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THE CORAL-INHABITING BARNACLES (CRUSTACEA : THORACICA : PYRGOMATIDAE) FROM SOUTHERNMOST COAST OF TAIWAN[1]

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Ker-Yea Soong and Kun-Hsiung Chang (1983) The coral-inhabiting barnacles (Crustacea : Thoracica : Pyrgomatidae) from southernmost coast of Taiwan. *Bull. Inst. Zool., Academia Sinica* **22**(2): 243-253. The present paper reports fifteen newly recorded barnacles from the inshore waters off the southernmost Taiwan. They are: *Nobia conjugatum*, *N. grandis*, *Pyrgoma cancellata*, *Savignium crenatum*, *S. milleporae*, *S. dentatum*, *Creusia indicum*, *Hiroa stubbingsi*, *Cantellius iwayama*, *C. septimus*, *C. sextus*, *C. tredecimus*, *C. secundus*, *C. pallidus*, and *C. transversalis*. Among them, only *S. milleporae* is symbiotic with *Millepora* sp., the remaining 14 species are symbiotic with several species of scleractinian corals. Diagnosis, figures of opercular plates and the host coral species of these cirripeds are given.

Cirripeds of Taiwan were previously reported by Hiro (1939), Utinomi (1950), Wu (1967) and Ross (1973); while the coral inhabiting species were poorly understood. The study of coral-inhabiting barnacles can be dated back as early as Leach (1817), Sowerby (1823), and Darwin (1854). The coral inhabiting barnacles were grouped into two genera: *Creusia* and *Pyrgoma*, based on the structure of the shell, by Darwin. The shell of *Creusia* is divided into four compartments in contrast to the fused shell in *Pyrgoma*. The genus *Creusia* was recognized to include one single species, *C. spinulosa*, with 11 varieties. These varieties were raised to several valid species within the genus *Creusia* by Withers (1926), Hiro (1935, 1938) and Baluk and Radwanski (1967). Recently Ross and Newman (1973) and Newman and Ross (1976) have made an extensive revision on the world wide coral inhabiting barnacles. They grouped those barnacles into ten genera based on variations of the shell and opercular valves, and some emendations were made by Holthuis (1982) later.

The following accounts are brief description of fifteen newly recorded pyrgomatids collected during the study period.

MATERIALS AND METHODS

Specimens were collected on coral reefs from inshore waters at the southern tip of Taiwan. Barnacles were obtained from several species of host corals which were collected with Scuba gears. The collecting sites are indicated in Fig. 1:

Site 1. Ta-lau-ko (大硓𥑮), depth 6–20 m.
Site 2. Nan-wan (南灣), depth 10 m.
Site 3. Wan-li-ton (萬里桐), depth 7–12 m.
Site 4. Mao-bi-tou (貓鼻頭), depth 3–7 m.
Site 5. Shan-geo-wan (香蕉灣), depth 2–4 m.

Most samples were preserved in 10% formalin or 70% ethyl alcohol. Some specimens were decayed naturally in order to obtain intact opercular plates. Diagrams of opercular

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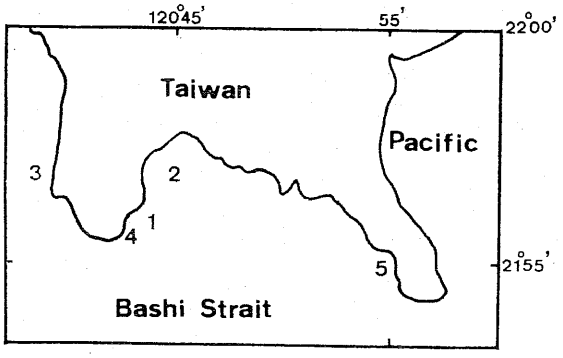

Fig. 1. Map of study area. (Sampling sites numbered and described in text.

plates were prepared with the aid of Nikon drawing tube. The abbreviations used in measurement of specimens are: S. L., shell length; S. W., shell width; O. L., orifice length; R. R., number of radiating ridges. The horizontal bar in each figure represents one milimeter for opercular valves only. These specimens are catalogued and deposited in the Museum of the Institute of Zoology, Academia Sinica.

RESULTS

Systematic accounts

Family Pyrgomatidae

Key to the species of pyrgomatids from southern tip of Taiwan

1. Shell concrescent 2
   Shell consists of 4 parietes.....7
2. Opercular plates fused 3
   Opercular plates separable 4
3. Spur projecting .....*Nobia conjugatum*
   Spur rudimentary.....*Nobia grandis*
4. Tergal spur well developed .....
   .....*Pyrgoma cancellata*
   Tergal spur rudimentary.....5
5. Occludent ledge well developed 6
   Occludent ledge absent .....
   ..... *Savignium milleporae*
6. Articular ridge of scutum well developed..
   ..... *Savignium dentatum*
   Articular ridge poorly developed .....
   ..... *Savignium crenatum*

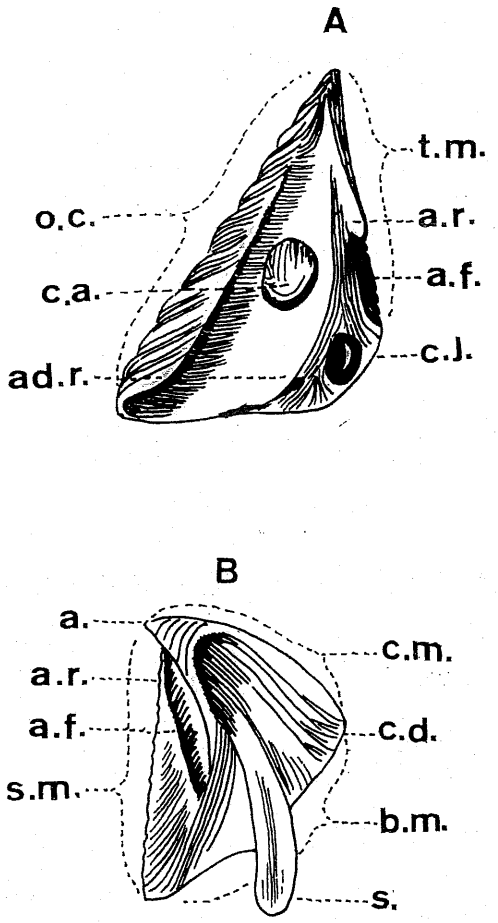

Fig. 2. Terminology of scutum (A) and tergum (B) used in text (after Darwin). a., apex; ad. r., adductor ridge; a. f., articular furrow; a. r., articular ridge; b. m., basal margin; c. a., cavity for adductor muscle; c. d., crests for depressor muscle; c. l., cavity for lateral depressor muscle; c. m., carinal margin; o. m., occludent margin; s. m.: scutal margin; s., spur; t. m., tergal margin.

7. Opercular plates highly modified 8
   Opercular plates balanoid.....9
8. Opercular plates fused .....*Creusia indicum*
   Opercular plates separate ..*Hiroa stubbingsi*
9. Scutum with entire basal margin and no rostral tooth .....*Cantellius transversalis*
   Scutum with notched basal margin and commonly a rostral tooth.....10
10. Tergum with a straight scutal margin...11

Tergum with an inward-curved scutal margin 13
11. Articular ridge well developed and can be seen externally .....
.....*Cantellius iwayama*
Articular ridge do not form a plate....12
12. Rostral tooth well developed.....
..... *Cantellius septimus*
Rostral tooth remnant, if present .....
..... *Cantellius sextus*
13. Adductor plate well developed 14
Adductor plate remnant .....
.....*Cantellius tredecimus*
14. Tergum with a pointed projection at the end of spur .....*Cantellius secundus*
Tergum without projection at the end of spur .....*Cantellius pallidus*

1. *Nobia conjugatum* (Darwin, 1854)

Fig. 3

Pyrgoma conjugatum Darwin, 1854: 364.

Materials: Nine specimens in the host coral *Cyphastrea* sp., Site 4, March 9, 1983. Specimens measured: S. L., 2.3–4.1 mm; S. W., 2.0–3.3 mm; O. L., 1.0–1.7 mm; R. R., 17–33.

Diagnosis: Shell oval, flat, dark purple, with prominent radiating ridges. Orifice oval and narrow. Scutum and tergum fused to one piece. Scutum with a broad adductor ridge extending below the basal margin. Tergum relatively thin, with a prominent projecting spur.

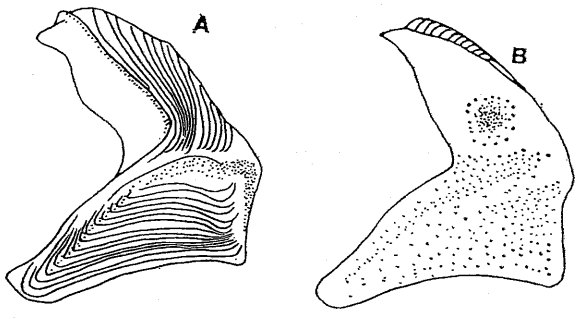

Fig. 3. *Nobia conjugatum* from *Cyphastrea* sp. A, external view of opercular valve; B, internal view of opercular valve.

Remarks: This species can easily be distinguished from *N. grandis* by shell ridges and spur of the tergum.

2. *Nobia grandis* (Sowerby, 1839)

Fig. 4

Pyrgoma grande, Darwin, 1854: 365; Hiro, 1935: 60.

Materials: One specimen in the host coral *Euphyllia* sp., Site 1, May 1982; three in *Galaxea* sp. Sites 1 and 2, May 1982; two in *Coeloseris mayeri*, Site 3, Oct. 1982; one in *Lobophyllia robusta*, Site 2, Dec. 1982. Specimens measured: S. L., 6.2–11.3 mm; S. W., 3.6–6.7 mm; O. L., 2.2–3.7 mm.

Diagnosis: Shell oval, conical, with feeble traces of radiating ridges if not encrusted by coral. Orifice oval, large, widened at rostral end. Scutum and tergum fused. Scutum triangular with adductor ridge extending below basal margin. A narrow band of occludent ledge is present. Tergum broad with remnant spur.

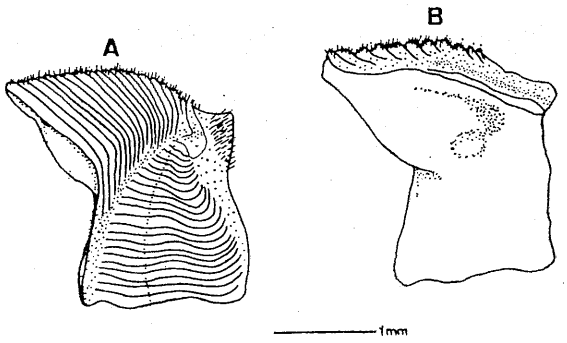

Fig. 4. *Nobia grandis* from *Galaxea* sp. A, external view of opercular valve; B, internal view of opercular valve.

Remarks: Settled in the empty space among corallites of *Galaxea* sp.; and in *Euphyllia* sp., imbedding in the fossa and occupying the space of septa. The specimens in the host coral *Lobophyllia robusta* was found attaching to the wall of the coral and has a slender scutal portion. The specimens in the host coral *Coeloseris mayeri* are smaller with a much deeper furrow on tergum and a partly vacated rostral corner on the adductor ridge.

3. *Pyrgoma cancellata* Leach, 1824

Fig. 5

Pyrgoma cancellatum, Darwin, 1854: 362; Hiro, 1935: 54.

Materials: Three specimens in the host coral *Tubastrea* sp., Site 1, Sept. 1982. Specimens measured: S. L., 6.2–7.8 mm; S. W., 4.8–6.2 mm; R. R., 20–24.

Diagnosis: Shell oval, flat, bulged in the surroundings of orifice. Radiating ridges prominent in the shell margin. Orifice narrow. Scutum elongated transversely with a very broad adductor ridge. Tergum with a long spur and is externally furrowed.

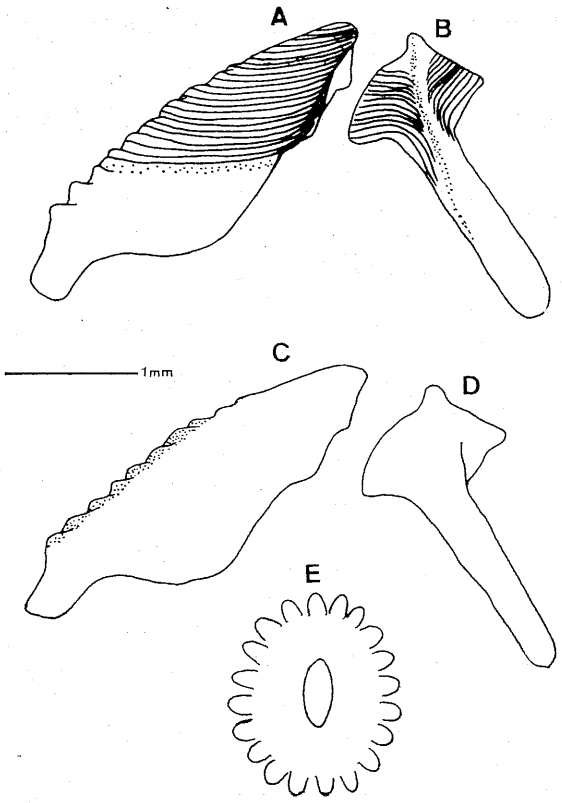

Fig. 5. *Pyrgoma cancellata* from *Tubastrea* sp. A, external view of scutum; B, external view of tergum; C, internal view of scutum; D, internal view of tergum; E, internal view of shell.

Remarks: Imbedded mostly on the peripheral surface of the plocoid corallum of *Tubastrea* sp. In some cases, two small furrows are formed in the proximal part of the spur due to the presence of a longitudinal ridge.

4. *Savignium milleporae* (Darwin, 1854)

Fig. 6

Pyrgoma milleporae Darwin, 1854: 367; Hiro, 1938: 401.

Materials: Seven specimens from *Millepora* sp. 1, 2, Sites 4 and 5 Sept. 1982. Specimens measured: S. L., 4.6–8.4 mm, S. W. 3.5–7.3 mm, O. L., 1.1–1.8 mm.

Diagnosis: Shell oval and flat. No radiating ridges. Orifice small and is located closely to the carinal end; the carinal end rounded and the rostral end pointed. Scutum is much elongated in transverse direction with a well developed articular ridge. Tergum triangular in shape.

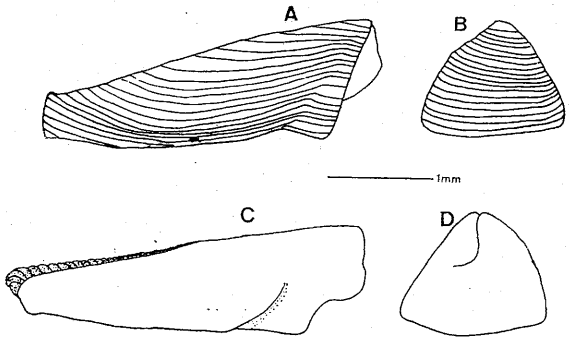

Fig. 6. *Savignium milleporae* from *Millepora* sp. A, external view of scutum; B, external view of tergum; C, internal view of scutum; D, internal view of tergum.

Remarks: Opercular plates tend to fuse together due to calcification. Articular ridge of scutum often attached to tergum when they are torn apart.

5. *Savignium dentatum* (Darwin, 1854)

Fig. 7

Pyrgoma dentatum Darwin, 1854: 369; Hiro, 1935: 56.

Materials: One specimen in the host

coral *Platygyra* sp., Site 2, Sept. 1982. Shell broken, not measured.

Diagnosis: Shell flat and oval, pinkish in color. Distinct ridges on shell do not extend to the periphery of orifice. Scutum much elongated in transverse direction with a wide occludent ledge and a very prominent articular ridge; adductor ridge thick, not forming a plate. Tergum small, irregular shape; upper part of tergum broad. Scutal margin hollowed out internally and left a conspicuous space for the articular ridge of scutum.

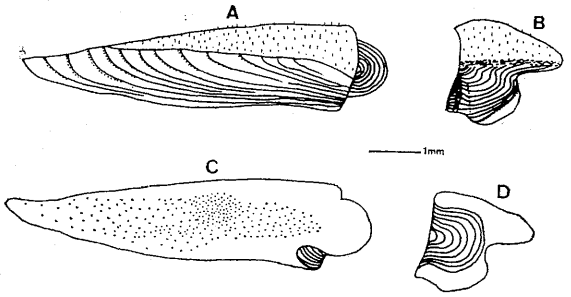

Fig. 7. *Savignium dentatum* from *Platygyra* sp. A, external view of scutum; B, external view of tergum; C, internal view of scutum; D, internal view of tergum.

Remarks: Scutum is slenderer than that described by Darwin (1854) and Hiro (1935). Tergum of this species resembles that in the variety 2 of *Pyrgoma dentatum* described by Darwin.

6. *Savignium crenatum* Sowerby, 1823

Fig. 8

Pyrgoma crenatum, Darwin, 1854: 370; Hiro, 1935: 58.

Materials: Three specimens in the host coral *Platygyra* sp., Site 2, May 1982; four in *Favites* sp. and *Montastrea* sp., Site 2, March 1983; two in *Merulina* sp., Site 2, Dec. 1982. Specimens measured: S. L., 4.8–9.1 mm; S. W., 3.5–7.7 mm; O. L., 2.0–3.1 mm; R. R., 10–17.

Diagnosis: Shell oval and flat; color generally pink, but paler at carinal end. Radiating ridges very prominent. Orifice large and oval, rounded at carinal end and sharpened at rostral end. Scutum much elongated with a prominent occludent ledge. Well developed adductor ridge descend below the basal margin. Tergum consists of two portions: the upper portion formed by occludent ledge and the lower portion a little elongated in transverse direction and much depressed. The external surface of the occludent ledges are furnished with many spinules.

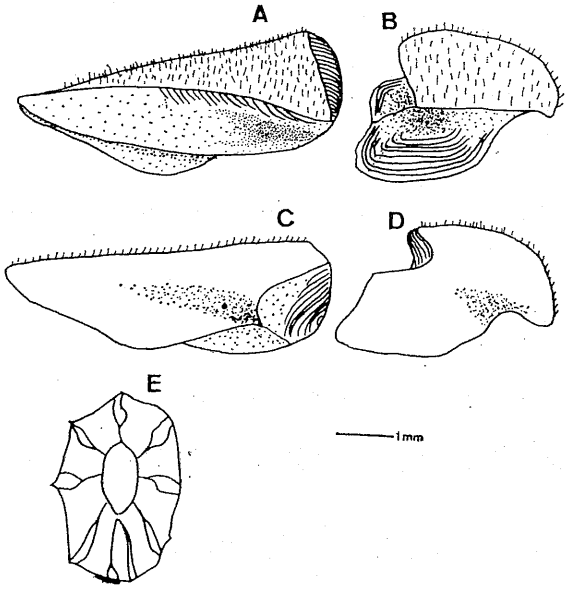

Fig. 8. *Savignium creatum* from *Platygyra* sp. A, external view of scutum; B, external view of tergum; C, internal view of scutum; D, internal view of tergum; E, external view of shell.

Remarks: This species is variable in shapes. In the specimens we examined, the tergum has a broader lower portion and is thus much elongated in transverse direction. The growth ridge on occludent ledge can hardly be seen due to the thickly furnished spinules.

7. *Creusia indicum* (Annandale, 1924)

Fig. 9

Creusia spinulosa var. 11 Darwin, 1854: 381.
Creusia spinulosa form *angustiradiata* Hiro, 1935: 51.
Creusia indicum, Ross and Newman, 1973: 155.

Materials: Two specimens in the host coral *Hydnophora* sp., Site 3, Oct. 1982; five in *Goniopora* sp., Site 5, Dec. 1982; one in *Favia* sp., Site 2, March 1983; one in *Montastrea* sp., Site 4, Sept. 1982. Specimens measured: S. L., 5.9–12.8 mm; S. W., 4.4–10.0 mm; O. L., 1.6–3.0 mm; R. R., 14–24.

Diagnosis: Shell oval and flat, and often raised from the surface of corallum of coral. Color generally pale pinkish. The shell has very prominent ridges which are often extended beyond the shell margin. Orifice large, oval, about 1/3 to 1/4 the length of shell. Rostral end of the shell is always oriented upward. Shell consists of four plates. Scutum and tergum fused to each other. Adductor ridge of scutum well developed and descends below the basal margin. Tergum is more or less quadratic except the curved basal margin.

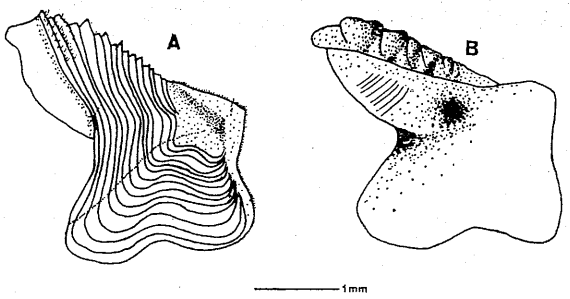

Fig. 9. *Creusia indicum* from *Hydnophora* sp. A, external view of opercular valve; B, internal view of opercular valve.

Remarks: The opercular valve of this species can hardly be distinguished from that of *Nobia grandis*, and many are intermediate between *C. indicum* and *C. deciua*. We assigned our specimens to *C. incicum* for their less protuberant spur in tergum.

8. *Hiroa stubbingsi* Ross and Newman, 1973

Fig. 10

Hiroa stubbingsi Ross and Newman, 1973: 153.

Materials: Ten specimens in the host coral *Astreopora myriophthalma*, Site 3, Oct. 1982. Specimens measured: S. L., 6.5–89 mm; S. W., 5.1–6.7 mm; O. L. 1.9–2.4 mm; R. R., 28–32.

Diagnosis: Shell oval and conical, consisting of four parietes. Radiating ridges very prominent. Scutum and tergum separate. Scutum elongate transversely with very broad adductor plate extending below the basal margin. Tergum has a pronounced spur and a deep furrow.

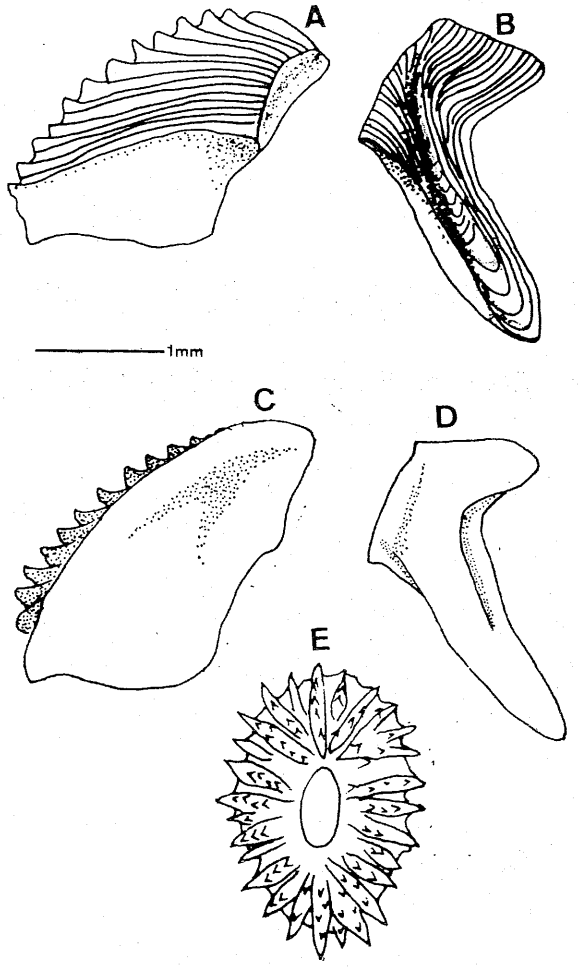

Fig. 10. *Hiroa stubbingsi* from *Astreopora incrustans*. A, external view of scutum; B, external view of tergum; C, internal view of scutum; D, internal view of tergum; E, external view of shell.

Remarks: The shell has a very clear boundary with peritheca of the coral, which can be easily pried off.

9. *Cantellius transversalis* (Nilsson-Cantell, 1938)

Fig. 11

Cantellius transversalis Ross and Newman, 1973: 153.

Materials: Ten specimens in the host coral *Acropora* sp., Site 3, Oct. 1982. Specimens measured: S. L., 3.7–4.9 mm; S. W., 3.4–4.2 mm; O. L., 1.0–1.3 mm.

Diagnosis: Shell oval, thin and very flat. Radiating ridges about 45 in number, which are series of short projections from the surface of shell. Orifice small. Scutum much elongated in transverse direction; adductor ridge prominent but not forming a plate. Tergum deeply furrowed near the scutal margin with distinct spur.

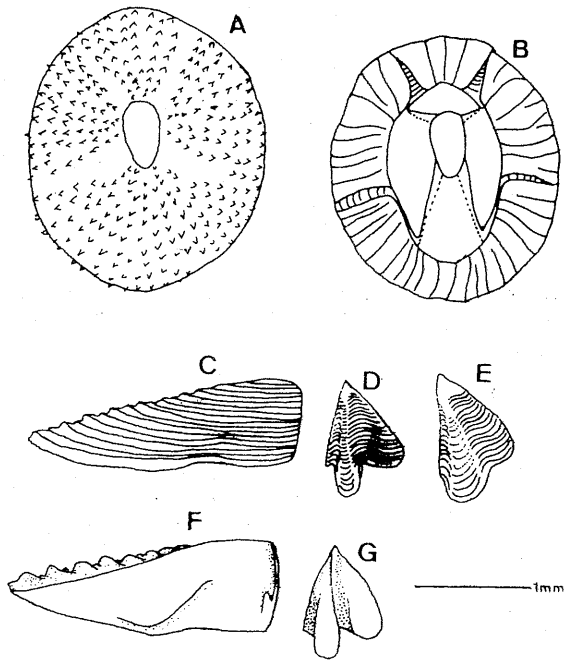

Fig. 11. *Cantellius transversalis* from *Acropora* sp. A, external view of shell; B, internal view of shell; C, external view of scutum; D and E, external view of tergum; F, internal view of scutum; G, internal view of tergum.

Remarks: At the first glance of the tergum, the present species is easily confused with *Ceratoconcha* sp. which were never encountered in the Indo-Pacific areas, (Ross and Newman, 1973). However, it is much similar to *Cantellius transversalis* in some respect (Newman, personal communication).

10. *Cantellius iwayama* (Hiro, 1938)

Fig. 12

Creusia spinulosa form *iwayama* Hiro, 1938: 393.

Materials: Two specimens in the host coral *Porites hawaiiensis*, Site 3, Oct. 1982.

Specimens measured: S. L., 3.7–5.0 mm; S. W., 3.0–4.2 mm; O. L., 1.3–1.4 mm.

Diagnosis: Shell flat, pearl-shape, pointed upward. The surface of shell is overgrown by coral; radiating ridges absent. Orifice rhombic. Scutum has a well developed articular ridge extending far beyond the tergal margin. Adductor ridge extends below basal margin with a moderately developed rostral tooth. Tergum has a straight scutal margin and a very broad spur.

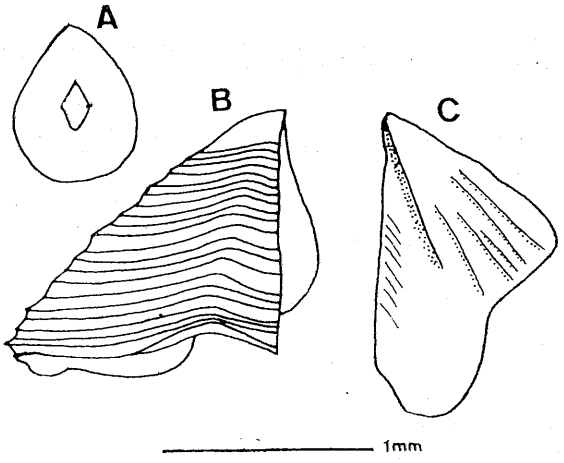

Fig. 12. *Cantellius iwayama* from *Porites hawaiiensis*. A, external view of shell; B, external view of scutum; C, internal view of tergum.

Remarks: Crests for depressor muscle are very distinct on the internal surface of tergum. This species is easily distinguished from other co-generic species in having the most pronounced articular ridge and a broad, flattened tergum.

11. *Cantellius septimus* (Hiro, 1938)

Fig. 13

Creusia spinulosa var. 7 Darwin, 1854: 380.
Creusia spinolosa form *septima* Hiro, 1938: 395.

Materials: Two specimens in the host coral *Acropora* sp., Site 5, Nov. 1981; three in *Montipora* sp., Site 5, Sept. 1982. Specimens measured: S. L., 3.1–6.2 mm; S. W., 3.0–5.3 mm; O. L., 1.0–1.9 mm; R. R., 25–34.

Diagnosis: Shell round to oval, flat, with very prominent radiating ridges, dark purple. End of ridges always projecting beyond the margin of shell. Orifice oval, medium size. Shell has four parietes. Scutum and tergum separate. Scutum subtriangular and is transversely elongated; rostral tooth extends below the basal margin. Tergum fragile, with a distinct and long spur.

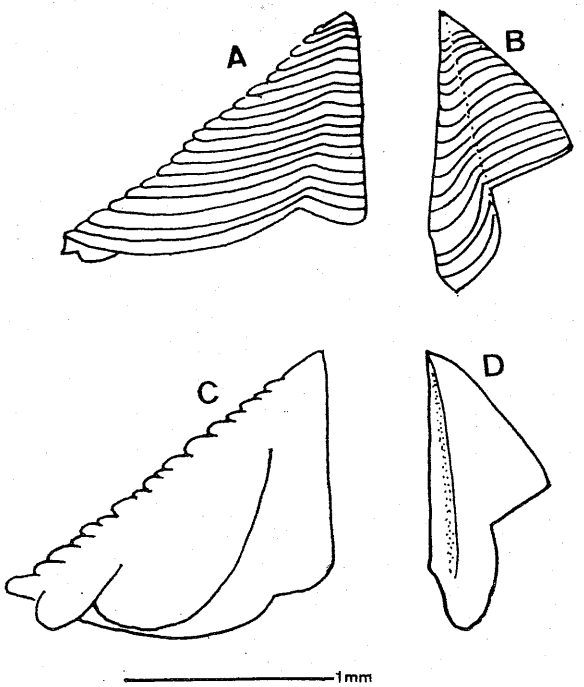

Fig. 13. *Cantellius septimus* from *Montipora* sp. A, external view of scutum; B, external view of tergum; C, internal view of scutum; D, internal view of tergum.

Remarks: Adductor ridge extends below the basal margin in the case of *Acropora* sp., but concealed in the case of *Montipora* sp. The coenosteum of *Montipora* sp. often appears a ring around the orifice, leaving a notch at the rostral end. The ring is U-shaped and does not extend to the margin of the shell.

12. *Cantellius sextus* (Hiro, 1938)

Fig. 14

Creusia spinulosa var. 6 subvar. 3 Darwin, 1854: 379.
Creusia spinulosa form *sexta* Hiro, 1938: 398.

Materials: Four specimens in the host coral *Pachyseris rugosa*, Site 2, Sept. 1982. Specimens measured: S. L., 2.0–5.0 mm; S. W., 1.7–4.0 mm; O. L., 0.9–1.8 mm.

Diagnosis: Scutum is transversely elongated with a well developed adductor ridge extending below the basal margin. Basal margin of scutum curved near the tergal margin. Tergum subtriangular with a straight scutal margin and an apparent articular furrow.

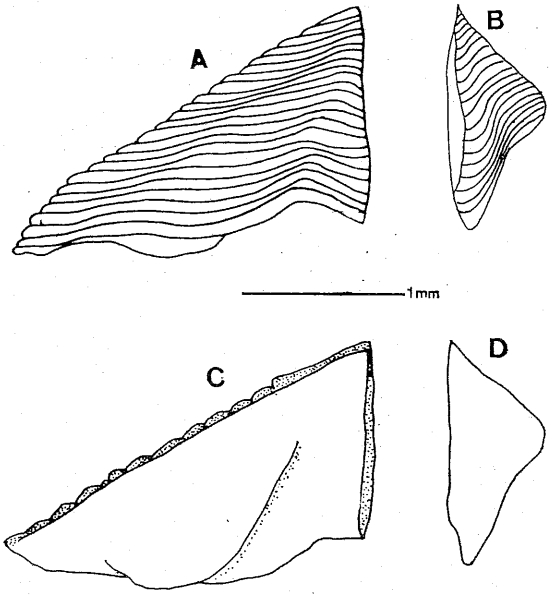

Fig. 14. *Cantellius sextus* from *Pachyseris rugosa*. A, external view of scutum; B, external view of tergum; C, internal view of scutum; D, internal view of tergum.

Remarks: The shell is always covered by coral forming an U-shaped bulge in the

surrounding of the orifice; the rostral end of shell is not encrusted by coral. Radiating ridges can only be seen in young stages, while those on rostrum remained until the old stage. These rostral ridges are often wedged by two distinct reddish-brown band.

13. *Cantellius tredecimus* (Kolosvary, 1947)

Fig. 15

Cantellius tredecimus Ross and Newman 1973: 151.

Materials: Two specimens in the host coral *Montipora* sp., Site 5, Sept. 1982. Specimens measured: S. L., 6.7–7.8 mm, S. W., 5.0–6.9 mm; O. L., 2.4–3.0 mm.

Diagnosis: Shell conical and oval. Radiating ridges absent. Orifice large, pointed at the rostral end. Shell consists of four parietes. Scutum triangular and depressed in the center resulting the uprising of apex and basal margin when viewed externally. Adductor ridge remnant while articular ridge well developed. Tergum large, flat; its scutal margin curved inward with a beak-like apex.

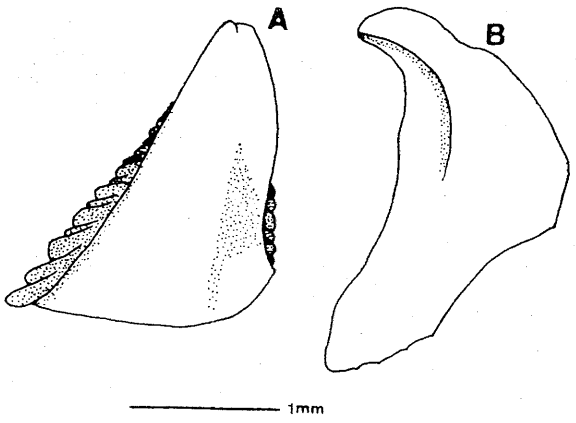

Fig. 15. *Cantellius tredecimus* from *Montipora* sp. A, internal view of scutum; B, internal view of tergum.

Remarks: Imbedded shallowly on the upper surface of the corallum and does not drill deeply into the coral. The surface of the shell is always encrusted by coral. This species is found together with *C. septimus* in the same colony of *Montipora* sp.

14. *Cantellius secundus* (Broch, 1931)

Fig. 16

Creusia spinulosa var. 2 Darwin, 1854: 378.
Creusia spinulosa form *secunda* Hiro, 1938: 397.

Materials: Two specimens in the host coral *Acropora* sp., Site 4, Sept. 1982. Shell broken, not measured.

Diagnosis: Shell oval, slightly conical, which is often encrusted by coral. Radiating ridges absent. Orifice rhombic and medium in size. Scutum has a well developed addutor ridge and an articular ridge; the rostral tooth is less prominent, sometimes absent. Tergum has a curved scutal margin, with a thorn-like projection at the end of spur.

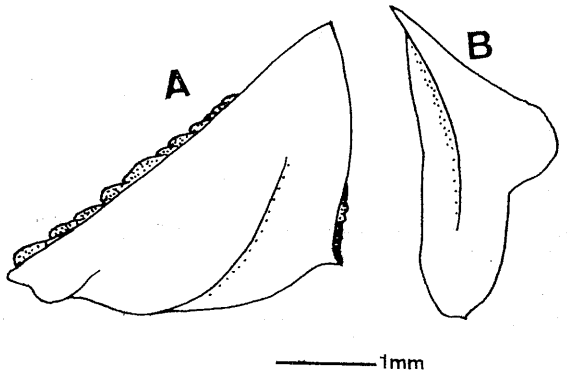

Fig. 16. *Cantellius secundus* from *Acropora* sp. A, internal view of scutum; B, internal view of tergum.

15. *Cantellius pallidus* (Broch, 1931)

Fig. 17

Creusia spinulosa var. *pallida* Hiro, 1935: 50; Hiro, 1938: 394.

Materials: One specimen in the host coral *Pocillopora verrucosa*, Site 4, Sept. 1982; two in *P. eudouxi*, Site 4, Sept. 1982; two in *P. damicornis*, Site 2, March 1983; four in *Stylophora pistillata*, Site 1, May, 1982; three in *Alveopora* sp., Site 5, Dec. 1982; one in *Astreopora myriophthalma*, Site 3, Oct. 1982; three in *Pachyseris speciosa*, Site 1, May 1982; one in *Porites lutea*, Site 3, Oct. 1982. Specimens

measured: S. L., 6.1-8.2 mm; S. W., 4.9-7.2 mm; O. L., 1.5-2.1 mm.

Diagnosis: Shell oval, slightly conical, which is often encrusted by coral in the margin. Radiating ridges remnant, if present. Orifice diamond-shaped. Shell consists of four parietes. Scutum and tergum separate. Scutum subtriangular with an adductor ridge which does not extend below basal margin. Basal margin hollowed out near the basitergal corner; articular ridge prominent. Tergum thin in the carinal margin, with a broad spur and a distinct articular furrow.

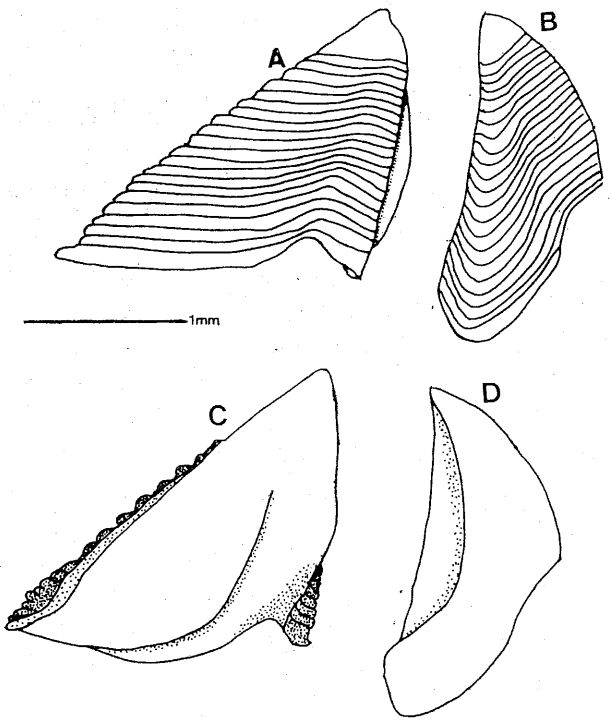

Fig. 17. *Cantellius pallidus* from *Stylophora pistillata*. A, external view of scutum; B, external view of tergum; C, internal view of scutum; D, internal view of tergum.

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臺灣南端海域產與珊瑚共生的藤壺

宋 克 義　張 崑 雄

本研究紀錄並描述在臺灣南端沿海所發現與珊瑚共生的藤壺，共計七屬十五種，均爲新紀錄。除了其中一種 *Savignium milleporae* 與水螅蟲綱之多孔蟲共生外，其它均在石珊瑚上發現。