Phuket Island, Thailand (present study).

Remarks
The inclusion of the species in *Scintilla* is provisional, as the rudimentary state of the cardinals and the total absence of laterals do not fit the definition of the genus. The poorly developed hinge resembles that of *S. stevensoni* Powell, 1932, except that in this species there is only one, not two obsolete cardinals in the left valve. The mantle of *S. stevensoni*, described by Ponder (1967) is also covered all over with numerous papillae, although they are much longer than in *S. papillosa*.

Etymology
From Latin *papilla* (wart), referring to the warty appearance of the mantle surface.

NUDISCINTILLA GEN. NOV.

Diagnosis
Shell subovate, rather thin, surface smooth. Umbones small, submedian. Each valve with a single small low cardinal. Lateral teeth absent. Mantle smooth, partly reflected over the shell. Without papillae nor tentacles, except for a minute posterior siphonal tentacle.

Type species: Nudiscintilla glabra sp. nov.

Remarks
The combination of a single cardinal in both valves and the total absence of papillae or paired tentacles distinguish the genus from all other galeommatid genera in which the soft parts are known.

Etymology
Prefix Latin *nudus* (naked), in allusion to the absence of papillae and tentacles on the mantle folds.

NUDISCINTILLA GLABRA SP. NOV.
(FIGS 6F, 38, 39)

Material examined
Holotype: PMBC 20111, reef off PMBC, Thailand, February 1975, SL = 6.8 mm.

Description of material from Phuket
Shell: Subovate, rather compressed, whitish, opaque, relatively thin, irregularly commarginally striate, surface smooth. Anterior and posterior sides evenly rounded, dorsal and ventral margin slightly curved. Size 6.8 × 4.25 mm, prodissoconch II 260 μm in diameter. Umbones small, submedian, posterior region only a little longer than the anterior. Maximum height occurring in posterior part. Hinge plate narrow, with a small opisthodetic resilifer and a single small low cardinal in each valve. No lateral teeth.

Soft parts: The anterior part of the reflected mantle folds forms a wide inhalant region in front of the shell. An anterior siphonal tentacle is apparently absent, but a small pointed tentacle rises above the exhalant opening, which is without a true siphon. The mantle may be reflected over at least the marginal parts of the shell. It is unusual in being completely smooth, without traces of papillae or tentacles. The foot is tongue-shaped.

Habitat
The only specimen was found intertidally and brooded 120–125 μm long D-larvae in the gills. The number of larvae was estimated at 6000. Three

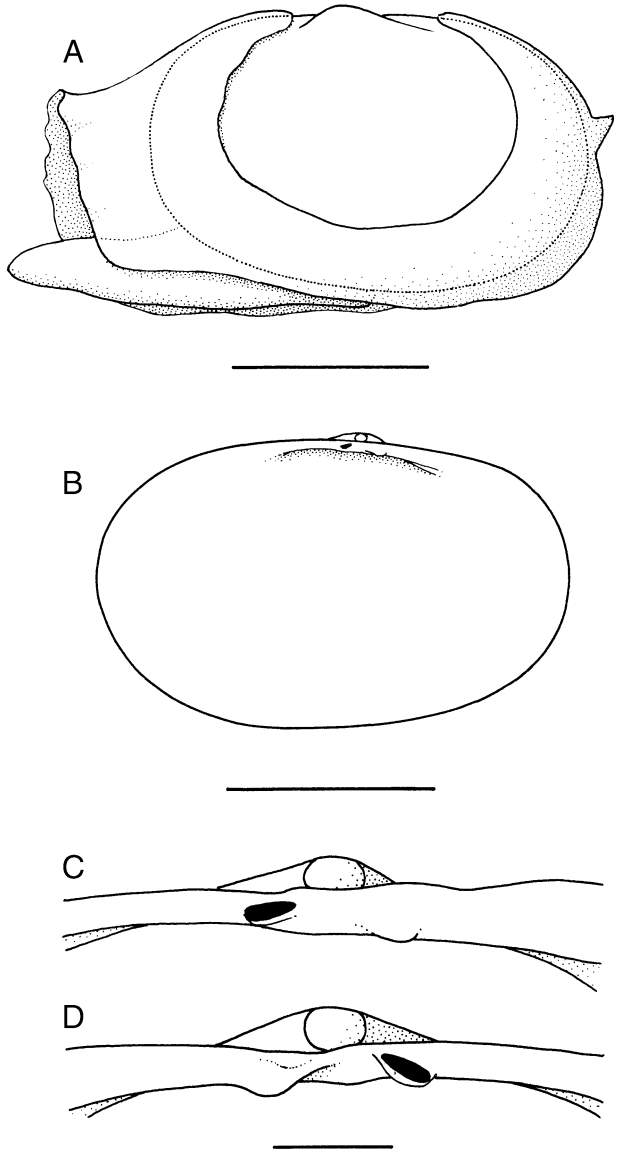

Figure 38. ***Nudiscintilla glabra*** **gen.** et **sp. nov.** holotype: A, living animal in left side view, dotted line indicating outline of shell. B, left valve in internal view. Left (C) and right valve hinge (D) showing prodissoconch II and resilifer of internal ligament (black). Scale bars: A, B = 3 mm, C, D = 500 μm.

small juveniles had settled close to each other on the left mantle lobe.

Distribution
Phuket Island, Thailand (present study).

Etymology
From Latin *glaber* (bald), in allusion to the smooth surface of the mantle.

Figure 39. ***Nudiscintilla glabra*** **gen.** et **sp. nov.** Live holotype in dorsal view. Scale bar = 5 mm.

GENUS *GALEOMMA* TURTON, 1825

Shell irregularly quadrangular-transverse, more or less gaping ventrally. Sculpture of weak radial riblets and/or pits into the surface. Hinge margin straight, umbones low. True cardinals and laterals absent, replaced by low tubercles. Live animal with mid-mantle folds reflected over the shell. The mantle folds are unfused anteriorly and form a wide inhalent-pedal aperture. The small posterior exhalent siphon is low and conical. Mantle with anterior and posterior short siphonal tentacles guarding the two openings and numerous relatively large pointed papillae scattered evenly all over the surface.

Type species (monotypy): *Galeomma turtoni* Turton, 1825.

GALEOMMA (AMPHILEPIDA) OBOCKENSIS
(JOUSSEAUME, 1888)
(FIG. 6A)

Scintilla obockensis Jousseaume, 1888: 202. – Shopland, 1902: 178.
Galeomma (Amphilepida) obockensis Chavan, 1953: 136, figs 8–10.
Galeomma obockense Tantanasiriwong, 1979: 9.

Material examined
Museum material: PMBC 916, M102, reef off Nai Yang, 7 July 1976, a cleaned and dried shell.

Description
The shell is described and illustrated by Jousseaume (1888) and Chavan (1953). Size ranges from 10.0×5.0 mm (Jousseaume, 1888) to 13.1×7.6 mm

(present material). The live animal has never been described.

Habitat

The Phuket specimen was taken from the underside of corals.

Distribution

Red Sea (Jousseaume, 1888); Gulf of Aden (Shopland, 1902); Phuket Island, Thailand (Tantanasiriwong 1979).

GALEOMMA (GALEOMMA) LAYARDI DESHAYES, 1856 (FIGS 6C, 40–44)

Galeomma layardi Deshayes, 1856a: 169 in part. – Melvill & Standen, 1906: 818.
Scintilla layardi: Sowerby, 1874: species 31, pl. IV, fig. 31a, b.
Galeomma indecora Deshayes, 1856a: 169 (**syn. nov.**). – Sowerby, 1874: species 8, pl. I, fig. 8.
Galeomma paucistriata Deshayes, 1856a: 170 (**syn. nov.**). – Sowerby, 1874: species 2, pl. I, fig. 2.
Galeomma chloroleuca Deshayes, 1856a: 170 (**syn. nov.**). – Sowerby, 1874: species 5, pl. I, fig. 5.
Galeomma angusta Lynge, 1909: 184 (**syn. nov.**).
Galeomma (Paralepida) takii Kuroda, 1945: 39, pl. 2, figs 9–12 (**syn. nov.**). – Morton, 1973: 133–150, pl. 1, text-figs 1–9.
Paralepida takii: Habe, 1964: 185, pl. 57, fig. 12. Kuroda *et al*., 1971: 411, pl. 120, figs 3, 4. Higo *et al*., 1999: 460, B658.
Galeomma argentea: Tantanasiriwong, 1979: 9.
Lepirodes takii: Habe, 1981: 104; Okutani, 2000: 937, pl. 465, fig. 2.
Galeomma takii: Morton & Scott, 1989: 150, pl. I, q, text-figs 21, 22A.
Galeomma (Pseudogaleomma) sp. Fukuda *et al*., 1999: 54, figs 11–15.

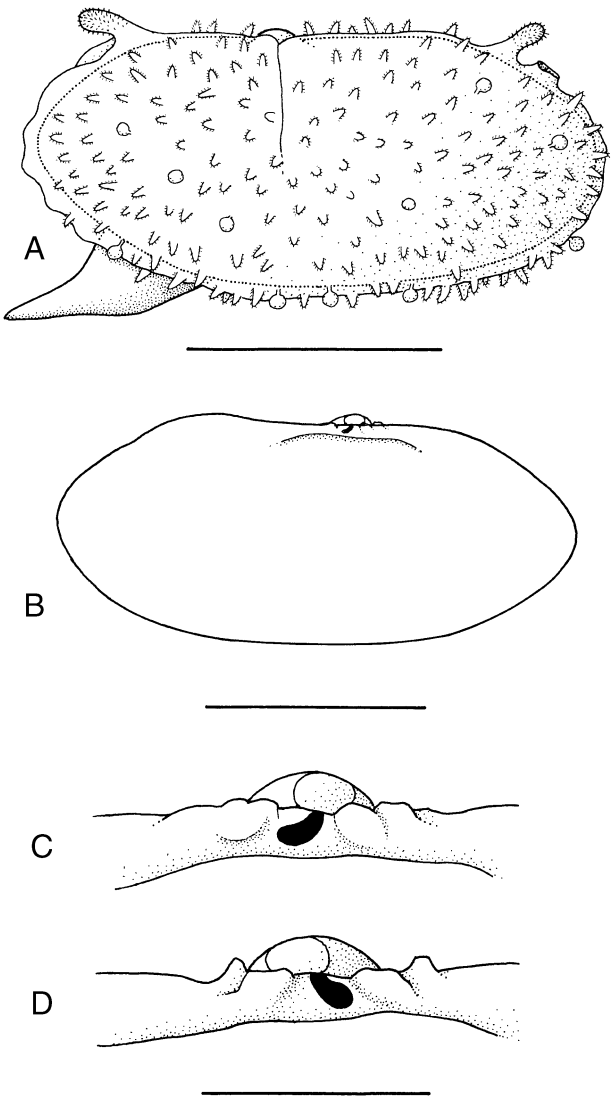

Figure 40. *Galeomma layardi.* A, living animal in left side view, dotted line indicating out line of shell. B, left valve in internal view. Left (C) and right valve hinge (D) showing prodissoconch II and resilifer of internal ligament (black). Scale bars: A = 5 mm, B = 3 mm, C, D = 1000 μm.

Material examined

Lectotype (here designated)*:* BMNH 196751/1, Sri Lanka, SL = 8.2 mm.

Museum material: Syntypes of *Galeomma chloroleuca*, BMNH 196757, Basay, Island of Samar, Philippines; holotype of *G. indecora*, BMNH 196752, Island of Masbate, Philippines; syntypes of *G. paucistriata*, BMNH 196755/1–3, Basay, Island of Samar, Philippines. Phuket Island: PMBC Ref.Coll. 918, M104, one specimen (as *G. argentea*); Koh Chang and coast of Lem Ngop, Gulf of Thailand: ZMUC, unregistered, 150 specimens (as *G. angusta*, Lynge). BMNH, unregistered: specimens from Pulau Sakra, off Singapore (as *G. angusta*); Port Galera, Island of Mindoro, Philippines (as *G. argentea*); 20 miles from Dar es Salaam, Tanzania (as *G.* (*Paralepida*) *formosa*); Bai Chai, Ha Long City, Vietnam and from Ibrahim Maidari (both undetermined).

New material: Reef off PMBC: February 1975, five specimens; 23 February to 4 March 2002, 32 specimens; 3 February 2003, *c*. 20 specimens (one of them PMBC 20113). Tai Tam Bay, Hong Kong: March 2002, several specimens.

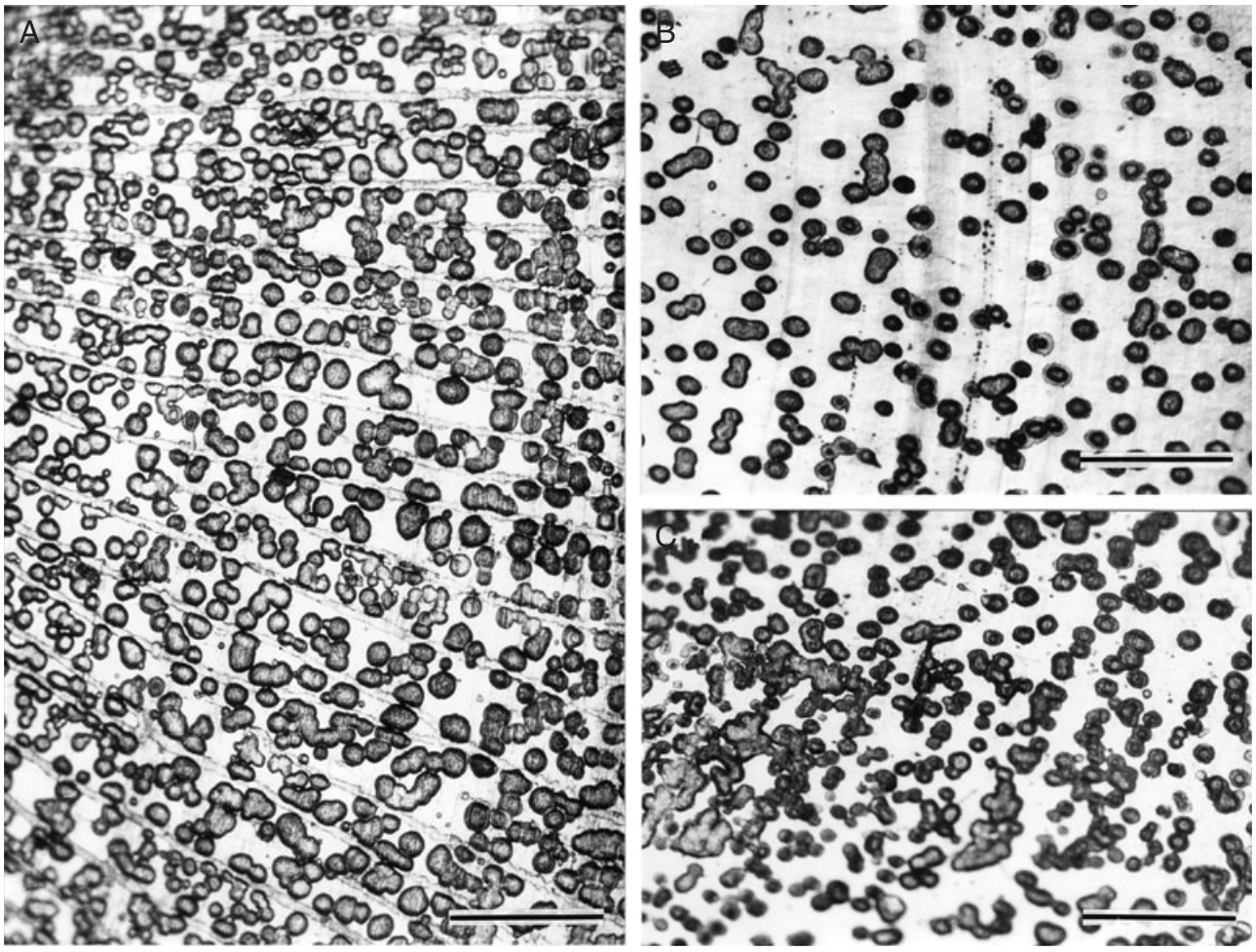

Figure 41. Shell structure (in transparency) of *Galeomma layardi* (A) and *G. ambigua* (B, C). Scale bars = 50 μm.

Description of material from Phuket

Shell: Elongate-ovate, whitish to pale yellow, translucent, rather thin and brittle, surface smooth and polished. With many large, irregularly shaped pits in the surface, framed in between numerous radiating riblets that tend to branch towards the margins (Figs 41A, 42). Morton & Scott (1989) construed the surface pits as 'pustules', which they resemble under LM, but SEM of our material leaves no doubt that they are pits. They are basically circular in outline, but in the older parts of the shell may unite to form irregularly shaped figures and penetrate more deeply into the shell. Outline variable, with a straight dorsal margin and sloping antero- and posterodorsal margins, otherwise regularly rounded in front and behind, but most often sometimes angular at both ends. The ventral margins of both valves are gently rounded, producing a characteristic wide gape, which cannot be closed. SL and SH of three specimens 6.4×3.0 mm, 8.4×4.2 mm, and 10.5×5.2 mm. The ratio SL : SH varies considerably. Maximum SL 19.2 mm. The prodissoconch II is 285 μm in diameter. Umbones slightly posterior to centre of shell, shell highest behind the umbones. Right valve with a pair of unequally large subtriangular teeth both anterior and posterior to the internal ligament. Left valve with two similar anterior teeth and a single larger posterior tooth.

Soft parts: The reflected middle fold of the mantle is whitish or greyish yellow, transparent and almost entirely covers the shell. It bears numerous conical, pointed papillae and fewer spherical stalked excrescences believed to have arisen from the papillae and to be capable of autotomy, releasing a noxious secretion to deter would-be predators (Morton, 1973). Two short siphonal tentacles arise dorsal to the large anterior inhalant and much smaller posterodorsal exhalant apertures. Papillae and tentacles are adorned by numerous minute hair-like processes. The soft parts

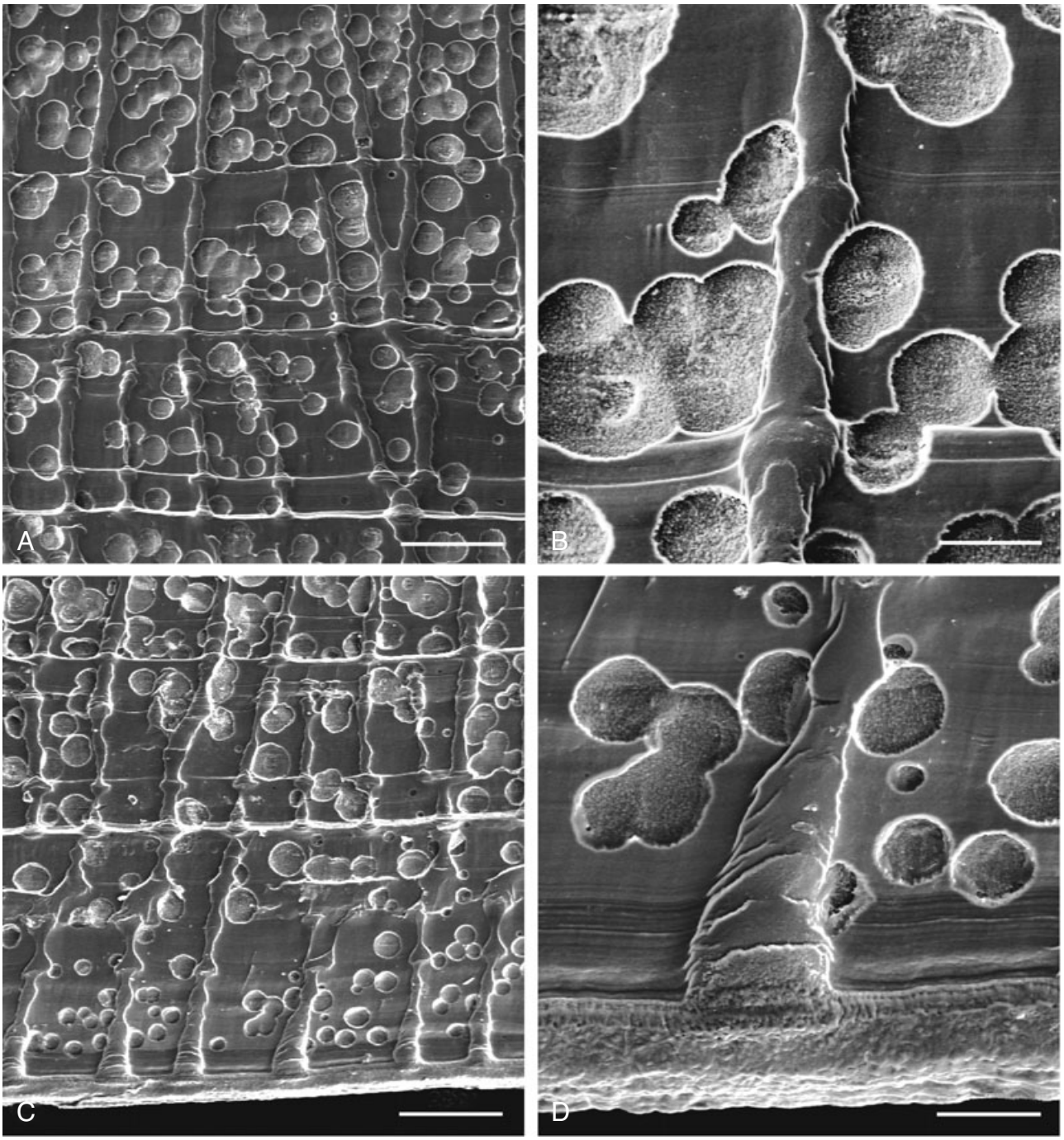

Figure 42. SEM of shell of *Galeomma layardi* on the middle of the shell (A, B) and at the shell margin seen (C, D). Scale bars: A, C = 200 μm; B, D = 50 μm.

are illustrated in colour by Fukuda, Yamashita & Fujii (1999).

Habitat

At Phuket, the species is common in middle and inner intertidal zones under rocks; it is often found in groups (Fig. 44), occasionally with *G. ambigua, G. phuketi* sp. nov., *Scintilla imperatoris*, and *Pseudogaleomma japonica*.

Distribution

Sri Lanka; Islands of Masbate and Samar, Philippines (Deshayes, 1856a); Arabian Sea (Melvill & Standen, 1906); Koh Chang and Lem Ngop, Gulf of Thailand

(Lynge, 1909); Kii Peninsula; Honshû to Kyûshû, Japan (Kuroda, 1945; Habe, 1964); Hong Kong (Morton, 1973); Phuket Island, Thailand (Tantanasiriwong, 1979 and present study); Saga Prefecture, Japan (Fukuda *et al*., 1999); Pulau Sakra, off Singapore (BMNH); Port Galera, Island of Mindoro, Philippines (BMNH); Dar es Salaam, Tanzania (BMNH); Bai Chai, Halong City, Vietnam (BMNH); Ibrahim Maidari (BMNH).

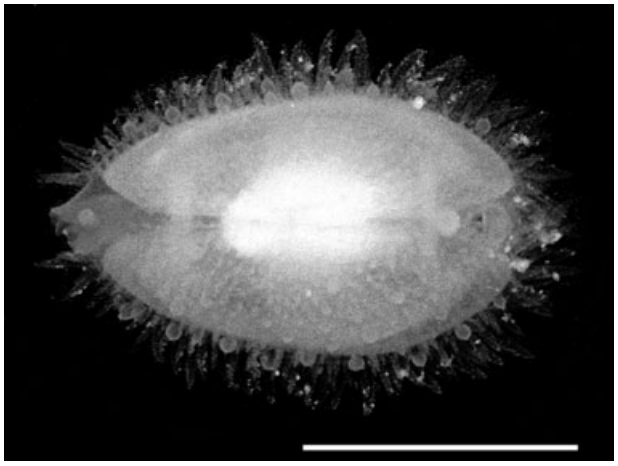

Figure 43. Live specimen of *Galeomma layardi* seen from the dorsal side. Scale bar = 5 mm.

Remarks

The radial riblets, irregularly shaped pits, details of the hinge and large ventral gape are always present in our specimens. The combination of these characters is perfectly matched by the smaller of the two syntypes of *G. layardi*, here selected as lectotype. The same characteristics also occur in the holotype of *G. indecora*, and in the syntypes of *G. paucistriata*, and *G. chloroleuca*. The second syntype of *G. layardi* (BMNH 196751/2) belongs to *G. ambigua* (Deshayes) (see below). All the specimens identified by Lynge (1909) as *G. angusta* Deshayes are also identical with *G. layardi*.

The type specimen of *G. angusta* (BMNH 196754) has a prominent concentric sculpture unlike that of *G. layardi,* and we therefore disagree with both Lynge (1909) and Prashad (1932) in synonymizing *G. angusta* with *G. chloroleuca* (= *G. layardi*). Hong Kong specimens identified as *G. takii* by Morton (1973) and Morton & Scott (1989) and those seen by us share the shell outline, hinge, large ventral gape and shell sculpture with *G. layardi* and with our Thai material. Another Hong Kong specimen (SBMNH 35065, identified as *G. takii*; Scott, 1994; Valentich-Scott, 2003) does not appear to be identical to *G. layardi* as the pits are absent, but is otherwise indeterminable. The Japanese records of *G. takii* are probably identical with *G. layardi*, but the type specimen could not be located. The outline of the shell of *Galeomma (Pseudogaleomma)* sp. from western Japan

Figure 44. A family flock of *Galeomma layardi*. Scale bar = 1 cm.

illustrated by Fukuda *et al*. (1999) matches that of *G. layardi*.

The holotype of *Scintilla porulosa* Deshayes, 1856 (BMNH 196790) has pits of the same size and shape as those in *G. layardi*, but there are no radial riblets.

Several specimens (SL = 9.2–19.2 mm) had 1–3 very small bivalves (SL = < 1.75 mm) attached to the reflected mantle fold, usually near the edge of the valves. Two were sectioned and proven to be juveniles. Morton (1973) also observed postlarvae attached between the papillae of the adult of the same species.

Only three (SL = 12.5–14.5 mm) of *c*. 57 specimens collected during February–March (1975, 2002 and 2003) brooded larvae in the gills. SL of the prodissoconch I (D-larva) is 150 μm.

GALEOMMA (GALEOMMA) AMBIGUA (DESHAYES, 1856) (FIGS 6B, 41B, C, 45–47)

Galeomma ambigua Deshayes, 1856a: 168. – Mitchell, 1867: 63.
Galeomma layardi Deshayes, 1856a: 169 (*in part*). – Melvill & Standen, 1906: 818.
Scintilla pallidula Deshayes, 1856b: 178 (**syn. nov.**). – Sowerby, 1874: species 10, pl. II, fig. 10.
Scintilla forbesii Deshayes, 1856b: 179 (**syn. nov.**). – Sowerby, 1874: species 18, pl. II, fig. 18a, b.
Scintilla aurantiaca Deshayes, 1856b: 179 (**syn. nov.**).
Scintilla adamsi Deshayes, 1856b: 179 (**syn. nov.**). – Sowerby, 1874: species 25, pl. III, fig. 25.
Scintilla faba Deshayes, 1856b: 180 (**syn. nov.**). – Shopland, 1902: 178. Pelseneer, 1911: 43, pl. XVI, fig. 7. Prashad, 1932: 169.
Scintilla ambigua Reeve, 1860: 127 (**syn. nov.**). – Sowerby, 1862: 176. Sowerby, 1874: species 19, pl. III, fig. 19A–D. Prashad, 1932: 169. Habe, 1977: 151. Morris & Purchon, 1981: 324.
Scintilla borneensis Sowerby, 1874: species 22, pl. III, fig. 22 (**syn. nov.**). – Lamprell & Healy, 1998: 152, fig. 390.
Scintilla durbanensis Sowerby, 1897: 26 (**syn. nov.**). – Turton, 1932: 237. Kilburn, 1973: 703.
Scintilla elongata Preston, 1908: 206, pl. XVII, fig. 71 (non Sowerby, 1897).
Galeomma peilei Le Tomlin, 1921a: 964 (**syn. nov.**). – Le Tomlin, 1921b: 156.
Solecardia durbanensis Barnard, 1964: 483 (**syn. nov.**).
Scintilla aurantia Lamprell & Healy, 1998: 152, fig. 391 (**syn. nov.**).

Material examined

Syntypes: BMNH 196748/1–4, Island of Ticoa, Philippines and Port Essington, Northern Territory, Australia.

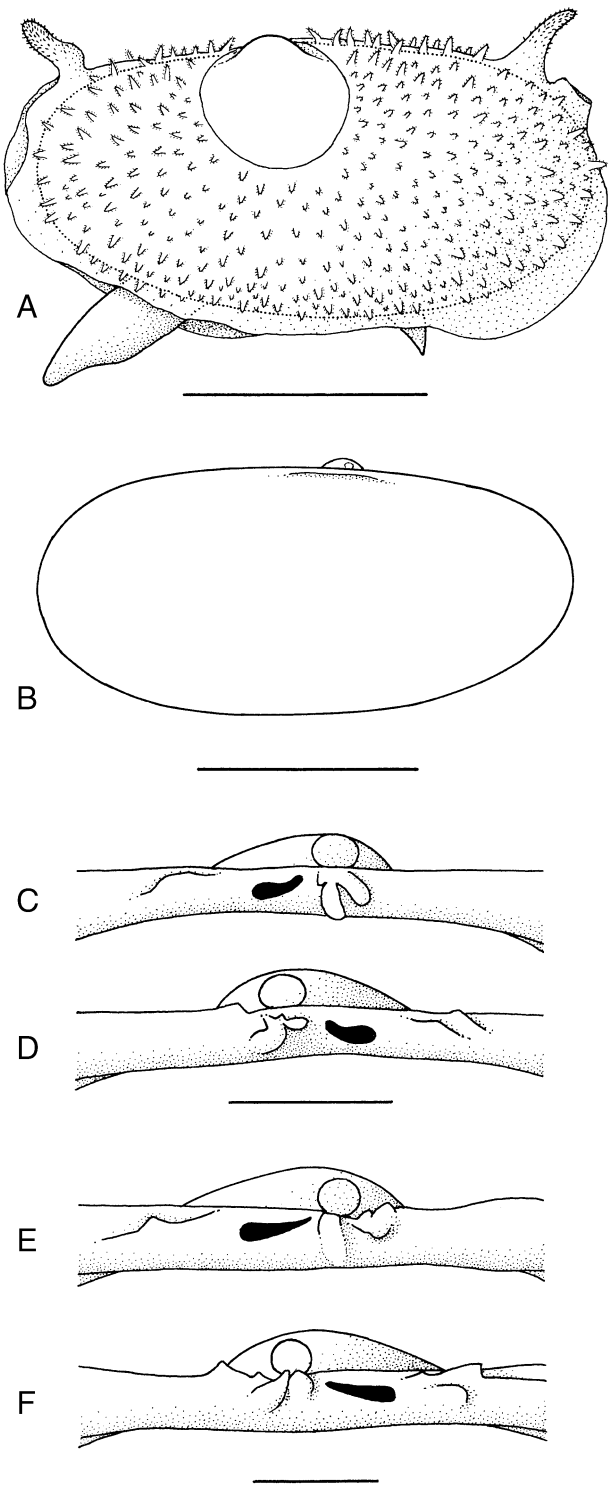

Figure 45. *Galeomma ambigua*. A, living animal in left side view, dotted line indicating outline of shell. B, left valve in internal view. Hinges of small (C, D) and large (E, F) specimens. C, E, left and D, F, right valve hinge showing prodissoconch II and resilifer of internal ligament (black). Scale bars: A, B = 5 mm, C–F = 1000 μm.

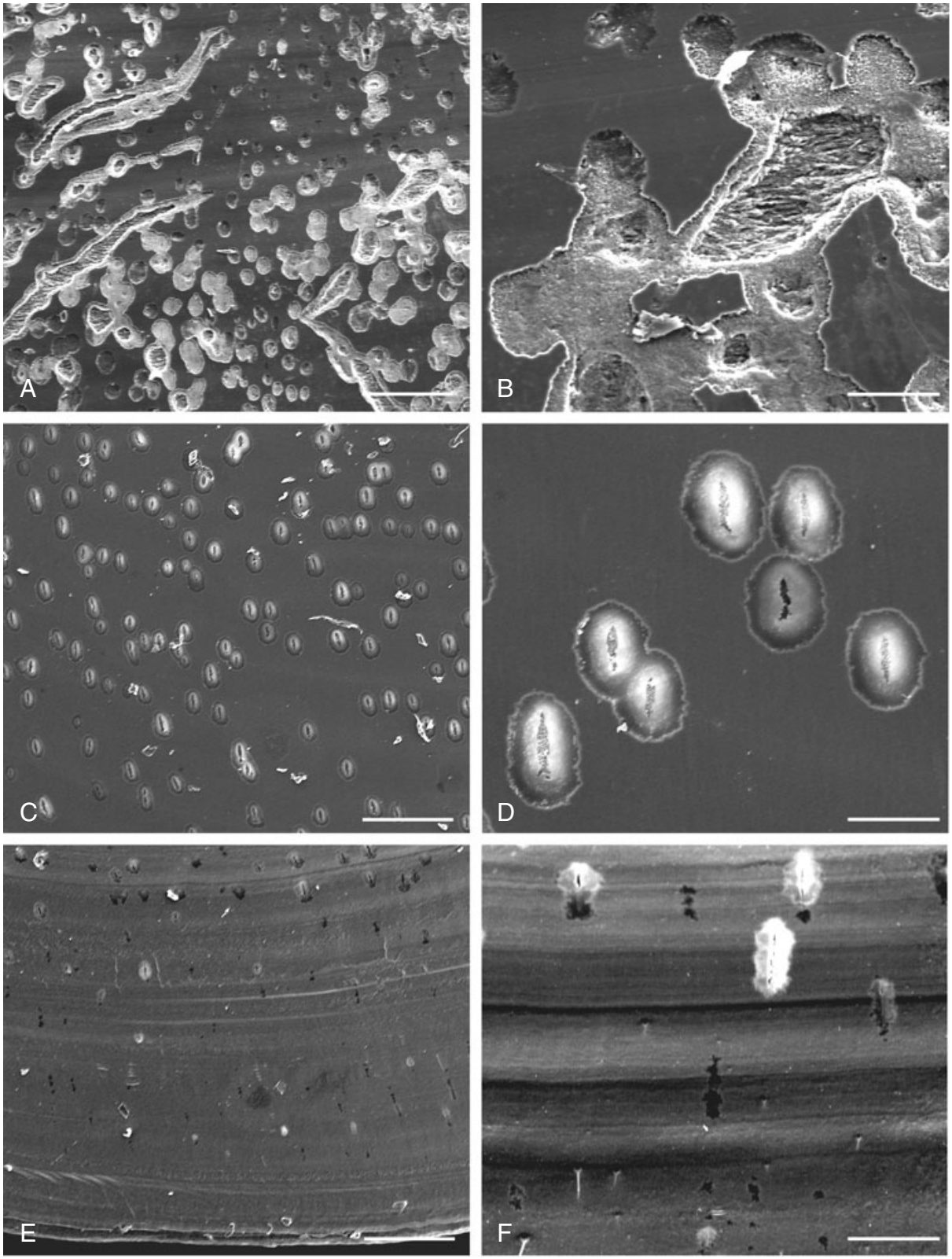

Figure 46. SEM of shell of *Galeomma ambigua*. A & B, older part of the shell with deep pits, some of which are confluent. C & D, younger part of the shell with coffee-bean-shaped pits. E & F, growing edge of the shell with narrow rifts and early pits of the coffee-bean shape. Scale bars: A, C, E = 200 μm; B, D, F = 50 μm.

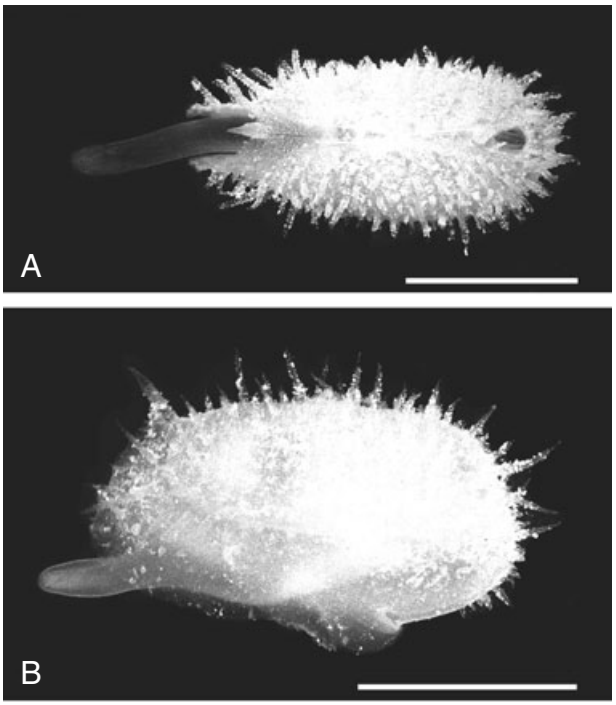

Figure 47. *Galeomma ambigua*. Live specimen seen from the dorsal (A) and the left side. Scale bars = 5 mm.

Museum material: The larger (SL = 10.2 mm) of two syntypes of *Galeomma layardi*, BMNH 196751/2, Sri Lanka; syntypes of *Scintilla adamsi*, BMNH 196787, Island of Bohol, Philippines, several shells, SL to 16 mm; holotype of *S. aurantiaca*, BMNH 196786, North Australia; holotype of *S. borneensis*, BMNH 196101, Borneo; syntypes of *S. faba*, BMNH 196792/1–4,4 Borneo; syntypes of *S. forbesi*, BMNH 196785/1–2, Borneo, SL to 14 mm; holotype of *S. pallidula*, BMNH 196784, San Nicola, Island of Cebu, Philippines; syntypes of *S. durbanensis*, BMNH 1899.4.14, 3502–3, Durban, South Africa, two specimens; syntypes of *Galeomma peilei*, BMNH, unregistered, Sri Lanka, two specimens; many specimens in BMNH (unregistered and undetermined or determined as *Galeomma*, *G. ambigua*, *G. peilei*, *Scintilla aurantiaca* or *S. faba*) from the following localities: Karachi and Manora, Pakistan; Mumbai; Krusadei, Gulf of Mannar; Trincomalee, Sri Lanka; N and S Andaman Islands; Pulau Bidang, N of Penang, Malaysia; Borneo; Port Molle, Queensland, Australia; Fiji Islands; one specimen determined as *S. borneensis*, ZMUC, unregistered, Pulau Milu, Little Nicobar.

New material: Reef off PMBC: March 1975, four specimens; February–March 1982, several specimens; 5 and 9 February 2003, *c*. 20 specimens (one of them PMBC 20114).

Description of material from Phuket

Shell: Oblong ovate, moderately inflated, colourless and vitreous, relatively thin, surface smooth, with very many close-set growth striae. The shell is dotted with numerous minute and mostly round or oblong pits in the surface (Fig. 46). The pits apparently begin as small, irregular rifts that are elongate perpendicular to the growing edge of the shell (Fig. 46E, F). As the rifts grow deeper, and regular, coffee-bean-shaped images emerge (Fig. 46C, D). In the older parts of the shell, the pits sometimes fuse to form short sinuous figures, which may penetrate more deeply into the shell (Fig. 46A, B). In reflected light the pits appear as small whitish dots.

Shell about twice as long as high, all margins gently rounded, dorsal and ventral margin only slightly so. Size up to 17.2 × 8.3 mm, the prodissoconch II 295–305 μm in diameter. The beaks are anterior to the middle. Hinge plate moderately stout. In small or moderate-sized bivalves the right valve has a large oblique cardinal basally flanked by two small tubercles plus a low posterior lateral well behind the resilifer. The left valve bears a longitudinal and a somewhat smaller oblique cardinal and has a posterior lateral. Larger specimens often develop a hooked shell margin anterior to the cardinals, protruding laterals and hooked dorsal extensions of the cardinals, which, on the right side, may split into two (Fig. 45F).

Soft parts: There are two fairly prominent tapering siphonal tentacles. The exterior mantle fold may cover the shell completely and bears numerous conical and pointed papillae of various size (poorly illustrated by Pelseneer, 1911). The surface of both tentacles and papillae is rough due to the presence of numerous minute hair-like protuberances. Spherical papillae borne on a short stalk, such as those found in *G. layardi*, were never seen.

Habitat

At Phuket, the species is relatively common on the underside of shale blocks resting on sand in the upper part of the tidal zone on the reef off PMBC. When at all noted by other authors, animals were always found under stones at low water. Two or three often occur together or in company with *G. layardi*. Juveniles up to SL 2.0 mm may attach to the exterior mantle of larger ones.

Distribution

Island of Ticoa, Philippines; Port Essington, Northern Territory, Australia; Sri Lanka (Deshayes, 1856a); Mumbai, India (Mitchell, 1867; Le Tomlin, 1921a, b); Chah Bahar, Gulf of Oman and Ras Ormara, Pakistan

(Melvill & Standen, 1906); San Nicola, Island of Cebu, Philippines; Borneo; North Australia; Baclayon, Island of Bohol, Philippines (Deshayes, 1856b; Sowerby, 1874); Aden, South Yemen (Shopland, 1902); Kuandang, Sulawesi; Ambon, Moluccas; Roti Island, W of Timor (Prashad, 1932); S of Okinawa, Japan (Habe, 1977); W coast of Malaysia (Morris & Purchon, 1981); Central Queensland, Australia (Lamprell & Healy, 1998); Durban, South Africa (Sowerby, 1897); Port Alfred, South Africa (Kilburn, 1973); Andaman Island (Preston, 1908); Baia de Lourenco Marques (Delagoa Bay) (Barnard, 1964); Sri Lanka (BMNH); Karachi and Manora, Pakistan (BMNH); Krusadei, Gulf of Manaar (BMNH); Trincomalee, Sri Lanka (BMNH); N and S Andaman Islands (BMNH); Pulau Bidang, N of Penang, Malaysia (BMNH); Port Molle, Queensland, Australia (BMNH); Fiji Islands(BMNH); Pulau Milu, Little Nicobar (ZMUC); Phuket Island, Thailand (present study).

Remarks

The species has been described under at least 12 different species names. We have compared the type specimens of *Galeomma ambigua* with the larger (10.0 mm) of the two syntypes of *G. layardi* and the type specimens of *G. peilei, Scintilla adamsi*, *S. aurantiaca*, *S. borneensis*, *S. faba*, *S. forbesi*, *S. pallidula*, and *S. durbanensis* and found no noticeable differences. The hinge of Hong Kong specimens identified as *G. polita* Deshayes by Morton & Scott (1989) and Valentich-Scott (2003) differs considerably from that of the present species, although pits are numerous and scattered all over the shell.

The shape and dimensions of the shells of *G. ambigua* may vary, which was the only difference noted by Prashad (1932) between Sibogan specimens of *G. ambigua* and *S. faba*. A study of many specimens from a restricted area (the reef off PMBC) showed that the dentition in smaller specimens (Fig. 45C, D) is basically the same as in species of *Scintilla*, which explains why most of the records have been referred to that genus, while in larger specimens (Fig. 45E, F) it may vaguely resemble that of *G. layardi*. The hinge of all the specimens we have seen falls within this range of variation. The species' most characteristic feature is that numerous minute pits are scattered more or less evenly over the shell. This was also noted by Sowerby (1874), who found the shell of *G. ambigua* 'very minutely punctured'. SEMs demonstrate that they are true indentations in the surface of the shell (Fig. 46), while the term 'pustules', used by some authors, is an inadequate description.

Tiny bivalves were occasionally seen attached to, or moving around upon, the reflected part of the mantle. The only one sectioned turned out to be a male (SL 0.7 mm), provided with an ovoid testes filled with mature sperm cells.

Because they are so similar in external appearance, in the field *Galeomma ambigua* may be mistaken for *G. layardi*, with which it also shares the same habitat. However, the shells of the two species clearly differ in outline, dentition and in the size, shape and arrangement of the small pits and absence/presence of radial ribs (compare Fig. 41A and 41B, C). The ventral gape of the closed shell of *G. ambigua* is also small compared to that in *G. layardi*.

The largest specimen (collected 9 February 2003) was ovigerous.

GALEOMMA PHUKETI SP. NOV.

(FIGS 6D, 48, 49)

Material examined

Holotype: PMBC 20115, reef off PMBC, Thailand, 21 March 1975, SL = 6.0 mm.

Paratypes: Reef off PMBC: 21 March 1975, one specimen (section series of entire animal); 26 February 2002, one specimen.

Description of material from Phuket

Shell: Oblong ovate, rather inflated, colourless, quite thin, rather opaque, surface dull with many fine com-

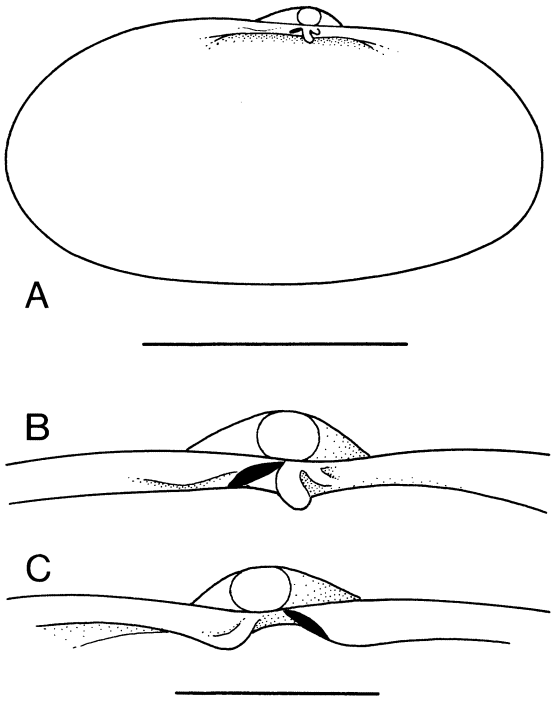

Figure 48. ***Galeomma phuketi*** **sp. nov.** A, left valve in internal view. Left (B) and right valve hinge (C) showing prodissoconch II and resilifer of internal ligament (black). Scale bars: A = 3 mm, B, C = 1000 μm.

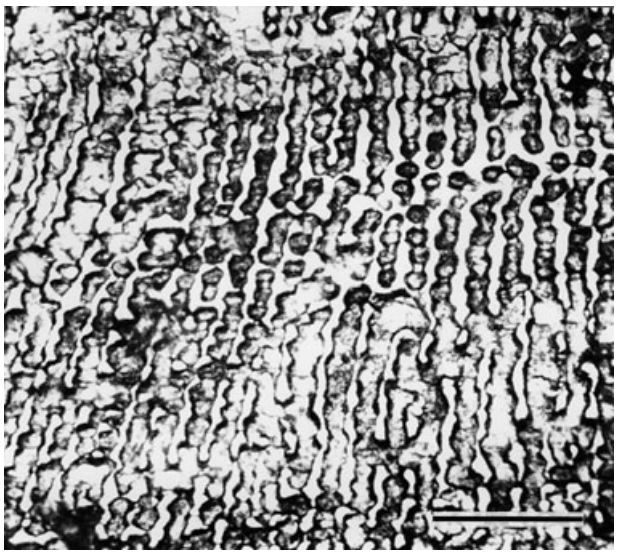

Figure 49. ***Galeomma phuketi*** **sp. nov.** Shell structure seen in transmitted light. Scale bar = 50 μm.

marginal striae. The shell displays a very characteristic pattern of radiating close-set slightly wavy grooves on its surface, which occasionally break up into shorter sections or merge with one another (Fig. 49). Dorsal margin almost straight, both antero- and posterodorsal margins sloping, otherwise rounded at both ends, slightly gaping posteriorly. Size of the three specimens 4.6×2.3, 4.6×2.4, and $6.0 \times 3.2 \times 2.5$ mm. The prodissoconch II is 300 μm in diameter. Beaks prominent, slightly anterior to the middle. Hinge plate rather narrow. Right valve with a single rounded cardinal immediately in front of umbo, left valve with a large and a small cardinal below umbo. Short laterals are present behind the resilifer.

Soft parts: Live specimens were not studied, but the preserved ones displayed finger-shaped unpaired anterior and posterior siphonal tentacles.

Habitat
All three specimens were collected intertidally under pieces of shale.

Distribution
Phuket Island, Thailand (present study).

Remarks
The dentition places the species in the genus *Scintilla*, but is also similar to that of young specimens of *Galeomma ambigua*. We have referred the species to *Galeomma* because the grooves of the shell surface are clearly comparable to the pits of *G. ambigua* and *G. layardi*.

Etymology
The species is named after its locality.

GENUS *PSEUDOGALEOMMA* HABE, 1964

Shell thin, but rather solid, oblong ovate, narrowing towards the anterior end, with a narrow ventral gape. Each valve with a small tuberculous cardinal and with one or two minute denticles arising from the shell margins (emended from Habe, 1964). Reflected mantle with short finger-shaped siphonal tentacles, small scattered papillae and a number of spherical warts.

Type species (monotypy): *Galeomma japonica* A. Adams, 1862.

PSEUDOGALEOMMA JAPONICA (A. ADAMS, 1862) (FIGS 6E, 50)

Galeomnia japonica A. Adams, 1862: 228.
Solecardia vitrea japonica: Pilsbry, 1904: 558, pl. 41, fig. 6.
Pseudogaleomma japonica: Habe, 1964: 185, pl. 57, fig. 13. Kuroda *et al*., 1971: 410, pl. 120, figs 11, 12. Habe, 1981: 104. Higo *et al*., 1999: 460, B662., Tsi & Ma, 1982: 449. Okutani, 2000: 937, pl. 466, fig. 4. Valentich-Scott, 2003: 279.

Material examined
New material: Reef off PMBC: 3 March 2002, one specimen (PMBC 20116); 3 March 2002, one specimen (section series of entire animal); 7 and 9 February 2003, two specimens.

Description of material from Phuket
Shell: Elongate-oval, rather compressed, semitransparent, rather thin, glassy, surface smooth. Anterior and posterior sides evenly rounded, maximum height between umbo and posterior margin. Ventral margins straight in the middle and slightly gaping. Two specimens measured 10.2×4.9 mm (width 2.9 mm) and 10.2×5.0 mm. The prodissoconch II is 240 μm in diameter. Beaks small, distinctly anterior to the middle. Hinge plate narrow, each valve with a small tuberculous cardinal and with one (left) or two (right) minute denticles arising from the shell margins.

Soft parts: The dorsal part of the anterior inhalant region protrudes as a relatively small forwardly

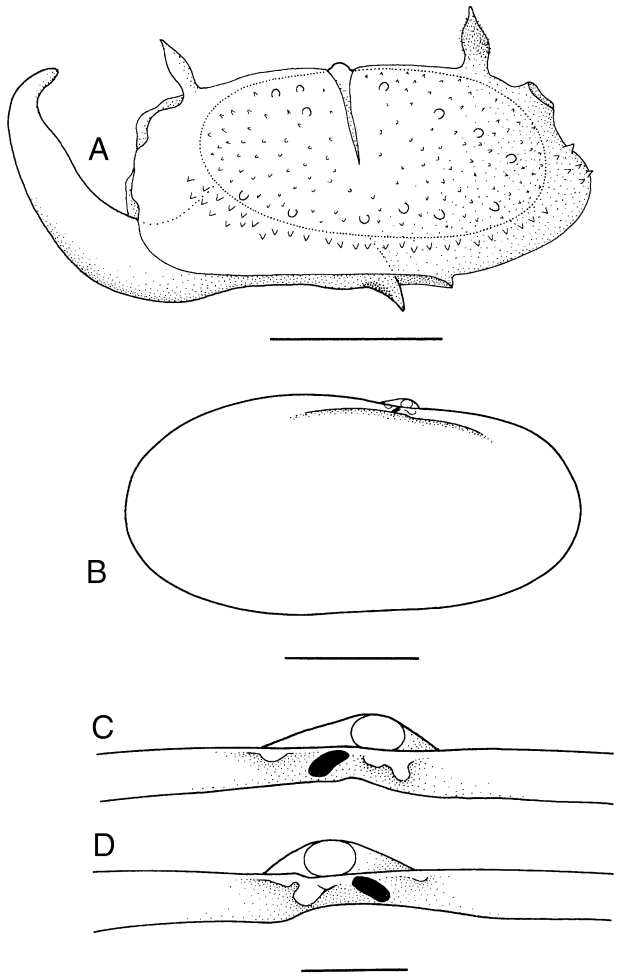

Figure 50. *Pseudogaleomma japonica.* A, living animal in left side view, dotted line indicating outline of shell. B, left valve in internal view. Left (C) and right valve hinge (D) showing prodissoconch II and resilifer of internal ligament (black). Scale bars: A = 5 mm, B = 3 mm, C, D = 500 μm.

directed siphon above which arises a finger-shaped short tentacle. The posterodorsally directed exhalant siphon is small and short, with another tentacle close to it. Ventrally on the reflected mantle there are a few serially placed pointed papillae and a small number of spherical warts ending in a minute whip. Numerous, very small papillae are spread nearly all over the mantle's surface. Habe (1964) described the shell as covered by a 'mammillated mantle'.

Habitat

All four specimens were found under rocks resting on coarse sand, in the upper part of the tidal zone, two of them together with specimens of *G. layardi*. In Japan the species occurs under stones from the shore to a depth of > 100 m.

Distribution

Minoshima, Sea of Japan (A.Adams, 1862); Hiradoshima, W Kyûshû, Japan (Pilsbry, 1904); from Sagami Bay, Honshû to Kyûshû, Japan (Habe, 1964); coast of Guangdong to Hainan Island, S China (Tsi & Ma, 1982); Hong Kong (Valentich-Scott, 2003); Phuket Island, Thailand (present study).

Remarks

The shell corresponds exactly in size and dimensions to Pilsbry's *Solecardia vitrea japonica*. Morton & Scott (1989) considered Pilsbry's specimen synonymous with *Galeomma polita* Deshayes, but the shell they illustrate of this species is higher, has two, not a single pointed and oblong cardinal in each valve, and a larger (300 μm) prodissoconch II. The mantle of *G. polita* (as illustrated by Morton & Scott, 1989: fig. 23) bears numerous smaller or larger papillae, which differ markedly in number and size from those of the present species, the soft parts of which were unknown to Morton & Scott. In *G. polita* there is a large pedal gape (Morton, 1975), while in *P. japonica*, this is small, even in the live animal.

GENUS *EPHIPPODONTA* TATE, 1889

Shell semielleptical, laterally angular, most extended not far from straight hinge margin, ventrally rounded. Externally smooth, striated, papillose or reticulated. Internal ligament bounded on each side by obtuse tooth with bifid crown. Shell more or less internalized by overgrowth of the papillose mantle.

Type species: Scintilla lunata Tate, 1886.

Remarks

The genus is divided into three sub-genera (*Ephippodonta*, *Ephippodontoana* and *Ephippodontina*).

EPHIPPODONTA (EPHIPPODONTINA) GIGAS KUBO, 1996 (FIGS 6H, 51A–C, 52)

Ephippodonta (Ephippodonta) gigas Kubo, 1996: 1–5, figs 1–6.
Ephippodonta (Ephippodonta) gigas: Higo *et al.,* 1999: 460, B660.

Material examined

New material: Reef off PMBC: 3 March 1975, four specimens; 10 March 1982, three specimens. Koh Rok,

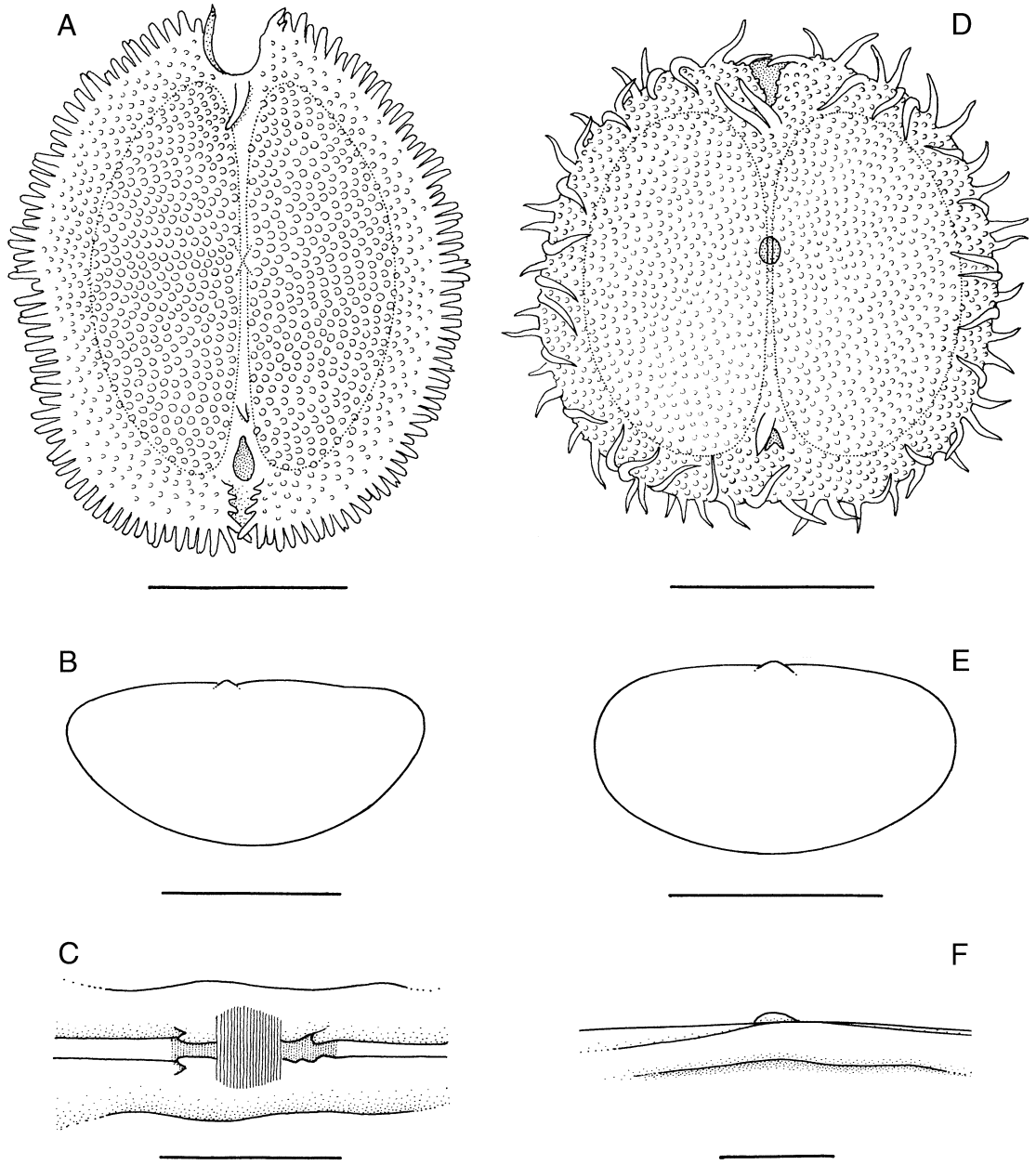

Figure 51. *Ephippodonta* (*Ephippodonta) gigas* (A–C) and ***Aclistothyra orientalis*** **sp. nov.** (D–F). A & D, dorsal view of animal, anterior end at the top. B & E, left valve seen from outside. C, hinge viewed from inside, left valve above. F, right valve hinge. Scale bars: A, B, D, E = 5 mm, C, F = 1000 μm.

Phuket Island: 7 March 1982, one specimen (PMBC 20117).

Description of material from Phuket

Shell: Semicircular, acuminate at both ends, compressed, glossy white, smooth and transparent. Often with very distinct commarginal lines. Size of eight specimens ranges from 6.1 × 2.5 to 16.0 × 6.5 mm, but Okinawa specimens may attain an SL of 19 mm. The prodissoconch II in our specimens is 300 μm across, but 200 μm in bivalves from Okinawa (Kubo, 1996). Umbo slightly in front of middle. Hinge margin straight, internal ligament situated between two small cardinal teeth.

Soft parts: The shell is completely covered by the reflected middle mantle lobe, which bears numerous

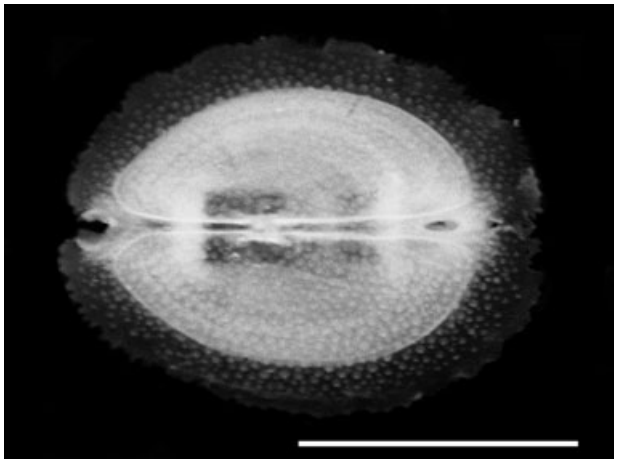

Figure 52. *Ephippodonta* (*Ephippodonta) gigas*. Dorsal view of animal. Scale bar = 5 mm.

small spherical papillae. Inhalant and exhalant siphons open at anterior and posterior margin in the median line, and are each provided with a single eversible siphonal tentacle. Inhalant siphon petaloid, larger than exhalant siphon. When fully extended, the mantle forms a horizontal membrane which along its margin is split into many relatively short, pointed and often branching fringes.

Habitat
At Phuket the species is found attached to undersurfaces of stones, often buried deep down (15 cm) in the sandy substrate. Of the eight specimens there were two groups of three and four. The first group was found within a mud tube probably inhabited by a thalassinidean shrimp. A similar association between the burrowing thalassinidean *Axius plectorhynchus* and *Ephippodonta (Ephippodonta) lunata* and *E. (Ephippodontoana) macdougalli* Tate, 1889 was noted by Tate (1889) and Matthews (1893). Kubo (1996) did not observe commensalism in his specimens.

Distribution
Okinawa Island, SW Japan (Kubo, 1996); Phuket Island, Thailand (present study).

Remarks
The semielliptical shell and the absence of radial papillae place the species in the subgenus *Ephippodontina* (not *Ephippodonta* as suggested by Kubo). In *E. (Ephippodontina) oedipus* Morton, dwarf males are incubated in a pair of pallial pouches in the female (Morton, 1976). Such males were absent in specimens of the present species of which two sectioned specimens were a male (SL 6.1 mm) and a hermaphrodite (SL 12.9 mm).

GENUS *ACLISTOTHYRA* MCGINTY, 1955

The valves are thin, nearly flat, about half as high as long, broadly gaping. They are rounded, not angular, at the ends of the straight hinge-line. The minute submedian umbones are convex and rounded. Hinge margin very thin but slightly thicker medially, without teeth. Shell entirely and permanently covered by mantle except for a small circular foramen near umbo. A series of cylindrical pointed tentacles arise from the mantle peripherally to the shell margins (emended from McGinty, 1955).

Type species: Aclistothyra atlantica McGinty, 1955 (monotypy).

Remarks
The genus is close to *Ephippodonta*, differing mainly in the complete absence of hinge teeth. Whether it also should be included in that genus must await further study of the soft parts and interior anatomy.

ACLISTOTHYRA ORIENTALIS SP. NOV.
(FIGS 6I, 51D–F)

Material examined
Holotype: PMBC 20118, reef off PMBC, Thailand, no date, SL = 8.5 mm.
Paratype: Reef off PMBC: no date, one specimen.

Description of material from Phuket
Shell: Smoothly and regularly elongate ovate, very thin and brittle, almost translucent, whitish, slightly shining, surface completely smooth without any sculpturing. Almost flat except for slightly vaulted area near the small umbo, which is located in the middle. Hinge margin nearly straight along the middle third, emarginated anteriorly and posteriorly. Shell margins rounded at both ends. Size of two specimens 8.5×4.9 mm and 10.0×5.1 mm. The prodissoconch II is large, 400 μm in diameter. Hinge plate in both valves an elongate, rounded edentulous bar, with an external ligament only, a resilifer being absent.

Soft parts: The valves of one of the specimens were held horizontally; in the other they gaped about 90°. The shell is overlain by a thin sheet of the reflected mantle except for a small circular foramen in front of

the umbones. All along the shell margins the mantle continues as a dorsoventrally flattened girdle peripherally terminating in an edge which sharply divides the mantle into dorsal and ventral parts. Many relatively long cylindrical pointed tentacles issue all along the mantle edge. They number 30–35 on each side and are most crowded anteriorly and posteriorly. Their length varies, probably according to their relative state of retraction.

The dorsal part of the mantle is everywhere beset with numerous regularly spaced wart-like papillae, which are also present in a narrow marginal zone on the mantle's ventral part. The anterior inhalant region is a vertical slit connecting ventrally with a large pedal gape. A pair of close-set siphonal tentacles guards the dorsal margin of the inhalant aperture. They are similar to the marginal tentacles, but larger. The exhalant opening in both preserved bivalves is small and provided with a single short, thick and pointed posterior siphonal tentacle. Whether the inhalant and exhalant openings may be protruded siphon-like in life as in some species of *Ephippodonta* is unknown.

Distribution
Phuket Island, Thailand (present study).

Remarks
In several galeommatid genera the valves gape widely and the animals are limpet-like. Shell characteristics, such as shape, thinness, lack of a distinct ornamentation, and especially the complete edentulous condition of the hinge, place the present species in *Aclistothyra*, but the soft parts cannot be compared, as they are unknown in the only other described species, *A. atlantica* McGinty. In the likewise limpet-like *Ephippodonta* the shells are also dorsoventrally flattened.

Species of the subgenera *Ephippodonta* and *Ephippodontoana* have a shell ornamentation of distinct papillae; this is developed only toward the margin in the former, while it is arranged along radiating dichotomously branching riblets in the latter. In both subgenera the hinge bears interlocking cardinals and laterals. In the subgenus *Ephippodontina* the surface of the shell is finely reticulate. Dentition is rather well developed except in *E. (Ephippodontina) oedipus* Morton in which only questionable laterals are preserved. The only species of *Ephippodonta* with a smooth shell surface like that of the present species is *E. gigas*; in the latter, however, the cardinals as well as a resilium have been preserved (Kubo, 1996). In limpet-like galeommatids true marginal tentacles similar to those of *A. orientalis*, rather than an incised mantle margin, occur in *E. gregaria* Gofas (assignation to subgenus dubious) and *E. (Ephippodontina) murakamii* Kuroda, but the tentacles in these species are smaller and more, or much more, numerous.

Etymology
The species is named after the geographical region where it was found.

DISCUSSION

The family Galeommatidae occurs predominantly in tropical marine coastal waters, where it is sometimes the most speciose group of molluscs. The 27 species we have recorded from Phuket have been found in a rather restricted habitat, i.e. that of the underside of shales and corals in the tidal zone of four beaches. Our tally exceeds the 23 species recently found at a well-studied, but larger and ecologically more diverse site, the coral reef lagoon of Koumac on the NW coast of New Caledonia (SW Pacific Ocean) (Bouchet *et al*., 2002). At Guam, the Mariana Islands, Paulay (2003) recorded 23 mostly unidentified species of Galeommatidae *s.s.* By comparison, several years collecting in the subtropical Hong Kong area resulted in the finding of only seven species (Morton & Scott, 1989). A discussion of the evolutionary and ecological significance of a large number of species with a seemingly identical biology in such a small area is outside the scope of this paper, but constitutes a promising area for further research.

Serial sections of a number of the species discussed above indicate that they are hermaphrodites. This finding contrasts with Pelseneer's (1911: 43, 45) belief that all species of *Scintilla* and *Galeomma* have separate sexes. Hermaphroditism has also been recorded in *Scintillona bellerophon* Ó Foighil & Gibson, 1984, in *S. brissae* Morton & Scott, 1989, and in species of *Divariscintilla* Powell, 1932 (Ó Foighil & Gibson, 1984; Mikkelsen & Bieler, 1989; Jespersen, Lützen & Nielsen, 2004). Dioecism may prevail in *Scioberetia australis* Bernard, 1896 and *Ephippodonta oedipus* Morton, 1976 (Bernard, 1896; Morton, 1976), but these two species are probably exceptional in this respect.

Dwarfish male individuals attached to the shell or reflected mantle have been demonstrated in a few species (*E. oedipus*; *G. turtoni*; *G. coalita* Gofas; *Chlamydoconcha orcutti* Dall; Gofas, 1991; Morton *et al.* 1981) and were also found in one instance by us (on *G. ambigua*). Postlarvae attached to larger specimens may have been attracted to the adults rather than to the microhabitat and, if not turning into dwarf males, would detach after a short stay to become independent, although remaining in the near vicinity. This

would explain how family groups arise. Morton (1973) suggested that such larvae were released from the gills of the animal on which they were found to be living temporarily among the protective tentacles. We find this unlikely since, if so, the number of postlarvae per adult ought to be much higher (only a very few were found) and because this explanation neglects the fact that between release and settling all larvae obviously go through a planktonic phase.

All galeommatids incubate their eggs in the suprabranchial chamber of all four demibranchs, a feature first observed for any bivalve by Mittre (1847; in *G. turtoni*). In one instance (*Nudiscintilla glabra*), the number was estimated at 6000. The fact that remarkably few of the species and specimens taken at Phuket were brooding may be due to the restricted season of sampling, i.e. January–March, but different reproductive periods may be a mechanism of separating the species. Although Lebour (1938: 124) cryptically, and probably also erroneously, stated that the European *G. turtoni* releases free-swimming embryos without a shell, we have observed shelled D-larvae (prodissoconch I) in the gills of four of our species. These larvae ranged from 120 to 162 μm in length. In four other brooding galeommatid species the prodissoconch I ranged between <100 and 190 μm: *Scintillona bellerophon*: 130 μm; *Scintilla vitrea*: 190 μm; *Galeomma turtoni*: < 100 μm; *Ephippodonta gregaria* Gofas: < 100 μm (Arakawa, 1960; O' Foighil & Gibson, 1984; Gofas, 1991). We have measured the prodissoconch II (larval shell) in as many species as possible (26) and found that the diameter in 23 of the species ranged between 215 and 330 μm, with maxima occurring at 225–250 μm ($N = 9$) and 285–295 μm ($N = 6$). In three species, *Scintilla agilis*, *S. sannio*, and *Aclistothyra orientalis*, the larval shells were even larger (395, 400 and 450 μm, respectively). From the considerable difference in size between prodissoconch I and II it is inferred that the species studied go through a planktotrophic phase of some length. This is also stated to be the case in *Scintillona bellerophon*, *G. turtoni* and *E. gregaria* (O'Foighil & Gibson, 1984; Gofas, 1991).

Among the Phuket galeommatids only one species (*Ephippodonta gigas*) is suspected to live commensalistically (with a thallasinidean crustacean). All other species live cryptically in dead coral galleries or under stones on the boulder-strewn shores. Their occurrence is obviously patchy, as one may turn over a large number of rocks until an inhabited one shows up, which may then display several bivalves. This probably depends on the water movement along the underside of the stones, with the bivalves dependent on a constant flow of water (see Fig. 2). The galeommatids tend to aggregate in small family flocks that may comprise up to three species. Generally, however, the number of specimens actually found under a single rock or a piece of coral was quite small, and in many instances only one was recorded. However, we believe that the weak byssal attachment of several species leads to detachment of specimens when the rocks are lifted, so several more specimens may have occurred in family groups. This is supported by the fact that in several cases loose specimens were found in the sediment under stones/corals with attached bivalves.

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