

**A New Species of *Schizobopyrina* Markham, 1985
(Crustacea: Isopoda: Bopyridae: Bopyrinae) Parasitic
on a *Gnathophyllum* Shrimp from Polynesia, with
Description of an Associated Hyperparasitic Isopod
(Crustacea: Isopoda: Cabiropidae)**

Jason D. Williams^{1,3} and Christopher B. Boyko²

¹ Department of Biology, Hofstra University, Hempstead, New York 11549, U.S.A.;

² Division of Invertebrate Zoology, American Museum of Natural History,
Central Park West at 79th St., New York, New York 10024, U.S.A.

A male and female bopyrid pair was found in the branchial chamber of a bumblebee shrimp, *Gnathophyllum americanum* Guérin-Méneville, collected from Tonga. Examination of these specimens showed that they belong to the bopyrid genus *Schizobopyrina* Markham, but cannot be placed in any of the described species. We describe this new species as *S. bombyliaster* and compare it to the other species in the genus. This is the first described species of branchial bopyrid from the genus *Gnathophyllum*, and only the second bopyrid described from a member of the Gnathophyllidae. The marsupium of the female bopyrid contained specimens of a new species of the hyperparasitic isopod genus *Cabirops* Kossmann, which is described based on light and scanning electron microscope investigations and discussed in relation to other species in the genus.

Bopyrid isopods of the subfamily Bopyrinae are obligate parasites found in the branchial chambers of caridean shrimp (Decapoda: Caridea). The genus *Schizobopyrina* Markham, 1985, was erected for species formerly placed in *Bopyrina* Kossmann, 1881, but which possess a maxilliped palp, elongate oostegites 2–5, and lateral or complete separation of the pleomeres of the female.

A single parasitized specimen of *Gnathophyllum* shrimp (Fig. 1) was found by one of us (CBB) in the collections of the California Academy of Sciences and was identified as belonging to the widespread species *G. americanum* Guérin-Méneville. Examination of the bopyrid parasites showed they belong to an undescribed species of *Schizobopyrina*. In addition, the female specimen of *Schizobopyrina* was hyperparasitized by specimens of a new species of isopod of the genus *Cabirops* Kossman, 1872. The only other described species of bopyrid isopod on a member of *Gnathophyllum*, or the family Gnathophyllidae, is the abdominal species *Diplophryxus kempfi* Chopra, 1930 (Hemiarthrinae), from *G. americanum* (originally as *G. fasciolatum* Stimpson) collected in the Andaman Islands. A branchial bopyrid on *G. modestum* Hay in the Gulf of México was reported by Dardeau et al. (1980; repeated by Markham 1985), but was never identified even to the subfamily level. All other hosts of *Schizobopyrina* species are in either the Palaemonidae, which with the Gnathophyllidae forms part of the Palaemonoidea, or the Hippolytidae (Alpheoidea).

³ Contact author: biojdw@hofstra.edu

METHODS

Camera lucida sketches made of specimens were scanned into a Macintosh™ computer. Images were then prepared using the programs Adobe Photoshop™ and Adobe Illustrator™. For Scanning Electron Microscopy (SEM), the male *Cabirops* specimen was dehydrated in an ascending ethanol series followed by four changes of 100% ethanol. Dehydration was completed with a Samdri 795 Critical Point Drier. The dried specimen was mounted on an aluminum stub, coated with gold (EMS-550 Sputter coater), and viewed with a Hitachi S-2460N SEM.

Carapace length (CL), including the rostrum, is provided as an indicator of size for the host shrimp. Isopod size is given as total body length (anterior margin of head to posterior margin of pleotelson). Measurements were made to 0.01 mm using an ocular micrometer.

All specimens are deposited in the Division of Invertebrate Zoology, California Academy of Natural Sciences, San Francisco, U.S.A (CASIZ), except for the specimen of *Schizobopyrina gracilis* (Chopra, 1923), which is in the Museum National d'Histoire Naturelle, Paris (MNHN).

DESCRIPTIONS OF TAXA

Family Bopyridae Rafinesque-Schmaltz, 1815
Subfamily Bopyrinae Rafinesque-Schmaltz, 1815**Genus *Schizobopyrina* Markham, 1985*****Schizobopyrina bombyliaster* Williams and Boyko, new species**

(Figs. 1-4)

MATERIAL EXAMINED.—Holotype: female (4.41 mm), infesting right branchial chamber of female *Gnathophyllum americanum* (3.71 mm CL; CASIZ 170233), 18°43'S, 174°05'E, on coral reef to coral rubble on sand bottom, leeward side of reef, north side of reef between Langitau and Vaka'eitu Island, Vava'u Island Group, Tonga, 2–10 ft (= 0.6–2.7 m) depth, hyperparasitized by *Cabirops bombyliophila* sp. nov. (CASIZ 170231–170232), coll. Van Syoc, Ferreira, Campbell, and Cornfield, 30 July 1985 (CASIZ 5707). Allotype: male (1.04 mm), same data as holotype (CASIZ 170234).

TYPE LOCALITY.—18°43'S, 174°05'E, leeward side of reef, north side of reef between Langitau and Vaka'eitu Island, Vava'u Island Group, Tonga, Pacific Ocean, 0.6–2.7 m depth.

DESCRIPTION.—Female (Figs. 2–3). Body length 4.41 mm, maximal width 2.34 mm, head length 0.94 mm, head width 1.01 mm, pleon length 1.31 mm. Pereon and pleon deflexed dextrally. Body outline of pereon broad anteriorly, tapering posteriorly; pleon subequal to posterior pereon. All body regions and pereomeres distinctly segmented (Fig. 2A–B).

Cephalon triangular, tapering posteriorly, median region strongly delineated; well withdrawn into first pereomere, nearly obscuring median of first pereomere; frontal lamina strong, triangular, width approximately one-half of head and distinctly separated from head. Eyes lacking. Antenna and antennule (Fig. 3B) of 3 articles each, distal margin of distal segments with setae. Maxilliped (Fig. 3C) with narrow rounded spur; palp single segmented and non-articulated with 7 thick elongate setae at distal margin.

Pereon composed of 7 pereomeres, broadest across pereomere 3, tapering anteriorly and posteriorly. All pereomeres separated. Coxal plates on sides of pereomeres all similar, indistinct; dorsolateral bosses produced on pleomeres 1–4, strongest on 2–4 and larger on right side of body (Fig. 2A). Oostegites enclosing only approximately one-fourth of brood pouch (Fig. 2B); first oostegit-

es asymmetrical, right one slightly smaller, with posterolateral lobe extended, smoothly angled, distal end rounded, not setose (Fig. 3D), left one with posterolateral lobe short, sharply angled, distal end setose (Fig. 3E). Pereopods (Figs. 2A, 3F–G) of about same size. Propodus of all pereopods with shallow cup-like insertion for dactylus (Fig. 3F); distoventral margin of carpus with numerous scales and few short setae at distal tip. First 2 pereopods surrounding head region; no large gaps between any pereopods.

Pleon with 5 distinct pleomeres. Pleomeres 1–4 increasingly concave on median of posterior margin, with extended ovate, distally tapering and acute, biramous pleopods and uniramous, distally produced and rounded lateral plates (Figs. 2B, 3A); pleomere 5 fused with pleotelson (Figs. 2A), anteriorly sharply convex and posteriorly straight, lacking pleopods and with subquadrate, distally directed, lateral plates; uropods lacking (Fig. 2A).

Male (Fig. 4). Length 1.04 mm, maximum width 0.40 mm, head length 0.15 mm, head width 0.27 mm, pleon length 0.29 mm. Occurring on ventral surface of female's pleon between pleopods (Fig. 2A); directed anteroposteriorly.

Head anterior margin subovate, posterolateral margins slightly concave, posterior margin straight, widest medially, incompletely fused with 1st segment of pereon. Moderate sized eyes located mediolaterally. Antenna and antennule of 2 articles each (Fig. 4C), distally setose; extending posterolaterally from head, not overreaching margins of head.

Pereomere 3 broadest, tapering slightly anteriorly and posteriorly. Pereomeres 1–3 directed laterally; 4–7 with posterolateral margins directed slightly posterolaterally. Body lacking pigmentation. All pereopods (Fig. 4D–E) of subequal size, all articles distinctly separated; distoventral surfaces of propodus and carpus with large flat scales and few short setae.

Pleon tapering posteriorly, pleomeres directed laterally and fringed with setae. All segments fused, but with deep lateral indentations and faint dorsal suture lines demarcating segments. No

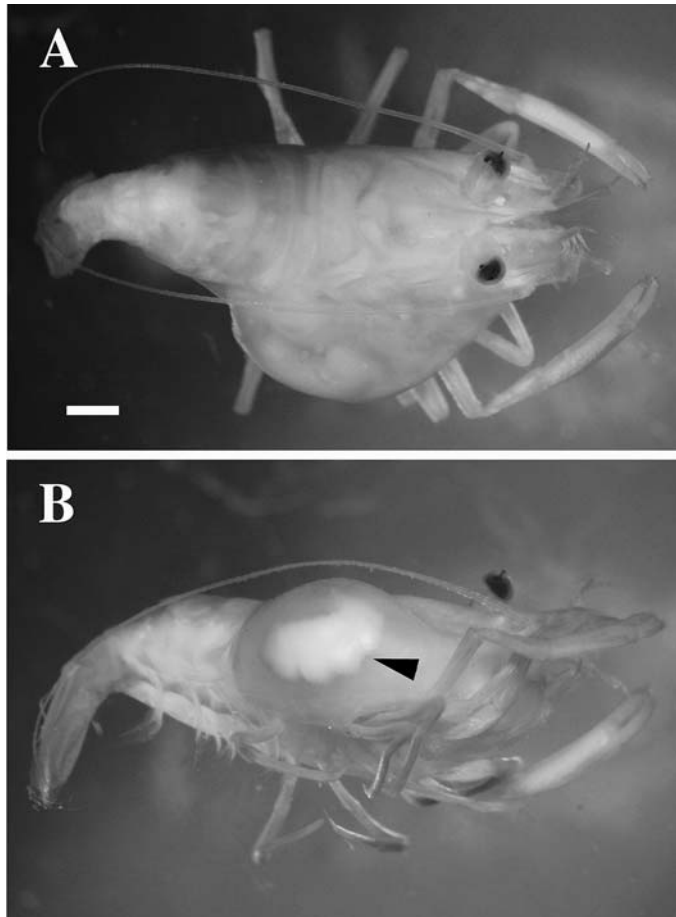


FIGURE 1. The bumblebee shrimp (*Gnathophyllum americanum*) harboring *Schizobopyrina bombyliaster* sp. nov. and *Cabirops bombyliophyla* sp. nov. in right branchial chamber, CASIZ 170233 (shrimp), 5707 (female bopyrid), 170232 (female cabiropid). A, dorsal view; B, lateral view (arrowhead indicates *Cabirops* female within brood chamber of *Schizobopyrina* female). Scale = 1.0 mm.

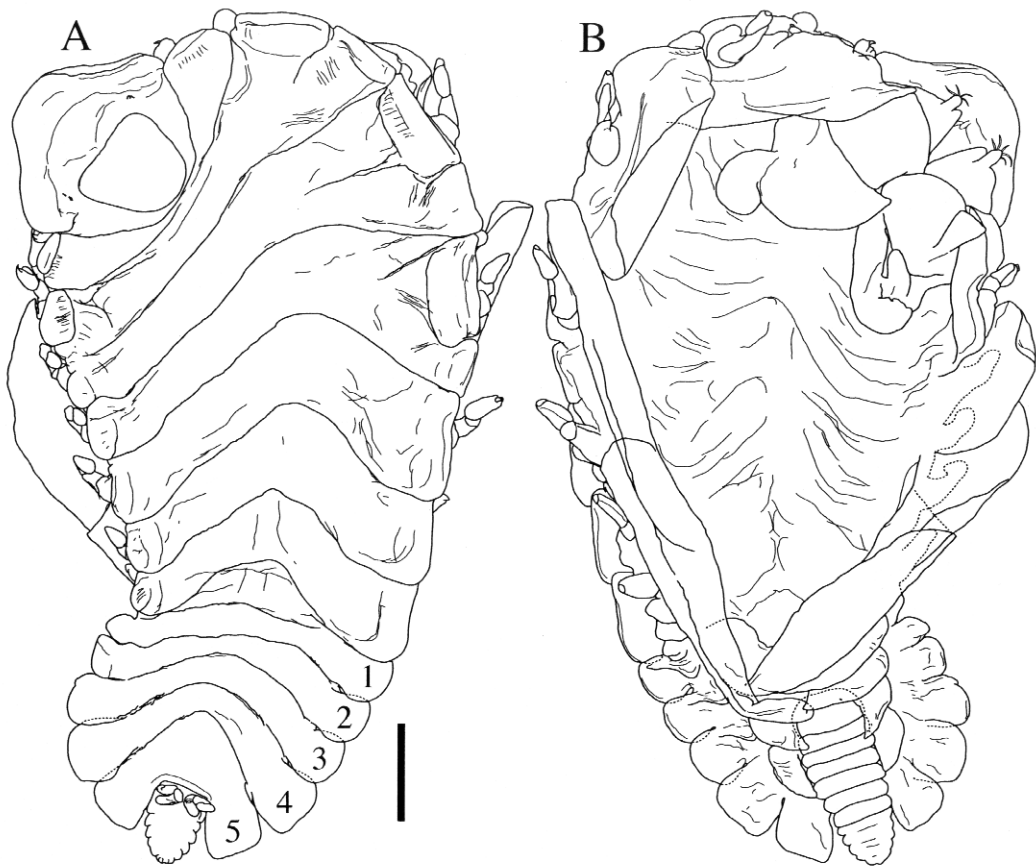


FIGURE 2. *Schizobopyrina bombyliaster* sp. nov., female, 4.41 mm, CASIZ 5707, holotype (with male *in situ*). A, dorsal view; B, ventral view. Numbers indicate pleomere. Scale = 500 μ m.

midventral tubercles; 5 pairs of subquadrate tuberculiform pleopods, last pair markedly smaller and more ovate than other pairs (Fig. 4B). Pleotelson (Fig. 4A–B) slightly produced medially, with sinuous lateral margins, uropods absent.

DISTRIBUTION.— Found on the shrimp, *Gnathophyllum americanum* from Tonga; 0.6–2.7 m depth.

ETYMOLOGY.— The specific name, literally bumblebee-eater, is given to call attention to the occurrence of this parasite on a bumblebee shrimp of the genus *Gnathophyllum*.

REMARKS.— Of the 12 other species currently placed in *Schizobopyrina* (see Campos and Campos 1990), this new species most closely resembles *S. gracilis* (Chopra, 1923). The female of *S. gracilis* reported by Bourdon (1983, as *Bopyrina gracilis*) was examined for comparison to the material from Tonga, as the types of *B. gracilis* are in the Zoological Survey of India and unavailable for examination. Bourdon's (1983) specimen (MNHN-Ep 347, female 1.88 mm, Amboine (= Ambon, Indonesia) coll. Rumphius II, 1975, ex *Periclimenes tenuis* Bruce) corresponds well with the type of *S. gracilis* as described and figured by Chopra (1923), although the lateral plates and dorsal segmentation of the pleomeres are even less distinctly separated in the Ambon specimen. Unfortunately, the male specimen from Ambon has become lost and could not be examined, but all the characters given for it by Bourdon (1983) match those of the male type of *S. gracilis*.

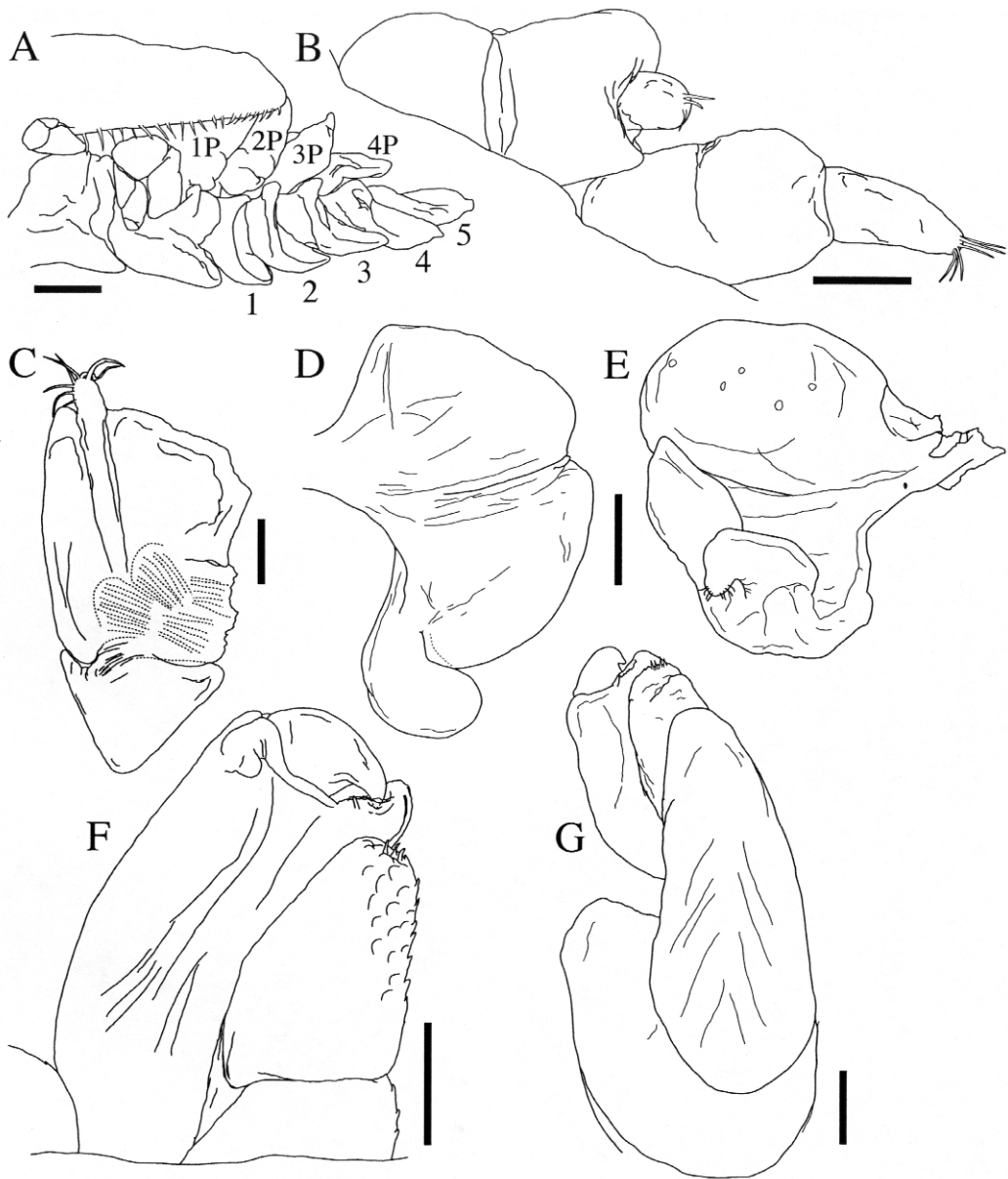


FIGURE 3. *Schizobopyrina bombyliaster* sp. nov., female, 4.41 mm, CASIZ 5707, holotype. A, posterolateral view, left side (P=pleopod; numbers indicate pleomere); B, left antenna and antennule; C, left maxilliped, external view; D, right oostegite 1, external view; E, left oostegite 1, external view; F, right pereopod 7; G, right pereopod 2. Scale = 250 μ m (A), 500 μ m (B), 150 μ m (C), 250 μ m (D, E), 50 μ m (F-G).

The female of *S. bombyliaster* sp. nov. resembles *S. gracilis* in the overall shape of the head, the number of pleomeres (pleomere 5 fused with pleotelson), and the shape of the posterior margin of the pleomere 5/pleotelson. It differs from *S. gracilis* in that the frontal lamina of the head and the dorsolateral bosses on the pereomeres are much more developed, the pleomere segments are distinct, the lateral plates on pleomeres 1-4 are much more separated, and the lateral plates of

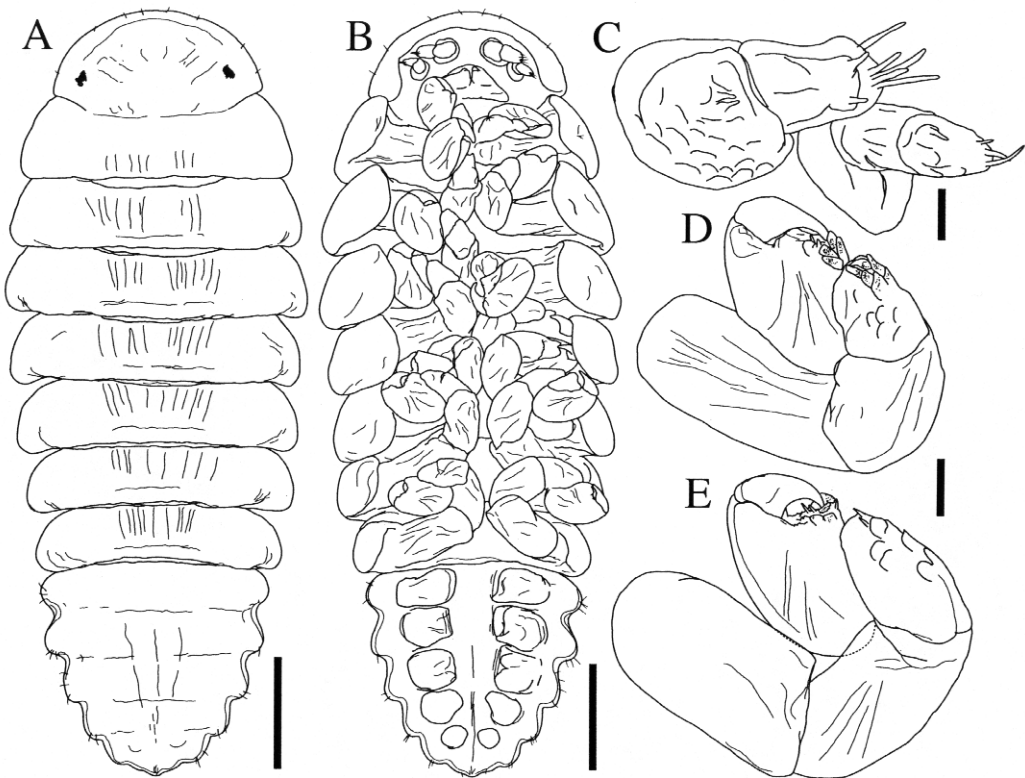


FIGURE 4. *Schizobopyrina bombyliaster* sp. nov., male, 1.04 mm, CASIZ 170234, allotype. A, dorsal view; B, ventral view; C, left antenna and antennule; D, right pereopod 1; E, right pereopod 7. Scale = 150 μ m (A–B), 125 μ m (C), 250 μ m (D–E).

pleomere 5/pleotelson are subquadrate instead of rounded. The shape of the left oostegite 1 is also quite different from that of *S. gracilis* or any other *Schizobopyrina* species. The male of *S. bombyliaster* sp. nov. is very much like that of *S. gracilis*, but the posterior margin of the pleotelson is only slightly produced, while that of *S. gracilis* is strongly produced.

The genus *Schizobopyrina* now contains 13 species, although we concur with Campos and Campos (1990) that *S. lobata* Bourdon and Bruce, 1983, does not appear to belong to this genus. *Schizobopyrina bombyliaster* sp. nov. belongs to the group of *Schizobopyrina* with females having pleomere 5 partly or wholly fused with the pleotelson that also includes *S. amakusaensis* (Shiino, 1939), *S. andamanica* (Chopra, 1923), *S. bruscai* Campos and Campos, 1990, *S. gracilis* (Chopra, 1923), and *S. miyakei* (Shiino, 1942). Both Chopra (1923) and Campos and Campos (1990) described *S. andamanica* (as *andamica* [sic] in Campos and Campos [1990]) and *S. gracilis* as having 5 pleomeres plus pleotelson, but the illustrations of Chopra (1923) clearly show only slight lateral distinction between the segments in some specimens of *S. andamanica* (Chopra 1923: pl. 20, fig. 1, text-fig. 28) and no discernable distinction in *S. gracilis* (Chopra 1923: pl. 21, fig. 6). This is in agreement with the specimen of *S. gracilis* reported by Bourdon (1983) and unlike the clear separation of those segments in all other *Schizobopyrina* species.

Family Cabiropidae Giard and Bonnier, 1887**Genus *Cabirops* Kossmann, 1872*****Cabirops bombyliophila* Williams and Boyko, new species**

(Figs. 1, 5–8)

MATERIAL EXAMINED.— Holotype: male (0.91 mm) infesting female *Schizobopyrina bombyliaster* sp. nov. (4.41 mm; CASIZ 5707) ex *Gnathophyllum americanum* (3.71 mm CL; CASIZ 170233), 18°43'S, 174°05'E, on coral reef to coral rubble on sand bottom, leeward side of reef, north side of reef between Langitau and Vaka'eitu Island, Vava'u Island Group, Tonga, 2–10 ft (= 0.6–2.7 m) depth, coll. Van Syoc, Ferreira, Campbell, and Cornfield, 30 July 1985 (CASIZ 170231). Allotype: immature female (2.36 mm), same data as holotype (CASIZ 170232).

TYPE LOCALITY.— 18°43'S, 174°05'E, leeward side of reef, north side of reef between Langitau and Vaka'eitu Island, Vava'u Island Group, Tonga, Pacific Ocean, 0.6–2.7 m depth.

DESCRIPTION.— Male (Figs. 5–7). Length 0.91 mm, maximum width 0.41 mm at segment 4, head length 0.11 mm, pleon length 0.41 mm; body tear-drop shaped. Cuticular surface with distinct striations, prominent on coxal plates (Fig. 6C–D).

Head anterior margin ovate, posterior margin convex, widest at posterolateral junction with segment 1 (Figs. 5A, 6A–B). Subovate, moderately large eyes (approximately 60 µm in maximal length) located mediolaterally, eyes with irregular pigment most prominent around medially directed edge (Fig. 5A). Antenna of 3 articles (Fig. 5C), first article with 3 setae near anterolateral border, article 1 slightly overlaps basal article of antennule, article 2 with series of shelves, 4 setae on distal margin of article 2, distal bundles of long setae on antenna extend to segment 1, extending slightly beyond margin of head (Fig. 5B). Antennule of 9 articles (4 peduncular and 5 flagellar) (Fig. 5B), first article with rounded anterior edge, articles 1 and 2 with apophysis on posteromedial edge, articles 3 and 4 lacking apophysis; flagellar articles much narrower than peduncular articles, each with a terminal seta, proximal flagellar article shortest, flagellar articles 2–5 of increasing length, article 5 with approximately 2 long and 2 short, distal setae.

Pereomere 4 broadest, tapering anteriorly and posteriorly. Body pigmentation lacking. Pereomeres with toothed coxal plates; three denticles in plates 1–5, 1 denticle in plates 6–7 (Figs. 5B; 6C–E), medial tooth largest in all segments, lateral two teeth with rounded distal end, diminishing in size over segments 1–5 (Fig. 6C–E). Pereopods 1 and 2 gnathopodal with bifid dactyli (Fig. 7A–C); distoventral surfaces of propodus and carpus with large flat scales and a few setae, rows of minute setae along distal edge of propodus around joint with dactylus, with setae along edge apposed to dactylus, three stout setae on propodus near tip of dactyl (Fig. 7A–C). Pereopods 3–7 ambulatory, carpi of pereopods 3–7 with one stout terminal seta, proprodi with long axis curved, inner margins with two (pereopods 3–5) or one (pereopods 6 and 7) stout setae toward distal end (Figs. 5B; 7D–F) and comb of minute setae along edge (Fig. 7F), dactyli of pereopods 3–7 with long axis curved, tapering to a sharp point (pereopods 3–5), or blunt tip (pereopods 6 and 7), with comb of minute setae (Fig. 7D–E).

Pleon with 5 pleopods composed of basis (sympod), exopod, and endopod (Fig. 6F). Sympods with 1 or 2 medially directed spines, endopods with plumose setae (5 setae on pleopod 1), exopods with plumose setae (4 setae on pleopod 1) and one laterally directed seta (short on pleopod 1, longer on pleopods 2–5); setae on endopods and exopods reduced in number on pleopod 5. Pleotelson quadrangular, endopods approximately twice as long as exopods, basis with 1 or 2 posterior setae, endopods and exopods with terminal setae (Fig. 5A–B).

Immature female (Figs. 1, 8). Maximal body length 2.36 mm (from pereonal lobe 2 to pereon-

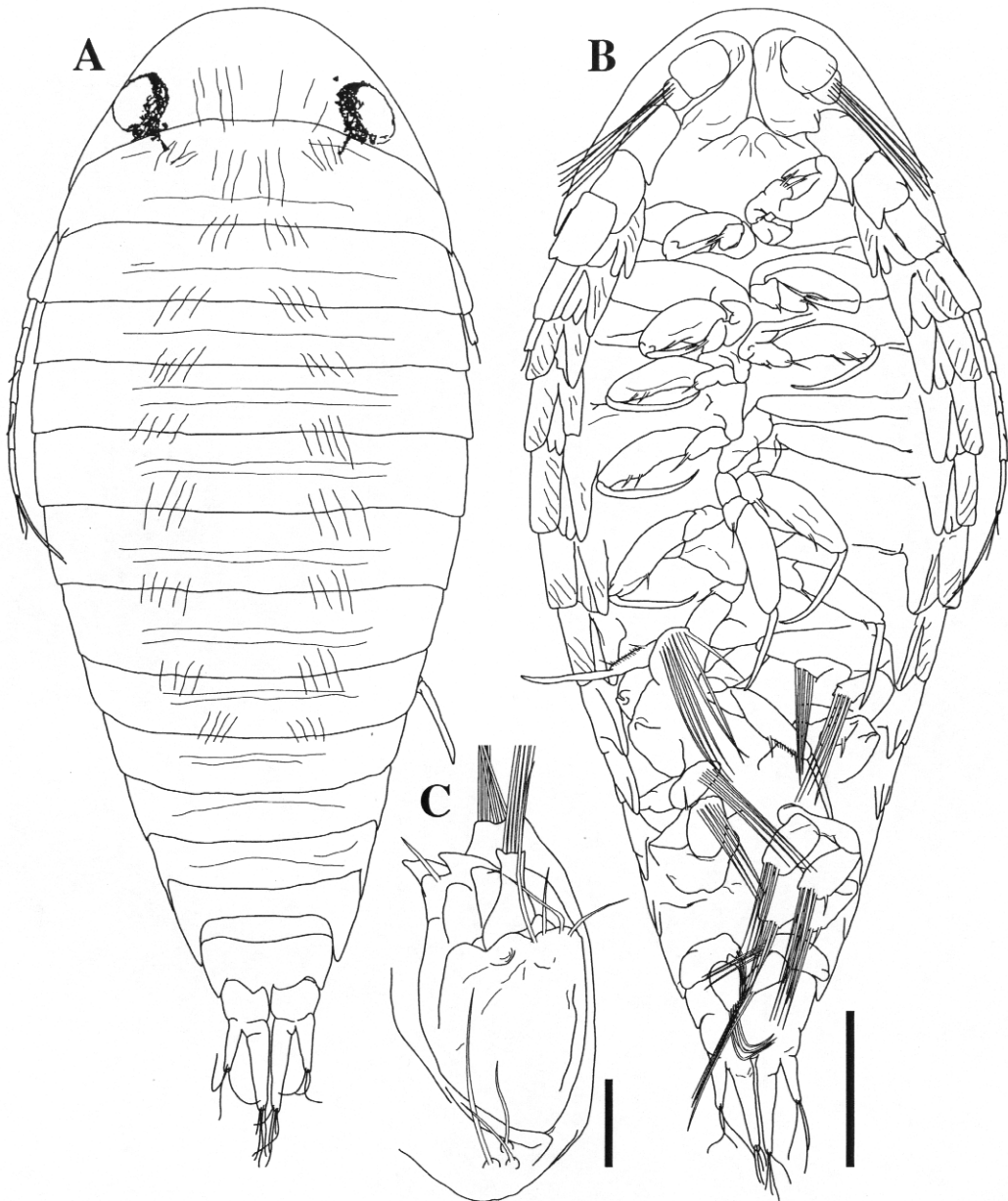


FIGURE 5. *Cabirops bombyliophila* sp. nov., male, 0.91 mm, CASIZ 170231, holotype. A, dorsal view; B, ventral view; C, first antenna, ventral view (terminal setae only partially drawn). Scale = 150 μ m (A, B), 25 μ m (C).

al lobe 7), maximal width 1.81 mm, pleon length 0.73 mm. In lateral aspect, body highly curved ventrally, forming U-shape with head region and pleon apposed (Fig. 8). Slight light-brown pigmentation on rostrum (Fig. 8B). Pereon with 7 pereonal lobes, lobes 4–6 largest, on right side all lobes rounded (Fig. 8A), on left side lobes 1–3 rounded and lobes 4–6 with semi-circular depressions (Fig. 8B). Faint indication of segmentation on ventral side of pereon, no appendages. Pleon

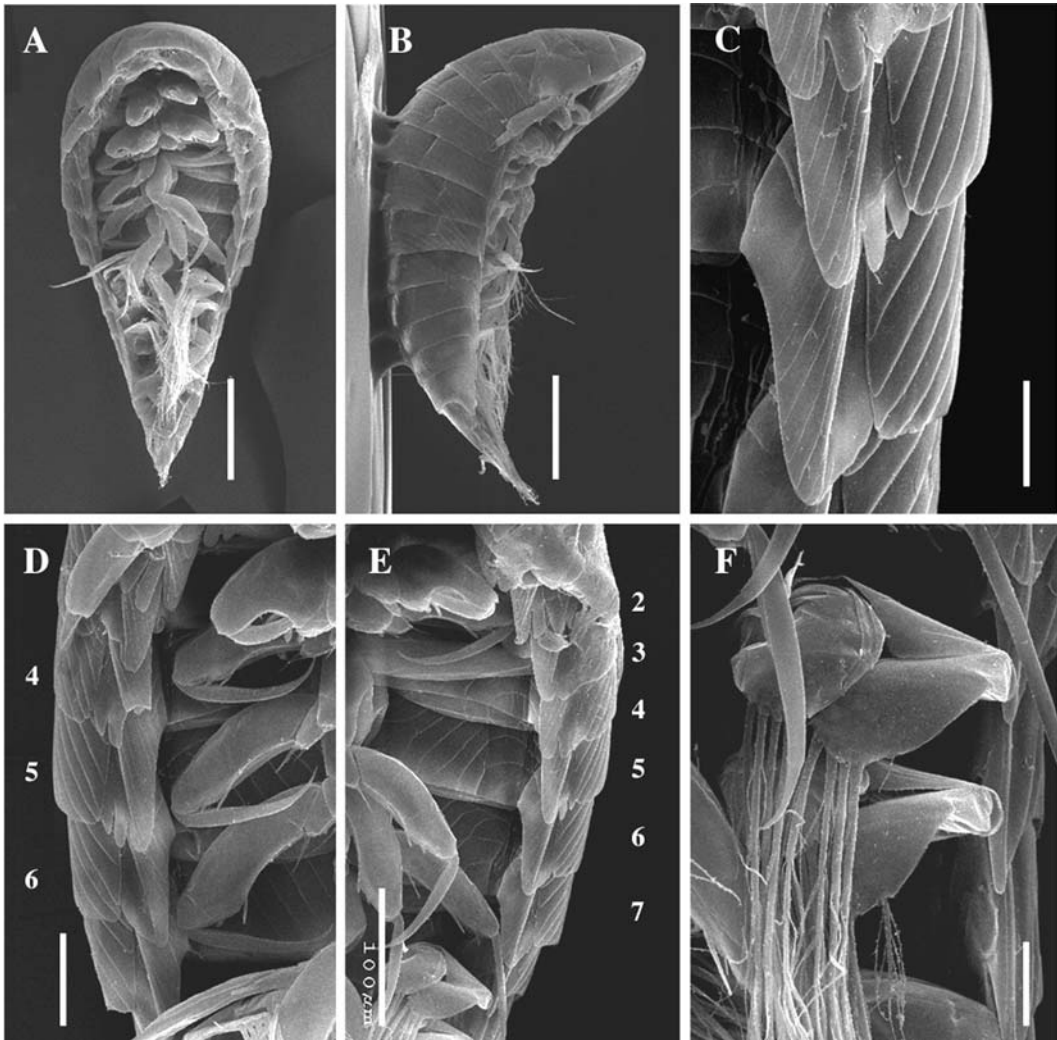


FIGURE 6. *Cabirops bombyliophila* sp. nov., male, 0.91 mm, CASIZ 170231, holotype. A, ventral view; B, lateral view; C, ventral view of segments 5 and 6 showing dentition, left side; D, ventrolateral view of segments 4-6, right side; E, ventrolateral view of segments 2-7, left side; F, left pleopods 1 and 2. Scale = 200 μ m (A, B), 25 μ m (C, F), 50 μ m (D), 100 μ m (E).

conical in shape, with faint indication of segmentation. Pleon with 4 semi-circular depressions on right side in a trapezoidal configuration (Fig. 8A).

DISTRIBUTION.— Found in marsupium of female *Schizobopyrina bombyliaster* sp. nov. ex *Gnathophyllum americanum* from Tonga; 0.6-2.7 m depth.

ETYMOLOGY.— The specific name refers to the finding of this hyperparasite in association with the parasite of a bumblebee shrimp of the genus *Gnathophyllum*.

REMARKS.— The genus *Cabirops* now contains 17 species (six of these remain unnamed) and this likely represents only a fraction of the species that await description (Sassaman 1985; Boyko and Williams 2004). Sassaman (1985) reviewed the genus and indicated that it could be divided into two groups based on coxal plate dentition. Group one contains species with 2 or 3 denticles on

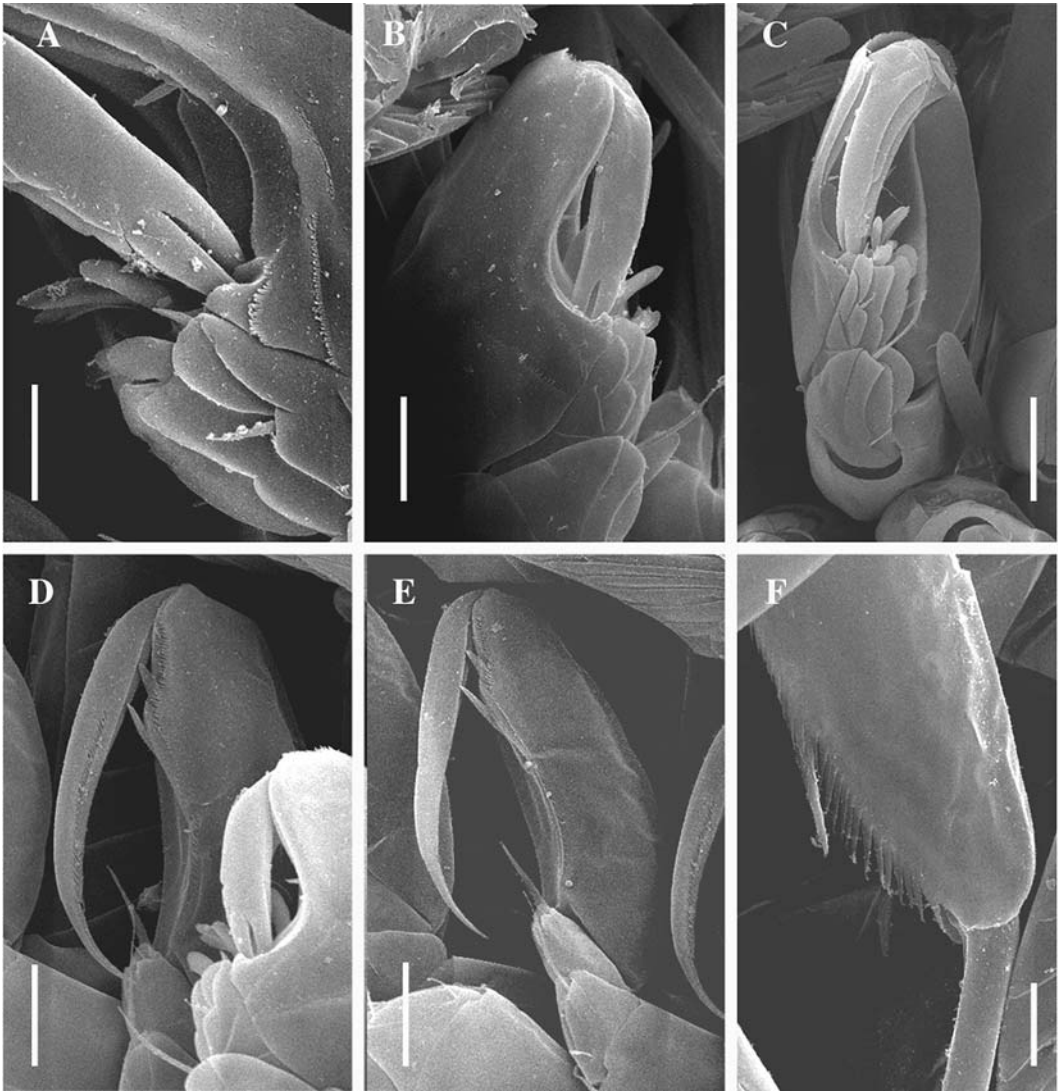


FIGURE 7. *Cabirops bombyliophila* sp. nov., male, 0.91 mm, CASIZ 170231, holotype. A, right pereopod 1; B, left pereopod 2; C, left pereopod 2; D, left pereopod 3; E, left pereopod 4; F, left pereopod 6. Scale = 10 μm (A, F), 20 μm (B, D), 25 μm (C, E).

coxal plates 1–5 and 1 denticle on coxal plates 6 and 7, group two contains species with 2 or 3 denticles on all coxal plates. Members of group one parasitize hosts of the subfamilies Pseudioninae or Orbioninae while members of group two are found on hosts of the subfamilies Ioninae and Bopyrinae. While the morphology of *Cabirops bombyliophila* sp. nov. places it in group one (exhibiting only one denticle on plates 6 and 7), the species is a parasite of a bopyrine host. Such discrepancy is not surprising considering recent studies on *Cabirops* species from the Bahamas have indicated two species with dentition patterns unlike those in either group (Boyko and Williams 2004). In addition, other characters such as the dactyli of pereopods 1 and 2 (bifid vs. simple) and internal apophysis on article 2 of antennae 2 (strong vs. weak) differ between groups.

Cabirops bombyliophila sp. nov. most closely resembles *C. codreanui* Bourdon, 1966, *C. montereyensis* Sassaman, 1985, and *C. orbionei* Bourdon, 1972 but can be distinguished from these species based on the dentition pattern (3 denticles on coxal plate 1 in *C. bombyliophila* sp. nov. vs. two denticles on coxal plate 1 in *C. codreanui*, *C. montereyensis*, and *C. orbionei*). In addition, *C. codreanui* and *C. montereyensis* are parasites of pseudionines while *C. orbionei* is found on orbionines; however, due to the potentially large number of undescribed *Cabirops* species, conclusions on the degree of host specificity are probably premature. *Cabirops bombyliophila* sp. nov. is further distinguished from *C. montereyensis* by exhibiting a blunt tip on the dactyli of pereopods 6 and 7 (bifid dactyli are present in *C. montereyensis*). Finally, the apophysis on article 2 of antennae 2 is strong in *C. bombyliophila* sp. nov. but weak in *C. orbionei*. *Cabirops bombyliophila* sp. nov., *C. montereyensis*, and *C. orbionei* are apparently the only species in the genus to exhibit a setal comb on the dactyl of pereopod 3; however, as indicated by Sassaman (1985), this feature may have been overlooked in earlier descriptions.

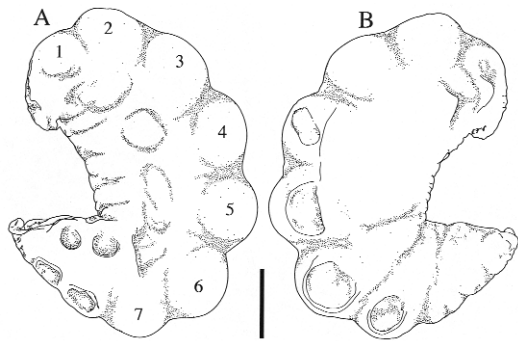


FIGURE 8. *Cabirops bombyliophila* sp. nov., female, 2.36 mm, CASIZ 170232, allotype. A, view of right side, numbers indicate dorsal pereopodal lobes; B, view of left side. Scale = 500 μ m.

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