

## Cirripedia Thoracica : Verrucomorpha of New Caledonia, Indonesia, Wallis and Futuna Islands

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### ABSTRACT

Verrucomorpha from deep sea collections made by several French cruises in New Caledonian area (including Chesterfield and Loyalty Islands), Wallis Island and Futuna Island waters, and by the French-Indonesian cruise KARUBAR in Indonesian waters, over the period 1985-1993, are discussed. The fauna includes 16 species, seven of which are new; the bathymetric and geographic ranges of many other taxa are extended, making this one of the most diverse verrucomorph faunas known. The status of species within both *Altiverruca* and *Metaverruca* is considered, with six names being synonymised with *Metaverruca recta* (Aurivillius), and a key to genera of the Verrucidae is given.

The distribution of the Verrucidae in the region is discussed, with *Metaverruca recta* being confirmed as the species with the greatest geographic, bathymetric and stratigraphic distribution of any verrucid.

### RÉSUMÉ

**Cirripedia Thoracica : Verrucomorpha de Nouvelle-Calédonie, d'Indonésie et des îles Wallis et Futuna.**

Les Verrucomorphes, principalement bathyaux, récoltés lors de diverses campagnes françaises au large de la Nouvelle-Calédonie et des îles Loyauté, Chesterfield, Wallis et Futuna et lors de la campagne franco-indonésienne KARUBAR dans les eaux indonésiennes, entre 1985-1993, sont étudiés ici. Seize espèces ont été trouvées, parmi lesquelles sept sont nouvelles pour la science. La faune des Verrucomorphes étudiée ici apparaît ainsi comme l'une des plus diversifiée connue dans une même région. Les distributions bathymétrique et géographique de plusieurs espèces sont étendues.

Le statut des espèces des genres *Altiverruca* et *Metaverruca* est examiné. Six espèces sont mises en synonymie avec *Metaverruca recta* (Aurivillius), et une clé des genres de la famille Verrucidae est proposée.

La répartition des Verrucidae dans la région prospectée est discutée, et il est confirmé que *Metaverruca recta* est l'espèce ayant la plus vaste répartition géographique, bathymétrique et stratigraphique de tous les Verrucidae.

## INTRODUCTION

The deep sea verrucomorph cirripede fauna of Indonesia, New Caledonia and the Wallis and Futuna Islands had not been collected prior to 1977; although previous work on verrucomorphs (generally shallow water species) in the Indo-Pacific region has been carried out by HOEK (1907, 1913); PILSBRY (1907, 1912); BROCH (1922, 1932); GRUVEL (1907, 1920); ROSELL (1981, 1991); NILSSON-CANTELL (1929); FOSTER (1978); BUCKERIDGE (1983) and ZEVINA (1987, 1988). This paper records material collected from New Caledonian waters by BIOCAL (1985), MUSORSTOM 4 (1985), CHALCAL 2 (1986), BIOGEOCAL (1987), SMIB 5 (1989), SMIB 8 (1993); from the Loyalty Islands region by MUSORSTOM 6 (1989); from the Chesterfield Islands region by MUSORSTOM 5 (1986) and CORAIL 2 (1988); from the volcanoes south of Vanuatu by VOLSMAR and GEMINI (1989); from the Wallis and Futuna Islands region by MUSORSTOM 7 (1992), and from Indonesian waters by KARUBAR (1991) expeditions. Some specimens collected by the MUSORSTOM 3 (1985) expedition in the Philippines and not studied by ROSELL (1991) are also recorded. The collections examined have shown an exceptional diversity of Verrucidae : from the 124 sites considered, 16 verrucid species are recorded; seven of these are new to science, and the range of many other taxa is extended. This paper also considers aspects of verrucomorph systematics, biogeography and distribution.

The Verrucidae are characterised by six calcareous plates. The shell is made up of the carina and rostrum, plus a tergum and scutum, the latter two having moved from the operculum to become "fixed" as part of the shell wall. The remaining plates, a tergum and scutum (hereafter termed movable plates) make up the operculum. It appears to be totally random as to whether the "left" or "right" opercular plates move to complete the shell wall (DARWIN, 1854), in the specimens studied the ratio being close to 50:50. However, in *Neoverruca*, right or left sidedness depended on which side the juveniles settled on, relative to the current (NEWMAN, 1989).

TYPES : All new taxa are either from New Caledonian or Wallis and Futuna waters; holotypes are held by the Muséum national d'Histoire naturelle (e.g. MNHN-Ci) in Paris, France. Paratypes are held by the Muséum national d'Histoire naturelle, and when numbers of specimens available permit, by the National Museum of Natural History, Washington (e.g. USNM) and UNITEC Institute of Technology, New Zealand (e.g. CAX).

In addition to types, figured material collections have also been allocated registration numbers (e.g. MNHN-Ci, held by the Muséum national d'Histoire naturelle, Paris).

In the lists of material examined the abbreviations of the gears used are : CC = otter trawl (shrimps); CP = beam trawl; DC = Charcot dredge; DS = Sanders epibenthic dredge; DW = Warren dredge; KG = Usnel Box-Corer.

## LIST OF SPECIES

Genus **VERRUCA** Schumacher, 1817

*Verruca albatrossiana* Pilsbry, 1912

Genus **ALTIVERRUCA** Pilsbry, 1916

*Altiverruca cristallina* (Gruvel, 1907)

*Altiverruca galapagosa* Zevina, 1987

*Altiverruca laeviscuta* sp. nov.

*Altiverruca navicula* (Hoek, 1913)

*Altiverruca nitida* (Hoek, 1883)

Genus **CAMERAVERRUCA** Pilsbry, 1916

*Cameraverruca nodiscuta* sp. nov.

Genus **BROCHIVERRUCA** Zevina, 1993

*Brochiverruca dens* (Broch, 1932)

*Brochiverruca polystriata* sp. nov.

Genus **METAVERRUCA** Pilsbry, 1916

*Metaverruca defayae* sp. nov.

*Metaverruca norfolkensis* sp. nov.

*Metaverruca pacifica* sp. nov.

*Metaverruca plicata* sp. nov.

*Metaverruca recta* (Aurivillius, 1898)

Genus **ROSTRATOVERRUCA** Broch, 1922

*Rostratoverruca intexta* (Pilsbry, 1912)

*Rostratoverruca kruegeri* (Broch, 1922)

## SYSTEMATIC ACCOUNT

Order THORACICA Darwin, 1854

Suborder VERRUCOMORPHA Pilsbry, 1916

DIAGNOSIS. — Sessile thoracican cirripedes, with an asymmetrical shell wall comprising a fixed scutum, fixed tergum, rostrum and carina, closed by a movable scutum and movable tergum (Verrucidae), sometimes including a rostrolatus and a carinolatus on the movable side (Proverrucidae), or basal whorls of imbricating plates (Neoverrucidae); basis membranous or calcareous; caudal appendages usually present; mandible generally tridentoid; crest of bullate labrum usually bearing teeth.

DISCUSSION. — NEWMAN and HESSLER (1989) described *Neoverruca brachylepadoformis*, a living, abyssal species that demonstrated links between the Brachylepadoromorpha and the Verrucomorpha. The significance of this find warranted a closer analysis of verrucomorph cirripedes, with a resultant split of the family, such that the revised Verrucidae comprise only those verrucomorphans with six plates.

Family VERRUCIDAE Darwin, 1854  
(amend. NEWMAN & HESSLER, 1989)

DIAGNOSIS. — Verrucomorphans with the primary wall (carina, rostrum, fixed scutum, fixed tergum), in contact with the substratum and without latera of any sort.

DISCUSSION. — In 1916, PILSBRY proposed four "Sections" or subgenera in the genus *Verruca*, and these were later added to by BROCH (1922), and ZEVINA (1978), who also elevated the subgenera to generic status. This paper follows ZEVINA's revision and includes her 1993 genus: *Brochiverruca*.

The presence of a myophore on the fixed scutum is generally of considerable value in classification, although in *Brochiverruca*, the myophore is absent from *B. dens* but present in *B. polystriata* sp. nov. It should also be noted that the angle of the operculum to the base may vary, particularly in *Altiverruca*, where the nature of the substrate appears to have a strong influence. *Metaverruca* and *Verruca* however, appear far more consistent, as I have not seen specimens with the operculum even close to perpendicular to the base. PILSBRY (1916) concluded that much could be deduced about the habitat of verrucids by the shell shape. His material demonstrated that shallow water forms were invariably depressed, with broadly spreading walls, whilst erect forms were found in deep water. The present collection, with depressed forms like *Metaverruca recta* having been collected from depths in excess of 2000 metres, does not bear this out.

I am a little uncertain about the status of *Spongoverruca* Zevina, (1978). Although some verrucids appear to be host specific, I am not confident that this is a sufficient criterion to warrant generic separation. Further, many workers, from PILSBRY (1916), consider a fixed scutal myophore to be of importance in defining verrucid genera, unfortunately in her diagnosis of *Spongoverruca*, ZEVINA makes no specific reference to this character (V. MELNIKOV, pers. com.).

Morphology of the soft parts can be of considerable help in identifying species, particularly of *Metaverruca*. However all new taxa described here possess differences in shell morphology as well, with most species being able to be identified on shell morphology alone. Most verrucids possess a mandible with a tridentoid cutting edge, the lower angle being pectinate, hirsute or a mixture of both. The first maxilla generally has one or two prominent upper spines, a central notch that may be hirsute or spinose, and a lower angle with shorter spines and hairs. Both the penis and caudal appendages vary considerably between taxa, ranging from less than the length of the basal segment of the pedicel of cirrus VI, to more than the length of the entire cirrus. The nomenclature used in this paper is explained in figure 1.

STRATIGRAPHIC RANGE. — ?Middle, Upper Cretaceous to Recent, Europe, South America, Australasia.

DISTRIBUTION. — Cosmopolitan in present seas.

### Key to genera of the Verrucidae

1. Rostral and carinal apices marginal ..... 2
  - Rostral apex only removed from margin ..... *Rostratoverruca*
  - Rostral and carinal apices removed from margin ..... *Brochiverruca*
2. Myophore present on fixed scutum ..... 3
  - Myophore absent on fixed scutum..... 4
3. Operculum nearly vertical to base ..... *Cameraverruca*
  - Operculum nearly parallel to base ..... *Metaverruca*
4. Operculum nearly vertical to base ..... 5
  - Operculum nearly parallel to base ..... *Verruca*
5. Not embedded in sponge ..... *Altiverruca*
  - Embedded in sponge ..... *Spongoverruca*

### Genus *VERRUCA* Schumacher, 1817

*Verruca* "Section B"- PILSBRY, 1916 : 23.

*Verruca* (*Verruca*) - FOSTER, 1978 : 68.

*Verruca* - ZEVINA, 1978 : 1812. — NEWMAN & HESSLER, 1989 : 268.

DIAGNOSIS. — Verrucids with apices of rostrum and carina marginal; fixed scutum without myophore; operculum parallel to base.

TYPE. — *Lepas stroemia* Müller, 1776. North Atlantic, northern Europe, Mediterranean, ?Red Sea, intertidal - 500 metres.

SPECIES. — 24 taxa are presently attributed to this genus : *V. stroemia* (Müller, 1776), *V. laevigata* (Sowerby, 1827), *V. prisca* Bosquet, 1853, *V. pusilla* Bosquet, 1857, *V. nuciformis* Buckeridge, 1983, *V. rocana* Steinmann, 1921, *V. spengleri* Darwin, 1854, *V. tasmanica tasmanica* Buckeridge, 1983, *V. tasmanica chatheca* Buckeridge, 1983, *V. cookei* Pilsbry, *V. withersi* Newman & Schram, 1980, *V. alba* Pilsbry, 1907, *V. alba caribbea* Pilsbry, 1916, *V. alba barbadensis* Pilsbry, 1916, *V. calotheca* Pilsbry, 1907, *V. calotheca flavidula* Pilsbry, 1916, *V. calotheca heteropoma* Pilsbry, 1916, *V. calotheca niasiensis* Nilsson-Cantell, 1929, *V. floridiana* Pilsbry, 1916, *V. xanthia* Pilsbry, 1916, *V. xanthia insculpta* Pilsbry, 1916, *V. entobapta* Pilsbry, 1916, *V. macani* Stubbings, 1936, *V. scrippsae* Zullo, 1964.

DISCUSSION. — The status of *Verruca sensu stricto* is a little unclear at present. There are forms like *Verruca stroemia* and *V. laevigata* that clearly fall into a distinct group : the shells possess a low profile, are found in higher energy, shallow water environments, and of necessity have the operculum approximately parallel to the substrate. Deeper water forms like *Verruca albatrossiana* Pilsbry are quite different, and although the operculum is indeed "sub-parallel" to the basis, *V. albatrossiana* is normally found growing attached to cylindrical objects like cidaroid spines. As such the base is curved, and in theory, will at some point parallel the operculum. I believe greater consideration of genus *Verruca* is warranted, and it is likely that the *V. albatrossiana*-like forms will form a separate genus. As there is only one "*Verruca*" species present in this collection, it is considered prudent to await consideration of a wider range of material before splitting the genus. A further complication exists in the

terminology used by BROCH (1932), where he uses the term *Eu-Verruca* for the central group of genus *Verruca sensu lato*. In a somewhat ambiguous footnote, BROCH (1932 : 45) states that *Eu-Verruca* "... may serve to bring confusion about".

STRATIGRAPHIC RANGE. — Cretaceous (Australia, New Zealand, Columbia, western Europe), Palaeogene (New Zealand, Argentina, Chatham Islands).

DISTRIBUTION. — Pacific, North Atlantic, Mediterranean, Caribbean, ?Red Sea, Indian Ocean, intertidal - 620 metres.

*Verruca albatrossiana* Pilsbry, 1912

Fig. 1 a-f

*Verruca albatrossiana* Pilsbry, 1912 : 292.

*Verruca (Eu-Verruca) albatrossiana* - BROCH, 1922 : 290, figs 39, 40.

*Verruca grex* Hoek, 1913 : 142, pl. 11, figs 7-13, pl. 13, figs 11-13.

MATERIAL EXAMINED. — **Indonesia**. KARUBAR : stn CP 39, 07°45'43"S, 132°28'22"E, 466-477 m, 28.10.1991 : 19 specimens (MNHN-Ci 2291), on cidaroid spines. — Stn CC 57, 08°15'48"S, 131°56'38"E, 603-620 m, 31.10.1991 : 9 specimens, on cidaroid spines.

DIAGNOSIS. — *Verruca* with rostrum and carina low, strongly developed longitudinally to give the shell an oblique appearance; fixed scutum considerably larger than fixed tergum, opercular plates displaced carinally.

DESCRIPTION. — Shell white, walls ribbed vertically; obliquely skewed towards the carina; rostrum moderately low, with an upper, broad triangular portion extending towards the carina; carina long, low, extending beneath much of the rostrum.

Fixed scutum considerably larger than fixed tergum, with a "folded over" portion on movable scutal margin, forming a zone confluent with the plane of the operculum; both fixed tergum and scutum with apices concurrent with those of the movable plates.

Movable scutum a little narrower than the movable tergum, triangular, with five diagonal ribs, primary rib arched towards tergal margin, strongly rounded, terminating at the basi-tergal angle, first secondary rib immediately adjacent to primary rib, secondary ribs interlocking with tergum; apex beaked.

Movable tergum quadrilateral, apex slightly curved towards scutum, primary apico-basal rib almost straight, with four secondary ribs.

Mandible tridentate, lower angle pectinate and divided into two portions; first maxilla with two large upper spines, a pectinate notch, lower angle with five shorter spines. Crest of labrum with fine, numerous teeth, palps pointed.

Cirrus I relatively hirsute compared with other cirri, inner ramus shorter; penis a little less than two thirds the length of cirrus VI; caudal appendages very long. Cirri from MNHN-Ci 2291 possessed the following number of segments (r-c being rostro-carinal diameter) :

r-c (mm)	I	II	III	IV	V	VI	c.a.
7.0	9,18	7,18	13,19	12,19	18,19	21,22	27

DISCUSSION. — This species is characterised by "the unusual length of the rostrum and fixed tergum" (PILSBRY, 1912), giving a distinct obliqueness to the shell, with a resultant displacement the opercular plates carinally. It falls into a group with *Verruca grex* Hoek, 1913, but is distinguished from *V. grex* by possessing a less elevated operculum, and fewer apico-basal ribs on the movable scutum.

DISTRIBUTION. — Indo-Pacific, 345-620 metres.

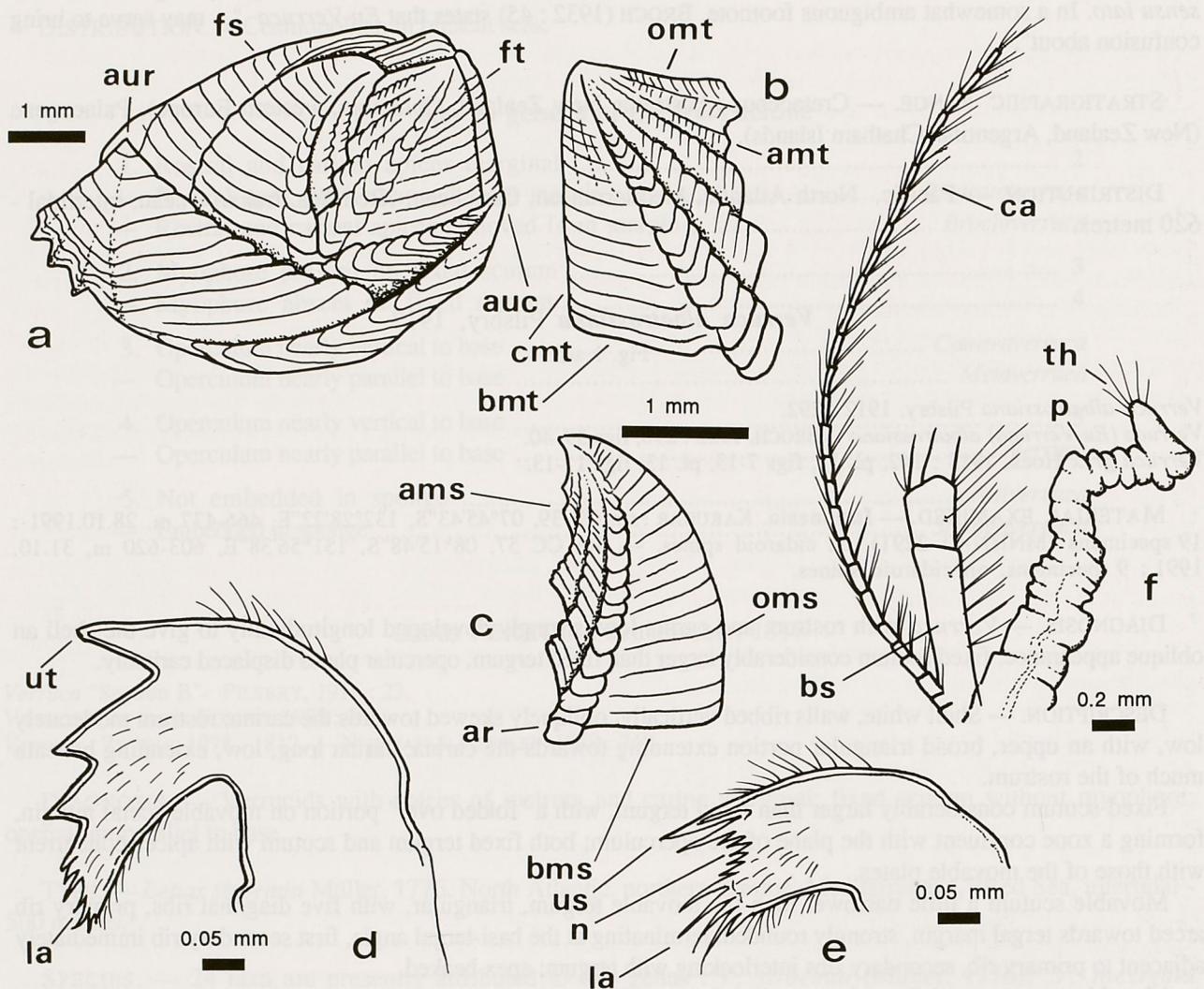


FIG. 1. — *Verruca albatrossiana* Pilsbry, 1912 : a, complete shell (right side), MNHN-Ci 2291; b, movable tergum (left, exterior); c, movable scutum (left, exterior); d, mandible; e, first maxilla; f, pedicel of sixth cirrus, with penis and caudal appendage attached. All material from KARUBAR, stn CP 39. Figures b and c are at the same scale.

Abbreviations : *a.m.s.* = articular margin of the movable scutum; *a.m.t.* = articular (scutal) margin of the movable tergum; *a.r.* = apico-basal ridge of scutum (and tergum); *a.u.c.* = apical umbone of carina; *a.u.r.* = apical umbone of rostrum; *b.m.s.* = basal margin of the movable scutum; *b.m.t.* = basal margin of the movable tergum; *b.s.* = basal segment of the pedicel of cirrus VI; *c.a.* = caudal appendage; *c.m.t.* = carinal margin of the movable tergum; *f.s.* = fixed scutum; *ft.* = fixed tergum; *l.a.* = lower angle of the first maxilla; *n.* = notch of first maxilla; *o.m.s.* = occludent margin of the movable scutum; *o.m.t.* = occludent margin of the movable tergum; *p.* = penis; *t.h.* = penis with hirsute terminus; *u.s.* = upper spine of the first maxilla; *u.t.* = upper tooth of the mandible.

#### Genus *ALTIVERRUCA* Pilsbry, 1916

*Verruca* "Section D": *Altiverruca* Pilsbry, 1916 : 40.

*Verruca* (*Altiverruca*) - FOSTER, 1978 : 68.

*Altiverruca* - ZEVINA, 1978 : 1813.

DIAGNOSIS. — Verrucids with erect form, bases of plates not inflected; operculum close to vertical; myophore absent.

TYPE. — *Verruca hoeki* Pilsbry, 1907 : 113. West Indies, 907-1060 metres.

SPECIES. — The 34 taxa presently attributed to this genus include : *A. gibbosa* (Hoek, 1883), *A. incerta* (Hoek, 1883), *A. obliqua* (Hoek, 1883), *A. nitida* (Hoek, 1883), *A. quadrangularis* (Hoek, 1883), *A. sulcata* (Hoek, 1883), *A. crenata* (Aurivillius, 1898), *A. erecta* (Gruvel, 1900), *A. longicarinata* (Gruvel, 1900), *A. radiata* (Gruvel, 1901), *A. cristallina* (Gruvel, 1907), *A. darwini* (Pilsbry, 1907), *A. hoeki* (Pilsbry, 1907), *A. mitra* (Hoek, 1907), *A. plana* (Gruvel, 1907), *A. cassis* (Hoek, 1913), *A. casula* (Hoek, 1913), *A. navicula* (Hoek, 1913), *A. bicornuta* (Pilsbry, 1916), *A. rathburniana* (Pilsbry, 1916), *A. cristallina laevis* (Broch, 1922), *A. gibbosa somaliensis* (Nilsson-Cantell, 1929), *A. aves* (Zevina, 1975), *A. angustiterga* Zevina, 1987, *A. galapagosa* Zevina, 1987, *A. gira* (Zevina, 1987), *A. sublima* Zevina, 1987, *A. sculpturata* Zevina, 1987, *A. longa* Zevina, 1988, *A. tchesunovi* Zevina, 1988, *A. vitrea* Zevina, 1988, *A. mollae* Zevina, 1990, plus the new species described here : *Altiverruca laeviscuta* sp. nov.

DISCUSSION. — *Altiverruca* is the largest verrucid genus known. On the basis of gross shell morphology, the material examined here suggests at least two groups within the genus. There are those with very laterally compressed shells (*A. galapagosa*, *A. laeviscuta*, *A. navicula*, and *A. nitida*); whilst the remaining species, *A. cristallina* possesses a more rounded cross-section. As discussed under *Verruca*, any subdivision of the genus is deferred until a wider range of taxa is able to be considered.

In his initial proposal of *Altiverruca*, PILSBRY stated that "Section D : *Altiverruca*" was characterised by species with very short caudal appendages. Since that time, on consideration of other features, further taxa have been included within the group (e.g. FOSTER, 1978), with some, like *A. navicula* and *A. nitida*, having very long caudal appendages.

DISTRIBUTION. — Cosmopolitan, 233- 4950 metres.

### *Altiverruca cristallina* (Gruvel, 1907)

Fig. 2 a-h

*Verruca cristallina* Gruvel, 1907 : pl. 1, figs 9, 10.

*Verruca cristallina laevis* - BROCH, 1922 : fig. 41 a-d.

*Verruca (Altiverruca) cristallina* - ROSELL, 1989 : 24, Pl. 6, figs d-i. — ROSELL, 1991 : 34.

MATERIAL EXAMINED. — **New Caledonia.** BIOCAL : stn CP 5, 21°16.49'S, 166°43.56'E, 2340 m, 11.08.1985 : 20 specimens (MNHN-Ci 2321), on pumice. — Stn CP 23, 24°45.84'S, 166°20.33'E, 2040 m, 28.08.1985 : 30 specimens, on pumice and bivalves. — Stn CP 26, 20°39.66'S, 166°27.41'E, 1618-1740 m, 28.08.1985 : 3 specimens. — Stn CP 27, 22°05.52'S, 166°26.41'E, 1850-1900 m, 28.08.1985 : 29 specimens, on pebbles. — Stn KG 28, 23°05.47'S, 166°27.27'E, 1750 m, 28.08.1985 : 3 specimens. — Stn DW 44, 22°47.35'S, 167°14.50'E, 450 m, 30.08.1985 : 1 specimen, on coral. — Stn CP 57, 23°44'S, 166°58'E, 1490-1620 m, 01.09.1985 : 18 specimens, on pebbles. — Stn CP 58, 23°56.52'S, 166°40.55'E, 2660 m, 01.09.1985 : 1 specimen. — Stn DS 59, 23°56.21'S, 166°41.10'E, 2650 m, 02.09.1985 : 3 specimens. — Stn DW 66, 24°55.43'S, 168°21.67'E, 510 m, 03.09.1985 : 1 specimen. — Stn KG 71, 22°04.85'S, 167°32.70'E, 2100 m, 04.09.1985 : 1 specimen, on pumice. — Stn CP 72, 22°10'S, 167°33'E, 2100-2110 m, 04.09.1985 : 7 specimens, on pumice.

**Loyalty Islands.** MUSORSTOM 6 : stn 438, 20°23.00'S, 166°20.10'E, 780 m, 18.02.1989 : 2 specimens, on pumice.

**Chesterfield Islands.** MUSORSTOM 5 : stn DW 337, 19°53.80'S, 158°38.00'E, 412-430 m, 15.10.1986 : 1 specimen. — Stn DC 385, 20°53.60'S, 160°49.40'E, 745-750 m, 22.10.1986 : 5 specimens, on coral.

**Wallis and Futuna Islands.** MUSORSTOM 7 : stn CP 551, 12°15.3'S, 178°28.1'W, 791-795 m, 11.05.1992 : 7 specimens, on shell debris. — Stn CP 623, 12°34.2'S, 178°15.1'W, 1280-1300 m, 28.05.1992 : 1 specimen, on pebble.

DIAGNOSIS. — *Altiverruca* with carina and rostrum interlocking with up to six ribs; movable tergum with four to five articulating ribs, at least two of which articulate with the scutum; caudal appendages short.

DESCRIPTION. — Shell white, almost translucent, less compressed laterally than most *Altiverruca*, with regular, sinusoidal growth lines; rostrum and carina interlock with two to three main ribs, but weaker interlocking occurs below this with another three to four ribs; base weakly calcified.

Fixed tergum and fixed scutum interlocking with a single rib only on larger specimens.

Movable tergum quadrangular, with three diagonal ribs, increasing to four in specimens over 5 mm in length, first rib strong, others decreasingly weaker away from diagonal.

Movable scutum triangular, relatively wide, with two diagonal ribs, which interlock with the tergum, the rib closest to the articular margin weak to absent in smaller specimens.

Mandible tridentate, second and third teeth pectinate on the upper surface; first maxilla with two large upper spines, notch with two small spines, lower angle with six to seven spines.

Labrum with finely toothed crest; palps pointed.

Cirrus I relatively hirsute compared with other cirri, inner ramus shorter, although it may have slightly more segments; cirri II-VI with inner ramus shorter; penis short, slightly hirsute terminally; caudal appendages short. Cirri possessed the following number of segments (r-c being rostro-carinal diameter) :

r-c (mm)	I	II	III	IV	V	VI	c.a.
4.6	9,11	11,13	21,23	26,30	19+,30	32,35	9
4.8	13,12	11,14	19,21	29,33	32,35	32,35	9

+ incomplete ramis

Of the specimens examined, the length of the caudal appendages was close to that of the basal segment of the pedicel of cirrus VI.

DISCUSSION. — The considerable amount of material collected of this species has shown the differences between *Verruca cristallina cristallina* and *Verruca cristallina laevis* listed by BROCH (1932), as insufficient for continued separation. The strength of ribbing on the opercular plates is variable, with larger specimens developing stronger ribs (the smaller specimens described by BROCH, about 4 mm in diameter, had weaker ribs). The long caudal appendages (with up to 25 segments) noted by GRUVEL (1907) have not been recorded in either this material or in that of BROCH (1922), perhaps this anomaly could have been used to split the species, but I feel that there is little point in following this course of action, particularly in light of GRUVEL's rather schematic drawings.

Up to six interlocking ribs between rostrum and carina can be observed in this material; however, all the specimens described by BROCH (1922) showed only three ribs, although the specimens he studied appeared to be less than 4 mm in rostro-carinal diameter. These extra ribs, and any rib between fixed tergum and scutum, are considered ontogenetic :

r-c (mm)	rib between r & c	rib between fixed s & t
2.9	3	no
3.4	3	yes
3.8	5	yes
3.8	6	no
4.4	5	yes

The degree of mineralisation of the base also varies, with extensive calcification only evident in larger specimens.

*Altiverruca allisoni* Rao & Newman, 1972 is close to this species. RAO and NEWMAN have distinguished *A. allisoni* on the basis of its possessing seven interlocking ribs between rostrum and carina, lacking multiple interlocking ridges between the suture of the fixed tergum and scutum, and in lacking the small beaded ridges along the scutal margin of the rostrum. Although only six interlocking ribs were noted between rostrum and carina in this study, analysis suggests that the first distinguishing feature (and perhaps the second), may be ontogenetic. The best way to differentiate between the two species is on the basis of the movable scutum, which in *A. cristallina* possesses an extra longitudinal rib.

This collection has extended the known depth range for this species from 1600 to 2340 metres.

DISTRIBUTION. — Tropical Pacific, 233-2340 metres.

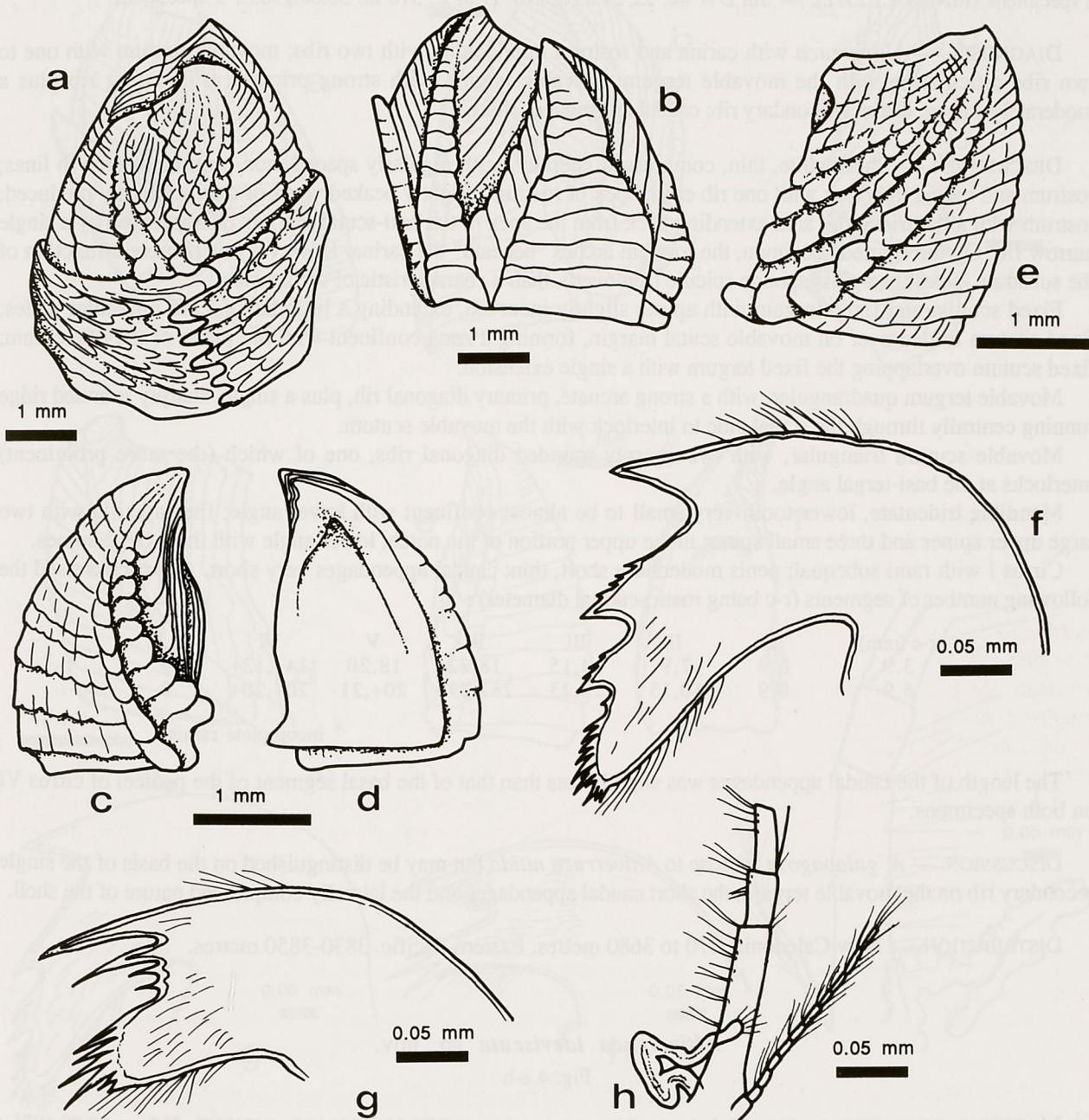


FIG. 2. — *Altiverruca cristallina* Gruvel, 1907 : a, complete shell (dorsal view), MNHN-Ci 2321; b, complete shell (fixed tergal-fixed scutal view), MNHN-Ci 2321; c, movable scutum (exterior); d, movable scutum (interior); e, movable tergum (exterior); f, mandible; g, first maxilla; h, basal portion of sixth cirrus, with penis and caudal appendage attached. All material from KARUBAR, stn CP 5.

*Altiverruca galapagosa* Zevina, 1987

Fig. 3 a-i

*Altiverruca galapagosa* Zevina, 1987 : 1814, pl. 1 figs a-h.

MATERIAL EXAMINED. — **New Caledonia**. BIOCAL : stn CP 17, 20°34.54'S, 167°24.68'E, 3680 m, 14.08.1985 : 2 specimens (MNHN-Ci 2322). — Stn DW 46, 22°53.05'S, 167°17.08'E, 570 m, 30.08.1985 : 3 specimens.

DIAGNOSIS. — *Altiverruca* with carina and rostrum interlocking with two ribs; movable scutum with one to two ribs articulating with the movable tergum; movable tergum with strong primary articulating rib plus a moderately strong, distinct secondary rib; caudal appendages short.

DESCRIPTION. — Shell white, thin, compressed laterally, with regularly spaced, non-prominent growth lines; rostrum and carina interlock with one rib each; apex of rostrum slightly beaked, apex of carina slightly produced; rostrum with a flat triangular area extending back from the apex to the basi-scutal margin, characterised by a single narrow rib. On the figured specimen, the rostrum arches "beneath" the carina. However this is more a function of the substrate, possibly a glass sponge spicule (removed), than a characteristic of the species.

Fixed scutum and fixed tergum with apices slightly incurved, extending a little beyond the opercular plates; fixed scutum folded over on movable scutal margin, forming a zone confluent with the plane of the operculum; fixed scutum overlapping the fixed tergum with a single extension.

Movable tergum quadrangular, with a strong arcuate, primary diagonal rib, plus a single, sharply rounded ridge running centrally through the scutal side to interlock with the movable scutum.

Movable scutum triangular, with two sharply rounded diagonal ribs, one of which (the more prominent) interlocks at the basi-tergal angle.

Mandible tridentate, lower tooth very small to be almost confluent with lower angle; first maxilla with two large upper spines and three small spines in the upper portion of the notch, lower angle with three large spines.

Cirrus I with rami subequal; penis moderately short, thin; caudal appendages very short. Cirri possessed the following number of segments (r-c being rostro-carinal diameter) :

r-c (mm)	I	II	III	IV	V	VI	c.a.
3.9	8,9	7,9	14,15	18,22	18,20	14+,13+	9
6.9	8,9	10,13	22,23	26+,29+	20+,21	20+,20+	9

+ incomplete ramis

The length of the caudal appendages was slightly less than that of the basal segment of the pedicel of cirrus V on both specimens.

DISCUSSION. — *A. galapagosa* is close to *Altiverruca nitida* but may be distinguished on the basis of the single secondary rib on the movable tergum, the short caudal appendages and the laterally compressed nature of the shell.

DISTRIBUTION. — **New Caledonia**, 570 to 3680 metres, Eastern Pacific, 3830-3850 metres.

*Altiverruca laeviscuta* sp. nov.

Fig. 4 a-h

MATERIAL EXAMINED. — **New Caledonia**. MUSORSTOM 4 : stn DW 221, 22°46'S, 167°09'E, 535 m, 29.09.1985 : 1 specimen, on coral.

TYPE. — *Holotype* : MNHN-Ci 2326, rostro-carinal diameter : 3.0 mm, height : 4.6 mm, (from MUSORSTOM 4, Stn DW 221).

DIAGNOSIS. — *Altiverruca* with movable tergum possessing two diagonal ribs; movable scutum flat, apical basal line defined by growth-line deflection; caudal appendages short.

DESCRIPTION. — Shell white, with regularly spaced, non-prominent growth lines; rostrum and carina interlock with three ribs; apex of rostrum and carina produced.

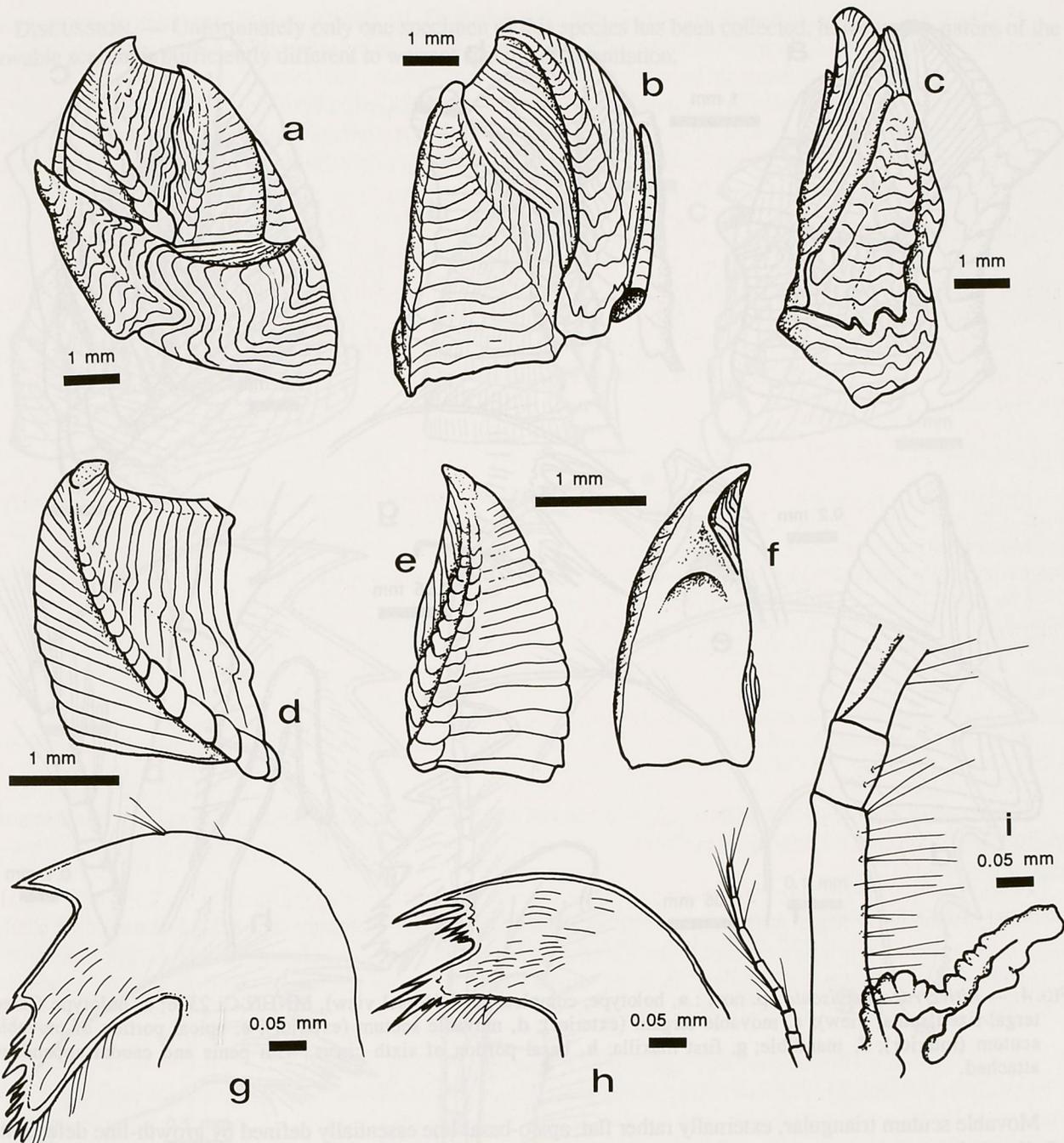


FIG. 3. — *Aliverruca galapagosa* Zevina, 1987 : a, complete shell (dorsal view), MNHN-Ci 2322; b, complete shell (fixed tergal-fixed scutal view); c, complete shell (rostral view); d, movable tergum (exterior); e, movable scutum (exterior); f, movable scutum (interior); g, mandible; h, first maxilla; i, basal portion of sixth cirrus, with penis and caudal appendage attached. All material from BIOCAL, stn CP 17.

Fixed scutum and fixed tergum with apices extending beyond the opercular plates; fixed scutum interlocking with the rostrum by two ribs, and folded over on its upper margin to form a surface confluent with the plane of the operculum.

Movable tergum quadrangular, with a strong, sharply rounded primary diagonal rib, plus a wide secondary rib running centrally through the scutal side.

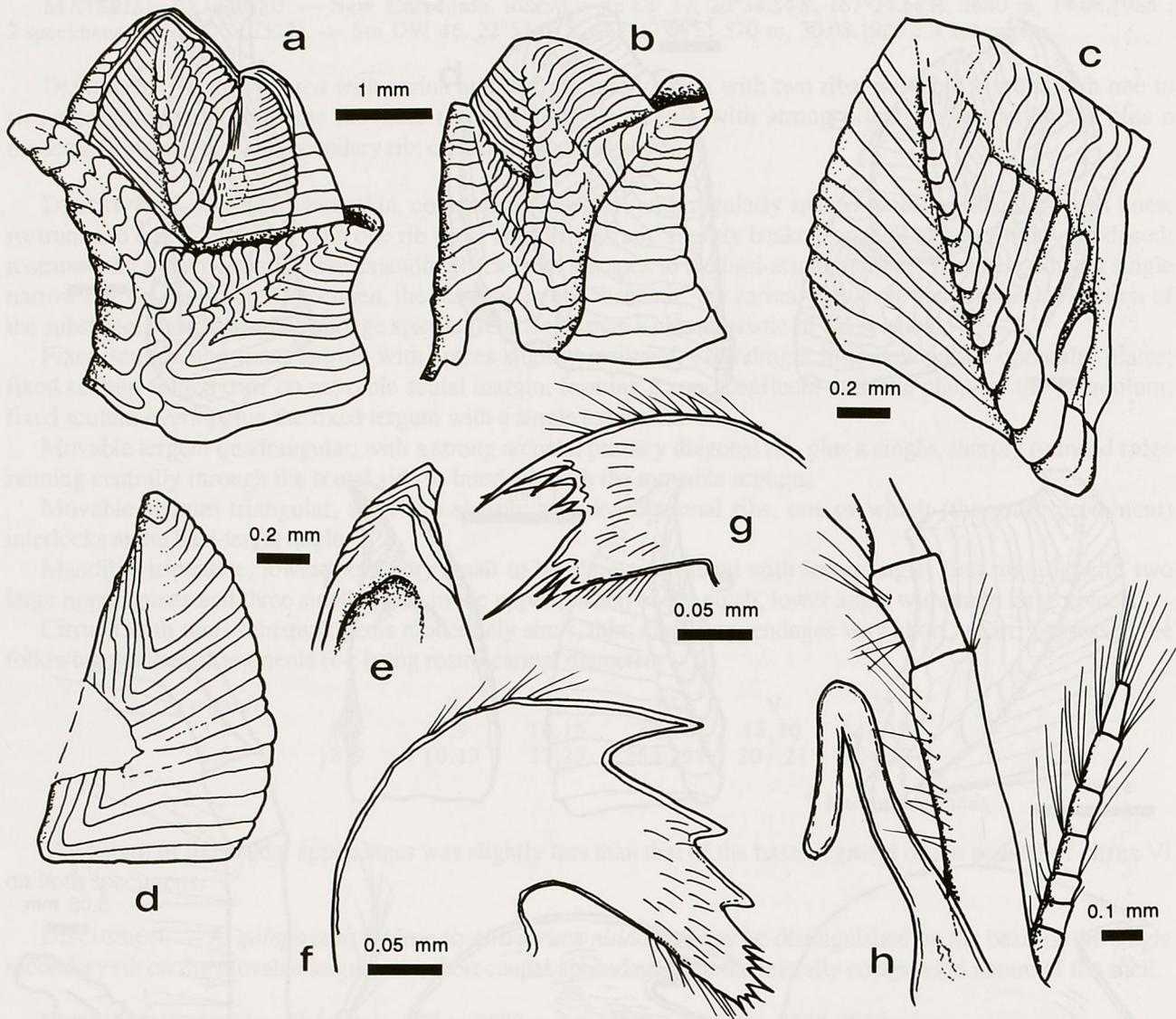


FIG. 4. — *Altiverruca laeviscuta* sp. nov. : a, holotype, complete shell (dorsal view), MNHN-Ci 2326; b, holotype (fixed tergal-fixed scutal view); c, movable tergum (exterior); d, movable scutum (exterior); e, apical portion of movable scutum (interior); f, mandible; g, first maxilla; h, basal portion of sixth cirrus, with penis and caudal appendage attached.

Movable scutum triangular, externally rather flat, apico-basal line essentially defined by growth-line defection, a further inflection on the tergal margin corresponds with a very weakly defined secondary tergal rib; interior with a moderately developed depression for the adductor muscle attachment.

Mandible tridentate, lower angle pectinate with six small spines; first maxilla with two large and one small upper spines, notch with two small spines, lower angle with one large spine and two smaller spines, hirsute.

Cirrus I with rami longer than those of cirrus II; penis short, thin; caudal appendages very short, stout. Cirri of MNHN-Ci 2326 possessed the following number of segments (r-c being rostro-carinal diameter) :

r-c (mm)	I	II	III	IV	V	VI	c.a.
3.0	10,8	7,10	14,16	19,22	23,25	24,25	7

The length of the caudal appendages was approximately equal to that of the basal segment of the pedicel of cirrus VI.

DISCUSSION. — Unfortunately only one specimen of this species has been collected, however the nature of the movable scutum is sufficiently different to warrant specific differentiation.

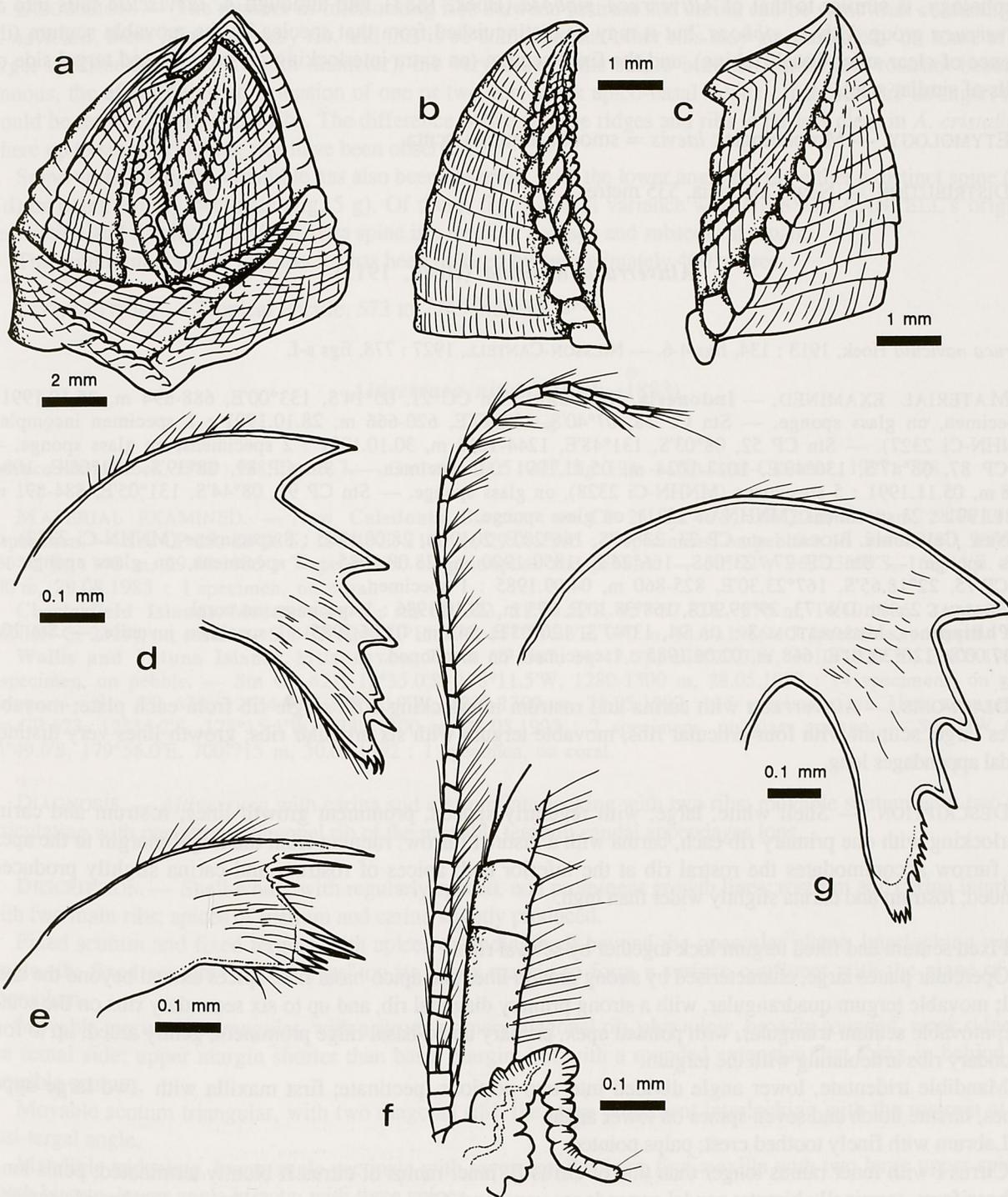


FIG. 5. — *Aliverruca navicula* (Hoek, 1913) : a, complete shell (dorsal view), MNHN-Ci 2328; b, movable scutum (exterior), MNHN-Ci 2327; c, movable tergum (exterior); d, mandible; e, first maxilla; f, basal portion of sixth cirrus, with penis and caudal appendage attached; g, mandible (variety), MNHN-Ci 2332. Material : a, from KARUBAR, stn CP 89; b-f, from KARUBAR, stn CP 38; g, from BIOCAL, stn CP 23.

*A. laeviscuta* may be distinguished from most other verrucids by the flat movable scutum. It is similar to *A. nitida* but possesses a stronger secondary rib on the movable tergum and shorter caudal appendages; it is distinguished from *A. galapagosa* by a longer rostro-carinal suture. The overall shell form, and soft part morphology, is similar to that of *Altiverruca gibbosa* (Hoek, 1883), and although *A. laeviscuta* falls into an *Altiverruca* group with *A. gibbosa*, but it may be distinguished from that species by the movable scutum (the absence of clear apico-basal ribbing), and the fixed scutum (an extra interlocking rib on the fixed tergal side on shells of similar size).

ETYMOLOGY. — Morphologic : *laevis* = smooth (Latin) + *scuta*.

DISTRIBUTION. — New Caledonia, 535 metres.

*Altiverruca navicula* (Hoek, 1913)

Fig. 5 a-g, 16 a-b

*Verruca navicula* Hoek, 1913 : 134, figs 4-6. — NILSSON-CANTELL, 1927 : 778, figs a-f.

MATERIAL EXAMINED. — **Indonesia.** KARUBAR : stn CC 21, 05°14'S, 133°00'E, 688-694 m, 25.10.1991 : 1 specimen, on glass sponge. — Stn CP 38, 07°40'S, 132°27'E, 620-666 m, 28.10.1991 : 1 specimen incomplete (MNHN-Ci 2327). — Stn CP 52, 08°03'S, 131°48'E, 1244-1266 m, 30.10.1991 : 2 specimens, on glass sponge. — Stn CP 87, 08°47'S, 130°49'E, 1017-1024 m, 05.11.1991 : 1 specimen. — Stn CP 89, 08°39'S, 131°08'E, 1084-1058 m, 05.11.1991 : 5 specimens (MNHN-Ci 2328), on glass sponge. — Stn CP 91, 08°44'S, 131°05'E, 884-891 m, 05.11.1991 : 21 specimens (MNHN-Ci 2331), on glass sponge.

**New Caledonia.** BIOCAL : stn CP 23, 22°46'S, 166°20'E, 2040 m, 28.08.1985 : 8 specimens (MNHN-Ci 2332), on glass sponge. — Stn CP 27, 23°06'S, 166°26'E, 1850-1900 m, 28.08.1985 : 2 specimens, on glass sponge. — Stn CP 75, 22°18.65'S, 167°23.30'E, 825-860 m, 04.09.1985 : 1 specimen.

CHALCAL 2 : stn DW 73, 29°39.90'S, 168°38.10'E, 573 m, 29.10.1986 : 1 specimen, on coral.

**Philippines.** MUSORSTOM 3 : stn 94, 13°47'S, 120°03'E, 842 m, 01.06.1985 : 1 specimen juvenile. — Stn 106, 13°47.00'S, 120°30.30'E, 668 m, 02.06.1985 : 1 specimen, on scaphopod.

DIAGNOSIS. — *Altiverruca* with carina and rostrum interlocking with single rib from each plate; movable plates large, scutum with four articular ribs, movable tergum with six articular ribs; growth lines very distinct; caudal appendages long.

DESCRIPTION. — Shell white, large, with regularly spaced, prominent growth lines; rostrum and carina interlocking with one primary rib each, carina with a distinct furrow, running from the tergal margin to the apex, this furrow accommodates the rostral rib at the inferior end; apices of rostrum and carina slightly produced, rounded; rostrum and carina slightly wider than high.

Fixed scutum and fixed tergum lock together by several ribs.

Opercular plates large, characterised by strong growth lines and apico-basal ribs; apices extend beyond the shell wall; movable tergum quadrangular, with a strong primary diagonal rib, and up to six secondary ribs on the scutal side; movable scutum triangular, with pointed apex, primary apico-basal ridge prominent, gently arced, up to four secondary ribs articulating with the tergum.

Mandible tridentate, lower angle divided into two portions, pectinate; first maxilla with two large upper spines, hirsute notch and seven spines on lower angle.

Labrum with finely toothed crest; palps pointed.

Cirrus I with inner ramus longer than that of cirrus II; inner ramus of cirrus II bluntly terminated; penis long, probosciform, terminally hirsute; caudal appendages very long. Cirri possessed the following number of segments (r-c being rostro-carinal diameter) :

r-c (mm)	I	II	III	IV	V	VI	c. a.
8.4	11,19	8,19	20,22	23,25	22,26	27,28	31
10.7	15,25	9,24	22,25	30,33	32,34	31,34	28

Of the specimens examined, the length of the caudal appendages was a little more than twice that of the basal segment of the pedicel of cirrus VI.

DISCUSSION. — The number of interlocking ribs between rostrum and carina can be somewhat confusing. In *A. navicula*, there is one primary rib, and this is so dominant that other ribs may go unnoticed; on some of the larger specimens (e.g. > 10 mm diameter), the very base of the suture between carina and rostrum becomes sinuous, the effect being an extension of one or two very weak apico-basal ridges. If these were stronger, they would be termed interlocking ribs. The difference between these ridges and ribs is far less clear in *A. cristallina*, where up to six interlocking ribs have been observed.

Some variation in the mandible has also been observed, with the lower angle having either a distinct spine (fig. 5 d) or being evenly pectinate (fig. 5 g). Of these, fig. 5 d is at variance with NILSSON-CANTELL's original description and it is likely that the extra spine is a result of damage and subsequent repair.

The minimum depth of this species has been reduced by approximately 400 metres.

DISTRIBUTION. — Tropical Pacific, 573 to 2745 metres.

*Altiverruca nitida* (Hoek, 1883)

Fig. 6 a-g

*Verruca nitida* Hoek, 1883 : 138, figs 6, 7. — GRUVEL, 1905 : 177, fig. 194. — NILSSON-CANTELL, 1927 : 778.

MATERIAL EXAMINED. — **New Caledonia.** BIOCAL : stn CP 23, 22°46'S, 166°20'E, 2040 m, 28.08.1985 : 1 specimen. — Stn CP 29, 23°08'S, 166°40'E, 1100 m, 29.08.1985 : 7 specimens, on pebbles. — Stn CP 30, 23°09'S, 166°41'E, 1140 m, 29.08.1985 : 7 specimens, on gastropods and pebbles. — Stn DW 36, 23°09'S, 167°11'E, 650-680 m, 29.08.1985 : 1 specimen, on coral.

**Chesterfield Islands.** MUSORSTOM 5 : stn CP 323, 21°18.52'S, 157°57.62'E, 970 m, 14.10.1986. 2 specimens, (MNHN-Ci 2329), on coral. — Stn CP 324, 21°15.01'S, 157°51.33'E, 970 m, 14.10.1986 : 3 specimens, on coral.

**Wallis and Futuna Islands.** MUSORSTOM 7: stn CP 567, 11°47.0'S, 178°27.3'W, 1010-1020 m, 20.05.1992 : 1 specimen, on pebble. — Stn CP 621, 12°35.0'S, 178°11.5'W, 1280-1300 m, 28.05.1992 : 14 specimens, on glass sponge. — Stn CP 622, 12°34.5'S, 178°10.9'W, 1280-1300 m, 28.05.1992 : 18 specimens, on glass sponge. — Stn CP 623, 12°34.2'S, 178°15.1'W, 1280-1300 m, 28.05.1992 : 2 specimens, on glass sponge. — Stn DW 635, 13°49.0'S, 179°56.0'E, 700-715 m, 30.05.1992 : 1 specimen, on coral.

DIAGNOSIS. — *Altiverruca* with carina and rostrum interlocking with two ribs; movable scutum with two ribs articulating with one strong diagonal rib of the movable tergum; caudal appendages long.

DESCRIPTION. — Shell white, with regularly spaced, non prominent growth lines; rostrum and carina interlock with two main ribs; apices of rostrum and carina slightly produced.

Fixed scutum and fixed tergum with apices extending well beyond the opercular plates; interlocking with a single rib; fixed scutum "folded over" on its upper margin to form a surface confluent with the plane of the operculum.

Movable tergum quadrangular, with a strong primary diagonal rib, plus a low, broadly rounded, weak ridge on the scutal side; upper margin shorter than basal margin, but with a rounded extension that locks in behind the movable scutum.

Movable scutum triangular, with two diagonal ribs, the more prominent interlocking with the rostrum at the basi-tergal angle.

Mandible tridentate, lower angle pectinate with seven small spines; first maxilla with two large upper spines, notch hirsute, lower angle hirsute, with three spines.

Cirrus I with inner ramus longer than that of cirrus II; penis long, probosciform, terminally hirsute; caudal appendages very long. Cirri possessed the following number of segments (r-c being rostro-carinal diameter) :

r-c (mm)	I	II	III	IV	V	VI	c. a.
8.3	12,21	10,24	24,28	28,29	30,32	30,36	35

Of the specimens examined, the length of the caudal appendages was approximately five times that of the basal segment of the pedicel of cirrus VI.

DISCUSSION. — *A. nitida* is related to *A. navicula*, and can be included within a group of *Altierruca* characterised by few interlocking ribs between rostrum and carina, opercular plates each with a prominent apicobasal ridge and long caudal appendages; as such juveniles of both species may appear similar. The bathyal range of this species has been extended by approximately 1000 metres.

DISTRIBUTION. — Tropical western Pacific, 650 to 2040 metres.

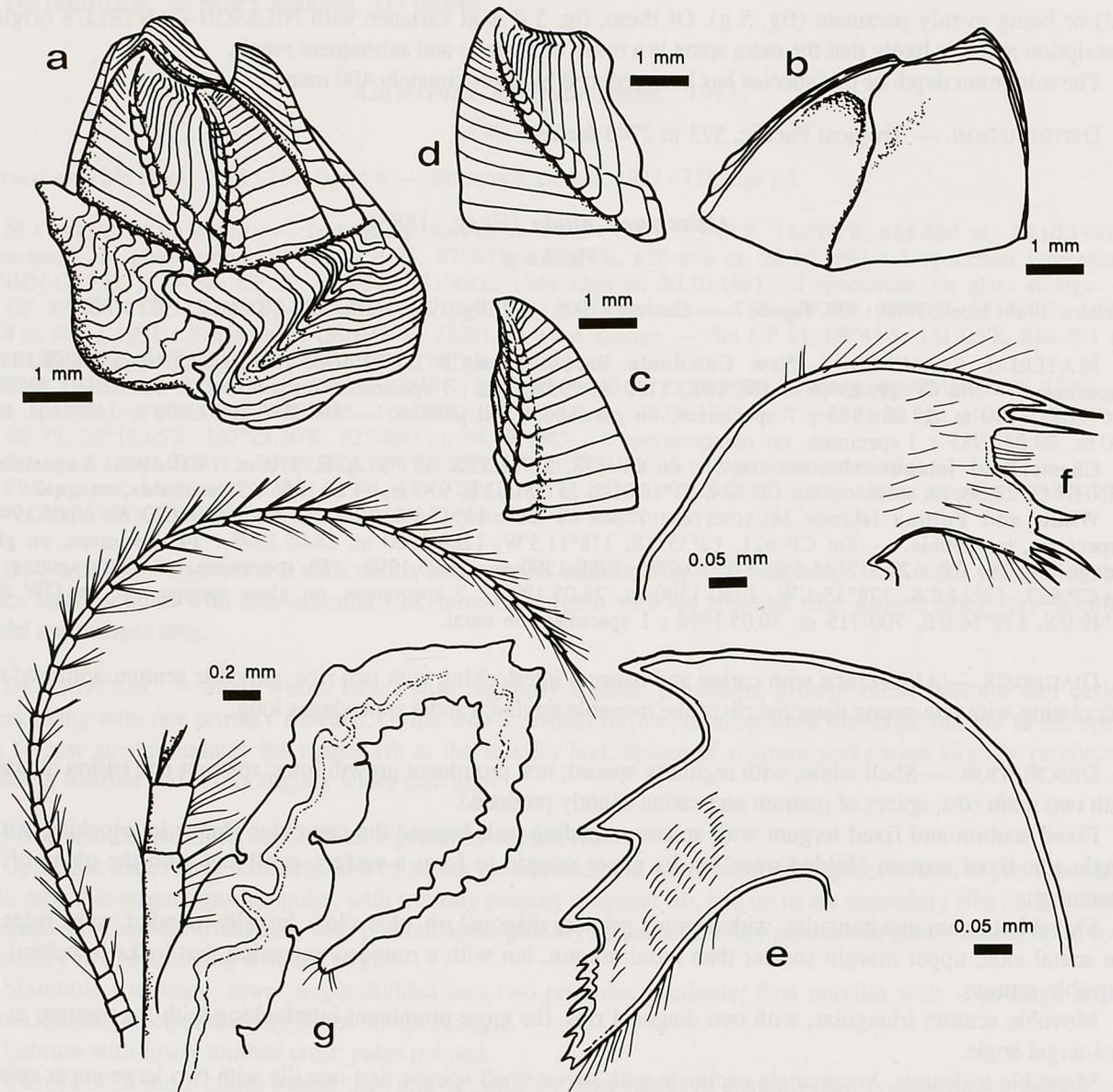


FIG. 6. — *Altierruca nitida* (Hoek, 1883) : a, complete shell (dorsal view), MNHN-Ci 2329; b, articulated movable scutum and tergum (interior); c, movable scutum (exterior); d, movable tergum (exterior); e, mandible; f, first maxilla; g, basal portion of sixth cirrus, with penis and caudal appendage attached. All material from MUSORSTOM 5, stn CP 323.

Genus *CAMERAVERRUCA* Pilsbry, 1916

*Verruca* "Section C": *Cameraverruca* Pilsbry, 1916 : 39.

*Verruca* (*Cameraverruca*) - FOSTER, 1978 : 68.

*Cameraverruca* - ZEVINA, 1978 : 1813.

DIAGNOSIS. — Verrucids with shell moderately erect; apical cavities of fixed tergum and rostrum partitioned off, forming a recess in the general cavity; myophore present on movable scutum.

TYPE. — *Verruca euglypta* Pilsbry, 1908 : 108. Florida, 805 metres.

SPECIES. — 3 species are presently attributed to this genus: the type, *Verruca euglypta* Pilsbry, 1908, *Cameraverruca radiata* (Gruvel, 1900), Canary Islands, and *Cameraverruca nodiscuta* sp. nov., New Caledonia.

DISCUSSION. — Amongst the features used by PILSBRY (1916) to define *Cameraverruca* were the erectness of the shell and the presence of a myophore on the fixed scutum. In *C. euglypta*, the myophore was described as "vertical, partition-like". The terminology "vertical" is at first instance confusing, fortunately however, the interior of the fixed scutum is figured in PILSBRY (1916, pl. 3, fig. 2a) where, although the myophore is shown to be vertically depending, it is aligned horizontally, and is thus similar to other myophores in other *Cameraverruca* and *Metaverruca*. The term "erect" may also lead to confusion : *C. nodiscuta* sp. nov. and *C. radiata* are not as erect as most *Altiverruca* species, but are certainly more erect than those of *Metaverruca* and *Verruca*.

I have also had an opportunity to examine GRUVEL's types of *V. radiata* and confirm that this possesses both an "erect" shell and a myophore on the fixed scutum.

STRATIGRAPHIC RANGE. — Recent.

DISTRIBUTION. — Atlantic and western Pacific, 380 - 912 metres.

*Cameraverruca nodiscuta* sp. nov.

Fig. 7 a-j

MATERIAL EXAMINED. — **Chesterfield Islands**. MUSORSTOM 5 : stn DW 300, 22°48.27'S, 159°23.94'E, 450 m, 11.10. 1986 : 1 specimen, on coral.

**Loyalty Islands**. MUSORSTOM 6 : stn DW 397, 20°47.35'S, 167°05.17'E, 380 m, 12.02.1989 : 2 specimens.

TYPES. — *Holotype* : MNHN-Ci 2315, r-c diameter : 4.5 mm, height : 6.6 mm, (from MUSORSTOM 5, Stn DW 300).

*Paratypes* : MNHN-Ci 2316-2317, (from MUSORSTOM 6, Stn DW 397).

DIAGNOSIS. — *Cameraverruca* with carina and rostrum interlocking with up to six ribs; movable scutum with three articulating ribs, the uppermost extended, node-like; fixed scutum with semicircular, upwardly concave myophore; caudal appendages short.

DESCRIPTION. — Shell off-white to palest pink, with regularly spaced, non prominent growth lines; carina and rostrum interlocking with up to six ribs, apex of carina and rostrum slightly produced; rostrum with apical cavity weakly partitioned off; base of plates thickened, slightly inflected; carina and fixed tergum interlocking with three ribs; rostrum and fixed scutum interlocking with four ribs; basis calcareous.

Fixed scutum and fixed tergum with apices extending beyond the opercular plates, both folded over on their opercular margins to form a zone confluent with the plane of the operculum; fixed scutum with semicircular, upwardly concave myophore; fixed tergum with apical cavity clearly partitioned off, forming a recess in the general cavity.

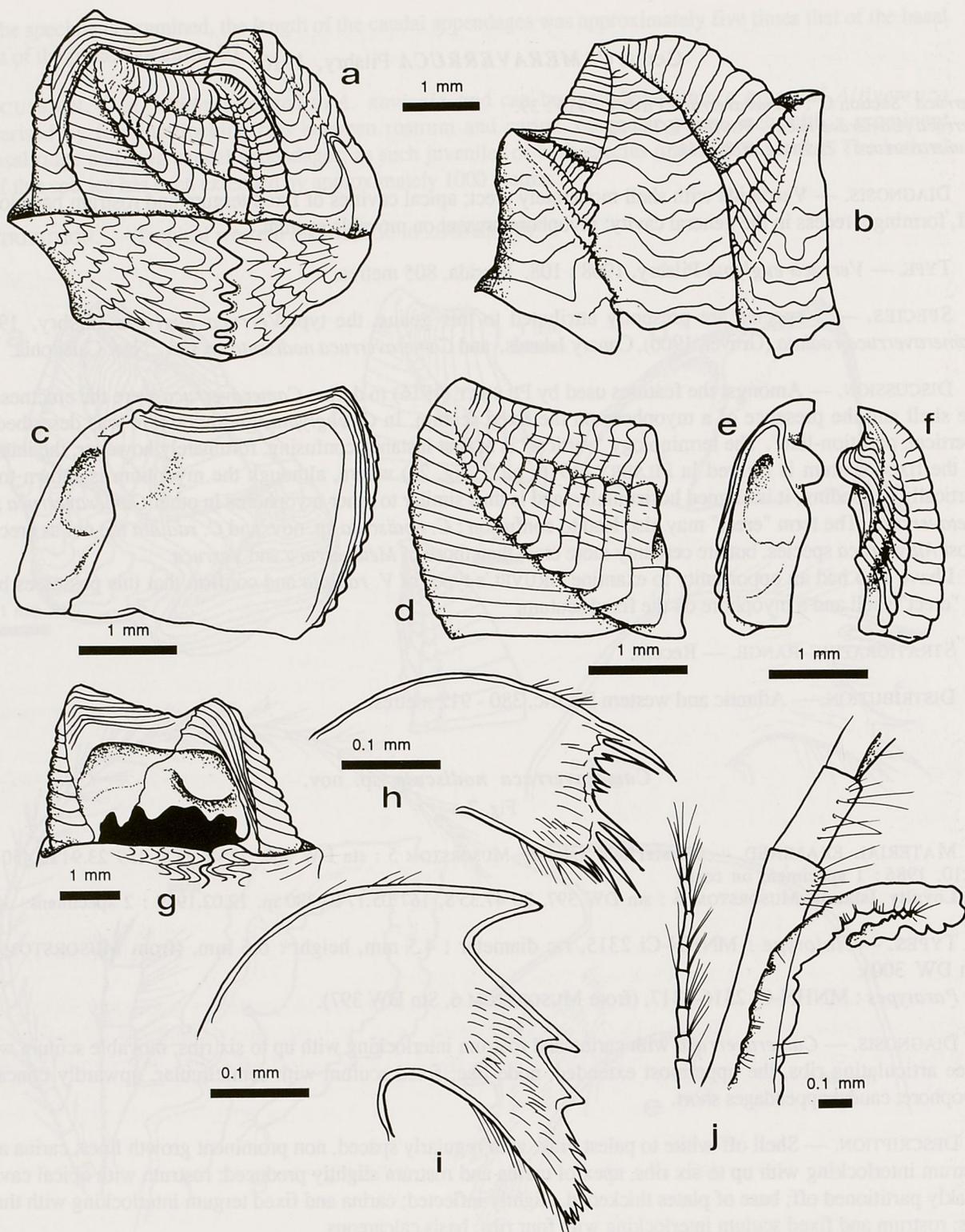


FIG. 7. — *Cameraverruca nodiscuta* sp. nov. : a, holotype, complete shell (dorsal view), MNHN-Ci 2315; b, holotype, complete shell (fixed tergal-fixed scutal view); c, articulated movable scutum and tergum (interior); d, movable tergum (exterior); e, movable scutum (interior); f, movable scutum (exterior); g, interior of holotype shell, showing pendant myophore on fixed scutum; h, first maxilla; i, mandible; j, basal portion of sixth cirrus, with penis and caudal appendage attached. All material from MUSORSTOM 5, stn DW 300.

Movable scutum rather narrow, triangular, with a moderately strong, arcuate, apico-basal ridge interlocking at the basi-tergal angle with the movable tergum, two further ribs articulate with the movable tergum, the uppermost of which is extended and node-like, to slot in between the second and third ribs on the tergum, interior with moderately deep adductor muscle pit.

Movable tergum with a strong apico-basal rib, plus a moderately strong and distinct secondary rib; scutal side further characterised by weak longitudinal striae; interior smooth except for a narrow zones of growth lines on upper and fixed tergal margins.

Mandible tridentate, lower angle pectinate; first maxilla with two strong upper spines, three smaller spines in the notch and four spines on an hirsute lower angle.

Cirrus I with anterior ramus longer, cirrus II with posterior ramus longer; penis thin, probosciform, about twice the length of the basal segment of the pedicel of cirrus VI; caudal appendages short, slightly less than that of the basal segment of the pedicel of cirrus VI. Cirri possessed the following number of segments (r-c being rostro-carinal diameter) :

r-c (mm)	I	II	III	IV	V	VI	c. a.
4.5	12,9	9,12	15,16	15,20	21,22	21,21	8

DISCUSSION. — *C. nodiscuta* may be distinguished from other *Cameraverruca* by the narrow, nodose scutum. It extends the geographic range of the genus from the Atlantic to the Pacific Ocean.

ETYMOLOGY. — Morphologic : from *nodus* = node (Latin) + *scuta*.

DISTRIBUTION. — New Caledonia, 380 to 450 metres.

#### Genus *BROCHIVERRUCA* Zevina, 1993

DIAGNOSIS. — Verrucids with apex (umbo) of both carina and rostrum removed from the margin of the plates; fixed scutum with or without a myophore.

TYPE. — *Brochiverruca margulisae* Zevina, 1993 : 10. Mozambique Channel, Indian Ocean, 935-950 metres.

SPECIES. — Three species are here attributed to this genus, the type, *Brochiverruca margulisae* Zevina, *Brochiverruca dens* (Broch) and *Brochiverruca polystriata* sp. nov., New Caledonia.

DISCUSSION. — BROCH (1932) included *B. dens* within *Rostratoverruca*, on the basis that it was most closely allied to taxa within that group. The inclusion however was tentative, and BROCH suggested that future investigations may warrant separation of the species from *Rostratoverruca*. Certainly the nature of the rostrum and carina and the cubic, "tooth-like" appearance make *Brochiverruca* one of the most easily distinguished verrucid genera. It is considered likely that future workers may wish to further divide *Brochiverruca*, particularly on the basis of the presence of a myophore on the fixed scutum of the new species. At this juncture, I consider the placement of these species within *Brochiverruca*, based on the similarity of overall shell morphology, to be a tentative solution to the problem.

STRATIGRAPHIC RANGE. — Recent.

DISTRIBUTION. — Western Pacific and Western Indian Ocean, 348-950 metres.

#### *Brochiverruca dens* (Broch, 1932)

*Verruca* (*Rostratoverruca*?) *dens* Broch, 1932 : 47, fig. 17 a-g.

MATERIAL EXAMINED. — **Indonesia**. KARUBAR : stn CP 69, 08°42'S, 131°53'E, 356-368 m, 02.11.1991 : 3 specimens without opercula and soft parts, on coral.

**DIAGNOSIS.** — Shell white, finely sculptured with delicate longitudinal striae crossed by fine, distinct, growth lines; rostrum and carina each with the apex separated from the upper margin by one third the distance from the basal margin; fixed scutum without a myophore.

**DESCRIPTION.** — Shell white, tooth-like, exterior very finely sculptured with delicate longitudinal striae crossed by distinct, but not prominent growth lines.

Rostrum and carina each with the apex separated from the upper margin by one third the distance from the basal margin; the margin between both plates is characterised by up to 13 fine, non-prominent, articulating ribs. Fixed scutum without a myophore. Soft parts and operculum absent from this collection.

In his original description, BROCH noted that this species possessed a broad, trapezoid movable tergum, with up to 12 delicate ribs articulating with the movable scutum; the movable scutum is about half the width of the tergum, internally with a shallow adductor muscle scar. Of the soft parts, it is significant to note that the labrum is smooth, and the palps short and narrow; *B. dens* is characterised by a relatively "stout penis, a little longer than the caudal appendages", which themselves are long, having 25 segments (about half as long as the sixth cirrus).

**DISCUSSION.** — This species often has a surface texture closely approximating that of the substrate. A large specimen from KARUBAR, Stn CP 69, with a rostro-carinal diameter of 6.8 mm, attached to a smooth surfaced stylasterid coral, showed little evidence of the normally characteristic fine sculpture. The specimen however, was represented by a shell wall only, and may have been subsequently modified by the coral and/or the physical environment.

**DISTRIBUTION.** — Western Pacific, 348-368 metres.

*Brochiverruca polystriata* sp. nov.

Fig. 8 a-j

**MATERIAL EXAMINED.** — **New Caledonia.** BIOCAL : stn DW 51, 23°05.27'S, 167°44.95'E, 700 m, 31.08.1985 : 1 specimen with opercula and soft parts absent, on *Ellanospammia*. — Stn DW 66, 24°55.43'S, 168°21.67'E, 510 m, 03.09.1985 : 1 specimen juvenile.

CHALCAL 2 : stn DW 77, 23°38.35'S, 167°42.68'E, 435 m, 30.10.1986 : 13 specimens, most without opercula and soft parts, on coral.

**TYPES.** — *Holotype* : MNHN-Ci 2292, rostro-carinal diameter : 4.3 mm, height : 4.5 mm, (from CHALCAL 2, Stn DW 77).

*Paratypes* : MNHN-Ci 2293, (from BIOCAL, Stn DW 66), MNHN-Ci 2294-2297 (from CHALCAL 2, Stn DW 77); UNITEC Cat. No. CAX 101, (from CHALCAL 2, Stn DW 77); USNM (from CHALCAL 2, Stn DW 77).

**DIAGNOSIS.** — Shell finely sculptured with delicate longitudinal striae crossed by growth lines to give a finely nodose surface texture; rostrum and carina each with the apex separated from the upper margin by slightly less than a third the distance from the basal margin; fixed scutum with myophore.

**DESCRIPTION.** — Shell white, tooth-like, exterior finely sculptured with numerous delicate longitudinal striae crossed by distinct growth lines with a resultant nodose effect.

Rostrum and carina each with the apex separated from the upper margin by slightly less than one third the distance from the basal margin; the margin between both plates is characterised by up to 21 fine, non-prominent, articulating ribs.

Fixed scutum protruded along rostral margin to form a covered portion on the upper surface adjacent to the movable scutum; articulating with the fixed tergum with up to seven delicate ribs, and with the rostrum with up to 13 ribs; with a clear lunuliform myophore on inner surface (Fig. 8f); fixed tergum and carina articulating with up to seven ribs.

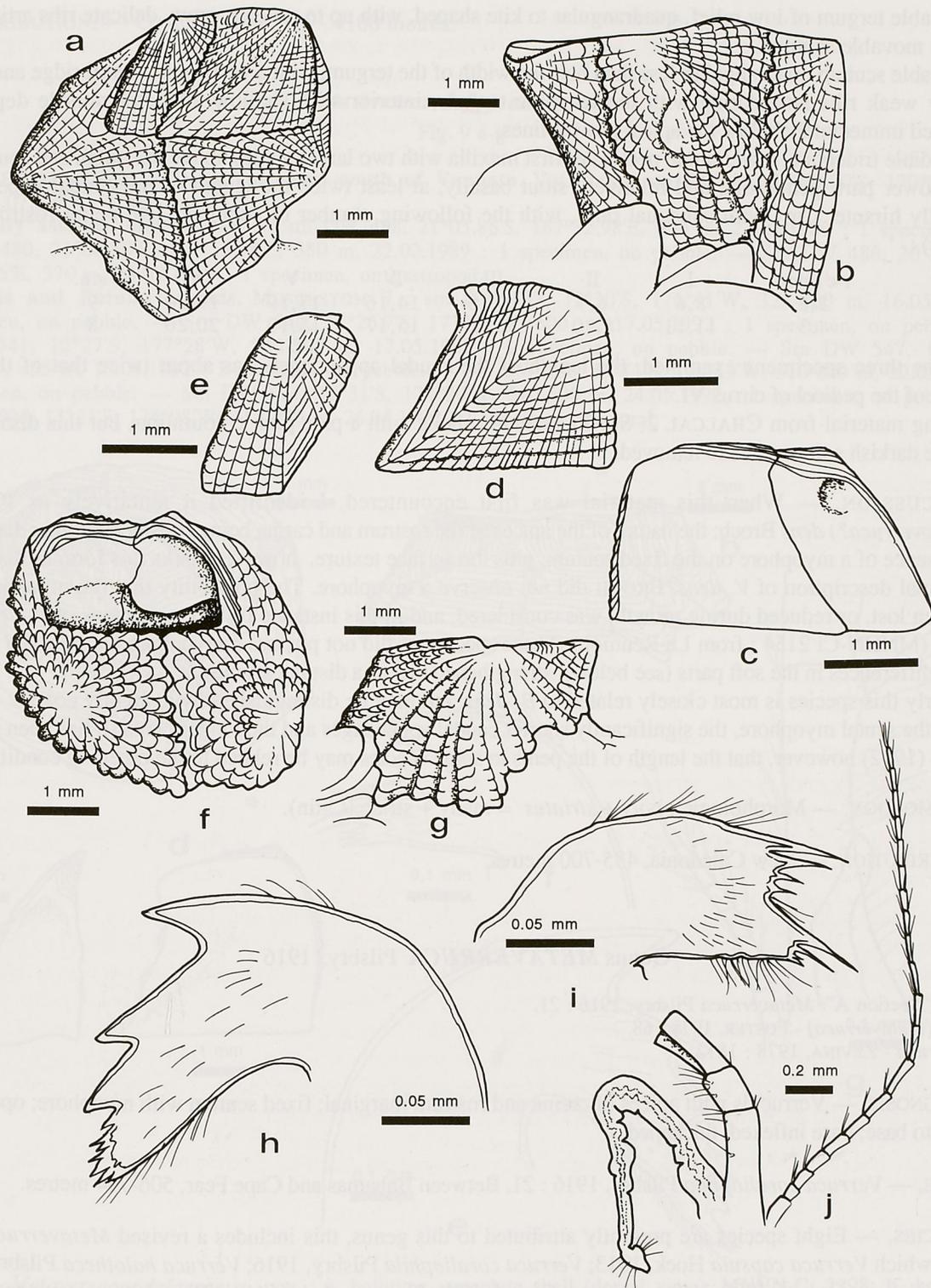


FIG. 8. — *Brochiverruca polystriata* sp. nov. : a, holotype, complete shell (dorsal view), MNHN-Ci 2292; b, holotype, complete shell (fixed tergal-fixed scutal view); c, articulated movable scutum and tergum (interior); d, movable tergum (exterior); e, movable scutum (exterior); f, shell with opercula removed, showing pendant myophore on fixed scutum; g, complete shell (fixed tergal-fixed scutal view); h, mandible; i, first maxilla; j, basal portion of sixth cirrus, with penis and caudal appendage attached. Material : a-e, from CHALCAL 2, stn DW 77; f-g, from BIOCAL, stn DW 51; h-j, from BIOCAL, stn DW 66.

Movable tergum of low relief, quadrangular to kite shaped, with up to seven narrow, delicate ribs articulating with the movable scutum.

Movable scutum quadrangular, less than half the width of the tergum, with a weak apico-basal ridge and five to six very weak ribs articulating with the movable tergum; interior with shallow adductor muscle depression positioned immediately below the apical growth lines.

Mandible tridentate, lower angle pectinate; first maxilla with two larger spines above the notch and four spines on the lower part; penis long and relatively stout basally, at least twice the length of the caudal appendages, terminally hirsute. Cirri with subequal rami, with the following number of segments (r-c being rostro-carinal diameter) :

r-c (mm)	I	II	III	IV	V	VI	c. a.
2.6	8,6	6,7	10,13	14,16	17,19	19,20	9
4.3	11,11	8,10	12,13	15,17	15,19	20,20	8

Of the three specimens examined, the length of the caudal appendages was about twice that of the basal segment of the pedicel of cirrus VI.

Living material from CHALCAL 2, Stn 77 included shells with a pale pink colouration, but this disappeared when the darkish soft parts were removed.

DISCUSSION. — When this material was first encountered, I identified it tentatively as *Verruca* (*Rostratoverruca?*) *dens* Broch; the nature of the apices of the rostrum and carina being considered rather diagnostic. The presence of a myophore on the fixed scutum, plus the surface texture, however marks this form as distinct. In his original description of *V. dens*, BROCH did not observe a myophore. The possibility that the myophore may have been lost, or reduced during growth, was considered, and in this instance further specimens of *V. dens* were studied, (MNHN-Ci 2154 : from La Réunion). These specimens did not possess a myophore on the fixed scutum. Further differences in the soft parts (see below), strengthened this as a distinct species.

Clearly this species is most closely related to *B. dens*, but may be distinguished by a slightly coarser external texture, the scutal myophore, the significantly shorter caudal appendages and the longer penis (It has been noted in BARNES (1992) however, that the length of the penis in some species may be related to the breeding condition).

ETYMOLOGY. — Morphologic : *poly* + *striatus* = many + striae (Latin).

DISTRIBUTION. — New Caledonia, 435-700 metres.

#### Genus *METAVERRUCA* Pilsbry, 1916

*Verruca* "Section A": *Metaverruca* Pilsbry, 1916 : 21.

*Verruca* (*Metaverruca*) - FOSTER, 1978 : 68.

*Metaverruca* - ZEVINA, 1978 : 1812.

DIAGNOSIS. — Verrucids with apices of carina and rostrum marginal; fixed scutum with myophore; operculum parallel to base; base inflexed, thickened.

TYPE. — *Verruca coraliophila* Pilsbry, 1916 : 21. Between Bahamas and Cape Fear, 506-794 metres.

SPECIES. — Eight species are presently attributed to this genus, this includes a revised *Metaverruca recta* (within which *Verruca capsula* Hoek, 1913; *Verruca coraliophila* Pilsbry, 1916; *Verruca halotheca* Pilsbry, 1907; *Verruca linearis* Gruvel, 1900; *Verruca magna* Gruvel, 1901; *Verruca sculpta* Aurivillius, 1898, are synonymised), *Metaverruca corrugata* Broch, 1922, *Metaverruca lepista* Zevina, 1987, *Metaverruca seriola* Zevina, 1987, plus the four new species described here : *Metaverruca defayeeae* sp. nov., *Metaverruca norfolkensis* sp. nov., *Metaverruca pacifica* sp. nov., and *Metaverruca plicata* sp. nov.

STRATIGRAPHIC RANGE. — Lower Miocene (New Zealand) to Recent.

DISTRIBUTION. — Cosmopolitan, 167- 4100 metres.

*Metaverruca defayae* sp. nov.

Fig. 9 a-g

MATERIAL EXAMINED. — **Volcanoes south of Vanuatu.** VOLSMAR : stn DW 55, 20°59.20'S, 170°01.90'E, 710 m, 5.07.1989 : 1 specimen.

**Loyalty Islands.** MUSORSTOM 6 : stn DW 468, 21°05.86'S, 167°32.98'E, 600 m, 22.02.1989 : 1 specimen. — Stn DW 480, 21°08.50'S, 167°55.98'E, 380 m, 22.02.1989 : 1 specimen, on pebble. — Stn DW 486, 20°21.40'S, 167°47.65'E, 370 m, 23.02.1989 : 1 specimen, on gastropod.

**Wallis and Futuna Islands.** MUSORSTOM 7 : stn DW 537, 12°30'S, 176°41'W, 325-400 m, 16.05.1992 : 1 specimen, on pebble. — Stn DW 540, 12°26.7'S, 177°28'W, 600 m, 17.05.1992 : 1 specimen, on pebble. — Stn DW 541, 12°27'S, 177°28'W, 500-505 m, 17.05.1992 : 1 specimen, on pebble. — Stn DW 547, 12°26'S, 177°26'W, 455 m, 17.05.1992 : 1 specimen, on pebble. — Stn DW 586, 13°11'S, 176°13'W, 510-600 m, 22.05.1992 : 1 specimen, on pebble. — Stn DW 594, 12°31'S, 174°20'W, 510-600 m, 24.05.1992 : 1 specimen, on pebble. — Stn DW 604, 13°21'S, 176°08'W, 415-420 m, 26.05.1992 : 1 specimen, on coral.

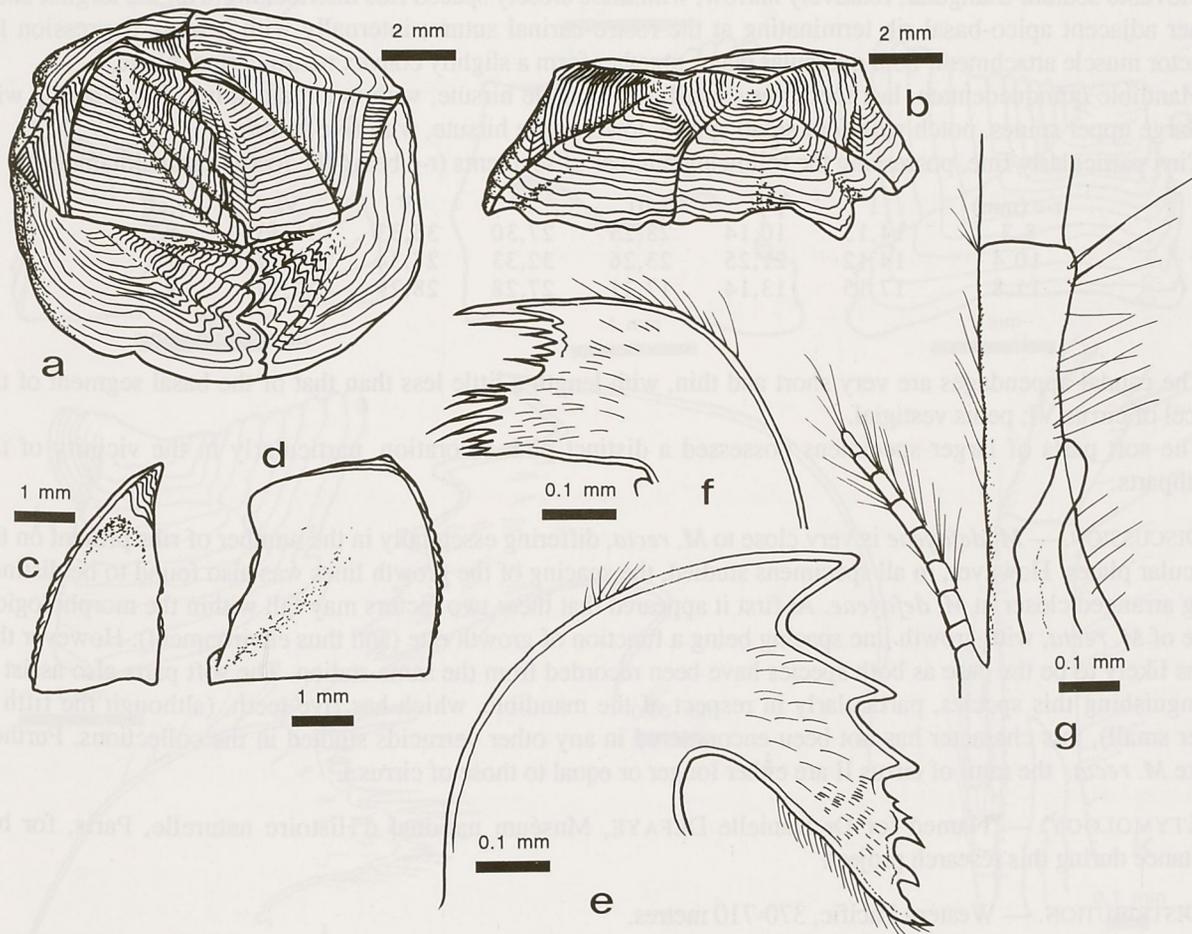


FIG. 9. — *Metaverruca defayae* sp. nov. : a, holotype, complete shell (dorsal view), MNHN-Ci 2298; b, holotype, complete shell (fixed tergal-fixed scutal view); c, movable scutum (interior); d, movable tergum (interior); e, mandible; f, first maxilla; g, basal portion of sixth cirrus, with penis and caudal appendage attached. Material : a-d, from VOLSMAR, stn DW 55; e-g, from MUSORSTOM 7, stn DW 537.

TYPES. — *Holotype* : MNHN-Ci 2298, rostro-carinal diameter : 10.4 mm, height : 3.4 mm, (from VOLSMAR, Stn DW 55).

*Paratypes* : MNHN-Ci 2299, (from MUSORSTOM 7, Stn DW 537); MNHN-Ci 2300, (from MUSORSTOM 7, Stn DW 540); UNITEC Cat. No. CAX 102, (from MUSORSTOM 7, Stn DW 541); USNM, (from MUSORSTOM 7, Stn DW 547).

**DIAGNOSIS.** — A large *Metaverruca* with movable tergum and scutum having four articular ribs; exterior smooth with closely spaced growth lines; mandible quinque-dentate, caudal appendages short, less the length of the basal segment of the pedicel of cirrus VI.

**DESCRIPTION.** — Large sized *Metaverruca* with shell white, low conic, sides steep; operculum sub-parallel to base, orifice D-shaped; exterior generally smooth, with relatively closely spaced, concentric growth lines; rostrum and carina articulating with up to five ribs; basis membranous.

Fixed scutum with a well formed myophore for adductor muscle attachment; basal margin of shell thickened and inflected on larger specimens; fixed tergum a little less than the width of fixed scutum, with basal margin thickened and inflected on larger specimens.

Movable tergum quadrangular, with a well defined apico-basal rib, and three secondary ribs, interlocking with the movable scutum.

Movable scutum triangular, relatively narrow, with three closely spaced ribs interlocking with the tergum and a further adjacent apico-basal rib terminating at the rostro-carinal suture; internally with a weak depression for adductor muscle attachment; both opercular plates together form a slightly convex rostro-carinal hinge.

Mandible quinque-dentate, last tooth very small, lower angle hirsute, with one main spine; first maxilla with two large upper spines, notch with four small spines, lower angle hirsute, with five spines.

Cirri particularly fine, possessing the following number of segments (r-c being the rostro-carinal diameter) :

r-c (mm)	I	II	III	IV	V	VI	c. a.
8.3	14,13	10,14	23,25	27,30	33,33	31,33	8
10.4	14,12	21,25	23,26	32,33	27,34	23+,30+	7
11.8	17,15	13,14	17,21	27,28	28,29	27,31	9

+ incomplete ramis

The caudal appendages are very short and thin, with length a little less than that of the basal segment of the pedicel of cirrus VI; penis vestigial.

The soft parts of larger specimens possessed a distinct pink coloration, particularly in the vicinity of the mouthparts.

**DISCUSSION.** — *M. defayae* is very close to *M. recta*, differing essentially in the number of ribs present on the opercular plates. However, in all specimens studied, the spacing of the growth lines was also found to be distinct, being arranged closer in *M. defayae*. At first it appeared that these two factors may fall within the morphological range of *M. recta*, with growth line spacing being a function of growth rate (and thus environment). However this is less likely to be the case as both species have been recorded from the same station. The soft parts also assist in distinguishing this species, particularly in respect of the mandible, which has five teeth, (although the fifth is rather small), this character has not been encountered in any other verrucids studied in the collections. Further, unlike *M. recta*, the rami of cirrus II are either longer or equal to those of cirrus I.

**ETYMOLOGY.** — Named for Dr Danielle DEFAYE, Muséum national d'Histoire naturelle, Paris, for her assistance during this research project.

**DISTRIBUTION.** — Western Pacific, 370-710 metres.

*Metaverruca norfolkensis* sp. nov.

Fig. 10 a-k

**MATERIAL EXAMINED.** — New Caledonia. BIOCAL : stn CP 29, 23°08'S, 166°40'E, 1100 m, 29.08.1985 : 1 specimen, on pumice.

SMIB 5 : stn DW 93, 22°20.00'S, 168°42.30'E, 255 m, 11.09.1989 : 1 specimen.

TYPES. — *Holotype* : MNHN-Ci 2301, rostro-carinal diameter : 4.1 mm, height : 1.8 mm, (from BIOCAL, Stn CP 29).

*Paratype* : MNHN-Ci 2302, (from SMIB 5, Stn DW 93).

DIAGNOSIS. — A medium size *Metaverruca* with movable tergum and scutum having four articular ribs; exterior smooth with moderately spaced growth lines; caudal appendages short, less the length of the basal segment of the pedicel of cirrus VI.

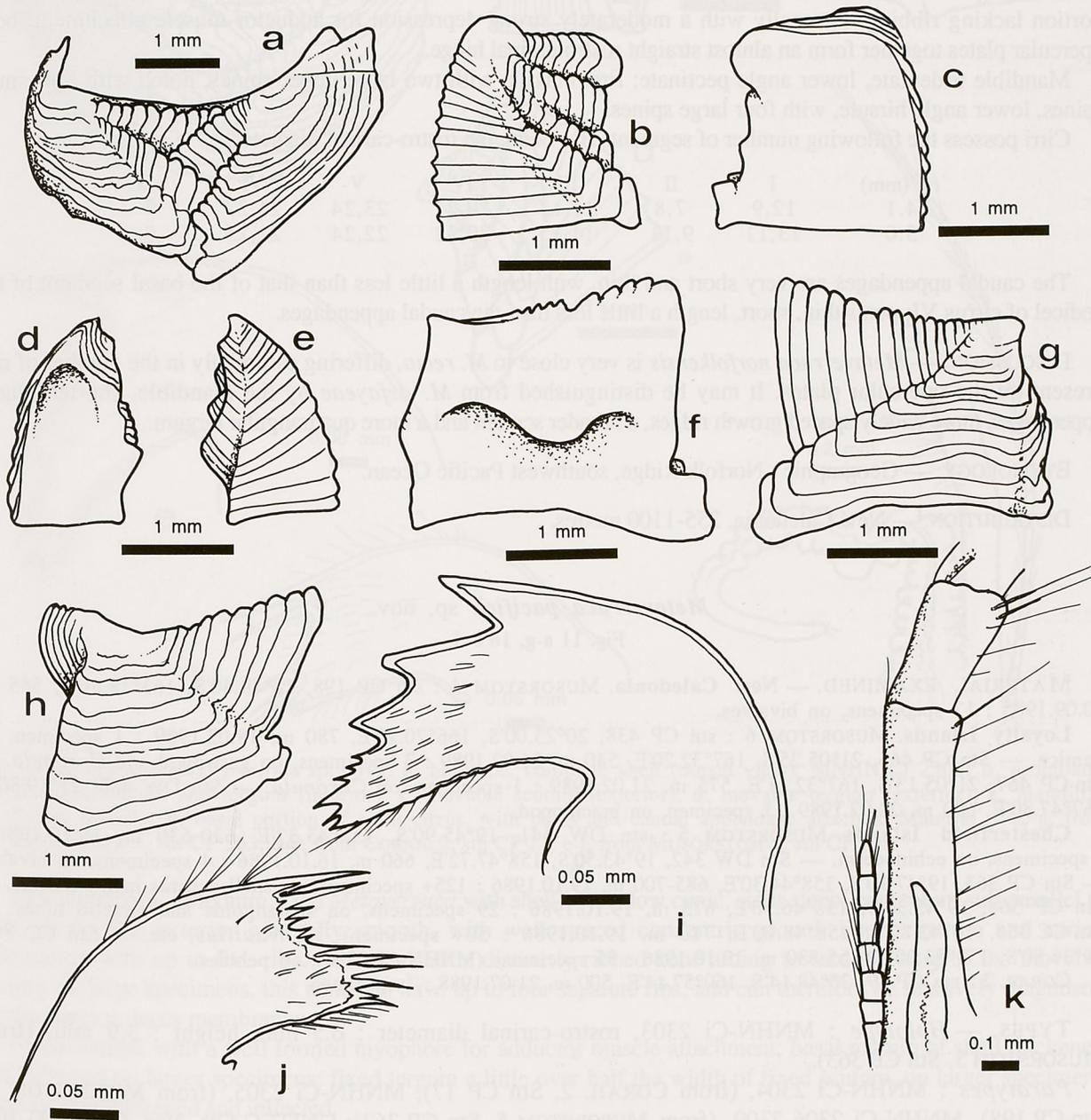


FIG. 10. — *Metaverruca norfolkensis* sp. nov. : a, holotype, rostrum and carina, MNHN-Ci 2301; b, movable tergum (exterior); c, movable tergum (interior); d, movable scutum (interior); e, movable scutum (exterior); f, fixed scutum showing myophore (interior); g, fixed scutum (exterior); h, fixed tergum (exterior); i, mandible; j, first maxilla; k, basal portion of sixth cirrus, with penis and caudal appendage attached. All material from MNHN-Ci 2301, BIOCAL, stn CP 29.

DESCRIPTION. — Medium sized *Metaverruca* with shell white, low conic, sides steep; operculum sub-parallel to base, orifice D-shaped; exterior generally smooth, with relatively closely spaced concentric growth lines; rostrum and carina articulating with up to three ribs; basis membranous.

Fixed scutum quadrangular, with a well formed myophore for adductor muscle attachment; basal margin of shell thickened and inflected on larger specimens; fixed tergum a little narrower than the fixed scutum.

Movable tergum quadrangular, with a well defined apico-basal rib, and three secondary ribs, interlocking with the movable scutum; articular margin moderately concave; movable scutum triangular, with three ribs interlocking with the tergum and a further adjacent curved, apico-basal rib terminating at the rostro-carinal suture; occludent portion lacking ribbing; internally with a moderately strong depression for adductor muscle attachment; both opercular plates together form an almost straight rostro-carinal hinge.

Mandible tridentate, lower angle pectinate; first maxilla with two large upper spines, notch with four small spines, lower angle hirsute, with four large spines.

Cirri possess the following number of segments (r-c being the rostro-carinal diameter) :

r-c (mm)	I	II	III	IV	V	VI	c.a.
4.1	12,9	7,8	11,13	20,21	23,24	24,27	7
5.0	13,11	9,11	14,15	20,22	22,24	22,25	9

The caudal appendages are very short and thin, with length a little less than that of the basal segment of the pedicel of cirrus VI; penis thin, short, length a little less than the caudal appendages.

DISCUSSION. — *Metaverruca norfolkensis* is very close to *M. recta*, differing essentially in the number of ribs present on the opercular plates. It may be distinguished from *M. defayeeae* by the mandible, shorter caudal appendages, more widely spaced growth ridges, a broader scutum and a more quadrangular tergum.

ETYMOLOGY. — Geographic : Norfolk Ridge, southwest Pacific Ocean.

DISTRIBUTION. — New Caledonia, 255-1100 metres.

### *Metaverruca pacifica* sp. nov.

Fig. 11 a-g, 16 c-d

MATERIAL EXAMINED. — New Caledonia. MUSORSTOM 4 : stn CP 198, 18°49.40'S, 163°18.80'E, 585 m, 20.09.1985 : 12 specimens, on bivalves.

Loyalty Islands. MUSORSTOM 6 : stn CP 438, 20°23.00'S, 166°20.10'E, 780 m, 18.02.1989 : 1 specimen, on pumice. — Stn CP 466, 21°05.25'S, 167°32.20'E, 540 m, 21.02.1989 : 3 specimens, on gastropod and *Coronula*. — Stn CP 467, 21°05.13'S, 167°32.11'E, 575 m, 21.02.1989 : 1 specimen, on *Coronula*. — Stn DW 483, 21°19.80'S, 167°47.80'E, 600 m, 23.02.1989 : 1 specimen, on brachiopod.

Chesterfield Islands. MUSORSTOM 5 : stn DW 341, 19°45.90'S, 158°43.37'E, 620-630 m, 16.10.1986 : 2 specimens, on echinoderm. — Stn DW 342, 19°43.50'S, 158°47.72'E, 660 m, 16.10.1986 : 4 specimens, on bivalve. — Stn CP 363, 19°47.90'S, 158°44.30'E, 685-700 m, 19.10.1986 : 125+ specimens, on shell detritus incl. *Nautilus*. — Stn CP 364, 19°45.30'S, 158°46.50'E, 675 m, 19.10.1986 : 29 specimens, on spatangoids and annelid tubes. — Stn CC 365, 19°42.82'S, 158°48.00'E, 710 m, 19.10.1986 : 50+ specimens, on *Nautilus*, etc. — Stn CC 367, 19°36.80'S, 158°53.20'E, 855-830 m, 19.10.1986 : 35 specimens (MNHN-Ci 2330), on pebbles.

CORAIL 2 : stn CP 17, 20°48.14'S, 160°57.14'E, 500 m, 21.07.1988 : 1 specimen.

TYPES. — *Holotype* : MNHN-Ci 2303, rostro-carinal diameter : 6.5 mm, height : 3.9 mm, (from MUSORSTOM 5, Stn CP 363).

*Paratypes* : MNHN-Ci 2304, (from CORAIL 2, Stn CP 17), MNHN-Ci 2305, (from MUSORSTOM 4, Stn CP 198), MNHN-Ci 2306-2309, (from MUSORSTOM 5, Stn CP 363); UNITEC Cat. Nos. CAX 103-105, (from MUSORSTOM 5, Stn CP 363); USNM, (from MUSORSTOM 5, Stn CP 363).

DIAGNOSIS. — *Metaverruca* with movable tergum and scutum having four articular ribs; exterior generally smooth with widely spaced growth lines; caudal appendages more than twice the length of the basal segment of the pedicel of cirrus VI.

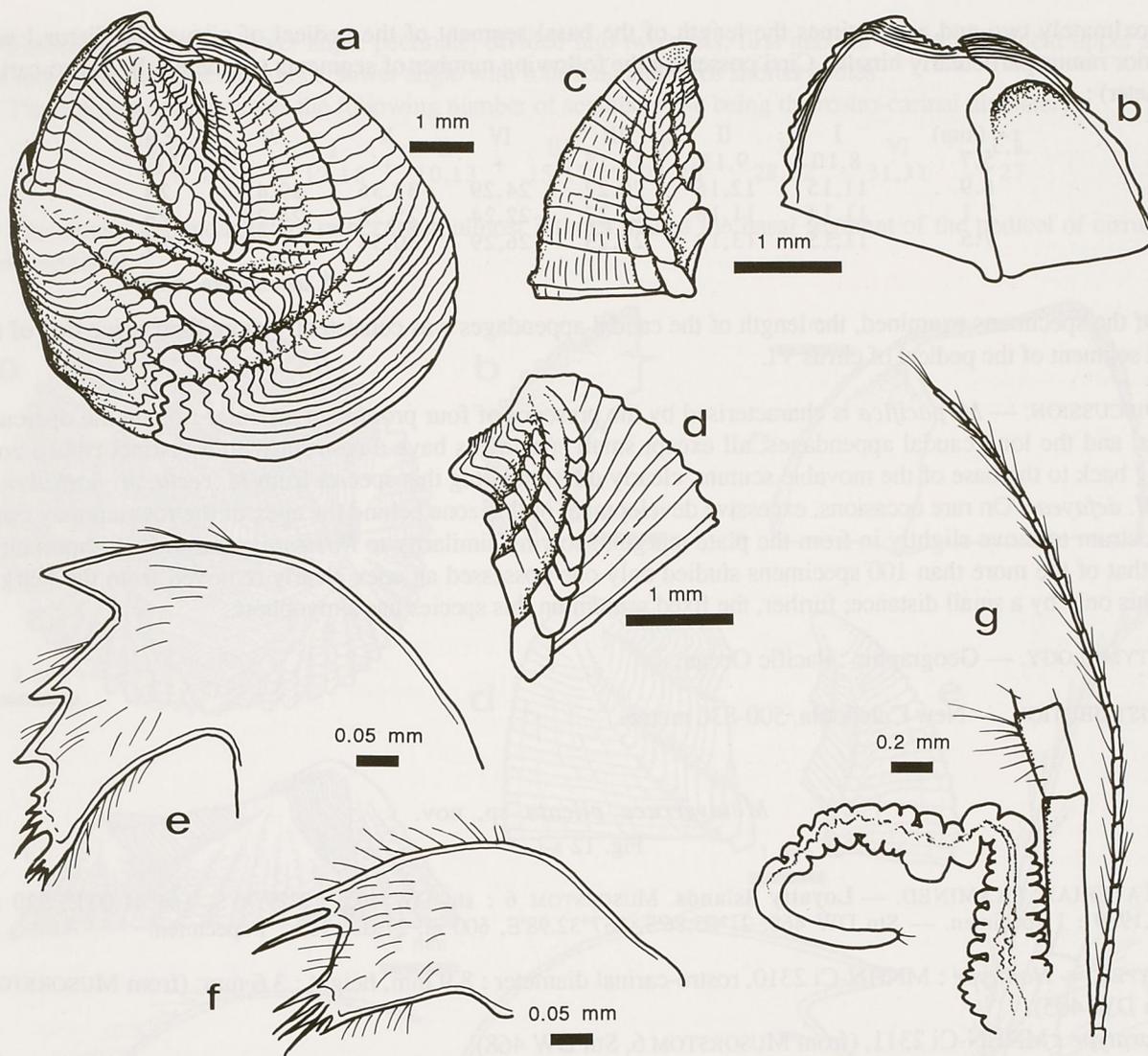


FIG. 11. — *Metaverruca pacifica* sp. nov. : a, holotype, complete shell (dorsal view), MNHN-Ci 2303; b, articulated movable scutum and tergum (interior); c, movable scutum (exterior); d, movable tergum (exterior); e, mandible; f, first maxilla; g, basal portion of sixth cirrus, with penis and caudal appendage attached. Material : a, g, from MUSORSTOM 5, stn CP 363; b-d, from CORAIL 2, stn CP 17; e-f, from MUSORSTOM 4, stn CP 198.

DESCRIPTION. — Medium sized *Metaverruca* with shell white, low conic, sides steep; operculum sub-parallel to base, D-shaped; exterior generally smooth, with well spaced concentric growth lines; rostrum and carina articulating with up to five ribs. Rostrum with a distinctly ribbed zone arcing toward the base of the movable scutum. In large specimens, this zone can have up to four separate ribs, and can therefore be relatively diagnostic for the species; basis membranous.

Fixed scutum with a well formed myophore for adductor muscle attachment; basal margin of shell thickened and inflected on larger specimens; fixed tergum a little over half the width of fixed scutum, on larger specimens basal margin thickened and inflected.

Movable tergum quadrangular, with three large and one or more narrow articular ridges, movable scutum triangular, with corresponding ridges externally and a moderate pit for adductor muscle attachment internally; both plates together form a straight rostro-carinal hinge.

Mandible tridentate, lower angle pectinate and divided into two portions; first maxilla with two prominent upper spines, a notch without spines and with four spines on a hirsute lower angle; penis moderately short,

approximately two and a half times the length of the basal segment of the pedicel of cirrus VI. Cirrus I with anterior ramus particularly hirsute. Cirri possessed the following number of segments (r-c being the rostro-carinal diameter):

r-c (mm)	I	II	III	IV	V	VI	c. a.
5.7	8,10	9,13	14,15	+	+	+	21+
6.9	11,15	12,16	20,22	24,29	32,36	39,41	24
7.1	11,14	11,16	21,22	22,24	25,28	24,28	26
7.5	11,15	13,19	22,23	26,29	30,34	31,32	24

+ incomplete ramis

Of the specimens examined, the length of the caudal appendages was consistently more than twice that of the basal segment of the pedicel of cirrus VI.

DISCUSSION. — *M. pacifica* is characterised by the presence of four prominent articular ribs on the opercular plates, and the long caudal appendages; all except small specimens have a rostrum with a distinct ribbed zone arcing back to the base of the movable scutum, clearly differentiating this species from *M. recta*, *M. norfolkensis* and *M. defayae*. On rare occasions, excessive development of this zone behind the apex of the rostrum may cause the rostrum to move slightly in from the plate margin, showing similarity to *Rostratoverruca*. It is important to note that of the more than 100 specimens studied only one possessed an apex clearly removed from the margin, and this only by a small distance; further, the fixed scutum on this species has a myophore.

ETYMOLOGY. — Geographic: Pacific Ocean.

DISTRIBUTION. — New Caledonia, 500-830 metres.

*Metaverruca plicata* sp. nov.

Fig. 12 a-i

MATERIAL EXAMINED. — Loyalty Islands. MUSORSTOM 6: stn DW 405, 20°29.75'S, 166°41.00'E, 520 m, 14.02.1989: 1 specimen. — Stn DW 468, 21°05.86'S, 167°32.98'E, 600 m, 21.02.1989: 1 specimen.

TYPES. — *Holotype*: MNHN-Ci 2310, rostro-carinal diameter: 8.9 mm, height: 3.6 mm, (from MUSORSTOM 6, Stn DW 405).

*Paratype*: MNHN-Ci 2311, (from MUSORSTOM 6, Stn DW 468).

DIAGNOSIS. — A medium to large *Metaverruca* with strong external ribbing; movable tergum and scutum having three articular ribs; movable scutum moderately narrow; caudal appendages long, about two and a half times the length of the basal segment of the pedicel of cirrus VI.

DESCRIPTION. — Medium to large sized *Metaverruca* with shell white, low conic, sides steep; operculum sub-parallel to base, orifice D-shaped; exterior characterised by strong, sharp vertical ribbing, with relatively closely spaced concentric growth lines, secondary ribs develop in the interstices of the primary ribs as the shell diameter increases, thus maintaining regularity of spacing; rostrum and carina articulating with up to six ribs; basis membranous.

Fixed scutum quadrangular, with a well formed myophore for adductor muscle attachment, articulating with the fixed tergum with one rib and with rostrum with four ribs; basal margin of shell thickened and inflected on larger specimens; fixed tergum of similar width to the fixed scutum, articulating with the carina with four ribs.

Movable tergum quadrangular, with a well defined apico-basal rib, and two secondary ribs, interlocking with the movable scutum; movable scutum triangular, relatively narrow, with two ribs interlocking with the tergum and a further adjacent curved, apico-basal rib terminating at the rostro-carinal suture; occludent portion with fine longitudinal striae crossing growth lines; internally with a moderately weak depression for adductor muscle attachment; both opercular plates together form an almost straight rostro-carinal hinge.

Mandible tridentate, lower angle pectinate, divided into two parts; first maxilla with a prominent upper spine and three smaller adjacent spines, lower angle with four long and three shorter spines.

The holotype cirri possess the following number of segments (r-c being the rostro-carinal diameter) :

r-c (mm)	I	II	III	IV	V	VI	c.a.
4.1	12,16	10,13	15,17	23,25	28,32	31,31	27

The caudal appendages are rather long, almost 3 times that of the basal segment of the pedicel of cirrus VI; penis vestigial.

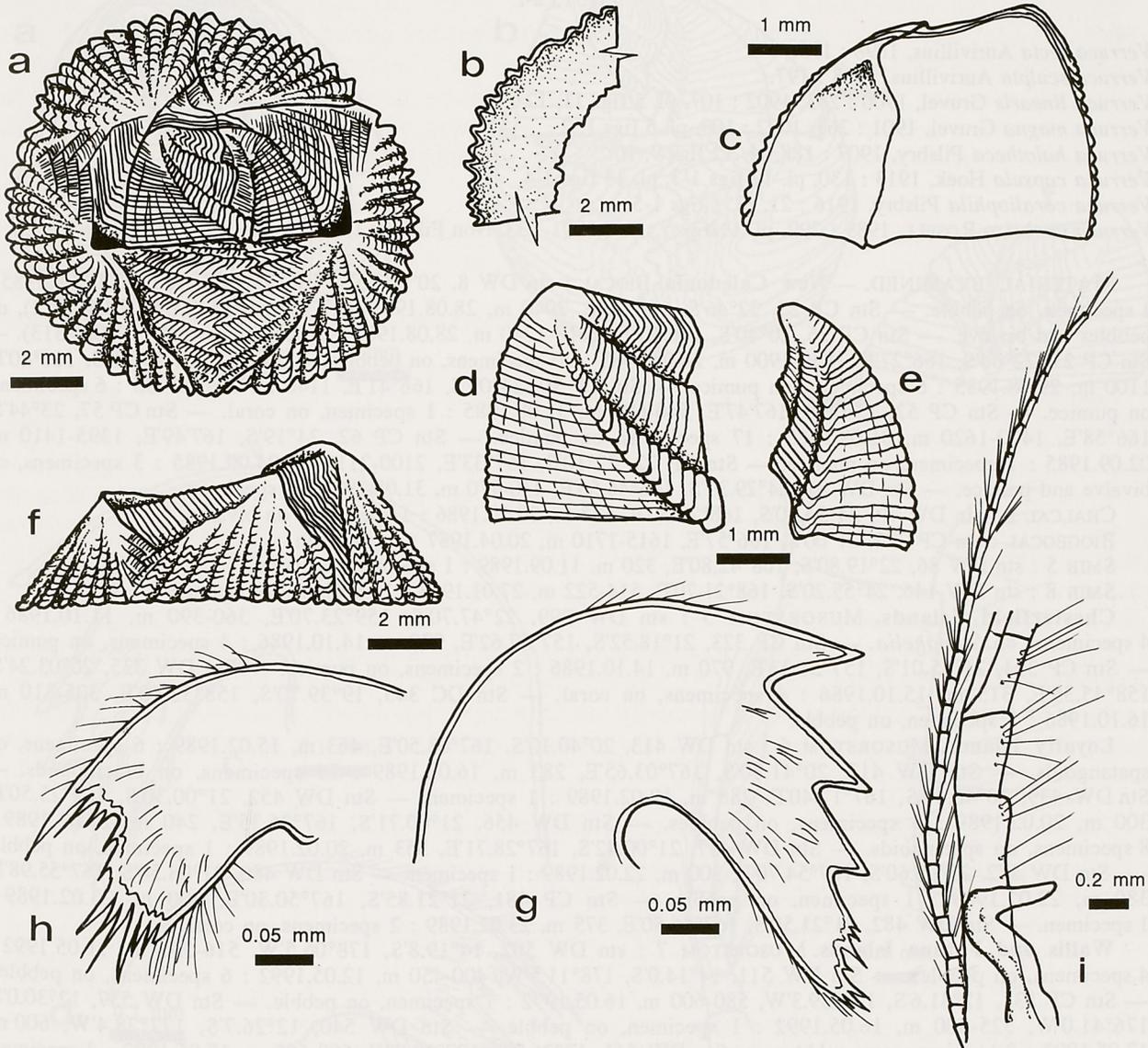


FIG. 12. — *Metaverruca plicata* sp. nov. : a, holotype, complete shell (dorsal view), MNHN-Ci 2310; b, holotype, portion of base (ventral view); c, articulated movable scutum and tergum (interior); d, movable tergum (exterior); e, movable scutum (exterior); f, holotype, complete shell (fixed tergal-fixed scutal view); g, mandible; h, first maxilla; i, basal portion of sixth cirrus, with penis and caudal appendage attached. All material from MUSORSTOM 6, stn DW 405.

DISCUSSION. — *M. plicata* is very distinct species, showing greatest similarity to *Metaverruca corrugata* (Broch, 1932), from which it differs in having significantly longer caudal appendages, a narrower movable scutum,

a greater number of articulating ribs on the wall plates and a lower shell profile. Like most *Metaverruca*, the rami of cirrus I possess more segments than those of cirrus II.

ETYMOLOGY. — Morphologic : in allusion to strong external ribbing, *plicatus* = ribbed or folded (Latin).

DISTRIBUTION. — Loyalty Islands, 520-600 metres.

*Metaverruca recta* (Aurivillius, 1898)

Fig. 13 a-f

*Verruca recta* Aurivillius, 1898 : 195.

*Verruca sculpta* Aurivillius, 1898 : 197.

*Verruca linearis* Gruvel, 1900 : 243; 1902 : 107, pl. 5 figs 11, 12.

*Verruca magna* Gruvel, 1901 : 261; 1092 : 109, pl. 5 figs 1, 2.

*Verruca halothea* Pilsbry, 1907 : 188, pl. 12 figs 9, 10.

*Verruca capsula* Hoek, 1913 : 130, pl. 12 figs 1-3, pl. 13 figs 1-4.

*Verruca coraliophila* Pilsbry, 1916 : 21, pl. 1 figs 1-5.

*Verruca cookei* - ROSELL, 1989 : 299, pl. 11 figs r,s,u,v; 1991 : 33. Non Pilsbry, 1927.

MATERIAL EXAMINED. — **New Caledonia.** BIOCAL : stn DW 8, 20°34.35'S, 166°53.90'E, 435 m, 12.08.1985 : 1 specimen, on pebble. — Stn CP 23, 22°46'S, 166°20'E, 2040 m, 28.08.1985 : 27 specimens (MNHN-Ci 2312), on pebbles and bivalve. — Stn CP 26, 20°40'S, 166°27'E, 1618-1740 m, 28.08.1985 : 2 specimens (MNHN-Ci 2313). — Stn CP 27, 22°06'S, 166°27'E, 1850-1900 m, 28.08.1985 : 20 specimens, on pebbles. — Stn CP 29, 23°08'S, 166°40'E, 1100 m, 29.08.1985 : 6 specimens, on pumice. — Stn CP 30, 23°09'S, 166°41'E, 1140 m, 29.08.1985 : 6 specimens, on pumice. — Stn CP 52, 23°06'S, 167°47'E, 540-600 m, 31.08.1985 : 1 specimen, on coral. — Stn CP 57, 23°44'S, 166°58'E, 1490-1620 m, 01.09.1985 : 17 specimens, on pumice. — Stn CP 62, 24°19'S, 167°49'E, 1395-1410 m, 02.09.1985 : 1 specimen, on pumice. — Stn CP 72, 22°10'S, 167°33'E, 2100-2110 m, 04.09.1985 : 3 specimens, on bivalve and pumice. — Stn DW 81, 24°29.31'S, 166°46.56'E, 430-470 m, 31.08.1985 : 1 specimen.

CHALCAL 2 : stn DW 72, 24°54.50'S, 168°22.30'E, 527 m, 29.10.1986 : 1 specimen, on bivalve.

BIOGEOCAL : stn CP 272, 21°00'S, 166°57'E, 1615-1710 m, 20.04.1987 : 1 specimen.

SMB 5 : stn DW 86, 22°19.80'S, 168°42.80'E, 320 m, 11.09.1989 : 1 specimen, on coral.

SMB 8 : stn DW 146, 24°55.20'S, 168°21.70'E, 514-522 m, 27.01.1993 : 1 specimen, on sponge.

**Chesterfield Islands.** MUSORSTOM 5 : stn DW 299, 22°47.70'S, 159°23.70'E, 360-390 m, 11.10.1986 : 4 specimens, on *Stenohelia*. — Stn CP 323, 21°18.52'S, 157°57.62'E, 970 m, 14.10.1986 : 4 specimens, on pumice. — Stn CP 324, 21°15.01'S, 157°51.33'E, 970 m, 14.10.1986 : 2 specimens, on pumice. — Stn DW 335, 20°03.24'S, 158°45.35'E, 315 m, 15.10.1986 : 4 specimens, on coral. — Stn DC 345, 19°39.70'S, 158°32.40'E, 305-310 m, 16.10.1986 : 1 specimen, on pebble.

**Loyalty Islands.** MUSORSTOM 6 : stn DW 413, 20°40.10'S, 167°03.50'E, 463 m, 15.02.1989 : 6 specimens, on spatangoids. — Stn DW 417, 20°41.80'S, 167°03.65'E, 283 m, 16.02.1989 : 11 specimens, on brachiopods. — Stn DW 439, 20°46.40'S, 167°17.40'E, 288 m, 19.02.1989 : 1 specimen. — Stn DW 452, 21°00.30'S, 167°25.50'E, 300 m, 20.02.1989 : 6 specimens, on pebbles. — Stn DW 456, 21°00.71'S, 167°26.35'E, 240 m, 20.02.1989 : 8 specimens, on spatangoids. — Stn DW 457, 21°00.42'S, 167°28.71'E, 353 m, 20.02.1989 : 1 specimen, on pebble. — Stn DW 472, 21°08.60'S, 167°54.70'E, 300 m, 22.02.1989 : 1 specimen. — Stn DW 480, 21°08.50'S, 167°55.98'E, 380 m, 22.02.1989 : 1 specimen, on pebble. — Stn CP 481, 21°21.85'S, 167°50.30'E, 300 m, 23.02.1989 : 1 specimen. — Stn DW 482, 21°21.50'S, 167°46.80'E, 375 m, 23.02.1989 : 2 specimens, on coral.

**Wallis and Futuna Islands.** MUSORSTOM 7 : stn DW 502, 14°19.8'S, 178°06.5'W, 516-535 m, 11.05.1992 : 4 specimens, on pebbles. — Stn DW 511, 14°14.0'S, 178°11.5'W, 400-450 m, 12.05.1992 : 6 specimens, on pebbles. — Stn CP 531, 12°31.6'S, 176°39.3'W, 580-600 m, 16.05.1992 : 1 specimen, on pebble. — Stn DW 537, 12°30.0'S, 176°41.0'W, 325-400 m, 16.05.1992 : 1 specimen, on pebble. — Stn DW 540, 12°26.7'S, 177°28.4'W, 600 m, 17.05.1992 : 2 specimens, on pebbles. — Stn DW 541, 12°26.7'S, 177°28.0'W, 500-505 m, 17.05.1992 : 1 specimen, on pebble. — Stn CP 550, 12°14.8'S, 177°28.0'W, 800-810 m, 18.05.1992 : 1 specimen, on gorgonian. — Stn CP 551, 12°15.3'S, 177°28.1'W, 791-795 m, 18.05.1992 : 59 specimens, on shell fragments. — Stn CP 552, 12°15.7'S, 177°27.8'W, 786-800 m, 18.05.1992 : 2 specimens, on shell fragments. — Stn DW 555, 11°47.5'S, 178°19.2'W, 540-542 m, 19.05.1992 : 1 specimen, on shell. — Stn DW 557, 11°48.1'S, 178°18.2'W, 600-608 m, 19.05.1992 : 2 specimens (MNHN-Ci 2314), on pebbles. — Stn DW 558, 11°49.9'S, 178°18.9'W, 635 m, 19.05.1992 : 1 specimen, on pebble. — Stn DW 560, 11°47.0'S, 178°20.0'W, 697-702 m, 19.05.1992 : 3 specimens, on pebbles. — Stn CP 562, 11°48.1'S, 178°22.1'W, 775-777 m, 19.05.1992 : 53 specimens, on echinoderms and shell. — Stn CP 564, 11°46.1'S, 178°27.4'W, 1015-1020 m, 20.05.1992 : 15 specimens, on pebbles. — Stn CP 565, 11°47.4'S, 178°25.3'W, 900 m,

20.05.1992 : 7 specimens, on shells. — Stn DW 586, 13°10.7'S, 176°13.1'W, 510-600 m, 22.05.1992 : 1 specimen, on coral. — Stn DW 597, 12°31.4'S, 174°18.6'W, 469-475 m, 24.05.1992 : 1 specimen, on coral. — Stn DW 598, 12°30.5'S, 174°18.6'W, 702-708 m, 24.05.1992 : 2 specimens, on pebbles. — Stn DW 618, 14°21.7'S, 178°00.5'W, 420-435 m, 27.05.1992 : 1 specimen, on spatangoid. — Stn CP 623, 12°34.2'S, 178°15.1'W, 1280-1300 m, 28.05.1992 : 1 specimen, on scalpellid. — Stn DW 636, 13°39.4'S, 179°55.5'E, 650-700 m, 30.05.1992 : 1 specimen, on coral.

**Philippines.** MUSORSTOM 3 : stn CP 106, 13°47.00'S, 120°30.30'E, 668 m, 02.06.1985 : 3 specimens, on bivalve.

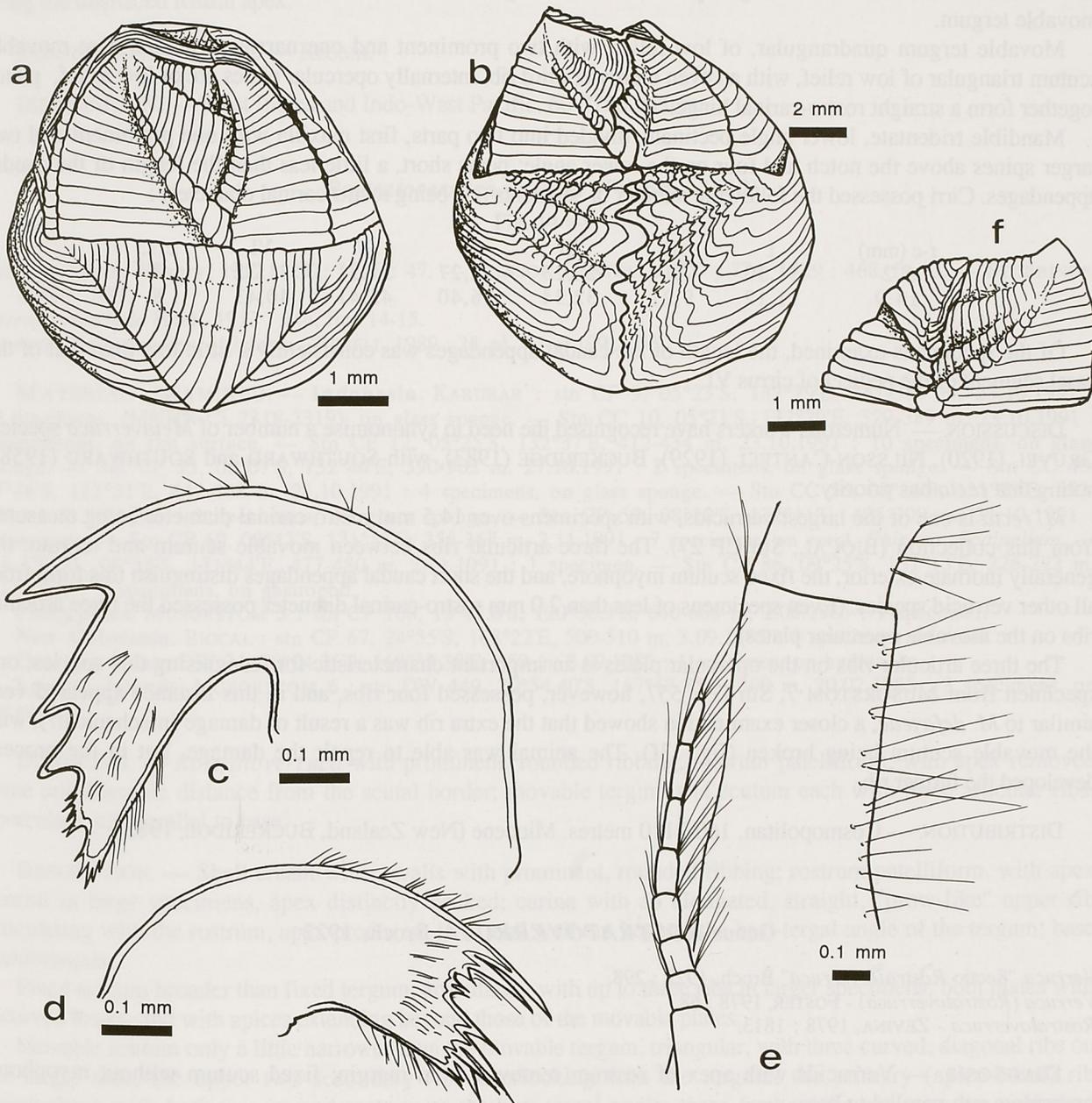


FIG. 13. — *Metaverruca recta* (Aurivillius, 1898) : a, complete shell (dorsal view), MNHN-Ci 2312; b, complete shell, larger specimen, showing development of interlocking ribs between rostrum and carina (dorsal view), MNHN-Ci 2313; c, mandible; d, first maxilla; e, basal portion of sixth cirrus, with caudal appendage attached; f, articulated movable scutum and tergum, showing repair to damaged scutum and resultant development of what appears to be a fourth rib on the tergum (exterior), MNHN-Ci 2314. Material : a, c-e from BIOCAL, stn CP 23; b from BIOCAL, stn CP 26; f from MUSORSTOM 7, stn DW 557.

DIAGNOSIS. — *Metaverruca* with movable tergum and scutum having three articular ribs; exterior generally smooth with widely spaced growth lines; caudal appendages short.

DESCRIPTION. — A large verrucid, shell white, low conic, sides steep; operculum sub-parallel to base, D-shaped; exterior generally smooth, with fine, well spaced concentric growth lines; rostrum and carina articulating with up to seven ribs.

Fixed scutum quadrangular, with a well formed myophore for adductor muscle attachment; basal margin of shell thickened and inflected on larger specimens; fixed tergum with umbo extending fractionally beyond that of movable tergum.

Movable tergum quadrangular, of low relief, with two prominent and one narrow articular ribs; movable scutum triangular of low relief, with an even narrower third rib, internally opercular plates are of low relief, plates together form a straight rostro-carinal hinge.

Mandible tridentate, lower angle pectinate, divided into two parts, first maxilla with one prominent and two larger spines above the notch and four on the lower angle; penis short, a little less than the length of the caudal appendages. Cirri possessed the following number of segments (r-c being rostro-carinal diameter) :

r-c (mm)	I	II	III	IV	V	VI	c.a.
5.2	11,10	7,14	22,23	22,27	31,31	31,32	8
14.9	11,12	9,21	32,34	36,40	43,41	40,43	8

Of the specimens examined, the length of the caudal appendages was consistently a little less than that of the basal segment of the pedicel of cirrus VI.

DISCUSSION. — Numerous workers have recognised the need to synonymise a number of *Metaverruca* species; GRUVEL (1920), NILSSON-CANTELL (1929), BUCKERIDGE (1983), with SOUTHWARD and SOUTHWARD (1958), noting that *recta* has priority.

*M. recta* is one of the largest verrucids, with specimens over 14.5 mm rostro-carinal diameter being measured from this collection (BIOCAL, Stn CP 27). The three articular ribs between movable scutum and tergum, the generally inornate exterior, the fixed scutum myophore, and the short caudal appendages distinguish this form from all other verrucid species. (Even specimens of less than 2.0 mm rostro-carinal diameter possessed the three articular ribs on the movable opercular plates).

The three articular ribs on the opercular plates is an important characteristic for recognising this species; one specimen from MUSORSTOM 7, Stn DW 557, however, possessed four ribs, and in this instance appeared very similar to *M. defayae*, a closer examination showed that the extra rib was a result of damage (mechanical?), with the movable scutum being broken (fig. 13f). The animal was able to repair the damage, but in the process developed the further rib.

DISTRIBUTION. — Cosmopolitan, 160-2110 metres. Miocene (New Zealand, BUCKERIDGE, 1983).

#### Genus *ROSTRATOVERRUCA* Broch, 1922

*Verruca* "Sectio *Rostrato-verruca*" Broch, 1922 : 298.

*Verruca* (*Rostratoverruca*) - FOSTER, 1978 : 68.

*Rostratoverruca* - ZEVINA, 1978 : 1813.

DIAGNOSIS. — Verrucids with apex of rostrum removed from margin; fixed scutum without myophore; operculum sub-parallel to base.

TYPE. — *Verruca nexa* Darwin, 1854 : 522. West Indies, 60 metres.

SPECIES. — With the placement of *Verruca dens* within *Brochiverruca*, the following 8 species are now attributed to this genus : *Rostratoverruca conchula* (Hoek, 1913), Timor; *Rostratoverruca intexta* (Pilsbry, 1912),

Indian Ocean - Western Pacific; *Rostratoverruca koehleri* (Gruvel, 1907), Bay of Bengal; *Rostratoverruca kruegeri* (Broch, 1922), Western Pacific; *Rostratoverruca murrayi* (Stubbings, 1936), Zanzibar; *Rostratoverruca nexa* (Darwin, 1854), West Indies; *Rostratoverruca sewelli* (Stubbings, 1936), Zanzibar; *Rostratoverruca malevichi* Zevina, 1988, South Pacific.

DISCUSSION. — As many of the specimens studied in this collection were attached to cidaroid spines, the angle between operculum and base is often difficult to ascertain. The most important criterion for recognising this genus being the displaced rostral apex.

STRATIGRAPHIC RANGE. — Recent.

DISTRIBUTION. — West Indies and Indo-West Pacific, 60-3250 metres.

*Rostratoverruca intexta* (Pilsbry, 1912)

Fig. 14 a-f

*Verruca intexta* Pilsbry, 1912 : 292; 1916 : 47. — NILSSON-CANTELL, 1927 : 774; 1929 : 468, fig. 3. — STUBBINGS, 1940 : 389.

*Verruca conchula* Hoek, 1913 : 146, figs 14-15.

*Verruca (Rostratoverruca) intexta* - ROSELL, 1989 : 26, pl. 7 f-g; 1991 : 33.

MATERIAL EXAMINED. — **Indonesia.** KARUBAR : stn CP 9, 05°23'S, 132°29'E, 361-389 m, 23.10.1991 : 25 specimens, (MNHN-Ci 2318-2319), on glass sponge. — Stn CC 10, 05°21'S, 132°29'E, 329-389 m, 23.10.1991 : 4 specimens, on flat surface. — Stn CP 12, 05°25'S, 132°37'E, 412-434 m, 23.10.1991 : 10 specimens, on glass sponge. — Stn CP 35, 06°07'S, 132°44'E, 390-502 m, 27.10.1991 : 2 specimens, on glass sponge. — Stn CC 40, 07°46'S, 132°31'E, 442-468 m, 28.10.1991 : 4 specimens, on glass sponge. — Stn CC 56, 08°16'S, 131°59'E, 552-549 m, 31.10.1991 : 2 specimens, on glass sponge. — Stn CP 59, 08°20'S, 132°11'E, 405-399 m, 31.10.1991 : 1 specimen. — Stn CP 69, 08°42'S, 131°53'E, 356-367 m, 2.11.1991 : 7 specimens, on coral, *Chirona*, *Scalpellum*. — Stn CP 71, 08°38'S, 131°44'E, 477-480 m, 2.11.1991 : 1 specimen. — Stn CP 86, 09°25'S, 131°13'E, 226-222 m, 4.11.1991 : 3 specimens, on gastropod.

**Philippines.** MUSORSTOM 3 : stn CP 106, 13°47.0'S, 120°30.3'E, 640-668 m, 2.06.1985 : 1 specimen.

**New Caledonia.** BIOCAL : stn CP 67, 24°55'S, 168°22'E, 500-510 m, 3.09.1985 : 1 specimen, on coral.

CHALCAL 2 : stn DW 74, 20°04.36'S, 168°38.38'E, 650 m, 3.09.1985 : 1 specimen, on hydrozoan.

**Loyalty Islands.** MUSORSTOM 6 : stn DW 449, 20°54.40'S, 167°17.75'E, 300 m, 20.02.1985 : 3 specimens, on gorgonian.

DIAGNOSIS. — *Rostratoverruca* with prominent, rounded ribbing; rostrum patelliform, with apex removed some considerable distance from the scutal border; movable tergum and scutum each with three articular ribs; operculum sub-parallel to base.

DESCRIPTION. — Shell cream-white, walls with prominent, rounded ribbing; rostrum patelliform, with apex central in large specimens, apex distinctly beaked; carina with an elongated, straight, "prow-like" upper rib articulating with the rostrum, apex produced, to extend well out beyond the basi-tergal angle of the tergum; base membranous.

Fixed scutum broader than fixed tergum, articulating with up to three ribs in larger specimens; both plates with incurved beaks, and with apices extending beyond those of the movable plates.

Movable scutum only a little narrower than the movable tergum, triangular, with three curved, diagonal ribs on the tergal side, the upper two secondary ribs interlocking with the tergum, the primary (apico-basal) rib interlocking with both tergum and rostrum at the basi-tergal angle; three further ribs occur on the occludent portion, interlocking basally with the rostrum; apex beaked; interior with a rounded moderately well developed adductor muscle depression.

Movable tergum quadrilateral, apex incurved towards scutum, primary apico-basal rib curved, interlocking at the basi-scutal angle; two secondary ribs articulate with the movable scutum.

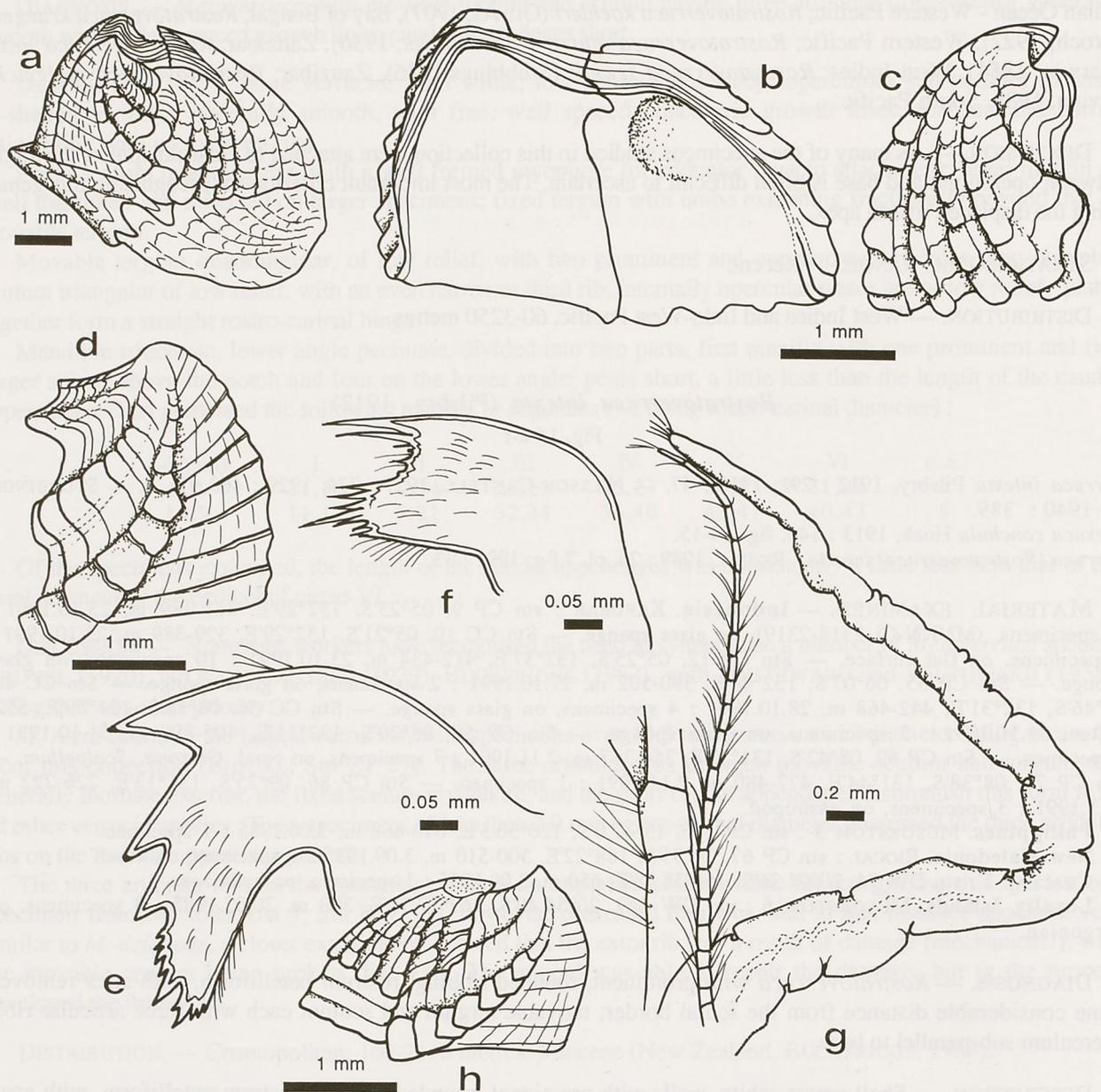


FIG. 14. — *Rostratoverruca intexta* (Pilsbry, 1912) : **a**, complete shell (dorsal view), MNHN-Ci 2318; **b**, articulated movable scutum and tergum (interior); **c**, movable scutum (exterior); **d**, movable tergum (exterior); **e**, mandible; **f**, first maxilla; **g**, basal portion of sixth cirrus, with penis and caudal appendage attached; **h**, articulated movable scutum and tergum, showing repair to damaged scutum and resultant development of a non-ribbed portion (exterior), MNHN-Ci 2319. All material from KARUBAR, stn CP 9.

Mandible tridentate, lower angle pectinate, divided into two parts; first maxilla with two prominent upper spines, notch hirsute, lower angle hirsute, with six or more spines.

Cirrus I and cirrus II subequal; caudal appendages longer than the pedicel of cirrus VI; penis very long, probosciform, slightly longer than caudal appendages. Cirri possessed the following number of segments (r-c being rostro-carinal diameter) :

r-c (mm)	I	II	III	IV	V	VI	c.a.
5.4	9,13	9,14	18,19	21,22	23,25	23,26	20

DISCUSSION.— This species is distinguished from *Rostratoverruca nexa* by the patelliform rostrum, the strong ribbing, the number of ribs on the movable tergum and scutum, and the prominent prow-like upper rib on the carina. It is similar to *Rostratoverruca kruegeri* (Broch, 1922) but possesses a much broader movable tergum and scutum than that species, and unlike *R. kruegeri*, has no strong ribbing on the occludent side of the apico-basal rib of the tergum.

The large amount of material available for observation provided an opportunity to gain an appreciation of morphological variation. One specimen in particular (fig. 14h), appears to demonstrate the effect of pathogenesis on both the movable scutum and rostrum, with characteristically strong ribbing present in early growth, but abruptly absent subsequently.

DISTRIBUTION. — Indo-Pacific, 194-1002 metres.

*Rostratoverruca kruegeri* (Broch, 1922)

Fig. 15 a-f

*Verruca Krügeri* Broch, 1922 : 295, figs 43-44.

*Verruca (Rostratoverruca) krügeri* - BROCH, 1932 : 46.

MATERIAL EXAMINED.— **Indonesia.** KARUBAR : stn CP 46, 08°01'S, 132°51'E, 271-273 m, 29.10.1991 : 28 specimens (MNHN-Ci 2320), on cidaroid spines. — Stn CP 85, 09°22'S, 131°14'E, 245-240 m, 4.11.1991 : 85 specimens, on cidaroid spines.

**Philippines.** MUSORSTOM 3 : stn CP 139, 11°52.9'S, 120°14.7'E, 240-267 m, 6.06.1985 : 200+ specimens, on cidaroid spines.

DIAGNOSIS. — *Rostratoverruca* with prominent, rounded ribbing on rostrum and carina; rostrum patelliform, with apex removed some considerable distance from the scutal border; fixed scutum and tergum with weak longitudinal ribbing; movable tergum and scutum each with four articular ribs.

DESCRIPTION. — Shell white, rostrum and carina with prominent, rounded ribbing; rostrum patelliform, with apex central in large specimens, apex slightly incurved; carina with a moderately elongated, "prow-like" upper rib articulating with the rostrum, but with superior margin ridged, due to fine secondary ribbing; apex produced, to extend out beyond the basi-tergal angle of the tergum; carina and rostrum generally interlocking with three ribs; base membranous.

Fixed scutum broader than fixed tergum, articulating with up to three ribs in larger specimens; longitudinal ribbing weak, especially on smaller specimens; both plates with apices slightly incurved, that of fixed tergum extending beyond that of the movable tergum.

Movable scutum only a little narrower than the movable tergum, triangular, with four curved, diagonal ribs on the tergal side, the upper three secondary ribs interlocking with the tergum, the primary (apico-basal) rib interlocking with both tergum and rostrum at the basi-tergal angle; three further ribs occur on the occludent portion, interlocking basally with the rostrum; apex incurved; interior with a rounded, moderately well developed adductor muscle depression.

Movable tergum quadrilateral, apex incurved towards scutum, primary apico-basal rib curved, interlocking at the basi-scutal angle; three secondary ribs articulate with the movable scutum; scutal margin with sulcus immediately below upper rib; three further ribs occur on the occludent portion, interlocking with the tergum.

Mandible tridentate, lower angle pectinate; first maxilla with prominent upper spine, notch poorly differentiated, with three small spines, lower angle hirsute, with four spines.

Cirrus I and cirrus II subequal; caudal appendages about half the length of cirrus VI; penis very long, probosciform, slightly longer than cirrus VI. Cirri possessed the following number of segments (r-c being rostro-carinal diameter) :

r-c (mm)	I	II	III	IV	V	VI	c.a.
5.6	8,13	9,13	14,16	19,21	19,23	20,24	19

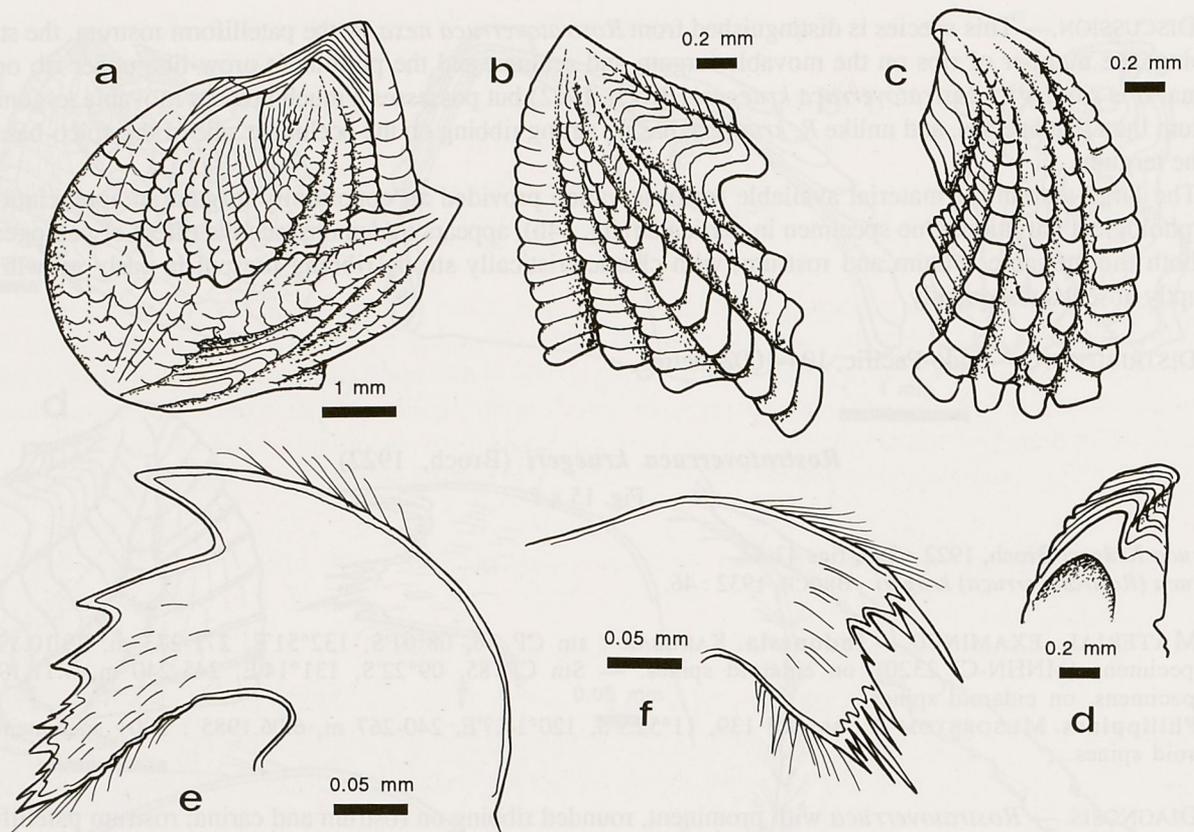


FIG. 15. — *Rostratoverruca kruegeri* (Broch, 1922) : a, complete shell (dorsal view), MNHN-Ci 2320; b, movable tergum (exterior); c, movable scutum (exterior); d, apical portion of movable scutum (interior); e, mandible; f, first maxilla. All material from KARUBAR, stn CP 46.

DISCUSSION. — This species is distinguished from *Rostratoverruca intexta* (Pilsbry, 1912) by the narrower movable plates, the number of ribs on the movable tergum and scutum, and the less prominent prow-like upper rib on the carina. It is similar to *Rostratoverruca koehleri* (Grüvel, 1907), but possesses a much more prominent apex on the fixed tergum, and greater ribbing on the occludent portion of the movable tergum.

DISTRIBUTION. — Western Pacific, 233-290 metres.

## DISCUSSION

DISTRIBUTION. — The material studied was collected from depths ranging between 223 and 3680 metres. On the basis of this, a bathymetric zoning may be determined for the region, but it is likely that water temperatures and currents will also have a bearing on this distribution. The following provides a broad appreciation of the distribution of verrucid genera, and confirms that *Alti-verruca*, in particular, is characteristic of slope and abyssal environments :

Genus	Depth range (metres)	Mean (metres)	No. of Stns
<i>Alti-verruca</i>	412-3680	1407 <sup>†</sup>	55
<i>Metaverruca</i>	240-2110	788	99
<i>Verruca</i>	466-620	542	2
<i>Brochiverruca</i>	356-700	520	6
<i>Cameraverruca</i>	380-450	415	2
<i>Rostratoverruca</i>	222-668	408	18

<sup>†</sup>only 2 specimens of *Alti-verruca* were recovered from depths less than 510 metres.

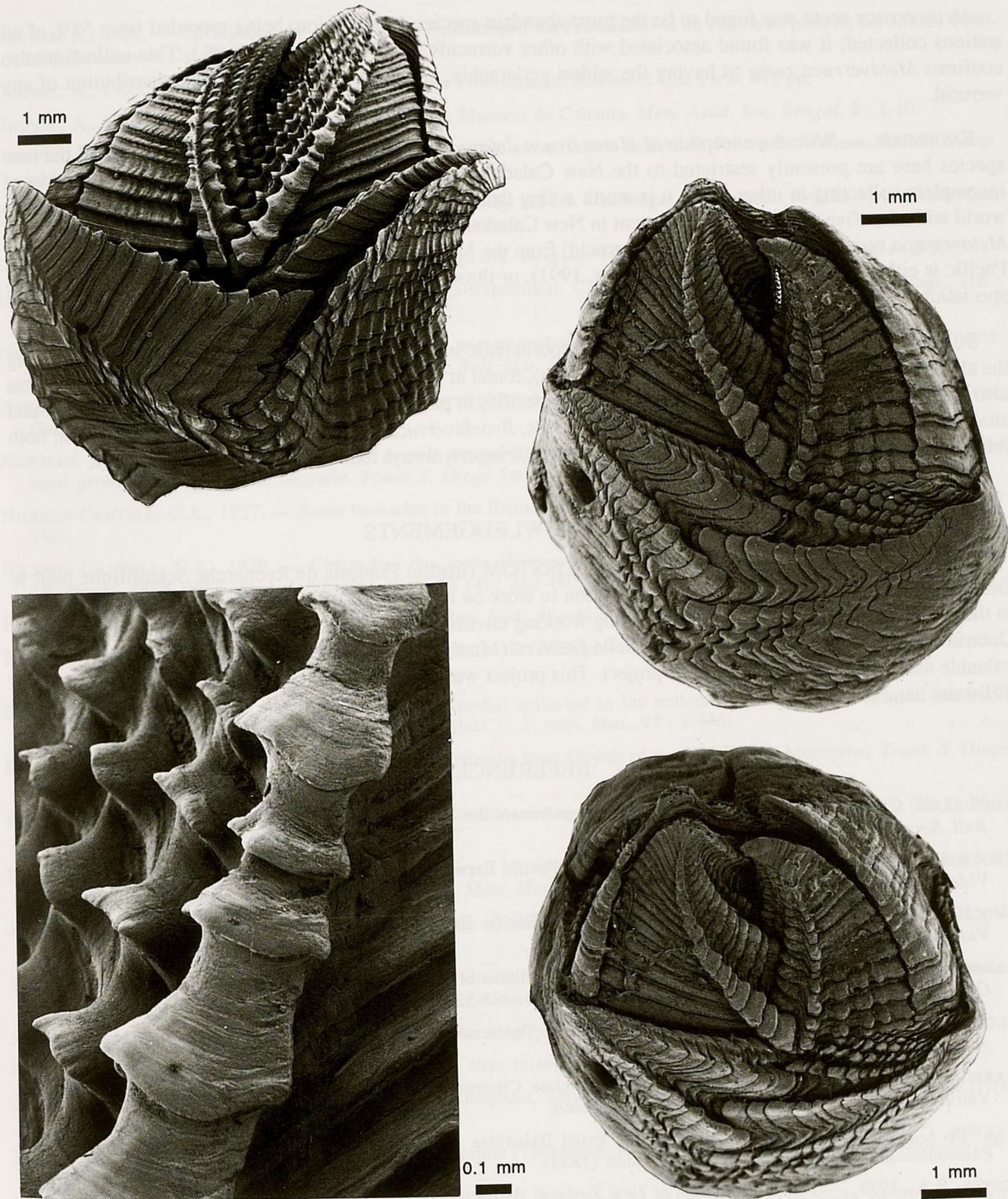


FIG. 16. — Scanning Electron Microscope views. : a, *Altiverruca navicula* (Hoek, 1913), complete shell, MNHN-Ci 2331; (dorsal view); b, *Altiverruca navicula* (Hoek, 1913), detail of apico-basal rib on movable tergum (exterior); c, *Metaverruca pacifica* sp. nov., complete shell (dorsi-frontal view), MNHN-Ci 2330; d, *Metaverruca pacifica* sp. nov., complete shell (dorsal view), MNHN-Ci 2330. Material : a-b, from KARUBAR, stn CP 91; c-d, from MUSORSTOM 5, stn CP 367.

*Metaverruca recta* was found to be the most abundant species in the region, being recorded from 55% of all stations collected; it was found associated with other verrucids at only 16 stations (24%). This collection also confirms *Metaverruca recta* as having the widest geographic, bathymetric and stratigraphic distribution of any verrucid.

ENDEMISM. — With the exception of *Metaverruca defayae* (Loyalty, Wallis and Futuna Islands) all the new species here are presently restricted to the New Caledonian region. Whilst this is likely to be a function of incomplete collecting in other areas, it is worth noting that *Metaverruca*, presently represented by eight species world wide, has five of these species present in New Caledonian waters. The occurrence of the now cosmopolitan *Metaverruca recta* (also the earliest metaverrucid) from the Miocene of New Zealand suggests that the southwest Pacific is either a centre of reliction (NEWMAN, 1991), or throughout the Neogene was a centre for *Metaverruca* speciation.

SUBSTRATE. — Verrucids tend to be rather opportunistic in the choice of substrate, the most common being the abundant benthic debris, (generally small pebbles), found at many stations, although broken shell material has also been utilised. Some species appear to be host specific, in particular *Altiverruca navicula*, which was found attached to glass sponges in almost 80% of specimens, *Brochiverruca polystriata* and *Brochiverruca dens*, both found attached to coral in all cases, and *Rostratoverruca kruegeri*, always found attached to cidaroid spines.

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