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ORIGINAL ARTICLE

# *Heteromysis cocoensis* n. sp. (Crustacea: Mysida: Mysidae) from coastal waters of Isla del Coco, Costa Rica

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## ABSTRACT

A survey of the invertebrate fauna of coral reef hard bottom communities in the shallow waters of Isla del Coco yielded a new species of mysid belonging to the genus *Heteromysis* S. I. Smith, 1873. *Heteromysis* (*Olivemysis*) *cocoensis*, n. sp. was collected from coral rubble at depths of 8 to 34 m. It differs from its congeners by having male pleopods 1, 3, and 4 with modified setae. Within the subgenus *Olivemysis* Băcescu, 1968, the new species is morphologically most similar to *Heteromysis ekamako* Wittmann and Chevaldonne, 2017 from the Pacific, *Heteromysis gomezi* Băcescu, 1970, *Heteromysis mayana* Brattegard, 1970, and *Heteromysis rubrocinta*, Băcescu, 1968 from the Western Atlantic, and *Heteromysis dardani* Wittmann, 2008, *Heteromysis wirtzi* Wittmann, 2008, and *Heteromysis sabelliphila* Wittmann and Wirtz, 2017 from the Eastern Atlantic. However, *H. cocoensis* n. sp. is distinguished from these six apparently closely related species by the following combination of characters: flagellate, modified setae on articles 1 and 3 of the antennular peduncle, and setation of thoracic endopod 3, male pleopods 1, 3 and 4, uropodal endopods, and the apical and lateral margins of the telson. A diagnostic table separating these eight species is given.

## KEY WORDS

mysid, coral reef, tropical Eastern Pacific, taxonomy.

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## Introduction

Price (2004) and Price *et al.* (2009) published annotated compilations of the published literature for the members of the family Mysidae Haworth, 1825 *sensu lato* reported from the Pacific waters of the Americas and specifically Costa Rica, respectively. Based on these reports and our review of the more recent literature, there are no published descriptions or records of mysids from Isla del Coco (5°30'–5°34'N 87°02'–87°06'W).

The marine biodiversity of Isla del Coco, which lies 550 km West Southwest of the Costa Rican mainland (see Fig. 1), is relatively well known, with more than 1,100 species reported to date (Cortés and Wehrtmann, 2009; Sibaja-Cordero *et al.*, 2016). Notwithstanding, new taxa continue to be discovered. Between 2007 and 2011, during surveys of coral reef hard bottom habitats, an undescribed species of mysid belonging to the genus *Heteromysis* S. I. Smith, 1873 was discovered. The description of this new species is presented herein.

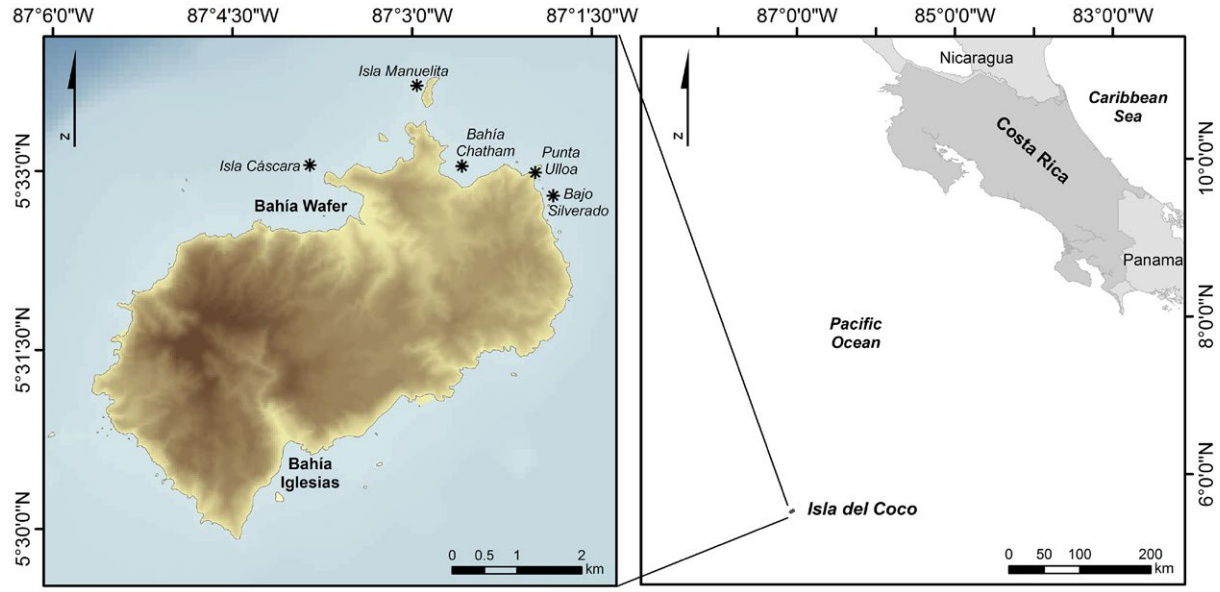


**Figure 1.** Isla del Coco, showing sites* at which *Heteromysis* (*Olivemysis*) *cocoensis* n. sp. was collected.

## Material and Methods

Mysids were sampled from coral reefs along the northeastern end of Isla del Coco and the north side of its satellite Isla Manuelita in Oct. 2007, May 2008, and Jul. 2011. Using SCUBA, coral rubble was collected manually, brought to the surface, and gently washed in seawater. Specimens collected in 2008 were captured alive and preserved in 95% ethanol. Specimens taken in 2007 and 2011 were preserved in a 3% formalin-seawater solution and later transferred to 70% ethanol for examination. Body length was determined as being the distance from the anterior margin of the carapace to the posterior margin of the telson, excluding setae. Type material and additional specimens are deposited in the University of Costa Rica, School of Biology, Zoology Museum (MZUCR) and the National Museum of Natural History (USNM).

## Systematics

**Order Mysida Boas, 1883**

**Family Mysidae Haworth, 1825**

**Subfamily Heteromysinae Norman, 1892**

**Tribe Heteromysini Norman, 1892**

**Genus *Heteromysis* S. I. Smith, 1873**

**Subgenus *Olivemysis* Băcescu, 1968**

***Heteromysis* (*Olivemysis*) *cocoensis* n. sp. Price, Heard and Vargas**

(Figs. 2–4)

*Type material.* Holotype: adult male (Length [L] 3.0 mm), Costa Rica, Isla del Coco, Bahía Chatham, 5°32'57.89"N 87°2'30.51"W, coral rubble washings, depth 8 m, R. Vargas Castillo, coll., 26 May 2008, MZUCR 2678-03; Paratypes: 2 adult males (L 3.1, 2.7 mm), Costa Rica, Isla del Coco, Bajo Silverado, 5°32'43.75"N 87°1'48.49"W, coral rubble washings, depth 11 m, R. Vargas Castillo, coll., 26 May 2008, MZUCR 2676-37; 2 ovigerous females (L 3.0, 2.8 mm), Costa Rica, Isla del Coco, coral rubble washings, depth 11 m, R. Vargas Castillo, coll., 26 May 2008, MZUCR 2615-06; 1 ovigerous female (L 3.1 mm), same collection data as holotype, MZUCR 2678-26; 1adult male (L 2.5 mm), Costa Rica, Isla del Coco, north side of Isla Manuelita, 5°33'48.95"N 87°2'51.53"W, coral reef, coral rubble washings, depth 14.5 m, R. Vargas Castillo, coll., 26 May 2008, USNM 1484992; 1 ovigerous female (L 3.3 mm), same collection data as holotype, USNM 1484993.

*Additional material examined.* 5 females (3 damaged), 5 males (all damaged), 4 juveniles, Costa Rica, Isla del Coco, north side of Isla Manuelita, 5°33'48.95"N 87°2'51.53"W, coral reef, coral rubble washings, depth 14.5 m, R. Vargas Castillo, coll., 26 May 2008, MZUCR 2682-14; 1 female, Costa Rica, Isla del Coco, Bajo Silverado, 5°32'43.75"N 87°1'48.49"W, coral rubble washings, depth 11 m, R. Vargas Castillo, coll., 26 May 2008, MZUCR 2676-07; 1 female, 2 males (all damaged), Costa Rica, Isla del Coca, Punta Ulloa, 5°33'1.58"N 87°1'52.82"W, coral reef, on rocks, depth 12–15 m, J. Sibaja, coll., 14 Oct. 2007, MZUCR 2502-08; 2 females (1 damaged), 3 males, Costa Rica, Isla del Coco, Punta Ulloa, 5°33'1.58"N 87°1'52.82"W, rock washings, R. Vargas, coll. 23 May 2008, MZUCR 2642-01; 1 female, 1 male, Costa Rica, Isla del Coco, Isla Cáscara, 5°33'3.43"N 87°3'45.91"W, coral reef, depth 32–34 m., J. Nivia, J, Sibaja, J. Cortes, coll., 7 Jul. 2011, MZUCR 3047-03.

*Diagnosis.* Antennular peduncle, article 3 with distomedial flagellate seta possessing small tubercles distally, article 1 with distodorsal flagellate seta; thoracic endopod 3 with 7–9 robust flagellate setae with microdentations on medial margin of carpopropodus; male pleopod 1 with 6 robust spiniform simple setae along distomedial and distal margins; male pleopod 3 with 6 stout flagellate setae on distal margin; male pleopod 4 with 28–36 small simple setae (no distal flagella) on distal margin; uropodal endopod armed with 2–3 spiniform setae along medial margin in region of statocyst; telson, lateral margins armed along posterior 0.3–0.4 length with 6–7 spiniform setae per margin (including apical setae); outer apical seta 3.3–5 times longer than inner; cleft depth 0.25–0.30 times telson length, cleft completely armed with 16–21 spinules.

*Description.* General body form (Fig. 2A): moderately slender; carapace with anterior margin produced into a triangular rostrum; posterior dorsal margin emarginated, partially exposing thoracic somite 8; anterolateral lobes rounded.

Antennule peduncle (Fig. 2B): article 1 subequal in length with article 3, distolateral epiprocess with 3–5 plumose setae, small lobe with 4 plumose setae and 1 strong, blade-like subapically flagellate seta on distodorsal margin; article 2 compressed with 2 plumose setae on distomedial border, 3–4 plumose setae near distolateral margin; article 3 with 1 thick, modified, subapically flagellate seta having small tubercles distally, 6–7 times as long as wide, and 1 long laterally directed simple seta on distomedial margin, small lobe with 4 setae on distodorsal margin, 2 short plumose setae near lateral margin; outer and inner flagella with attenuated setae along medial margins; males having moderately setose lobe on ventral surface.

Antenna (Fig. 2C): scale extending to or slightly beyond peduncle, 2.9–3.2 times as long as maximum width, medial margin slightly convex, lateral margin straight, apex faintly articulated, tip 0.07 times scale length, all margins setose; antennal peduncle 3-articulated; article 1 inconspicuous; article 2 is 1.3–1.4 times longer than article 3, armed with 3–4 plumose setae distomedially, 1 plumose seta on distolateral border; article 3 with 3–5 plumose setae distomedially, 3 short plumose setae along distolateral border; flagellum with attenuated setae along medial margin.

Eye (Fig. 2A): moderately large, oval, distal end of eyestalk slightly wider than cornea with ocular tooth on anteromedial margin; cornea large, oval, occupying distal third of eye.

Mandible (Fig. 2D): cutting edges typical of genus, molar processes with strong grinding surfaces on

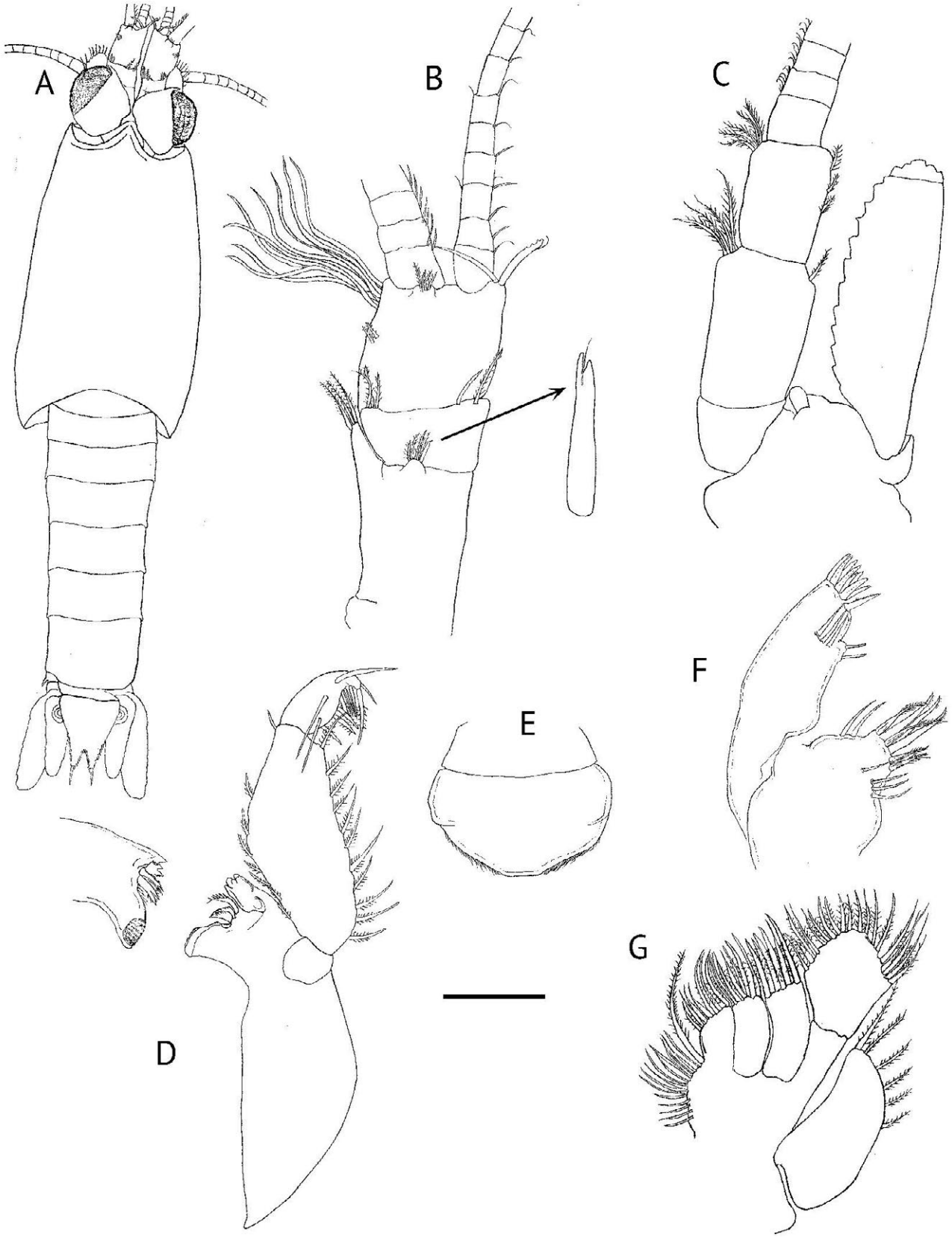


**Figure 2.** *Heteromysis* (*Olivemysis*) *cocoensis* n. sp. adult male, 3.0. mm. A. Dorsal view. B. Antennular peduncle with enlargement of modified flagellate seta. C. Antennal peduncle and scale. D. Mandibles with right palp. E. Labrum. F. Maxillule. G. Maxilla. Scale: A, 0.4 mm; B–G, 0.1 mm.

both mandibles; palp 3-articulated; article 1 small, inconspicuous; article 2 expanded medially, 2.5–3.0 times longer than article 3, lateral margin with a series of 7–8 plumose setae along entire length, medial margin with 9–11 plumose setae along entire length; article 3 with 1 long, strong pennate seta at apex and 9–12 shorter distally pennate setae along distomedial margin.

Labrum (Fig. 2E): typical of genus. oval, posterolateral margins rounded with dense clusters of fine setae; anterior margin not produced into a spiniform process.

Maxillule (Fig. 2F): outer lobe apex with 8–12 robust, weakly serrated spiniform and 3 subapical simple setae; inner lobe apex with 3 long, curved distally serrated setae, 9–11 simple and plumose setae on apex, inner, and outer margins.

Maxilla (Fig. 2G): typical of genus; exopod with 6–15 plumose setae, not extending beyond basal article of endopod; endopod 2-articulated, distal article moderately expanded, about 1.3 times as long as greatest width, distal and inner margins with dense series of plumose setae; sympod and sympodal endites densely armed with plumose, serrated, and simple setae.

Thoracic endopod 1 (Fig. 3A): short, robust; basis with large endite with stout plumose setae on medial margin; ischium and merus equally long with stout plumose setae on medial margins; carpopropodus short, with plumose and simple setae on distal margin; dactylus wider than long, with simple and plumose setae and a long, strong terminal claw; Thoracic endopod 2 (Fig. 3B): basis with medial endite; merus longer than combined preischium and ischium and about equal in length to combined carpopropodus and dactylus; dactylus with several stout, serrated and more slender plumose and simple setae. Thoracic endopod 3 (Fig. 3C): ischium 0.5–0.6 times length of merus; merus 1.1–1.3 times length of carpopropodus, medial margin with a series of 7–9 short and long simple setae, lateral margin with 1-2 simple setae distally; carpopropodus, medial margin with 7–9 robust flagellate setae with microdentations, 6–8 of these setae arranged in pairs distally, 1 single seta proximally, 1 simple seta at base of each single or pair of flagellate setae, lateral margin with 3–5 short simple setae; dactylus with long, curved, robust claw on distal end. Thoracic endopod 4 (Fig. 3D): merus 1.1 times length of ischium; carpopropodus 0.9 times length of merus, with 3 articles, distal 2 subequal in length, each 0.5 times as long as proximal article, dactylus small with slender claw. Thoracic endopod 5–8 (Fig. 3 E, F): merus 0.8–0.9 times length of ischium; carpopropodus 0.8–0.9 times length of merus, with 5–7 articles, distal 4–6 subequal in length, each 0.4–0.5 times as long as proximal article; dactylus armed with slender serrated claw.

Thoracic exopods: exopod 1 with 8 articles, exopods 2–8 with 9 articles.

Thoracic sternal processes: males with sternites 1–8 supporting median triangular spiniform processes; females with similar process on sternite 1 only.

Marsupium: females with pairs of developed oostegites on bases of the medial margins of thoracopods 7 and 8, respectively.

Penes: penes cylindrical, stiff with smooth cuticle and no discernable setae; about 6 times longer than wide; extending forward to base of thoracopod 6.

Pleopods: reduced to small uniarticulated plates in both sexes; male pleopods 2 and 5 unmodified; pleopod 1 (Fig. 4A) with row of 5–6 plumose setae on anterior surface (not shown in Fig. 4A), with 6 robust, spiniform simple setae along medial and distal margins, increasing in length distally with longest seta reaching distal end of pleopod 2, lateral margin with 2–3 plumose setae, pseudobranchial lobe (exite) with 4 plumose setae; pleopod 3 (Fig. 4B) with row of 5–6 plumose setae on anterior surface, distal margin with 6 stout flagellate setae and 1 long plumose seta, lateral margin with 2 plumose setae, pseudobranchial lobe with 4 plumose setae; pleopod 4 (Fig. 4C) with row of 5–6 plumose setae on anterior surface (not shown in Fig. 4C), distal margin with 28–36 small, simple setae (no distal flagella apparent) and 1 long plumose seta, lateral margin with 2 plumose setae, pseudobranchial lobe with 4 plumose setae.

Uropods (Fig. 4E): exopod 1.15–1.25 times longer than endopod, lateral margin straight, medial margin slightly convex, all margins setose; endopod linguiform with a row of 2–3 spiniform setae increasing in length distally on medial margin in region of statocyst, all margins setose.

Telson (Fig. 4D): length 1.0–1.1 times length of abdominal somite 6 and 0.7 times that of uropodal exopod, 1.2 times as long as maximum (basal) width;

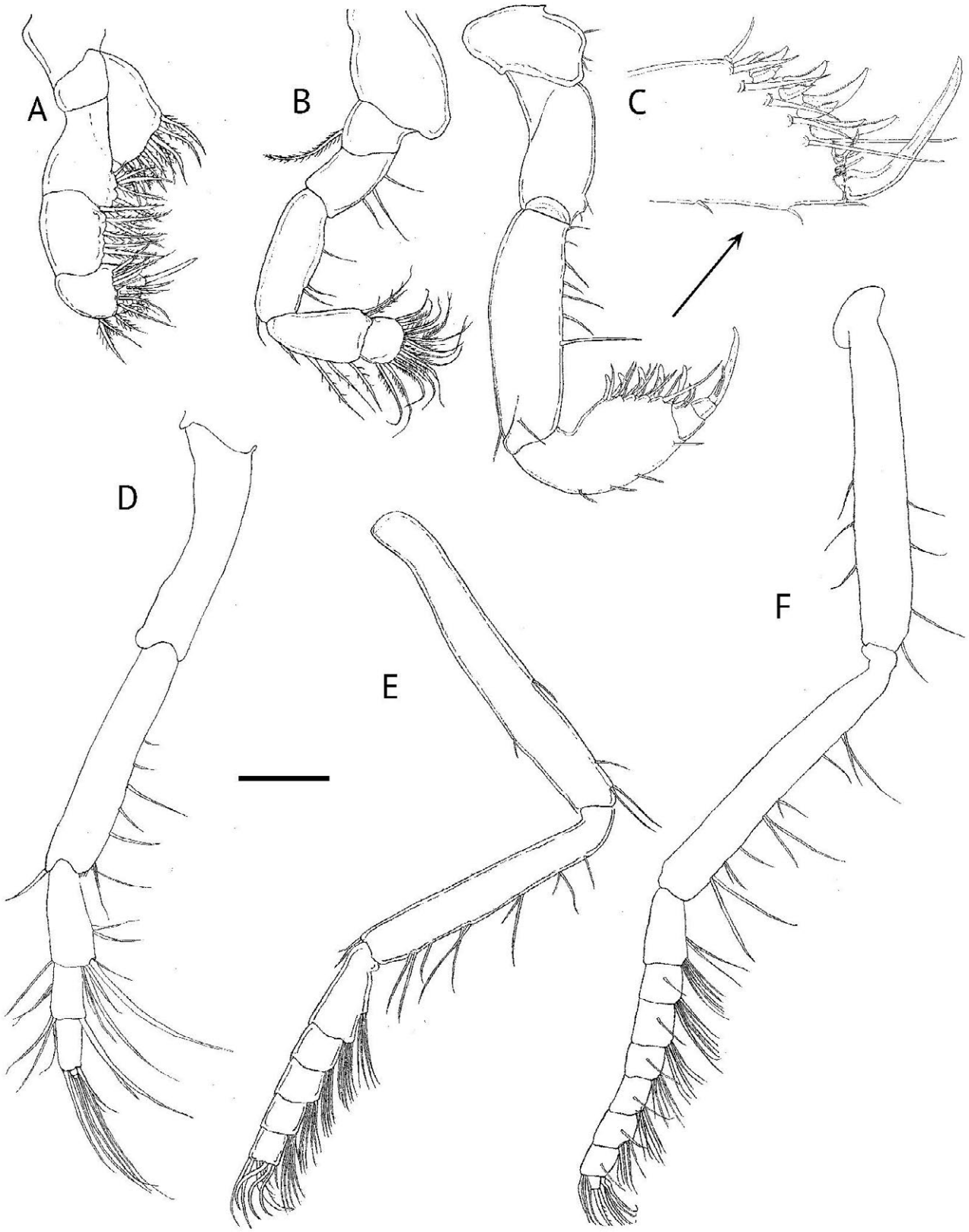


**Figure 3.** *Heteromysis* (*Olivemysis*) *cocoensis* n. sp. adult male, 3.0. mm. A, B. Thoracic endopods 1, 2. C. Thoracic endopod 3 (lateral view) with enlargement of distal end (mesial view). D–F. Thoracic endopods 4, 7, 5. Scale: A, B, D–F, 0.1 mm; C, 0.15 mm.

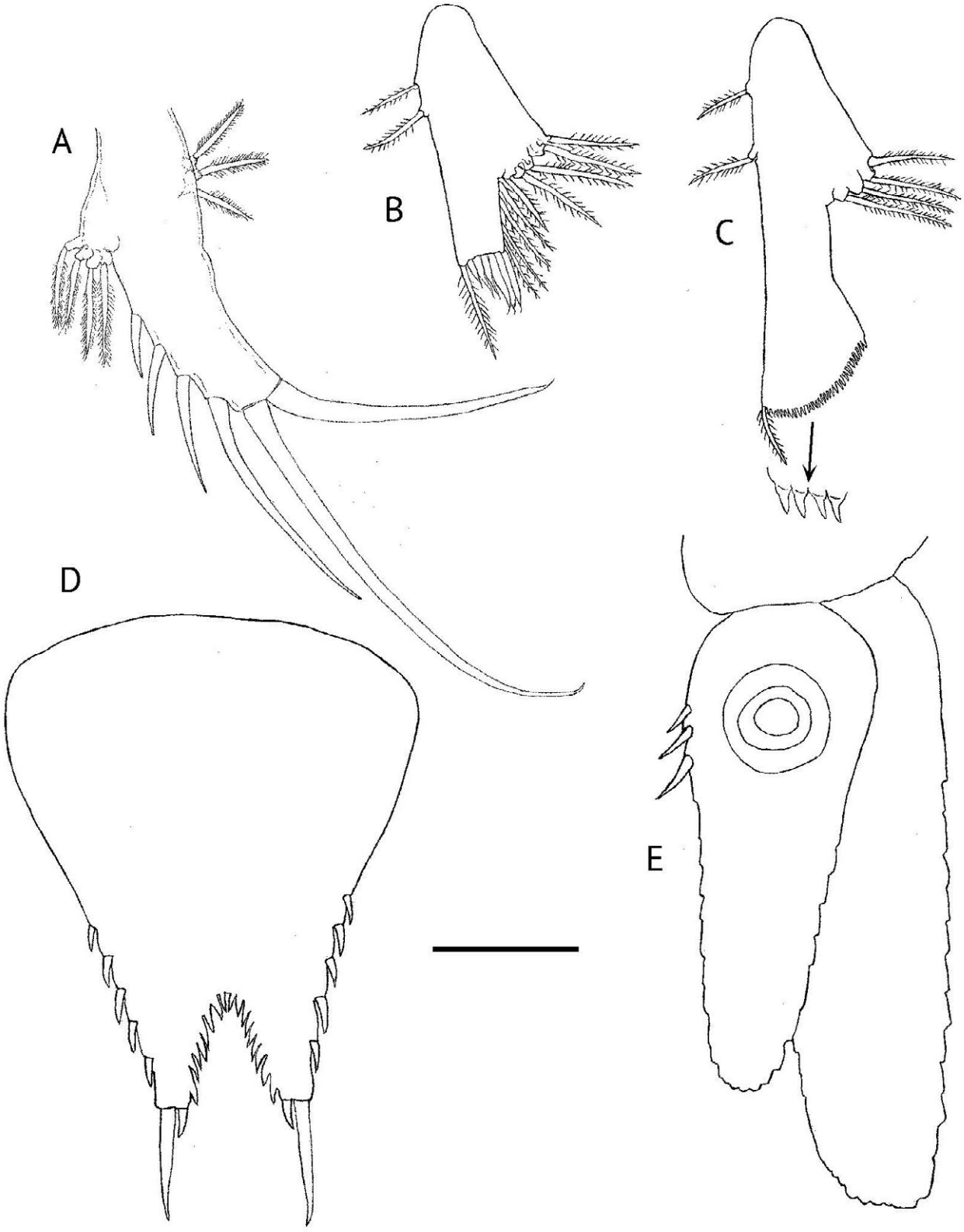


**Figure 4.** *Heteromysis* (*Olivemysis*) *cocoensis* n. sp. adult male, 3.0. mm. A. Pleopod 1, posterior view. B. Pleopod 3, posterior view. C. Pleopod 4, posterior view, with enlargement of distal setae. D. Telson. E. Uropod. Scale: A, 0.25 mm; B–E, 0.1 mm.

lateral margins moderately concave, armed along posterior 0.3–0.4 length with 6–7 spiniform setae per margin (apical setae included); outer apical seta 3.3–5 times longer than inner; cleft depth 0.25–0.30 times length of telson, completely armed with 16–21 spinules.

*Etymology.* The name refers to the type locality, Isla del Coco.

*Habitat. Heteromysis* (*Olivemysis*) *cocoensis* n. sp. collected from coral rubble washings with sponges, algae, and hydroids in depths of 8–34 m. Collecting techniques were too general to determine if this species was associated with a specific host; however, many species of *Heteromysis* are associated symbiotically with benthic invertebrates such as sponges, anthozoans, ophiuroids, and shells inhabited by hermit crabs (see Fukuoka, 2005 for details).

*Type locality*. Costa Rica, Isla del Coco, Bahía Chatham, 5°32'57.89''N 87°2'30.51''W, coral rubble washings, depth 8 m.

*Distribution.* This species is known only from coral reefs in coastal waters of Isla del Cocos.

## Discussion

*H. cocoensis*, n. sp. exhibits the morphological features attributable to the subgenus *Olivemysis* Băcescu, 1968. Among other characters these primarily include a subapically flagellate seta on the distomedial margin of the antennular peduncle and at least male pleopods 3 or 4 with modified setae or spines (Price and Heard, 2011; Wittmann and Wirtz, 2017). Of the 32 species of *Olivemysis* for which pleopods of mature males have been described, the majority has only pleopod 4 or pleopods 3 and 4 modified. However, seven species have pleopods 2–4 modified (*Heteromysis dardani* Wittmann, 2008; *Heteromysis ekamako* Wittmann and Chevaldonné, 2017; *Heteromysis macrophthalma* Băcescu, 1983; *Heteromysis quadrispinosa* Murano, 1988; *Heteromysis tenuispina* Murano, 1988; *Heteromysis wirtzi* Wittmann, 2008; *Heteromysis zeylanica* Tattersall, 1922), followed by two species (pleopods 1–4; *Heteromysis gomezi* Băcescu, 1970; *Heteromysis mayana* Brattegardi, 1970), and single species with pleopods 1–5 (*Heteromysis mclellandi* Price and Heard, 2011), 2–5 (*Heteromysis kushimotensis* Murano and Fukuoka, 2003), and 2–3 (*Heteromysis meenakshiae* Bamber, 2000) modified, respectively. *Heteromysis cocoensis* n. sp. is the only species in the subgenus (and genus) with males having pleopods 1, 3, and 4 bearing modified setae.

Within the Pacific members of the subgenus *Olivemysis, H. cocoensis* n. sp. appears to be most morphologically similar to *H. ekamako*, described from marine caves in the Marquesas Islands in the central Pacific, 6,000 km west of Isla del Coco. Both species have similar telsons, uropods, and third thoracic endopods. However, *H. cocoensis* n. sp. differs from the central Pacific species by having (1) a modified seta on articles 1 and 3 of the antennular peduncle, as opposed to a modified seta on all three articles; and (2) male pleopods 1, 3, and 4 modified as opposed to male pleopods 2, 3, and 4. In addition, the new species has male pleopod 3 with 28–36 apparently nonflagellate setae as compared to 13–26 flagellate setae for *H. ekamako* (see Tab. 1).

Of the Atlantic members of the subgenus, *H. cocoensis* n. sp. most closely resembles *H. mayana*, which is distributed throughout the Caribbean (Price and Heard, 2004), and *H. gomez* and *Heteromysis rubrocincta* Băcescu, 1968 from Cuba from the W. Atlantic as well as three species from the E. Atlantic: *H. dardani* and *H. wirtzi* from Madeira Island, and *Heteromysis sabelliphila* Wittmann and Wirtz, 2017 from the Cape Verde Islands. Although the telsons of these seven species are relatively similar, the outer: inner length ratio of the apical telsonal setae of *H. cocoensis* n. sp. is greater (3.3–5.0) than the other six species (1.8–3.0). The new species is further distinguished from its W. Atlantic congeners by having (1) the telson with lateral setae restricted to the posterior 40% of the telson as opposed to 50–70%; and (2) male pleopods 1, 3, and 4 modified as opposed to male pleopods 1–4 or 3–4 modified. Male pleopods 1 and 2 of *H. gomezi* and *H. mayana* have a single, large spiniform seta at the distal end rather than 6 robust, spiniform setae along medial and distal margins of pleopod 1 and a normal pleopod 2 for *H. cocoensis* n. sp. In addition, the new species has 28–36 small, apparently non-flagellate

**Table 1.** Diagnostic characters of species closely related to *Heteromysis* (*Olivemysis*) *cocoensis* n. sp.

| | ***H. (O.) dardani*** | ***H. (O.) ekmako*** | ***H. (O.) gomezi*** | ***H. (O.) mayana*** | ***H. (O.) rubrocincta*** | ***H. (O.) sabelliphila*** | ***H. (O.) wirtzi*** | ***H. (O.) cocoensis* n. sp.** |
|---|---|---|---|---|---|---|---|---|
| Flagellate setae on antennular peduncle | Article 1- 1<br>Article 2- 1<br>Article 3- 1 | Article 1- 1<br>Article 2- 1<br>Article 3- 1 | Article 1- ?<br>Article 2- ?<br>Article 3- 1 | Article 1- ?<br>Article 2- ?<br>Article 3- 1 | Article 1- ?<br>Article 2- ?<br>Article 3- 1 | Article 1- 1<br>Article 2- 1<br>Article 3- 1 | Article 1- 1<br>Article 2- 1<br>Article 3- 1 | Article 1- 1<br>Article 2- 0<br>Article 3- 1 |
| Flagellate setae on carpopropodus of thoracic endopod 3 | 5-8 | 6-7 | 3 | 5-7 | 0 | 5-8 | 7 | 7-9 |
| Modified male pleopods (P); no. of setae | P2, P3, P4: 1–7*, 0–4*, 0–4*, respectively | P2, P3, P4: 1**, 5–9*, 13–26*, respectively | P1, P2, P3, P4: 1**, 1**, 15*, 17–18*, respectively | P1, P2, P3, P4: 1**, 1**, 13–22*, 19–35*, respectively | P3, P4: 6–10*, 8–15*, respectively | P3, P4: 7–8*, 7–11*, respectively | P2, P3, P4: 9*, 16–17*, 19*, respectively | P1, P3, P4: 6 **, 6*, 28–36***, respectively |
| Spiniform setae on uropodal endopod | 3 | 2–3 | 3 | 1–4 | 4–5 | 2–3 | 4 | 2–3 |
| Lateral telson setae (apical seta included) | Posterior<br>0.4–0.5, 8–10 | Posterior<br>0.4, 7–8 | Posterior<br>0.6–0.7, 9 | Posterior<br>0.5–0.7, 6–9 | Posterior<br>0.5, 12–13 | Posterior<br>0.45–0.55, 6–10 | Posterior<br>0.40–0.45, 9–11 | Posterior<br>0.3–0.4, 6–7 |
| Telson cleft depth: telson length | 0.24–0.29 | 0.25–0.28 | 0.30 | 0.25–0.33 | 0.20 | 0.24–0.26 | 0.26–0.29 | 0.25–0.30 |
| Telson cleft spinules | Entire, 21–23 | Nearly entire, 18–21 | Entire, 20–22 | Entire, 14–20 | Entire, 15–16 | Entire, 15–22 | Entire, 24–27 | Entire, 16–21 |
| Outer: inner length of apical telson setae | 3.0 | 3.0–4.0 | 1.8–2.0 | 1.8–3.0 | 2.0 | 3.0 | 2.4 | 3.3–5.0 |
| Distribution | Madeira | Marquesas | Cuba | Caribbean | Cuba | Cape Verde | Madeira | Isla del Coco |
| References | Wittmann, 2008 | Wittmann and Chevaldonne, 2017 | Băcescu, 1970 | Brattegard, 1970; Price *et al.* 2002; Price and Heard 2004 | Băcescu, 1968 | Wittmann and Wirtz, 2017 | Wittmann, 2008 | present study |

* flagellate setae; **simple spiniform setae; ***simple small setae

setae on pleopod 4 as compared to 8–15, 17–18, and 19–35 flagellate setae in *H. rubrocincta*, *H. gomezi*, and *H. mayana*, respectively. Last, *H. cocoensis* differs from *H. rubrocincta* in having (1) 2–3 spiniform setae on the uropodal endopod rather than 4–5 and (2) 7–9 flagellate setae on the carpopropodus of thoracic endopod 3 rather than 0 (see Tab. 1).

The most important difference separating *H. cocoensis* n. sp. from the three closely related E. Atlantic species concerns characteristics of the male pleopods. While the new species has pleopods 1 (6 spiniform setae), 3 (6 flagellate setae), and 4 (28–36 non-flagellate setae) modified, the two Madeira Island species have pleopods 2–4 modified with 7, 0–4, and 0–4 flagellate setae, respectively, and *H. sabelliphila* has only pleopods 3 (7–8 flagellate setae) and 4 (7–11 flagellate setae) modified. Additionally, all three East Atlantic species have a modified setal pattern on the antennular peduncle similar to the central Pacific *H. ekamato*. For more specific characters distinguishing these eight species, refer to Tab. 1.

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