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# A new species and record of branchial parasitic isopods (Crustacea: Isopoda: Bopyridae: Pseudioninae) of porcellanid crabs from the Philippines

Jason D. Williams\*, Asma Z. Madad

Department of Biology, Hofstra University, Hempstead, NY 11549, USA

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## ABSTRACT

Branchial bopyrids infesting porcellanid crabs from the Philippines were investigated based on intertidal collections made in 1999–2000. Crabs of the genus *Petrolisthes* collected from sites in the northern Philippines were examined and two parasite species were found. One new pseudionine species found infesting *Petrolisthes* sp. [cf. *Petrolisthes asiaticus* (Leach)] is described as *Aporobopyrus galleonus* (prevalence 6.1%); this species is distinguished from other members of the genus by a setose palp on the maxilliped of the females, barbula morphology, and male characters including the possession of pleopods. This represents the second described species of *Aporobopyrus* from the Philippines, and the first from porcellanid crabs. In addition, *Pleurocrypta macrocephala* Nierstrasz and Brender à Brandis, 1923 (originally described from Indonesia) was found infesting the same unidentified *Petrolisthes* sp. (prevalence 2.6%); this is the first report of the species from the Philippines.

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## 1. Introduction

Members of the isopod family Bopyridae are obligate parasites of crustaceans. The Bopyridae (with ~590 species distributed among nine subfamilies) contains at least 80% of the described species of the epicaridean superfamilies Bopyroidea and Cryptoniscoidea (Markham, 1986; Boyko and Williams, 2009). Bopyrids parasitize a wide range of hosts including many in the Anomura (hermit crabs, porcelain crabs and their relatives). Anomurans are second only to caridean shrimp in harboring large numbers of bopyrid parasites, most of which are branchial parasites belonging to the subfamily Pseudioninae (Boyko and Williams, 2009). Despite the lack of sampling in many areas of the Indo-West Pacific (IWP), nearly half of pseudionine species occur in this region and many new species await description (Williams, personal observation). In particular, the Philippine archipelago (found to be the peak of marine biodiversity in the IWP for many taxa; Carpenter and Springer, 2005) has at least 34 described species of bopyrids (e.g., Richardson, 1910; Nierstrasz and Brender à Brandis, 1923, 1931; Bourdon, 1976, 1981; Markham, 1989, 1994). However, as Markham (1989) indicated, it is likely that the biodiversity of bopyrid fauna in the Philippines is underestimated.

The purpose of this investigation is to report on collections of porcelain crab hosts made in the Philippines during 1999–2000 and to present the description of a new species of branchial bopy-

rid within the genus *Aporobopyrus* Nobili, 1906. In addition, we provide the first record of *Pleurocrypta macrocephala* Nierstrasz and Brender à Brandis, 1923 from this region. Both parasite species were found in *Petrolisthes* sp. [cf. *Petrolisthes asiaticus* (Leach)] that potentially represents a new species (fide R. Kropp, personal communication). It is possible that this species is the same as *Petrolisthes* sp. previously collected from Puerto Galera, Philippines and discussed by Haig (1964) but further research of the hosts is required. This study represents the first in a series on the biodiversity of the bopyrid fauna from the Philippines.

## 2. Materials and methods

Porcellanid crabs were collected by hand (JDW) from beneath rocks and coral rubble in intertidal areas of the Oriental Mindoro province of the Philippines between March 1999 and July 2000. Specimens were either fixed directly in 70% ethyl alcohol or in 4% seawater/formalin. Host size is given as carapace length (CL) as measured with calipers. In total, 114 porcellanid specimens were examined under a dissecting scope for parasites after lifting of the carapace to expose the interior of the branchial chambers.

For SEM preparation, specimens were dehydrated in an ascending ethanol series, starting from 70% EtOH and ending with 100% EtOH, with the concentration of solutions increasing by 5%; specimens were placed in each solution for 10 min. Specimens were placed in four changes of 100% ethanol. Drying was accomplished with a Samdri 795 Critical Point Dryer. Once dried, the individual specimens were mounted on aluminum stubs, coated with gold

\* Corresponding author.

E-mail address: [biojdw@hofstra.edu](mailto:biojdw@hofstra.edu) (J.D. Williams).

using an EMS-550 Sputter coater, and viewed with a Hitachi S-2460N SEM. Photographic plates were developed using Adobe Photoshop and measurements of structures were made using ImageJ software. Adobe Illustrator was utilized to develop plates for drawing tube sketches of specimens. In the materials examined section and elsewhere, the numbers in the brackets refer to the catalog number of the specimens for tracking of type and voucher specimens deposited in the National Museum of Natural History, Smithsonian Institution, Washington, DC, USA (USNM). Parasite prevalence was calculated based on collections that had the presence of parasites; collections without any parasites were excluded from calculations of prevalence. All means (lengths, prevalences) reported with standard deviation.

### 3. Results

#### 3.1. Systematics

Family Bopyridae Rafinesque-Schmaltz, 1815.  
Subfamily Pseudioninae Codreanu, 1967.  
Genus *Aporobopyrus* Nobili, 1906.

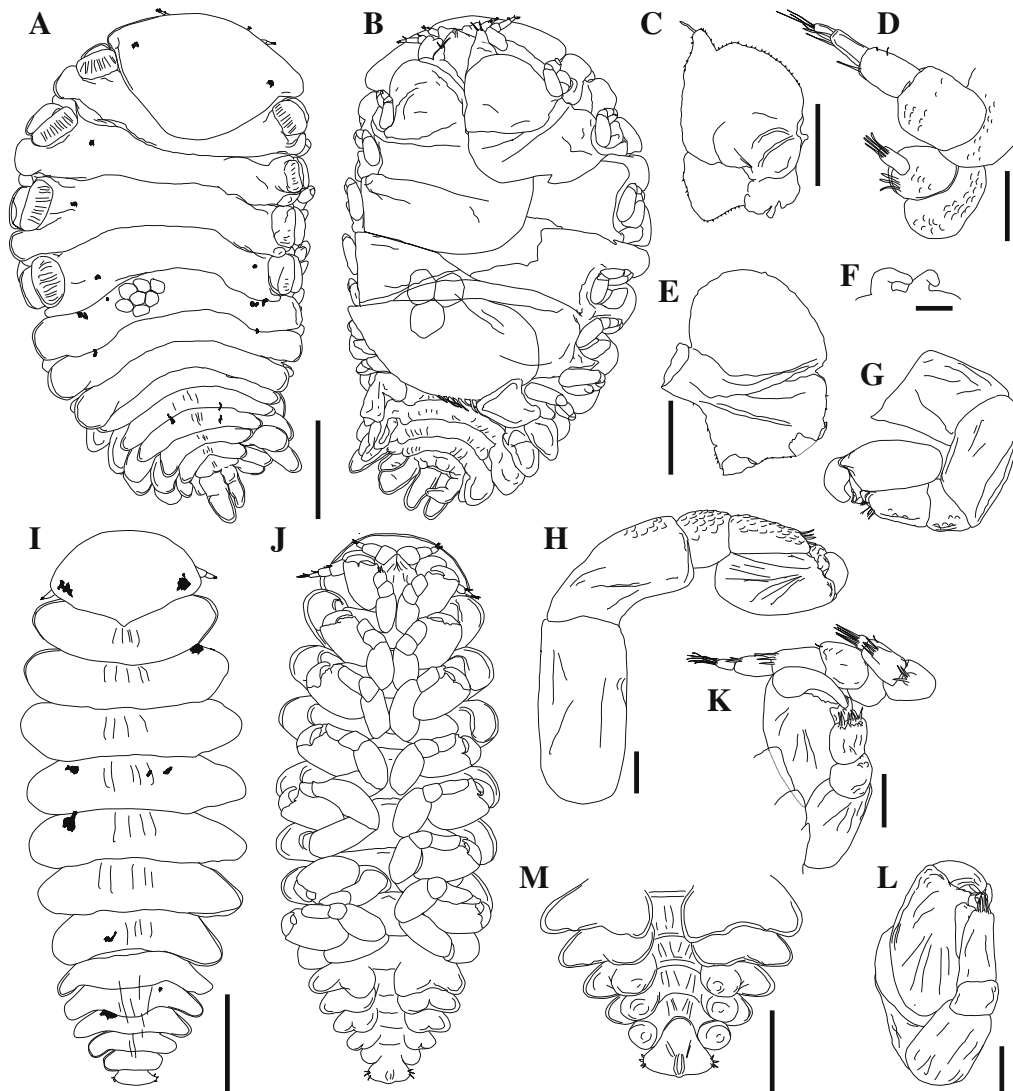
#### 3.1.1. *Aporobopyrus galleonus*, n. sp

Figs. 1–3.

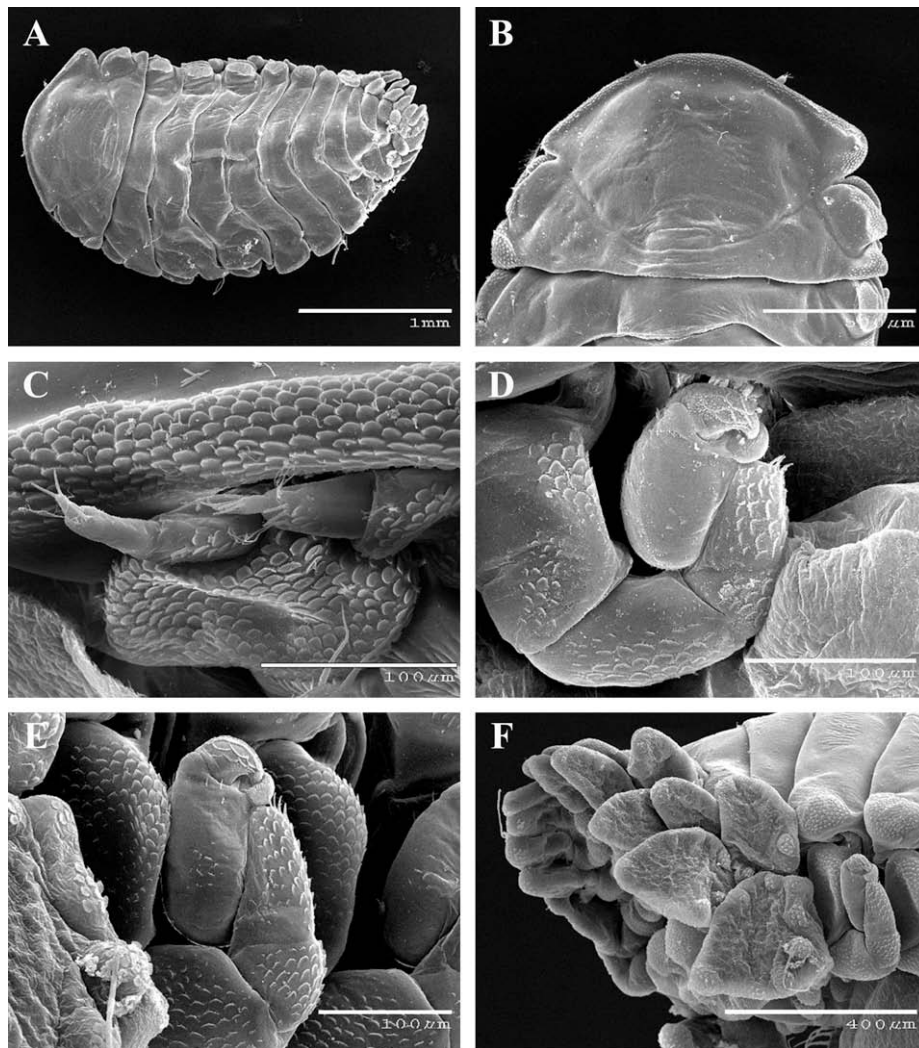
*Aporobopyrus* sp. A Madad, 2008: 20–25, 47; Figs. 4–6

#### 3.1.2. Materials examined

**Holotype:** Dextral ovigerous ♀ (2.57 mm) infesting ♂ *Petrolisthes* sp. (4.6 mm CL), Philippines, Oriental Mindoro, Puerto Galera, Big Lalaguna Beach (13°30'N, 120°57'E), intertidal from beneath rocks and coral rubble, coll. J.D. Williams, 28 March 1999, (USNM1129092). **Allotype:** ♂ (1.22 mm), same data as holotype (USNM1129093). **Paratypes:** 1 dextral ovigerous ♀ (2.66 mm), 1 ♂ (1.04 mm) [USNM1129094, on SEM stub], in left branchial chamber of ♂ *Petrolisthes* sp. (4.4 mm CL); 1 straight immature ♀ (1.39 mm), in left branchial chamber of intersex *Petrolisthes* sp. (2.6 mm CL), 28 March 1999, same collection data as holotype (USNM1129095). One dextral ovigerous ♀ (2.59 mm), 1 ♂ (1.44 mm) in left branchial chamber of ♀ *Petrolisthes* sp. (3.9 mm CL), 17 June 2000, same collection data as holotype (USNM1129096). One dextral immature ♀ (2.67 mm), in left branchial chamber of ♀ *Petrolisthes* sp. (4.7 mm CL); 1 sinistral ovigerous ♀ (2.9 mm), 1 ♂ (1.32 mm), in right branchial chamber of ♀



**Fig. 1.** *Aporobopyrus galleonus*. Female, USNM1129092, holotype (A–C and E); female, USNM1129097, paratype (D and F–H); male, USNM1129093, allotype (I, J and M); male, USNM1129097, paratype (H, K and L). (A) dorsal view (group of 7 developing eggs shown in pereopod 5); (B) ventral view (group of 3 eggs in posterior portion of brood pouch); (C) right maxilliped, external view; (D) left antennule and antenna; (E) right oostegite 1, internal view; (F) left barbula; (G) left pereopod 1; (H) left pereopod 6; (I) dorsal view; (J) ventral view; (K) left antennule, antenna and pereopod 1; (L) left pereopod 7; (M) pleon, ventral view. Scale bars = 0.5 mm (A and B), 250 µm (C, E, I and J), 50 µm (D, G, H, K and L), 100 µm (F and M).



**Fig. 2.** *Aporobopyrus galleonus*. Female, USNM1129094, paratype (A–F). (A) Dorsal view; (B) anterior end, dorsal view; (C) frontal lamina, left antennule and antenna; (D) right pereopod 1; (E) right pereopod 7; (F) right pleopods, lateral view (dorsal side up). Scale bars = 1 mm (A), 500  $\mu$ m (B), 100  $\mu$ m (C–E), 400  $\mu$ m (F).

*Petrolisthes* sp. (4.77 mm CL), 18 June 2000, same collection data as holotype (USNM1129097). One dextral ovigerous ♀ (2.25 mm), 1 ♂ (1.17 mm), in left branchial chamber of ♂ *Petrolisthes* sp. (4.16 mm CL), 25 July 2000, same collection data as holotype (USNM1129098).

### 3.1.3. Etymology

The specific name *galleonus* (Latin nominative singular of second declension noun) refers to the type locality of this species Puerto Galera, or Spanish for Port of Galleons, that provided a safe harbor for these merchant vessels beginning in the 16th century.

### 3.1.4. Description

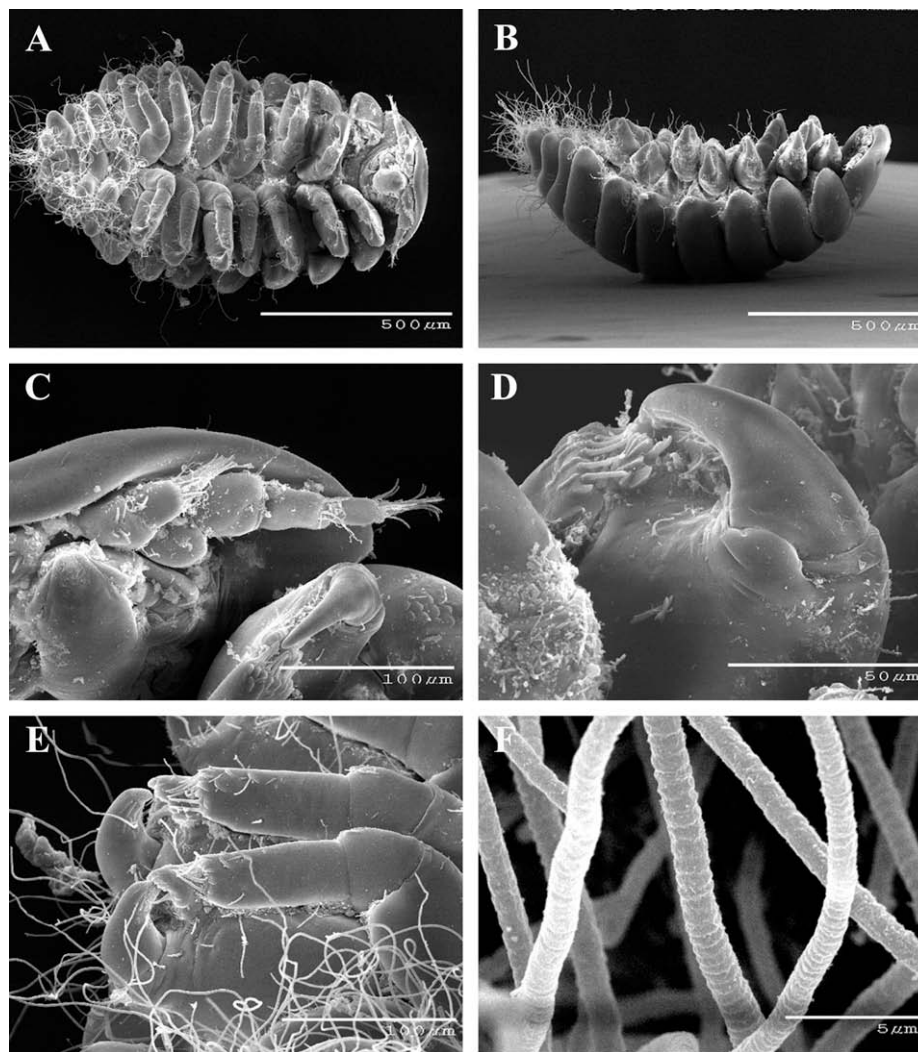
**3.1.4.1. Female.** Largest female with body length 2.90 mm, maximal width 1.72 mm, head length 0.7 mm, head width 1.13 mm, pleon length 0.83 mm. Mean maximum length of female specimens  $2.43 \pm 0.5$  mm, mean maximal width  $1.4 \pm 0.32$  mm ( $n = 7$ ). Head and pleon dextrally deflexed, approximately  $65^\circ$  distortion angle. Body convex with left side expanded and right side contracted. All body regions and segments distinct, pigmentation spots scattered on dorsal surface of pereomere and pleon (Figs. 1A, B and 2A).

Head large and almost elliptical, deeply set into pereon; frontal margin rounded, with broad frontal lamina covered in ovoid scales

(Fig. 2B). Small, irregularly shaped eyes present near midlateral margin of the head (Fig. 1A). Antennules of 3 articles, setae at distal tip of article 3 and scattered on ventral surface and margins of article 2 close to margin between articles 2 and 3, scales covering entire surface of article 1 (Figs. 1D and 2C). Antennae of 3 articles, article 1 covered in scales, tuft of setae at distal tip of article 3 and setae on margin between articles 2 and 3 (Figs. 1D and 2C). Maxilliped with large, lobiform setose palp (Fig. 1C); external margin of maxilliped setose (Fig. 1C). Barbula of two inward turning lateral projections (Fig. 1F). Oostegites completely enclosing brood chamber, setae on posterior margin of posteriormost oostegite (Fig. 1B). Inner ridge of oostegite 1 smooth with slight undulations toward base; proximal lobe rounded, distal lobe rounded but narrowing slightly posteriorly (Fig. 1E).

Pereon of 7 distinct pereomeres, broadest across pereomere 3, tapering toward pleon posteriorly (Figs. 1A and 2A); short setae scattered widely on dorsal surface of pereomeres. Reduced dorso-lateral bosses and coxal plates on pereomeres 2–4, covered with scales; pereomeres 5–7 without dorso-lateral bosses (Figs. 1A and 2A). Pereopods 6 and 7 smaller than pereopods 1–5 (Figs. 1G, H and 2D, E). Basis, ischium, merus, carpus and dactylus of pereopods covered in scales (Figs. 1G, H and 2D, E); short setae on propodus of pereopods. Pleon of 5 distinct pleomeres, all pleonal segments with





**Fig. 3.** *Aporobopyrus galleonus*. Male, USNM1129094, paratype. (A) Ventral view; (B) lateral view; (C) right antennule and antenna, buccal cone and pereopod 1; (D) right pereopod 1; (E) left pereopods 6 and 7, with thalli of an unidentified mesomycetozoean; (F) close-up of thalli. Scale bars = 500  $\mu$ m (A and B), 100  $\mu$ m (C and E), 50  $\mu$ m (D), 5  $\mu$ m (F).

lateral plates (Figs. 1A, B and 2A). Five pairs of biramous pleopods, ventral surface of pleomeres with scales (Fig. 2F). Small pair of lanceolate, distally rounded, uniramous uropods on pleomere 5.

**3.1.4.2. Male.** Largest male body length 1.44 mm, maximal width 0.67 mm at pereomere 4, head length 0.39 mm, head width 0.46 mm, pleon length 0.34 mm (Figs. 1I, J and 3A, B). Mean maximum length of male specimens  $1.24 \pm 0.15$  mm, mean maximal width  $0.58 \pm 0.07$  mm ( $n = 5$ ). Scattered pigmentation on dorsal surface of pereomeres and pleon, body long and slender (Fig. 1I). Head ovate, distinct from pereomere 1, all segments distinct (Fig. 1I). Large, irregularly shaped eyes present on lateral margin of head. Antennules of 3 articles, setae on distal tip and on margins of articles 2 and 3; antennae of 5 articles, tuft of setae on distal tip of antennae and margin of articles 2 and 3 (Figs. 1K, L and 3C). Cone shaped mouthparts (Fig. 3C) with a slender, pointed projection attached near the base of buccal cone.

Pereon of 7 distinct pereomeres, broadest at pereomere 4, tapering posteriorly (Fig. 1I). Pereopods 3 and 4 largest, size decreasing posteriorly and anteriorly with pereopods 6 and 7 smallest, ventral surface of carpus and merus covered in scales, propodus with ridges of scales on anterior portion underneath dactylus, tuft of setae on anterior tip of propodus facing dactylus tip (Figs. 1K, L and 3D, E).

Pleon of 5 distinct pleomeres, tapering posteriorly (Fig. 1J and H); distolateral edge of pleon fringed with setae. Pleopods tuberculate, present on pleomeres 1–4. Pleotelson notched medially, produced distolaterally, distolateral edges with setae, midventral tubercles absent, no uropods (Fig. 1J).

### 3.1.5. Remarks

Markham (2008) provided a useful review of the taxonomy of the genus *Aporobopyrus* and described the new species *Aporobopyrus bourdonis* Markham, 2008 from *Petrolisthes edwardsii* (de Sausure) collected in Costa Rica. Including *A. bourdonis*, Markham (2008) recognized 21 species in the genus but Boyko (2004) synonymized *A. lenticeps* (Shiino, 1958) with *A. retrorsa* (Richardson, 1910) thus leaving 20 species in the genus. With the addition of *A. galleonus* from the Philippines, the total number of described species is again 21. *Aporobopyrus* is the largest genus of bopyrids found parasitizing porcellanids, with only two species parasitizing non-porcellanid hosts: *A. gracilis* Nierstrasz and Brender à Brandis, 1929 on *Galathea* sp. and *A. retrorsa* (Richardson, 1910) on *Munida* spp. (Boyko, 2004; Schotte et al., 2008; Markham, 2008).

The female specimens of *A. galleonus* exhibit a relatively large head with a pronounced frontal lamina which narrows medially and is developed laterally into distinct lobes, small dorsolateral bosses and reduced pleonal lateral plates, all characteristics of

the genus *Aporobopyrus* (Adkison, 1988; Markham, 1988; Boyko, 2004). Previously, only two records of the genus *Aporobopyrus* have been made in the Philippines. *Aporobopyrus retrorsa* (Richardson, 1910) was originally described in the genus *Pseudione* based on specimens parasitizing the galatheid crab *Munida andamanica* Alcock from deep water (184–514 m). Boyko (2004) provided a redescription of the species (based in part on new material from Taiwan) and transferred it to the genus *Aporobopyrus*, recording it for the first time parasitizing *Paramunida scabra* (Henderson) from the Philippines. In addition, Boyko (2004) showed that *A. lenticeps* (Shiino, 1958), a parasite of *Munida heteracantha* Ortmann, was a synonym of *A. retrorsa*. Females of *A. galleonus* are distinguished from *A. retrorsa* based on lack of a maxilliped palp and having short antennae of three articles; males of *A. retrorsa* possess pronounced midventral tubercles on pereomeres 4–7 that are absent in *A. galleonus*. *A. retrorsa* is widely distributed in the Indo-West Pacific, being recorded in Japan, the Philippines, and Taiwan but has only been reported infesting galatheid hosts, never porcellanid crabs. Bourdon (1976) found a potentially new species of *Aporobopyrus* infesting the porcellanid crab *Pachycheles sculptus* (H. Milne Edwards) in the Philippines. Based on the large pereopods 1 and 2 of the male, Bourdon (1976) considered the unidentified species to be similar to *A. ryukyuensis* Shiino, 1939 from Japan (parasitizing *Petrolisthes hastatus* Stimpson and *P. yaeyamensis* Miyake), which exhibits pereopods 1 and 2 that are characteristically larger than pereopods 3–7. However, due to the fact that the only known female was damaged, the species was not described as new. *A. galleonus* can be distinguished from Bourdon's (1976) specimens and *A. ryukyuensis* based on pereopods 1 and 2 (similar in size to pereopods 3–7 in *A. galleonus*); in addition, the males of *A. ryukyuensis* lack pleopods whereas in *A. galleonus* the pleopods are pronounced. The female of *A. ryukyuensis* resembles *A. galleonus* in that the original description indicates a palp on the maxilliped but it appears to be non-setose; unlike in *A. galleonus*, the antennae of *A. ryukyuensis*

are reduced, not extending past the anterior margin of the head. Of the eight additional *Aporobopyrus* species from the Indo-West Pacific, the present specimens most closely resemble *A. megacephalon* (Nierstrasz and Brender à Brandis, 1929) and *A. petrolistheae* (Shiino, 1933). The host of *A. megacephalon* as originally described by Nierstrasz and Brender à Brandis was unknown; however, Markham (1982) reported *A. megacephalon* infesting *Pachycheles pectinica* Stimpson in Hong Kong. The female of *A. megacephalon*, as redescribed by Markham (1982), resembles *A. galleonus* in that the posterior margin of the head is V-shaped and there is a palp on the maxilliped. However, pereopods 1 and 2 of males in *A. megacephalon* are very large, with long curved dactyli (similar to pereopods 1 and 2 in *A. ryukyuensis*), whereas *A. galleonus* have pereopods 1 and 2 that are similar in size to pereopods 3–7. *Aporobopyrus petrolistheae* lacks a maxilliped palp and has a barbula with lateral projections that are branched or tuberculated on the sides (Shiino, 1933), in contrast to *A. galleonus* that has a maxilliped palp and two smooth lateral projections of the barbula. *A. petrolistheae* is reported to infest *Petrolisthes japonicus* (De Haan) in Seto, Japan (Shiino, 1933).

Thalli belonging to an unidentified mesomycetozoean (Class Mesomycetozoea, Order Eccrinales) obscured the posterior end of the male *A. galleonus* prepared for SEM (Fig. 3A, E and F). Eccrinales (formerly placed in the fungal class Trichomycetes) inhabit the gut or are ectocommensals on the exoskeleton of a wide variety of arthropods, including marine isopods (see McDermott, 2002; Cafaro, 2005).

### 3.1.6. Ecology

Total prevalence of infestation was 6.1% (7 of 114 hosts parasitized).

### 3.1.7. Distribution and host

From Puerto Galera, Philippines on *Petrolisthes* sp.

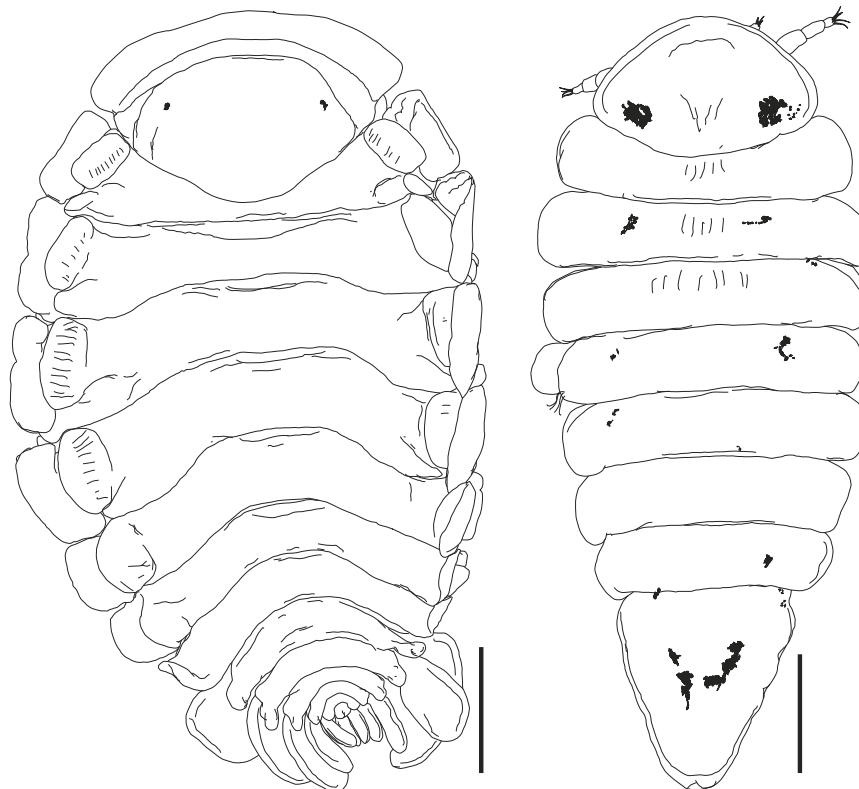


Fig. 4. *Pleurocrypta macrocephala* Nierstrasz and Brender à Brandis, 1931 (USNM1129099). (A) Female, dorsal view; (B) male, dorsal view. Scale bars = 500  $\mu$ m (A), 100  $\mu$ m (B).

### 3.2. Genus *Pleurocrypta* Hesse, 1865

*Pleurocrypta macrocephala* Nierstrasz and Brender à Brandis, 1923; Fig. 4.

*Pleurocrypta macrocephala* Nierstrasz and Brender à Brandis, 1923: 23–24; Figs. 12a–c [infesting *P. asiaticus* (Leach) from unknown locality in Indonesia]—Bourdon, 1976: 166, 220, 232–233, 240.

*Pleurocrypta macrocephalon* Nierstrasz and Brender à Brandis, 1931: 174—Markham, 1974: 271; Table 1. [Note that Nierstrasz and Brender à Brandis (1931) used *Pleurocrypta macrocephalon*; however, it is probable that they misspelled the name as they gave no indication that it was being emended (although such an emendation would be unjustified). Thus, the original spelling is followed herein, as in Bourdon (1976).]

#### 3.2.1. Materials examined

Philippines—Oriental Mindoro, Puerto Galera. Big Lalaguna Beach (13°30'N, 120°57'E), 1 dextral ovigerous ♀ (4.02 mm), 1 ♂ (0.96 mm), in left branchial chamber of ♂ *Petrolisthes* sp. (6.41 mm CL); 1 dextral ovigerous ♀ (3.15 mm), 1 ♂ (0.85 mm), in left branchial chamber of ♀ *Petrolisthes* sp. (4.82 mm CL); 1 dextral immature ♀ (2.99 mm, in left branchial chamber of ♀ *Petrolisthes* sp. (4.05 mm CL), intertidal from beneath rocks and coral rubble, coll. J.D. Williams, 18 June 2000, (USNM1129099).

#### 3.2.2. Remarks

The new material from the Philippines matches closely the original description of *P. macrocephala* by Nierstrasz and Brender à Brandis (1923) based on a single female specimen from *P. asiaticus* collected in Indonesia. Females of *P. macrocephala* from the Philippines are slightly dextrally deflexed with the head possessing minute eyes and a broad frontal lamina (Fig. 4A); the antennules and antennae are composed of 3 articles. Oostegite 1 has a digitate internal ridge and the maxilliped has a small palp; the barbula is composed of two smooth lateral projections. The pleon has five pairs of biramous pleopods and small uniramous uropods. The males of *P. macrocephala* have well developed eyes and slight pigmentation scattered on the pereomeres and pleon (Fig. 4B). The antennules have 3 articles, the antennae have 5 or 6 articles. The pleomeres are fused forming a tapering, triangular pleon, with slight indication of segmentation laterally; no pleopods, midventral tubercles, or uropods.

The holotype of *P. macrocephala* was reexamined by Bourdon (1976) who suggested that *P. yatsui* Pearse, 1930 and *P. macrocephala* were very likely synonymous. However, Bourdon (1976) chose not to synonymize the two, based on lack of a male specimen of *P. macrocephala*. *Pleurocrypta yatsui* is a widely distributed species in the western Pacific, as well as the Red Sea and Persian Gulf (e.g., Shiino, 1933; Bourdon, 1968, 1976; Kim and Kwon, 1988). The morphology of the Philippines specimens matches that of *P. yatsui* as described by Bourdon (1976) and supports its synonymy with *P. macrocephala*, although we refrain from making this synonymy here, as Markham (personal communication) is currently working on this issue based on new material from Singapore.

#### 3.2.3. Ecology

*P. macrocephala* was found in the same hosts (*Petrolisthes* sp.) as *A. galleonus* (see notes on host in Section 1). Total prevalence of infestation was 2.6% (3 of 114 hosts parasitized).

#### 3.2.4. Distribution and host

From Puerto Galera, Philippines on *Petrolisthes* sp.; from Indonesia (unknown locality) on *P. asiaticus* [but see notes in Remarks and likely wide distribution based on synonymy with *P. yatsui*].

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