

Two New Species of Siphonostomatoid Copepods (Crustacea) Associated with the Stoloniferan Coral *Tubipora musica* (Linnaeus) from Madagascar

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Two new species of siphonostomatoid copepods, *Asterocheres tubiporae* n. sp. and *Entomopsyllus stocki* n. sp., associated with the stoloniferan coral *Tubipora musica* (Linnaeus) are described from Madagascar. *Asterocheres tubiporae* is characterized by the possession of a large posteroventral process on the caudal ramus and the elongated free segment of leg 5. *Entomopsyllus stocki* is readily distinguished from its congeners by the possession in the female of 15-segmented antennule and three spines plus two setae on the third exopodal segment of leg 4.

Copepods associated with shallow-water marine invertebrates were intensively studied in the vicinity of Nosy Bé in northwestern Madagascar. Humes (1995) listed 244 species of copepods as associates of 270 species of invertebrate hosts from this area. Since then, Humes (1996a) added three new species of copepods from the scleractian corals of the genus *Galaxea*: the cyclopoid *Pterinopsyllus stirpipes* from a *Galaxea* sp.; the siphonostomatoid *Hetairosynopsis buculentus* from *Galaxea clavus* (Dana), *Galaxea fascicularis* (L.), and a *Galaxea* sp.; and the siphonostomatoid *Madacheres serrulatus* from *Galaxea fascicularis*.

While examining the copepod specimens in the collection of the late Dr. A. G. Humes, I found some vials containing copepod material collected by Dr. J. H. Stock in 1964 from Nosy Bé, Madagascar. Probably someone in the Zoological Museum of Amsterdam sent these specimens to Dr. Humes after the death of Dr. Stock. One of vials which are thought to be kept originally by Dr. Stock contained two species of copepods collected from the organ-pipe coral *Tubipora musica* (Linnaeus), a species living in the Indo-West Pacific. These two species of copepods turned out to be new to science.

From *T. musica* Humes and Ho (1967) previously reported four new species of poecilostomatoid copepods from Madagascar: *Plesiomolgus conjunctus* (as *Lichomolgus conjunctus*), *P. organicus* (as *Lichomolgus organicus*), *Hippomolgus cognatus*, and *H. latipes*.

By addition of two new species in the paper, the number of copepod species associated with marine invertebrates of Madagascar becomes 249.

Family Asterocheridae Giesbrecht, 1899
Genus *Asterocheres* Boeck, 1859

Asterocheres tubiporae n. sp.
(Figs. 1-4)

Material examined

10♀♀, 6♂♂ from the stoloniferan coral *Tubipora musica* (Linnaeus), about in 1 m, Pte. de la Fièvre, Nosy Bé, Madagascar, 5 January 1964, collected by J. H. Stock. Holotype (♀), allotype (♂), and paratypes (8♀♀, 4♂♂) will be deposited in the National Museum of Natural History, Smithsonian Institution, Washington, D. C. Dissected paratypes (1♀, 1♂) in the collection of the author.

Female

Body (Fig. 1A) dorsoventrally flat. Body length of dissected largest specimen 854 µm (650-854 µm, mean 782 µm, n=4). Prosome circular, disc-shaped, 579 µm long. Cephalothorax 367 µm long in midline, and 583 µm wide. Second pedigerous somite shorter than third pedigerous somite. Urosome (Fig. 1B,C) 4-segmented. Fifth pedigerous somite 110 µm wide, with tapering lateral sides and row of spinules along posterodorsal border. Genital double-somite 122×130 µm, widest in middle, with narrower posterior one-fifth bearing parallel lateral margins, transverse row of spinules along posteroventral border and on ventrolateral sides near widest portion, and setules on lateral margins posterior to genital areas. First abdominal somite 56×72 µm, with posterodorsal margin rimmed with hyaline membrane and posteroventral margin serrate. Anal somite 48×59

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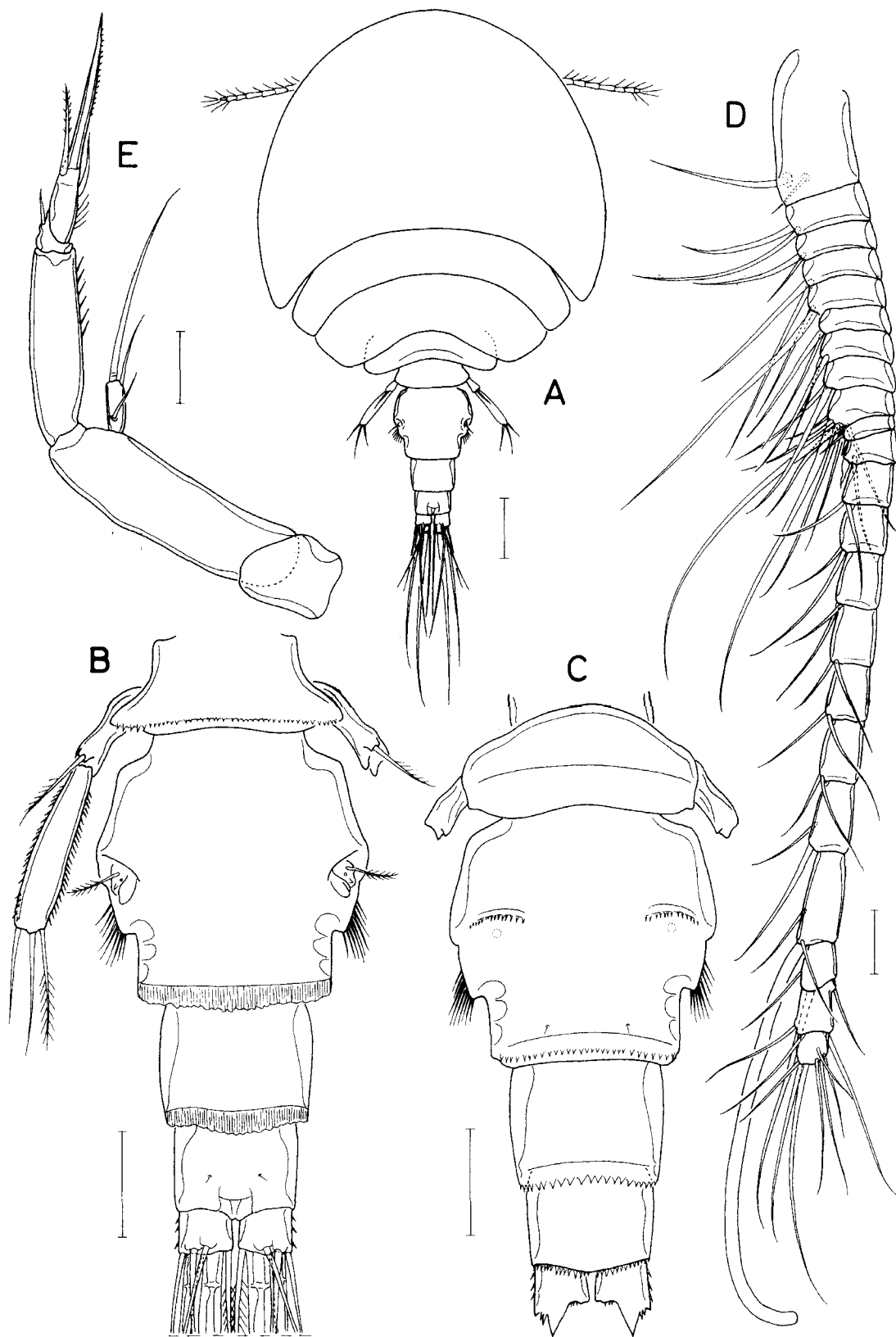


Fig. 1. *Asterocheres tubiporae* n. sp., female. A, Habitus, dorsal. B, Urosome, dorsal. C, Urosome, ventral. D, Antennule. E, Antenna. Scale bars= 100 μ m (A), 50 μ m (B, C), and 20 μ m (D, E).

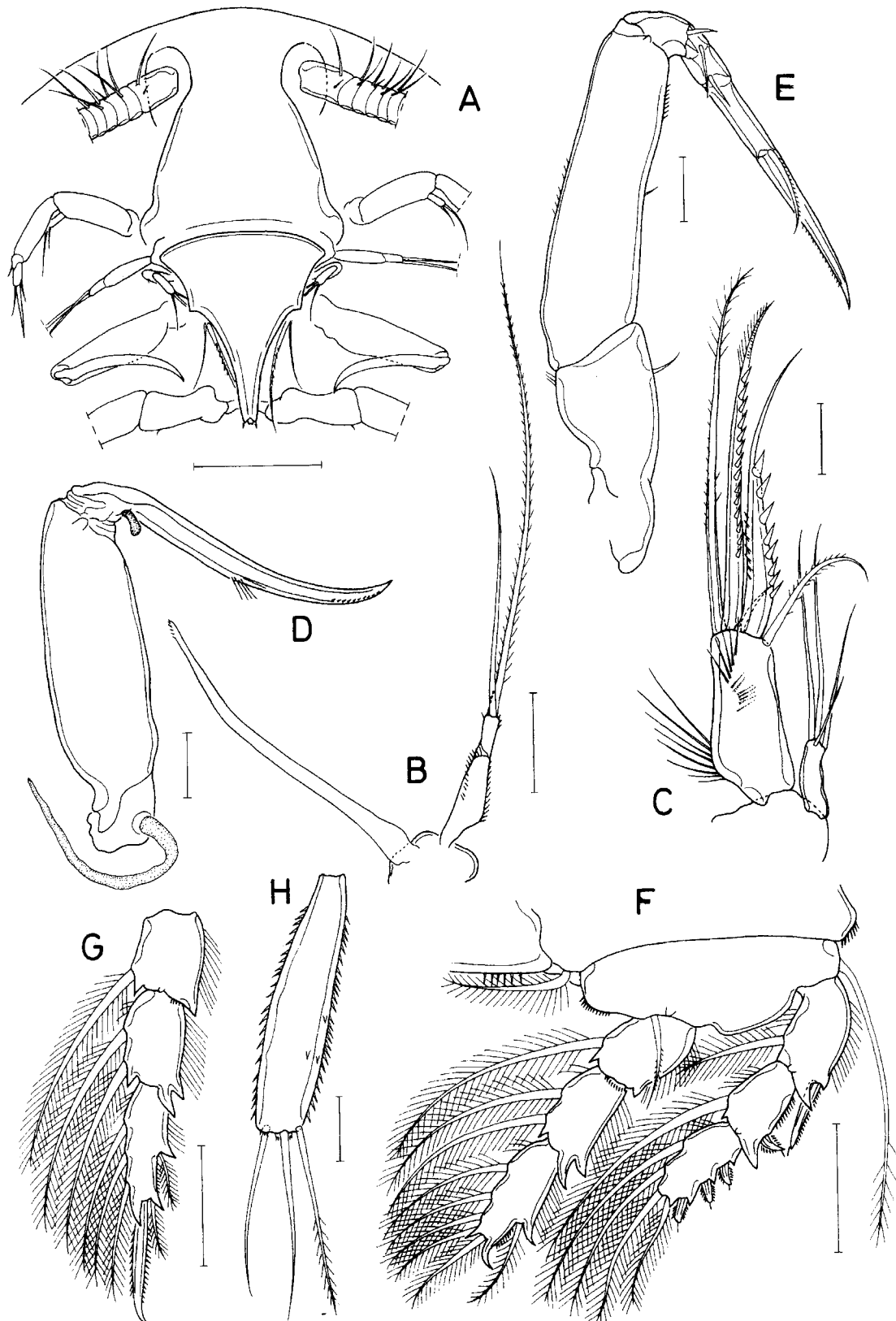


Fig. 2. *Asterocheres tubiporae* n. sp., female. A, Cephalic area, ventral. B, Mandible. C, Maxillule. D, Maxilla. E, Maxilliped. F, Leg 1. G, Endopod of leg 3. H, Free segment of leg 5. Scale bars=100 μ m (A), 50 μ m (B, F, G), and 20 μ m (C-E, H).

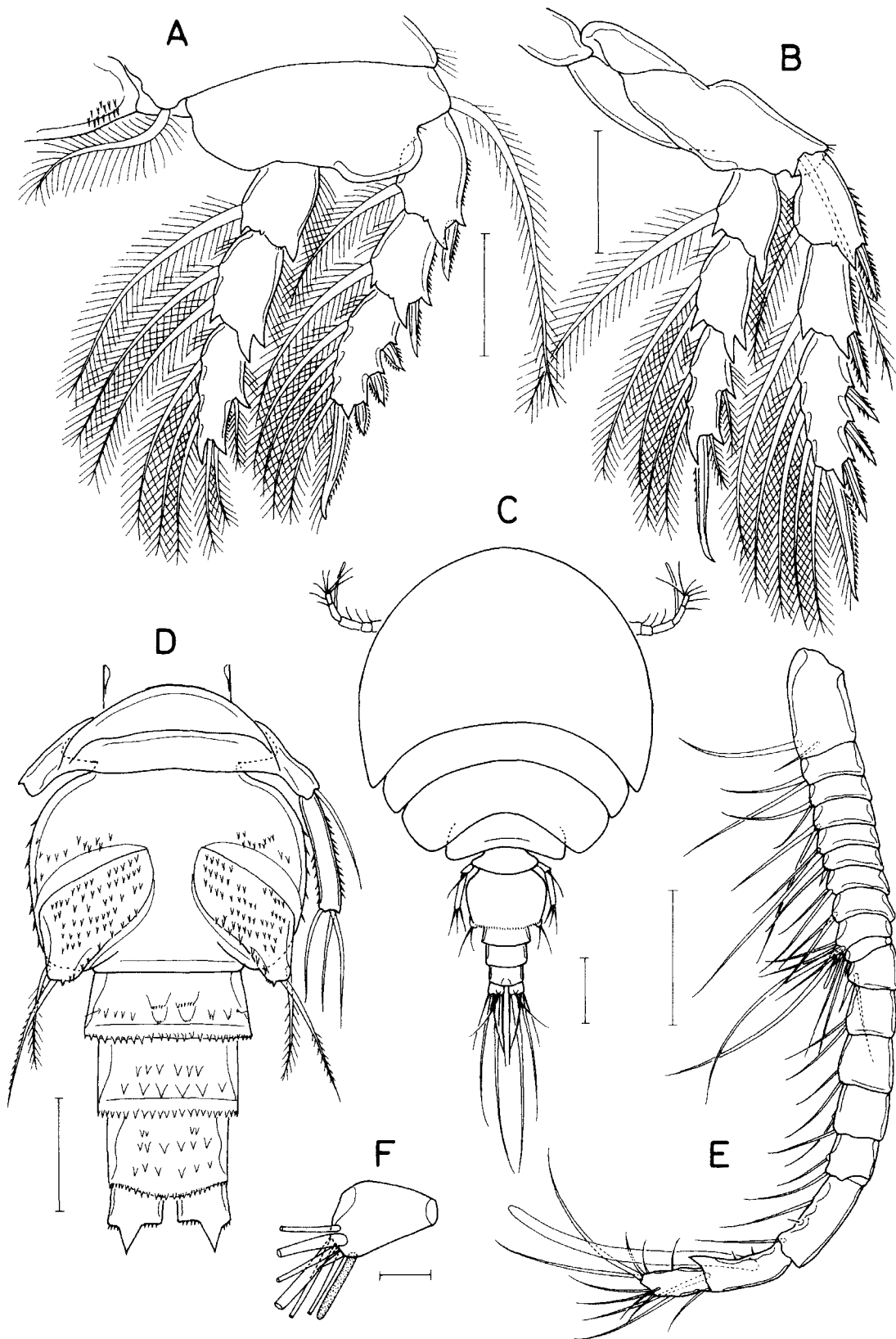


Fig. 3. *Asterocheres tubiporae* n. sp. Female: A, Leg 2. B, Leg 5. Male: C, Habitus, dorsal. D, Urosome, ventral. E, Antennule. F, Ninth segment of antennule. Sclae bars=50 μ m (A, B, D, E), 100 μ m (C), and 10 μ m (F).

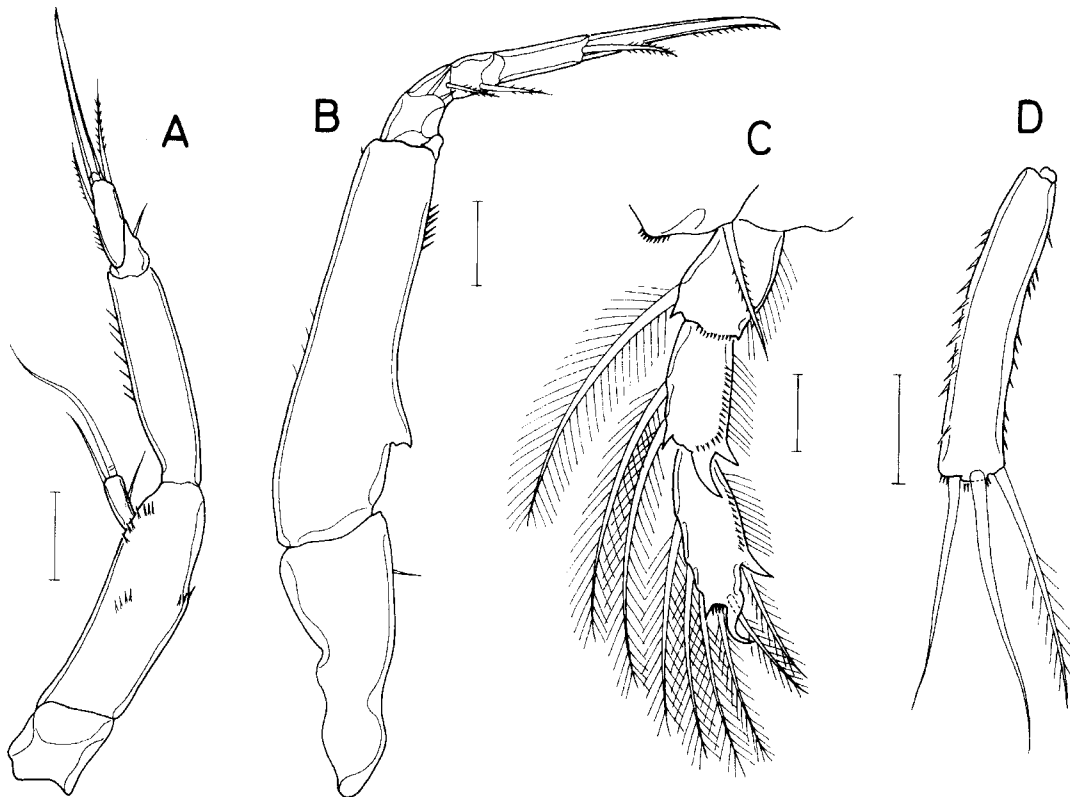


Fig. 4. *Asterocheres tubiporae* n. sp., male. A, Antenna. B, Maxilliped. C, Endopod of leg 1. D, Free segment of leg 5. Scale bar=20 μ m.

μ m, with spinules along posteroventral margin. Caudal ramus $22 \times 26 \mu$ m, ratio 1:1.18 (length measured excluding posteroventral process), with sharply pointed posterolateral process, 6 setae (2 dorsal and 4 distal), and 3 sinules (or scales) on outer lateral margin. Egg sac not seen.

Rostrum not defined, only represented by broad ridge continued from frontal margin to base of siphon (Fig. 2A). Antennule (Fig. 1D) 320μ m, 22-segmented. Ninth segment armed with 8 setae; nineteenth segment with 2 setae and 1 large aesthetasc; twenty-first segment with 4 setae; terminal segment with 7 setae; other segments each with 2 setae. All setae naked. Antenna with short coxa. Basis 67μ m long. Exopod 1-segmented, $14 \times 5 \mu$ m, armed with 1 small proximal setae and 2 very unequal, distal setae. Endopod 3-segmented. First segment 50μ m long, with setules on distal half of outer margin. Second segment short with 1 small distal seta. Terminal segment with setules on outer margin, 1 subdistal and 1 distal setae, and terminated by straight spine of 43μ m.

Oral cone $160 \times 135 \mu$ m, extending slightly over insertion of maxilliped, strongly tapering, and shaped as in Fig. 2A. Mandible (Fig. 2B) with 171μ m long, gnathobase not expanded, with minute denticles. Palp indistinctly 2-segmented; first segment expanded, 42μ m long, with minute setules on sides; distal segment 13μ m long, terminally with 1 large, weakly plumous seta and smaller naked seta; both setae distinctly longer than palp.

Maxillule (Fig. 2C) with lobate exopod and endopod; exopod small, 21μ m, armed distally 4 naked setae. Endopod 50μ m long, with rows of setules on side and distally 5 setae; 2 of them distinctly thickened, with longitudinal row of teeth-like barbs. Maxilla (Fig. 2D) 2-segmented. First segment basally with 1 large, but transparent, aesthetasc. Second segment giving rise to claw, proximally with 1 small aesthetasc-like process, setules near middle, and distally minute spinules. Maxilliped (Fig. 2E) 5-segmented with terminal claw; fourth segment with 3 setae; other segments each armed with 1 seta; terminal claw 55μ m long, almost straight, with fine spinules along distal part of inner margin.

Legs 1-4 with 3-segmented rami. Setal formula as follows.

Leg 1: coxa 0-1; basis 1-1; exopod 1-1; I-1; III,4; endopod 0-1; 0-2; 1,5

Leg 2: coxa 0-1; basis 1-0; exopod 1-1; I-1; III,1,4; endopod 0-1; 0-2; 1,2,3

Leg 3: coxa 0-1; basis 1-0; exopod 1-1; I-1; III,1,4; endopod 0-1; 0-2; 1,1+1,3

Leg 4: coxa 0-0; basis 1-0; exopod 1-1; I-1; III,1,4; endopod 0-1; 0-2; 1,1+1,2

Outer seta on basis of legs 1-4 large. Second endopodal segment of all these legs bifid. Outer spine of first exopodal segment of leg 1 28μ m long, extending to outer spine of second segment. Inner terminal process of

third endopodal segment of leg 1 distinctly curved and sharply pointed. All outer spines of exopod of leg 1 with small terminal flagellum. Leg 4 without inner coxal seta. Leg 5 2-segmented (Fig. 1B). First segment about twice as long as wide, slightly constricted near middle, with 1 distal, weakly plumous seta. Distal segment (Fig. 2H) 83×19 µm, proximally narrowed, with spinules on margins and 3 subequal, terminal setae, all these terminal setae shorter than segment, inner one of them weakly plumous. Leg 6 represented 1 small plumous seta and 2 minute spinules in genital area (Fig. 1B).

Male

Body (Fig. 3C) similar to that of female. Body length 736 µm (708–771 µm, n=6). Cephalothorax 279×458 µm. Urosome (Fig. 3D) 5-segmented. Posteroventral border of fifth pedigerous somite unornamented. Genital somite 89×122 µm, with many denticles on ventral and lateral surfaces. Three abdominal somites 29×73, 31×62, and 37×53 µm, respectively, gradually narrowed, with denticles along posteroventral margin and ventral surface.

Rostrum as in female. Antennule (Fig. 3E) 18-segmented. Ninth segment (Fig. 3F) with 7 setae and 1 small aesthetasc. Sixteenth segment with 3 setae, including 1 obscure seta; seventeenth segment with 3 (2 being minute) setae and 1 large aesthetasc; terminal segment with 11 setae; other segments each with 2 setae. Antenna (Fig. 4A) added by several spinules on basis.

Siphon, mandible, maxillule, maxilla as those of female. Maxilliped (Fig. 4B) with second segment bearing proximal process on inner margin, but without seta. Inner terminal process slightly more developed (Fig. 4C). Legs 2–4 as in female. Leg 5 with distal segment (Fig. 4D) bearing nearly parallel margins, 59×13 µm. Leg 6 represented by 2 distinct distal setae on genital flap.

Etymology

The specific name is derived from the generic name of the scleractinian host, *Tubipora*.

Remarks

One of distinguishing features of *Asterocheres tubiporae* n. sp. is the elongate leg 5 in which the free segment of the female is 4.37 times as long as wide. In *Asterocheres* such an elongate free segment of female leg 5 (more than four or more times as long wide) is recorded in the following seven known species, including *A. serrulatus* (Humes, 1996) which was originally assigned to the genus *Madacheres*: *A. eniwetakensis* Humes, 1997, *A. lunatus* Johnsson, 1998, *A. serrulatus*, *A. reginae* Boxshall and Huys, 1994, *A. jeanyeatmanae* Yeatman, 1970, *A. crenulatus* Johnsson, 1998, and *A. spinopaulus* Johnsson, 1998.

Asterocheres crenulatus and *A. spinopaulus* are unusual for *Asterocheres*, because they have an inner distal spine on the basis of leg 1, instead of a seta (Johnsson, 1998). Johnsson (1998) described also *A. lunatus* as it carries no inner distal element on the basis of the same leg. If his observations are correct, these three species are thought to belong to different genus.

In *Asterocheres eniwetakensis* Humes, 1997, the prosome is narrower than that of *A. tubiporae*, with a great width 0.37 mm (Humes, 1997), a dimension very different from that of *A. tubiporae* (about 0.58 mm). Its genital double-somite is longer than wide, unlike *A. tubiporae* where it is wider than long.

In the description of *A. jeanyeatmanae*, Yeatman (1970) described the free segment of female leg 4 of this species as it is four times as long as wide, but in his illustration of female leg 5 it hardly exceeds three times as long. Moreover, this Atlantic species carries only two terminal setae on the free segment of the same leg.

Asterocheres reginae is very close to *A. tubiporae* in many important respects, but can be distinguishable from the new species, because in this Atlantic associate of sponge the cephalothorax is greatly expanded laterally over lateral margins of the second pedigerous somite, the proximal segment of leg 4 is not elongated, and the urosomal somites are more wider than those of *A. tubiporae*, for example, the genital double-somite is 1.28 times wider than long (Boxshall and Huys, 1994) in contrast to 1.07 times in *A. tubiporae*.

While describing *A. dysideae*, Humes (1996b) remarked that the presence of a pointed posteroventral process on caudal ramus is a unique feature of this species. However, this feature is shared by *A. serrulatus* (Humes, 1996) and *A. tubiporae*. Interestingly, all of these three species have a circular, expanded prosome. *Asterocheres dysideae* differs from *A. tubiporae* in having the distinctly reduced middle seta on the free segment of leg 5 (see Fig. 3G of Humes, 1996b) in both sexes. *Asterocheres serrulatus* also differs from *A. tubiporae*, because it possesses the antennule bearing some of setae terminally bifurcate, the well-defined rostrum and the larger body size (1.20 mm long in the female, according to Humes, 1996a).

Most of all, the 22-segmented female antennule of *A. tubiporae* is not known yet in other species of *Asterocheres*. Therefore, this trait alone may characterize *A. tubiporae*.

Family Entomolepididae Brady, 1899
Genus *Entomopsyllus* McKinnon, 1988

Entomopsyllus stocki n. sp.
(Figs. 5, 6)

Material examined

One ♀ (holotype) from the stoloniferan coral *Tubipora*

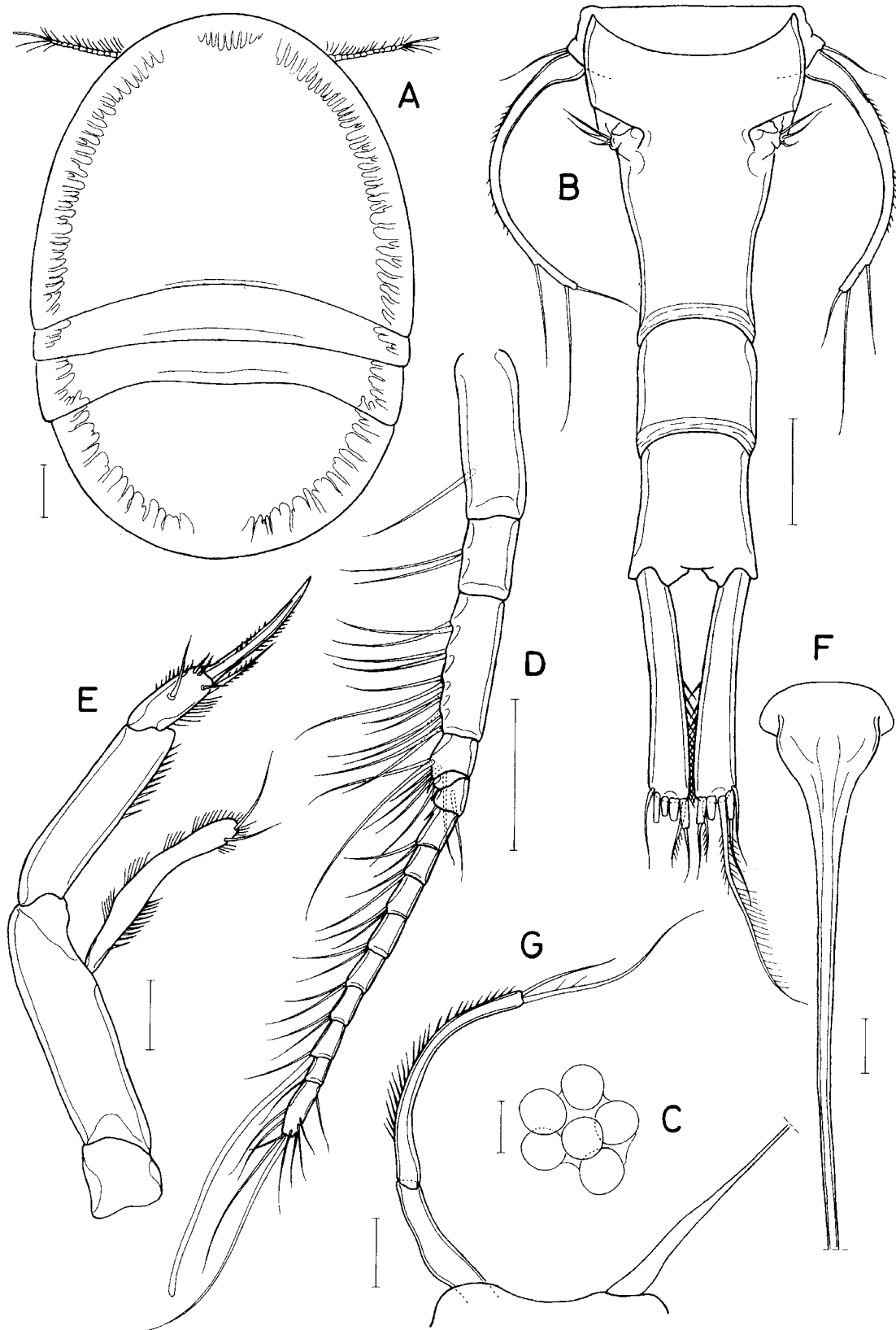


Fig. 5. *Entomopsyllus stocki* n. sp., female. A, Habitus, dorsal. B, Urosome, dorsal. C, Egg sac. D, Antennule. E, Antenna. F, Siphon. G, Mandible. Scale bars=100 μm (A, C, F), 50 μm (B, D), and 20 μm (E, G).

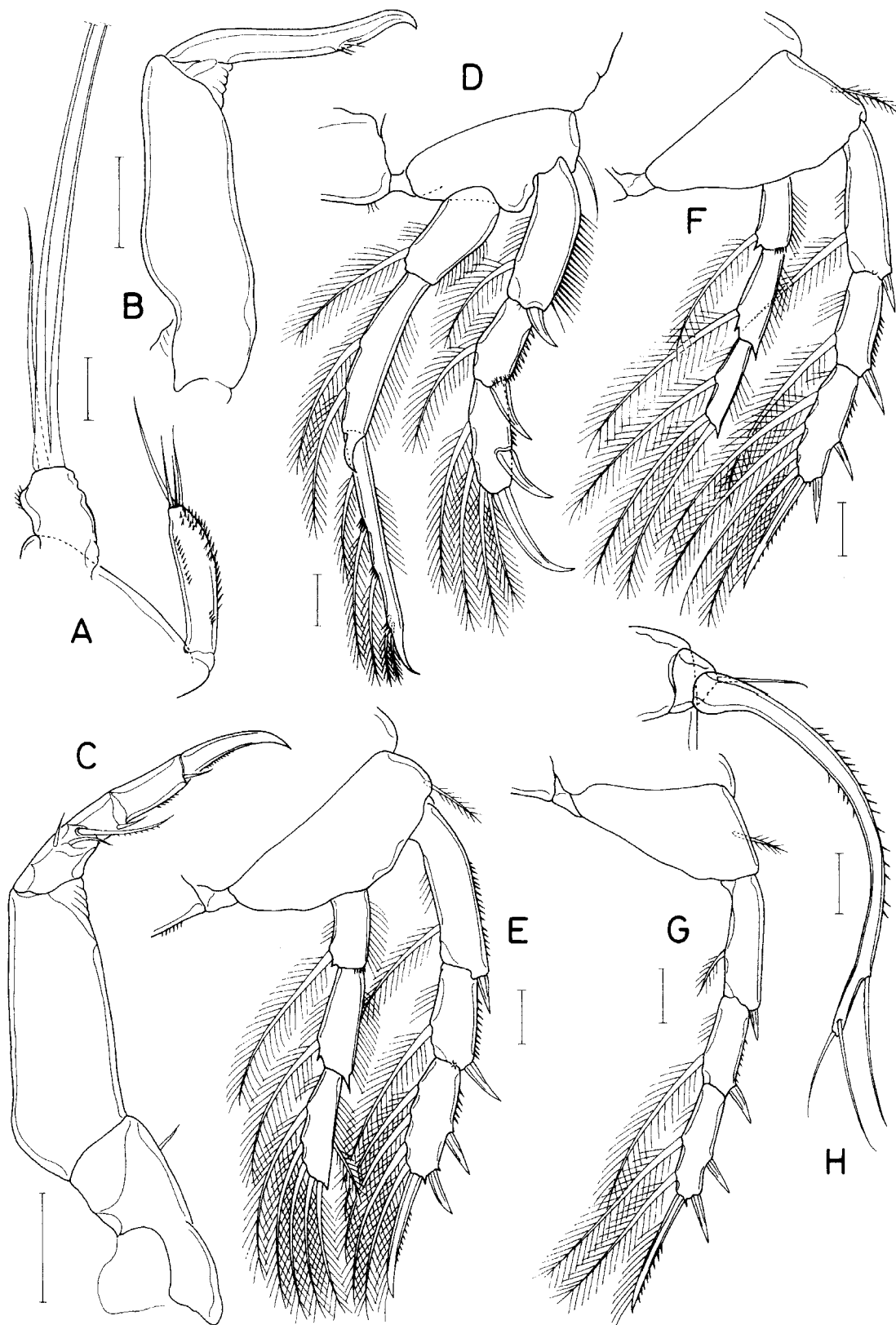


Fig. 6. *Entomopsyllus stocki* n. sp., female. A, Maxillule. B, Maxilla. C, Maxilliped. D, Leg 1. E, Leg 2. F, Leg 3. G, Leg 4. H, Leg 5. Scale bars=20 μ m (A, D-H), and 50 μ m (B, C).

musica (Linnaeus), Nosy Bé, Madagascar, collected by J. H. Stock, on 5 January 1964. Holotype (dissected and mounted on a slide) will be deposited in the National Museum of Natural History, Smithsonian Institution, Washington, D.C.

Female

Body (Fig. 5A) very flat, with disc-shaped prosome. Length of prosome 1.00 mm. Greatest width 761 μm . Lengths of 4 prosomal somites 528, 110, 83, and 339 μm , respectively, from anterior to posterior. Urosome (Fig. 5B) 4-segmented. Genital double-somite originated from dorsal side of fifth pedigerous somite, tapering, 146 \times 104 μm ; genital area positioned dorsolaterally, at about one-third length of somite. First and second abdominal somites 52 \times 57 and 63 \times 61 μm , respectively. Posterior margin of anal somite concave at insertion of caudal ramus. Caudal rami convergent, and gradually broadened distally; each ramus 110 \times 19 μm , ratio 5.79:1, with thick setules on inner margin and 6 setae on terminal margin, some of latter articulated near base. Egg sac (Fig. 5C) globular, containing less than 10 eggs; each egg 110 μm in diameter.

Rostrum not defined. Antennule (Fig. 5D) slender, 275 μm long, and 15-segmented; distal 9 segments much more slender than proximal segments; armature formula: 1, 2, 12, 7, 2, 2, 2, 2, 2, 2, 2, 1+1 aesthetasc, 2, and 10. All setae naked. Antenna (Fig. 5E) with short coxa. Basis 75 μm long. Exopod elongate, 63 \times 8 μm , constricted near middle, with setules on margins and 2 small distal setae. Endopod 2-segmented; first segment 58 μm long, with setules on distal half of outer margin; second segment 25 μm long, with setules on margins, 1 lateral seta near middle, 4 distal setae (3 of them small), and terminated by 1 claw of 43 μm long.

Siphon (Fig. 5F) very long and thin, extending to posterior margin of prosome. Mandible (Fig. 5G) thread-like, almost as long as siphon. Palp elongate and 2-segmented; first segment 42 μm long; second segment 72 μm long, distinctly curved, with setules along convex margin and 2 unequal terminal setae. Maxillule (Fig. 6A) with lobate exopod and endopod. Exopod 50 μm long, with spinules on surface and terminally 4 small naked setae. Endopod about 35 μm long, with 3 unequal naked setae characteristically inserted in siphon, one of them extremely long, nearly as long as siphon. Maxilla (Fig. 6B) simple; second segment with few setules subdistally. Maxilliped (Fig. 6C) 5-segmented, with terminal claw; armature formula: 1, 0, 3, 1, 1+claw; second segment slightly expanded at outer proximal part; claw relatively short, 53 μm long, with fine spinules on inner margin.

Legs 1-3 (Fig. 6D-F) with 3-segmented rami. Leg 4 with 3-segmented exopod, but endopod lacking. All these legs without inner coxal seta. Endopod of leg 1 slender and longer than exopod, its second and third

segments terminated by curved and acute process. Armature formula of legs 1-4 as follows:

Leg 1: coxa 0-0; basis 1-0; exopod I-1; I-1; I,I,4; endopod 0-1; 0-2; 5

Leg 2: coxa 0-0; basis 1-0; exopod I-1; I-1; II,I,4; endopod 0-1; 0-1; 1,5

Leg 3: coxa 0-0; basis 1-0; exopod I-1; I-1; II,I,4; endopod 0-1; 0-1; 2,1

Leg 4: coxa 0-0; basis 1-0; exopod I-1; I-1; II,I,2; endopod (lacking)

Leg 5 (Fig. 6H) 2-segmented. First segment distinctly articulated from somite, shorter than wide, with 1 naked seta. Second segment slender, elongated and strongly curved inward, 146 μm long, 13 μm in maximum width at base, with sparse spinules on margins and 3 (1 subdistal and 2 distal) naked distal setae. Leg 6 (Fig. 5B) represented by 3 setae in genital area, posterior one of them smaller.

Male

Unknown.

Etymology

This species is named for D. J. H. Stock who collected the species.

Remarks

While establishing the genus *Entomopsyllus* to accommodate a new species *E. nicholsi*, McKinnon (1988) transferred *Entomolepis adriae* Eiselt, 1959 to this genus. *Entomopsyllus adriae* (Eiselt, 1959) is known from the algae and sponges in Adriatic Sea (Eiselt, 1959) and *E. nicholsi* McKinnon, 1988 from plankton in Australia. *Entomopsyllus stocki* n. sp. can be easily distinguished from these two congeners, because this Madagascan species possesses the 15-segmented antennule (16-segmented in *E. adriae* and 11-segmented in *E. nicholsi*) and the three spines and two setae (formula II,I,2) on the third exopodal segment of leg 4 (formulae II,I,3 in *E. adriae* and II,I,4 in *E. nicholsi*).

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