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A new bomolochid copepod parasitic on bullseye puffer *Sphoeroides annulatus* (Jenyns) from Mexico, with reassignment of some species of *Acantholochus* Cressey and *Hamaticolax* Ho & Lin

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Abstract

A new bomolochid copepod species, *Acantholochus zairae* (Cyclopoida: Bomolochidae), was found on the bullseye puffer fish *Sphoeroides annulatus* (Jenyns). It is the ninth species belonging to *Acatholochus* Cressey around the world and the third from the Mexican Pacific. Females of *A. zairae* **sp. n.** can be distinguished from *Acantholochu*s spp. mainly by the presence of one seta (instead of two) on the second endopodal segment of leg 2 and by the strong, large claw of the maxilla. *Acantholochus zairae* **sp. n.** is attributable either to *Acantholochus* or to *Hamaticolax* Ho & Lin since no useful character to distinguish the genus *Acantholochus* from the genus *Hamaticolax* was found in the literature. We therefore suggest that species of the genus *Acantholochus* can only be distinguished from those of the genus *Hamaticolax* by the absence of the accessory process of the maxillipedal claw. Due to the above, three species of bomolochids hitherto placed in the genus *Acantholochus* [*H. galeichthyos* (Luque & Bruno) comb. nov., *H. paralabracis* (Luque & Bruno) comb. nov. and *H. unisagittatus* (Tavares & Luque) comb. nov.] are transferred to *Hamaticolax* and three species hitherto placed in the genus *Hamaticolax* [*A. albidus* (Wilson) comb. nov., *A. australiensis* (Byrnes) comb. nov. and *A. venustus* (Kabata) comb. nov.] are transferred to *Acantholochus*. In addition, keys to the females of both genera are provided.

Key words: *Acantholochus zairae*, fish parasite, Cyclopoida, Bomolochidae, taxonomy

Introduction

The bullseye puffer *Sphoeroides annulatus* (Jenyns) is an economically important fish and some studies have been done to assess its feasibility for large-scale aquaculture (Chávez-Sánchez *et al.* 2008). Parasites from several taxa, including copepods, are responsible for widespread diseases and mortality in finfish aquaculture (Ogawa 2005; Guo & Woo 2009). The best treatment against the copepod parasites of *S. annulatus* can be achieved through their accurate identification and more detailed investigation especially during the establishment of fish farms. Thus, a short-term study to describe temporal composition and variation in the parasite copepod community of the wild bullseye puffer was performed. Five species of copepods were found parasitizing the bullseye puffer. Of these, one bomolochid species turned out to be attributable either to *Acantholochus* Cressey or to *Hamaticolax* Ho & Lin.

The original diagnosis for *Acantholochus* was based on five species [*A. asperatus* (Cressey & Cressey), *A. crevalleus* (Cressey), *A. divaricatus* (Cressey & Cressey), *A. nasus* (Cressey) and *A. nudiusculus* (Cressey & Cressey)], whose females are mainly characterized by the presence of a pair of hooks on the rostrum, a 5-, 6- or 7-segmented antennule without modified setae on first segment, by the accessory process of the claw of the maxilliped being reduced or absent, by long and heavily sclerotized outer spines of the exopod of leg 3, and by the endopod of leg 4 being longer that the exopod (Cressey 1984). Later, three more species were added to the genus (*A. galeichthyos* Luque & Bruno; *A. paralabracis* Luque & Bruno; and *A. unisagittatus* Tavares & Luque). However, these three species does not fit the generic diagnosis by Cressey (1984), since they possess

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an accessory process on the claw of the maxilliped; also, the outer spines of the exopod of leg 3 are not heavily sclerotized in *A. paralabracis* and *A. unisagittatus*, and the endopod of leg 4 is not longer than the exopod in *A. galeichthyos*.

On the other hand, the genus *Hamaticolax* Ho & Lin was proposed to accommodate 10 "orphan species" of bomolochid copepods [*H. albidus* (Wilson), *H. attenuatus* (Wilson), *H. australiensis* (Byrnes), *H. embiotocae* (Hannan), *H. maleus* (Oldewage), *H. occultus* (Kabata), *H. prolixus* (Cressey), *H. scutigerulus* (Wilson), *H. spinulus* (Cressey) and *H. venustus* (Kabata)] previously placed in *Holobomolochus* Vervoort. Females of the species of *Hamaticolax* are characterized mainly by the anterior margins of the first two segments of the antennule that are not at right angles, and the possession of a pair of rostral hooks (Ho & Lin 2006).

Notwithstanding, after a thorough revision of the diagnoses of *Acantholochus* (Cressey 1984) and *Hamaticolax* (Ho & Lin 2006), no distinctive characters were detected to accurately define these genera, and to accommodate the new species described herein. Therefore, a new diagnosis for the genera *Acantholochus* and *Hamaticolax*, reassignment of some species, and the description of a new species are presented.

Materials and methods

Altogether 337 bullseye puffers caught from February 2007 to February 2008 in Santa Maria La Reforma lagoon (Sinaloa, north-western Mexico) were examined. The standard length and weight of the fishes ranged between 79 mm and 335 mm (mean= 158.9 mm; S.D. = ±40.4) and from 23.5 g to 1653.5 g (mean= 254.2 g; S.D. = ±204.8), respectively. The attached copepods were removed from the fishes and preserved in 70 % ethanol. Specimens were dissected in a drop of glycerin and the body parts and appendages mounted as semi-permanent slides using lactophenol as mounting medium. Observations and drawings were made from whole and dissected specimens mounted in lactophenol with a Leica compound microscope equipped with phase contrast and a drawing tube.

The type material was deposited in the collection of the Instituto de Ciencias del Mar y Limnología, Mazatlán Marine Station. The terminology for the general description was taken from Boxshall & Halsey (2004) and Ho & Lin (2005, 2006). The classification proposed by Boxshall & Halsey (2004) was adopted.

Systematic account

Order: Cyclopoida Burmeister

Family: Bomolochidae Sumpf

Genus: *Hamaticolax* Ho & Lin

Diagnosis (amended). Female. Body form typical for the family, with only the first pedigerous somite incorporated into cephalothorax. Abdomen 3-segmented. Caudal rami with 6 setae, 2 on mid-distal margin, much longer than others. Rostrum with pair of ventral hooks. Antennule 5-, 6- or 7-segmented; basal region without modified setae, anterior margins of first 2 segments not at right angles. Antenna and oral appendages typical for the family. Claw of the maxilliped with accessory process. Legs 1–4 biramous and trimerite. Middle segment of endopod of legs 2 and 3 with 1 or 2 inner setae. Endopod of leg 4 with 1 inner seta on middle segment, and 2 or 3 terminal elements on distal segment (one of them longer). Leg 5 typical for family.

Male. Abdomen 2-segmented. Antennule 5- or 6-segmented. Legs 1–3 biramous and trimerite. Leg 4 with 2-segmented endopod and 2- or 3-segmented exopod. Second segment of leg 5 tipped with 2 elements.

Type species: *Hamaticolax attenuatus* (Wilson) [described as *Bomolochus attenuatus* Wilson].

Type hosts: *Scorpaena plumieri* Bloch

Infection sites: Gills

Type locality: Jamaica

Other species: ***Hamaticolax embiotocae*** (Hanan) [Hosts: *Cymatogaster aggregate* Gibbson, *Rhacochilus vacca* (Girard) and *Zalembius rosaceus* (Jordan & Gilbert) from Southern California], ***H. galeichthyos*** (Luque & Bruno) comb. nov. [Host: *Galeichthys peruvianus* Lütken from Lima, Perú], ***H. maleus*** (Oldewage) [Host: *Malacocephalus laevis* (Lowe) from South Africa], ***H. occultus*** (Kabata) [Hosts: *Hippoglossoides elassodon* Jordan & Gilbert and *Lyopsetta exillis* (Jordan & Gilbert) from British Columbia], ***H. paralabracis*** (Luque & Bruno) comb. nov. [Host: *Paralabrax humeralis* (Valenciennes) from Lima. Perú], ***H. prolixus*** (Cressey) [Hosts: *Chitonotus pugetensis* (Steindachner), *Citharichthys soridus* (Girard), *Hippoglossina stomata* Eigenmann & Eigenmann, *Citharichthys stigmaeus* Jordan & Gilbert, *Genyonemus lineatus* (Ayres), *Icelinus quadriseriatus* (Lockington), *Microstomus pacificus* (Lockington), *Paralichthys californicus* (Ayres), *Parophrys vetulus* (Gyrard), *Pleuronichthys coenosus* Girard, *Pleuronichthys verticalis* Jordan & Gilbert, *Porichthys notatus* Girard, *Symphurus atricaudus* (Jordan & Gilbert), *Zalembius rosaceus* (Eigenmann & Eigenmann), *Zaniolepis frenata* (Eigenmann & Eigenmann) and *Zaniolepis latipinnis* Girard from Southern California], ***H. scutigerulus*** (Wilson) [Host: *Pseudupeneus maculatus* (Bloch) from West Indies and Belize], ***H. spinulus*** (Cressey) [Hosts: *Scorpaena guttata* Girard, *Sebastes dallii* (Eigenmann & Eigenmann), *Sebastes mystinus* (Jordan & Gilbert), *Sebastes serranoides* (Eigenmann & Eigenmann) and *Zaniolepis latipinnis* Girard from Southern California] and ***H. unisagittatus*** (Tavares & Luque) comb. nov. [Host: *Centropomus undecimalis* (Bloch) from Brazil]. Information given above was compiled from Cressey (1969, 1983), Hanan (1976), Ho & Lin (2006), Kabata (1971), Luque & Bruno (1990), Oldewage (1994), Tavares & Luque (2003), and Wilson (1913, 1935).

Key to species of *Hamaticolax* (females only)

1a. Abdomen longer than or as long as the cephalothorax 2
1b. Abdomen shorter than cephalothorax 3
2a. Mid-exopod segment of leg 3 with 2 outer spines and terminal exopod segment of leg 4 with 5 elements ..... *H. attenuatus*
2b. Mid-exopod segment of leg 3 with 1 outer spine and terminal exopod segment of leg 4 with 8 elements ..... *H. spinulus*
3a. Antennule with 7 segments 4
3b. Antennule with 5 or 6 segments 6
4a. Mid-endopod segment of legs 2 and 3 with 1 seta ..... *H. unisagittatus*
4b. Mid-endopod segment of legs 2 and 3 with 2 setae 5
5a. Prosome 3 times as long as urosome; terminal exopod segment of leg 2 with 8 elements; leg 3 exopod much smaller than endopod (one half as endopod) ..... *H. scutigerulus*
5b. Prosome 2 times as long as urosome; terminal exopod segment of leg 2 with 9 elements; leg 4 exopod about two thirds as long as endopod ..... *H. maleus*
6a. Terminal endopod segment of leg 4 with 2 elements ..... *H. galeichthyos*
6b. Terminal endopod segment of leg 4 with 3 elements 7
7a. Terminal exopod segment of leg 3 and 4 with 8 elements 8
7b. Terminal exopod segment of leg 3 and 4 with 7 elements and leg 4 exopod about two thirds as long as endopod ..... *H. embiotocae*
8a. Leg 4 endopod clearly elongated and almost 2 times as long as exopod ..... *H. paralabracis*
8b. Leg 4 endopod and exopod of same size 9
9a. Caudal rami without denticulation or row of spinules on ventral surface ..... *H. occultus*
9b. Caudal rami with two rows of spinules on ventral surface ..... *H. prolixus*

Genus: *Acantholochus* Cressey

Diagnosis (amended). Female. Body form typical for the family, with only the first pedigerous somite incorporated into cephalothorax. Abdomen 3-segmented. Caudal rami with 6 setae, 2 on mid-distal margin, much longer than others. Rostrum with pair of hooks. Antennule 5-, 6- or 7-segmented; basal region without

modified setae, anterior margins of first two segments not at right angles. Antenna typical for the family. Accessory process of maxilliped claw absent or reduced. Legs 1–4 biramous and trimerite. Middle segment of endopod of leg 2 with 1 or 2 inner setae. Middle segment of endopod of leg 3 with 2 inner setae. Middle segment of endopod of leg 4 with 1 inner seta. Outer spines of the exopod of leg 3 long and heavily sclerotized. Endopod of leg 4 much longer than exopod. Leg 5 typical for family.

Male. Abdomen 2-segmented. Terminal segment of maxilliped claw-shaped. Legs 1–4 biramous. Legs 2 and 3 with 3-segmented exopod and 3- or 2-segmented endopod. Outer spines of leg 3 exopod not heavily sclerotized. Leg 4 with 3- or 2-segmented exopod and 2-segmented endopod. Leg 5 with 2 terminal setae.

Type species: *Acantholochus divaricatus* (Cressey & Cressey)

Type hosts: *Scomberomorus brasiliensis* Collette, Russo & Zavala-Camín

Infection sites: Nasal sinuses

Locality: Brazil [also found on *S. brasiliensis* from Panama (Atlantic), Colombia (Atlantic) and Argentina; *Scomberomorus maculatus* (Mitchill) from Panama (Atlantic), USA (Atlantic) and Surinam; and *Scomberomorus regalis* (Bloch) from Florida, Cuba, Haiti, Puerto Rico, Colombia (Atlantic), Venezuela and Surinam].

Other species: ***Acantholochus albidus*** (Wilson) comb. nov. [Host: *Lophius piscatorius* Linnaeus from Massachusetts], ***A. asperatus*** (Cressey & Cressey, 1980) [Host: *Scomberomorus cavalla* (Cuvier) from Cuba, Georgia, Florida, Texas, Trinidad and Brazil], ***A. australiensis*** (Byrnes) comb. nov. [Hosts: *Acanthopagrus australis* (Günther) and *Acanthopagrus berda* (Forsskål) from Queensland, Australia], ***A. crevalleus*** (Cressey) [Host: *Caranx hippos* (Linnaeus) from Florida], ***A. nasus*** Cressey [Hosts: *Anisotremus interruptus* (Gill) from Panama (Pacific), *Anisotremus dovii* (Günther) from Colombia (Pacific), *Anisotremus davidsoni* (Steindachnar) and *Orthopristis reddingi* Jordan & Richardson from Mexico (Pacific)], ***A. nudisculus*** (Cressey & Cressey) [Hosts: *Scomberomorus sierra* Jordan & Starks from Colombia (Pacific), Mexico (Pacific) and Perú and *Scomberomorus concolor* Lockington from Mexico (Pacific)], ***A. venustus*** (Kabata) comb. nov. [Hosts: *Scorpaenichthys marmoratus* Gilbert and *Sebates courinus* Richardson from British Columbia] and ***A. zairae*** **sp. n.** [Host: *Sphoeroides annulatus* (Jenyns) from Mexico (Pacific)]. Information given above was compiled from Byrnes (1986), Cressey & Cressey (1980), Cressey (1981), Cressey (1984), Kabata (1971) and Wilson (1932).

Key to species of *Acantholochus* (females only)

1a. Antennule with 7 segments 2
1b. Antennule with 5 or 6 segments 3
2a. Spines of leg 3 without serrations ..... *A. asperatus*
2b. Spines of leg 3 with serrations ..... *A. nasus*
3a. Mid-endopod segment of leg 2 with 1 seta and maxilla tipped with a strong, large claw ..... *A. zairae* **sp. n.**
3b. Mid-endopod segment of leg 2 with 2 seta and maxilla not tipped with a strong, large claw 4
4a. Basal segment of maxilliped carrying a short and blunt papilla, tipped with a tuft of cilia ..... *A. albidus*
4b. Basal segment of maxilliped without papilla 5
5a. Outer spines of leg 3 exopod long and heavily sclerotized 6
5b. Outer spines of leg 3 exopod not long and heavily sclerotized 7
6a. Caudal rami with ventral patch of spinules ..... *A. crevalleus*
6b. Caudal rami without ventral patch of spinules 8
7a. Terminal endopod segment of leg 4 clearly elongated ..... *A. venustus*
7b. Terminal endopod segment of leg 4 not clearly elongated (all segments approximately of the same size) ..... *A. australiensis*
8a. Ventral surface of last abdominal segment with patch of stout spinules ..... *A. divaricatus*
8b. Ventral surface of last abdominal segment with patch of fine-hairs ..... *A. nudiusculus*

Remarks. Cressey (1984) created the genus *Acantholochus* to accommodate *A. asperatus*, *A. crevalleus*, *A. divaricatus* and *A. nudiusculus* previously assigned to *Holobomolochus*, and a new species, *A. nasus*. Some key characters of the females of those species are a rostrum with a pair of hooks, antennule without modified

setae on the first segment, accessory process of the claw of the maxilliped reduced or absent, long and heavily sclerotized outer spines of the exopod of leg 3, and endopod of leg 4 longer that the exopod (Cressey 1984). Luque & Bruno (1990) described *A. galeichthyo*s (=*H. galeichthyos* comb. nov.) and *A. paralabracis* (=*H. paralabracis* comb. nov.) but they did not give any justification to accommodate those species within *Acantholochus*. Luque & Bruno (1990) noted that one of their species (*H. galeichthyos* comb. nov.) can be distinguish from the five previously known species of *Acantholochus* by the setal formula of leg 4, and *H. paralabracis* comb. nov., by the lack of spinules on the surface of the abdominal segments and caudal rami. Noteworthily, Luque & Bruno (1990) remained silent regarding the presence of an accessory process of the maxillipedal claw, which contradicts Cressey's (1984) diagnosis of the genus. Another deviation from the original diagnosis is the leg 4 of *H. galeichthyos* comb. nov. with rami of the same size, and the outer spines of the exopod of leg 3 of *H. paralabracis* comb. nov. which are not heavily sclerotized. Thirteen years later, Tavares & Luque (2003) added one more species to *Acantholochus* (*H. unisagittatus* comb. nov.) which also carries an accessory process on the maxillipedal claw, and possess short outer spines on the exopod of leg 3. However these characteristics were not discussed by these authors. Despite the deviations from the original diagnosis, Luque & Bruno (1990) and Tavares & Luque (2003) included their species in the genus *Acantholochus* probably because it was the best genus in which they could accommodate their species at that time.

Ho & Lin (2006) created the genus *Hamaticolax* to accommodate 10 "orphan species" of bomolochid copepods (*H. albidus*, *H. attenuatus*, *H. australiensis*, *H. embiotoca*, *H. maleus*, *H. occultus*, *H. prolixus*, *H. scutigerulus*, *H. spinulus* and *H. venustus*) previously placed in *Holobomolochus*. The original diagnosis for *Hamaticolax* by Ho & Lin (2006) fits the 10 species hitherto placed in that genus. Nevertheless, three of these species (*A. albidus* comb. nov., *A. australiensis* comb. nov. and *A. venustus* comb. nov.) also fit the diagnosis of *Acantholochus*, mainly because of the lack of the accessory process on the claw of the maxilliped. Also, the endopod of leg 4 is longer than the exopod in *A. venustus* comb. nov.

After thorough revision of the available descriptions and diagnoses for all species of *Acantholochus* and *Hamaticolax*, not a single character was found useful as to separate them. In fact, in their work, Luque & Bruno (1990) already suggested that *H. australiensis* (= *A. australiensis* comb. nov.) should be considered as member of *Acantholochus*. In view of this situation and the necessity of placing the new species described below, it is suggested that the presence or absence of the accessory process of the maxillipedal claw is a key character to separate these two genera. Thus, three species of bomolochids, so far placed in the genus *Acantholochus* (*H. galeichthyos*, *H. paralabracis* and *H. unisagittatus*), are transferred to *Hamaticolax* and three species hitherto placed in the genus *Hamaticolax* (*A. albidus*, *A. australiensis* and *A. venustus*) are transferred to *Acantholochus*.

Acantholochus zairae sp. n.

Type material preserved in alcohol: Female holotype (EMUCOP-181207-01), male allotype (EMUCOP-011107-01), 28 female paratypes (EMUCOP-011107-02, EMUCOP-041007-01 to 041007-03, EMUCOP-181207-02 to 181207-09, EMUCOP-210207-01 and 210207-03, and EMUCOP-290208-01 to 290208-05) and 1 male paratype (EMUCOP-041007-01).

Dissected type material: 5 female paratypes (EMUCOP-011107-02 to 011107-05, EMUCOP-041007-04 and EMUCOP-210207-02) and 2 male paratypes (EMUCOP-290208-06 and 290208-07).

Type host: *Sphoeroides annulatus* (Jenyns) (Pisces: Tetraodontidae)

Habitat: Gill filament

Type locality: Santa María La Reforma lagoon (25° 10' N, 108° 20' W and 24° 50' N, 107° 55' W), Sinaloa, Mexico.

Female. Body form (Fig. 1A) typical of family, total body length ranging from 1,960 µm to 2,600 µm (mean= 2,300 µm; n = 10) excluding setae on caudal rami. Rostrum with a pair of ventral hooks (Fig. 2A). First pedigerous somite incorporated into cephalothorax; pedigers on prosome distinctly separated, tapering posteriorly. Prosome longer than urosome. Genital double-somite distinctly wider than long. Abdomen 3-

segmented (Fig. 1B); all somites lightly wider than long, tapering posteriorly; last segment with two patches of spinules ventrally. Caudal rami (Figs. 1C, D) two times as long as wide, ventral surface of each ramus with patch of spinules, and with 6 setae as follows: seta I lost; seta II set midway lateral margin; seta III on distal outer corner and slightly longer than seta II; setae IV and V longest (seta IV about half the length of seta V); seta VI on inner distal corner, as long as seta II; seta VII (with basis articulated) on distal sixth, as long as seta II.

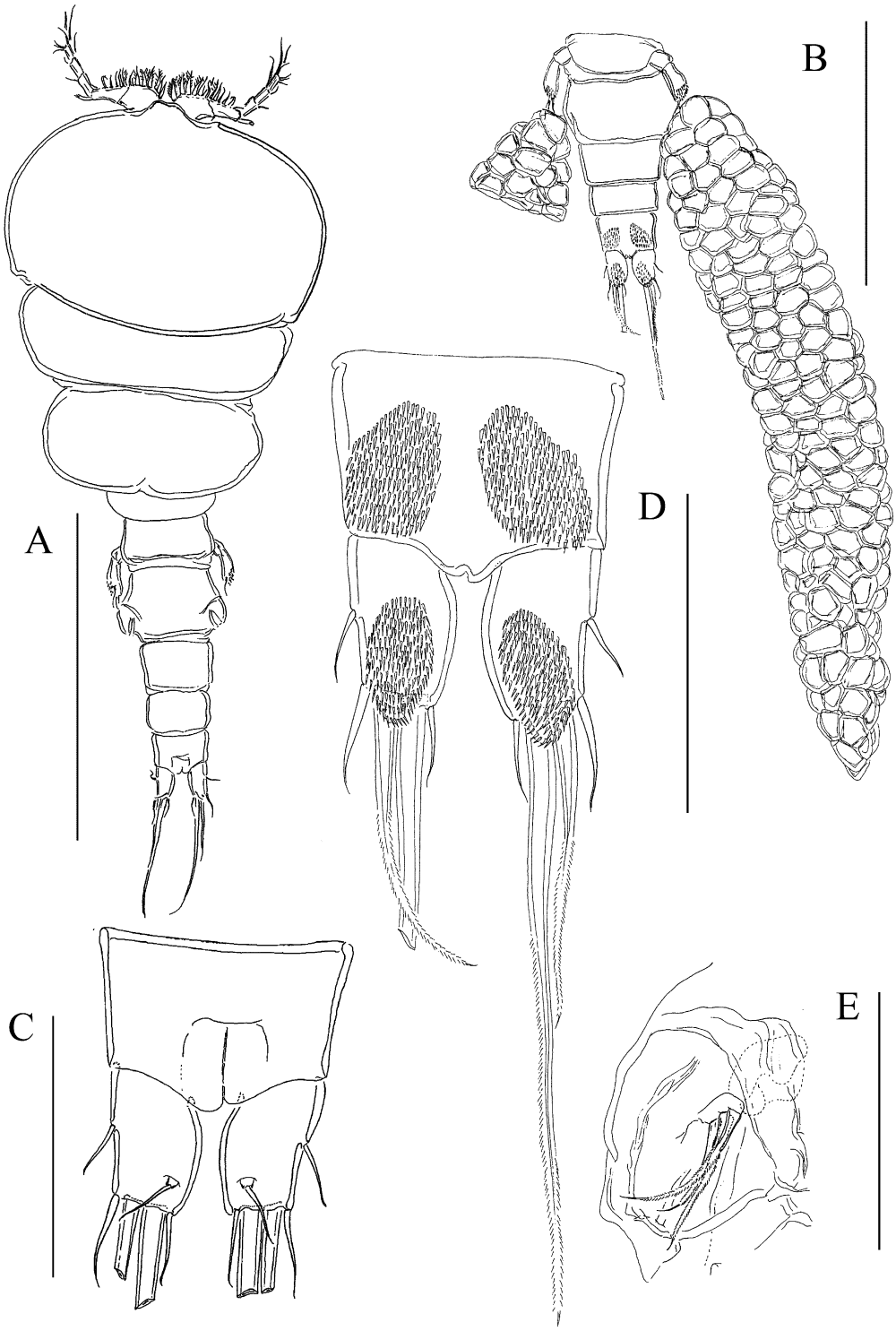

FIGURE 1. *Acantholochus zairae* **sp. n.**, female. **A**, habitus, dorsal; **B**, urosome, ventral; **C**, anal somite and caudal rami, dorsal; **D**, anal somite and caudal rami, ventral; **E**, leg 6. Scale bars: A = 1,296 µm, B = 805 µm, C and D = 200 µm, E = 128 µm.

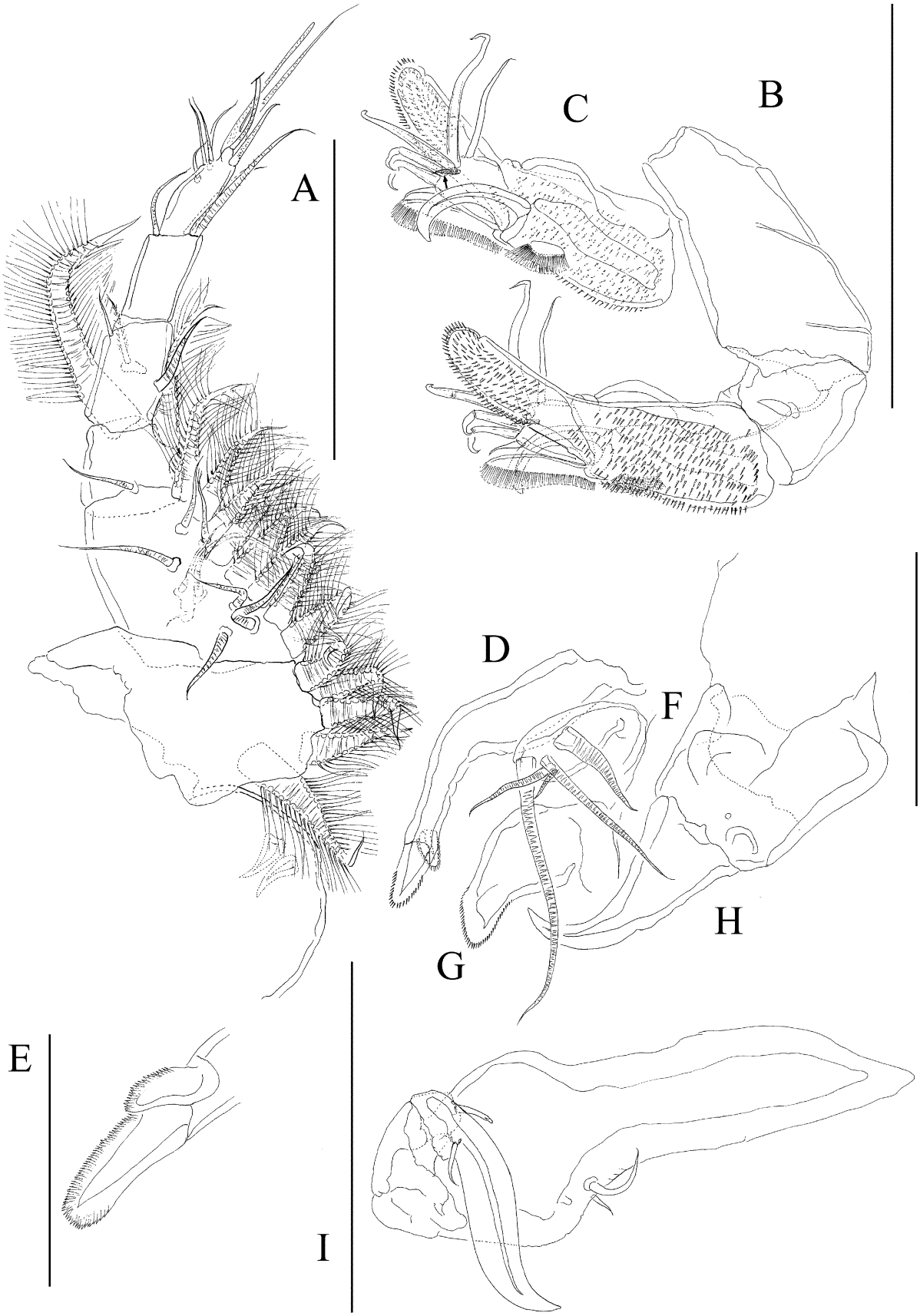

FIGURE 2. *Acantholochus zairae* **sp. n.**, female. **A**, antennule; **B**, antenna, posteroventral; **C**, distal segment of antenna, anterodorsal [arrow showing reduced setae]; **D**, mandible; **E**, blades of mandible; **F**, maxillule; **G**, paragnath; **H**, maxilla; **I**, maxilliped, ventral. Scale bars: A = 200 µm, B and C = 157 µm, D = 100 µm, E = 56 µm, F, G and H = 100 µm, I = 157 µm.

Antennule (Fig. 2A) 6-segmented; basal part heavily sclerotized. Main armature of basal part 15 robust, plumose setae, last seta much longer than remaining ones, in addition to 10 naked slender setae (7 dorsally and 3 ventrally). Formula of armature for cylindrical distal part: 3, 2 + 1 aesthete (?), and 7 + 1 aesthete.

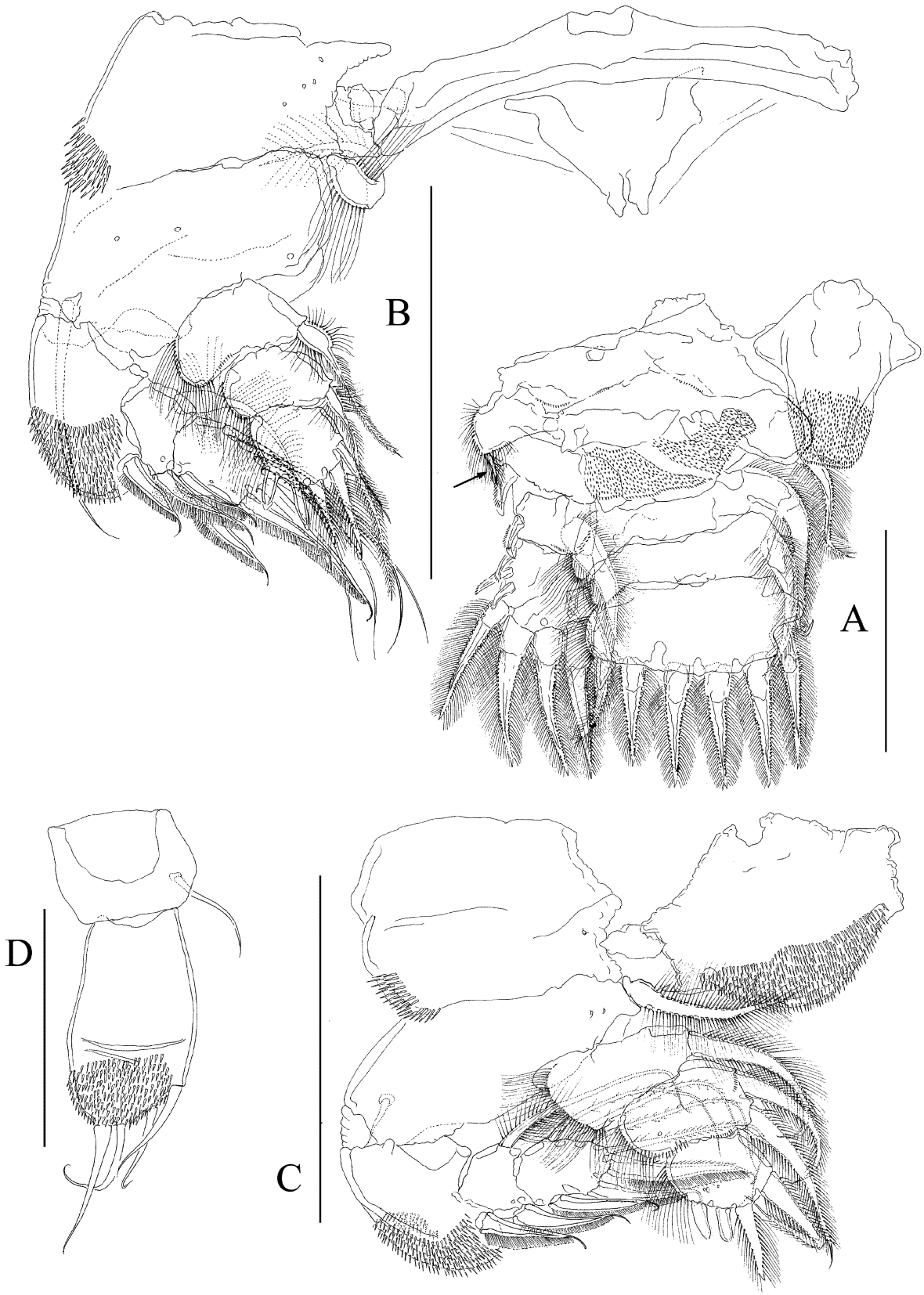

FIGURE 3. *Acantholochus zairae* **sp. n.**, female. **A**, leg 1 [arrow showing basis outer seta]; **B**, leg 2; **C**, leg 3; **D**, leg 5. Scale bars: A = 200 µm, B and C = 225 µm, D = 142 µm.

Antenna (Figs. 2B, C) 3-segmented; proximal segment longest, with long, naked seta at tip; middle segment smallest, bearing short, lamellate, medial seta; terminal segment reflected towards base of appendage, densely covered by denticles ventrally, and protruded distally into large, blunt cylindrical process with ventral denticles; distally with 1 hook, 3, curved, long claws, 4 naked setae (two of them tiny and arrowed in Fig. 2C), and 1 pectinate process.

Mandible (Figs. 2D, E) with 2 unequal uniserrated blades.

Maxillule (Fig. 2F) with 1 tiny, 3 median and 1 long seta.

Paragnath (Fig. 2G) a long biserrated lobe.

Maxilla (Fig. 2H) 2-segmented; proximal segment large, unarmed; distal segment robust, tipped with a strong claw.

Maxilliped (Fig. 2I) 3-segmented; proximal segment largest, with 2 medial, unequal, naked setae on medial margin; middle segment smallest, carrying 1 short seta; terminal segment a sigmoid claw without auxiliary hook, its proximal region carrying a small, naked seta.

Legs 1–4 biramous, each ramus 3-segmented.

Leg 1 (Fig. 3A) intercoxal plate partially covered by spinules. No clear division between coxa and basis. Coxa with patch of hairs on outer corner and broad inner seta. Basis with 2 patches of spinules on anterior surface, 1 outer seta (arrowed in Fig. 3A) and carrying setules on outer margin. Exopod with obscure segmentation; outer spines fringed with spinules on outer margin; first segment with 1 outer spine; second segment armed with 1 outer spine and 1 plumose, inner seta; third segment carrying 3 outer spines and 5 plumose setae on terminal to inner edge. Endopod broad, three segments ornamented with long hairs on outer distal corner; first and second segment with 1 plumose seta; third segment with 1 short spine and 5 setae on terminal margin.

Leg 2 (Fig. 3B) intercoxal plate without ornamentation. Coxa with a patch of spinules on outer distal corner and 1 plumose, inner seta (lobate at base). Basis with 1 long, naked, dorsal seta. Exopod armed with long flagellated, outer spines which are fringed with spinules on outer margin; first segment largest, lobate, partially covered by spinules and 1 spine at outer distal corner; second segment shortest, with 1 outer spine and 1 plumose inner seta; third segment with 4 outer to terminal spines and 4 terminal to inner setae (ornamented with tiny setules). Three segments of endopod with long hairs on outer margin; first and second segments with 1 plumose inner seta, similar to seta of coxa, with lobate base; third segment with 2 terminal spines and 3 terminal to inner plumose setae.

Leg 3 (Fig. 3C) intercoxal plate partially covered by spinules. Coxa with a patch of spinules on outer distal corner and 1 plumose, inner seta. Basis with 1 short, naked, dorsal seta. Exopod as in leg 2, except for third segment carrying only 3 spines. Three segments of endopod with long hairs on outer margin; first segment with 1 plumose inner seta; second segment with 2 plumose inner setae and a row of spinules on outer distal corner; third segment with 2 terminal spines and 2 terminal plumose setae.

Leg 4 (Fig. 4A) intercoxal plate partially covered with spinules. Coxa without armature. Basis with 1 naked dorsal seta. Exopod as in leg 2, except for third segment carrying 3 outer to terminal spines and 3 terminal to inner setae. Three segments of endopod partially covered by spinules; first and second segment with 1 inner seta; third segment with 1 long spine (similar to spines described for leg 2 exopod) and 2 setae.

Leg 5 (Fig. 3D) 2-segmented; proximal segment short, armed with 1 dorsal seta; distal segment about two times as long as wide, carrying 4 elements and ornamented with a patch of spinules on the distal third.

Leg 6 (Fig. 1E) represented by 3 long setae on genital operculum located in a pit for attachment of egg sac.

Armature of legs 1–4 as follows:

	Coxa	Basis	Exopod	Endopod
Leg 1	0–1	1–0	I–0; I–1; III, 5	0–1; 0–1; I, 5
Leg 2	0–1	1–0	I–0; I–1; II, II, 4	0–1; 0–1; II, 3
Leg 3	0–1	1–0	I–0; I–1; II, I, 4	0–1; 0–2; II, 2
Leg 4	0–0	1–0	I–0; I–1; II, I, 3	0–1; 0–1; I, 2

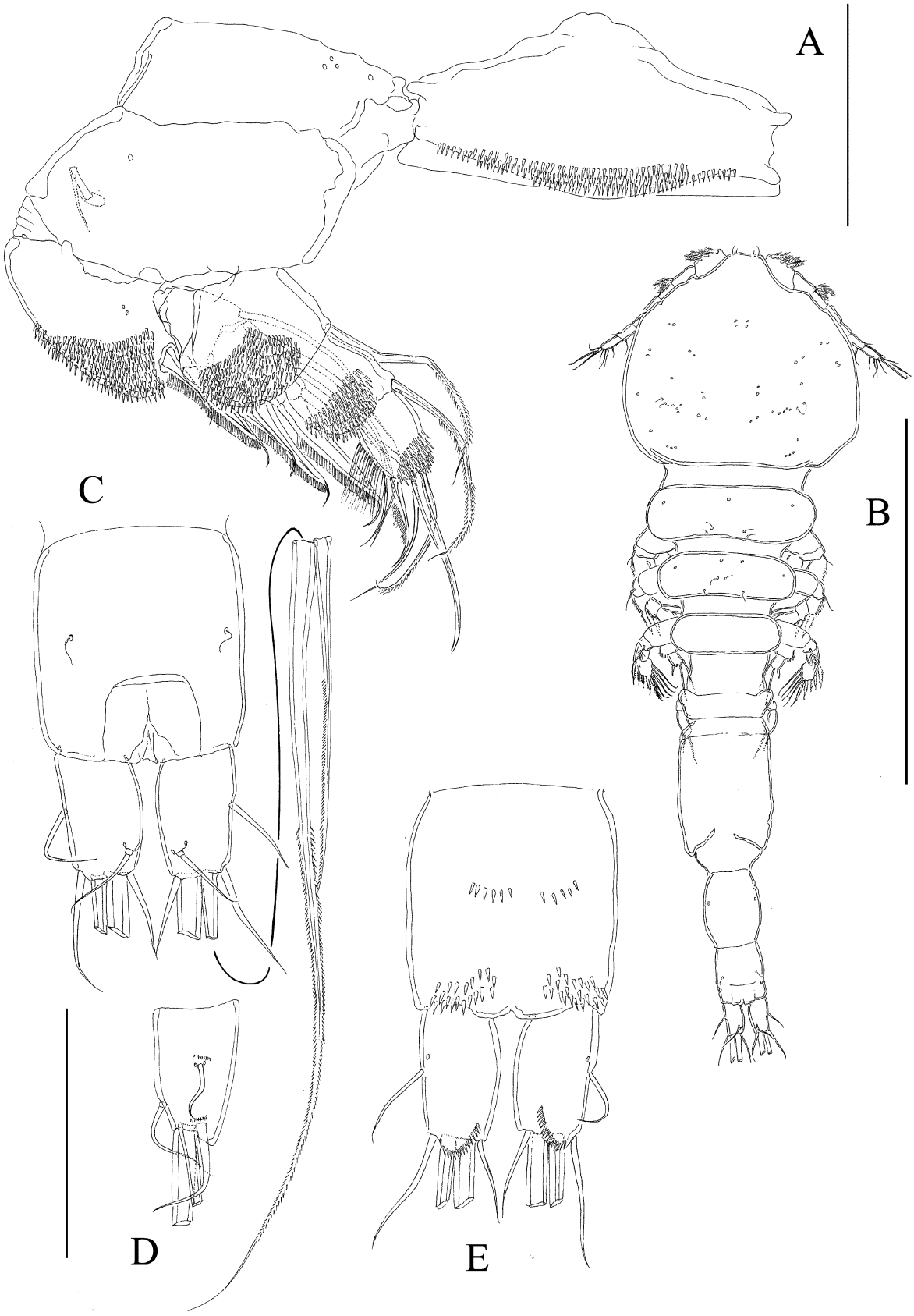

FIGURE 4. *Acantholochus zairae* **sp. n.** Female: **A**, leg 4. Male: **B**, habitus, dorsal; **C**, anal somite and caudal rami, dorsal; **D**, caudal ramus, lateral; **E**, anal somite and caudal rami, ventral. Scale bars: A = 100 µm, B = 500 µm, C, D and E = 100 µm.

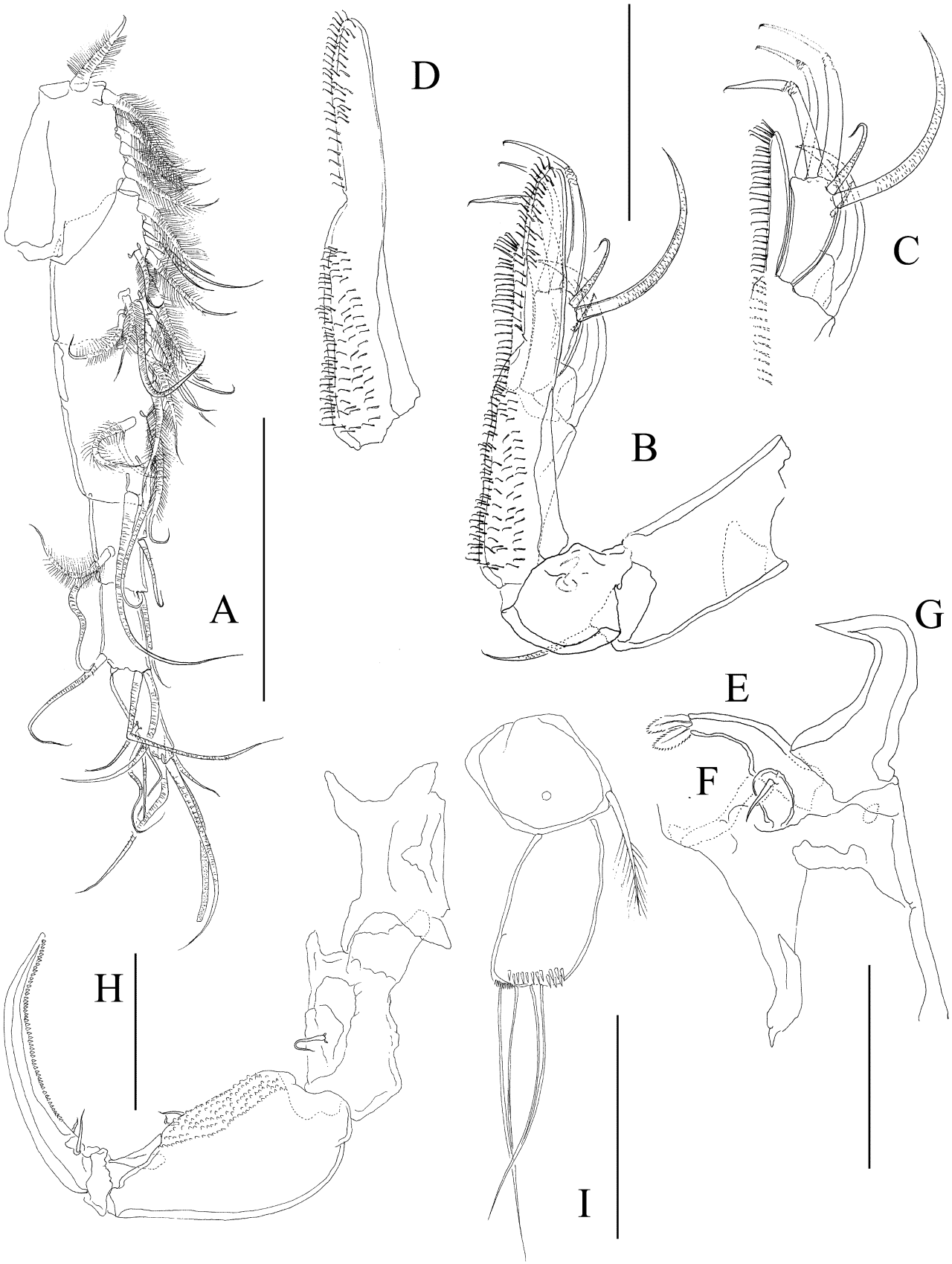

FIGURE 5. *Acantholochus zairae* **sp. n.**, male. **A**, antennule; **B**, antenna, posteroventral; **C**, distal segment of antenna, posteroventral; **D**, tip of antenna, anterodorsal; **E**, mandible; **F**, maxillule; **G**, maxilla; **H**, maxilliped; **I**, leg 5. Scale bars: A = 100 µm, B–G = 63 µm, H = 102 µm, I = 50 µm.

Male. Shape as in Fig. 4B, tapering posteriorly. Total body length ranging from 1,000 µm to 1,100 µm (mean, 1,050 µm; n, 3), excluding setae on caudal rami. Cephalothorax as long as wide. First pediger completely fused to cephalosome; somites bearing leg 2 to leg 4 distinctly separated. Urosome shorter than prosome. Genital segment distinctly longer than wide. Abdomen 2-segmented; both segments longer than wide; ventral surface of anal somite with ventral spinular pattern as shown (Fig. 4E). Caudal rami (Figs. 4C, D) about 2.5 times as long as wide, with a row of spinules ventrally (Fig 4E).

Antennule (Fig. 5A) 6-segmented, with indistinctly separated but heavily sclerotized basal part. Main armature of basal part 16 robust, plumose setae, in addition to 8 naked setae (5 on dorsal side and 3 on ventral side). Formula of armature for cylindrical distal part: 4, 3, and 7 + 1 aesthete.

Antenna (Figs. 5B–D) as in female except for comparatively longer last segment, the latter with 1 hook, 3 curved, long claws, 3 naked setae (one of them tiny), and 1 pectinate process.

Mandible (Fig. 5E) as in female except for more separated blades.

Maxillule (Fig. 5F) represented by small segment with 1 small, naked seta

Maxilla (Fig. 5G) as in female.

Maxilliped (Fig. 5H) 4-segmented; proximal segment with central seta; second segment almost as long as last segment, with large patch of denticles on medial surface and 2 short, tiny setae; third segment smallest and unarmed; terminal segment largest, claw-shaped with 2 small setae on basal region and row of teeth along medial margin of most part of claw.

Leg 1 (Fig. 6A) intercoxal plate with 2 patches of stout spinules. Coxa armed with a patch of spinules on outer distal corner and 1 plumose inner seta. Basis with 2 patches of spinules, 1 plumose outer seta and 1 inner spine fringed with spinules bilaterally. Exopod 2-segmented; first segment with spinules along venterolateral edge, hairs on inner edge and spine on outer distal corner; second segment with 4 outer to terminal spines and 4 terminal to inner setae. Exopod spines flagellated and fringed with spinules bilaterally, except for the most terminal spine relatively longer, flagellated, fringed with long, slender spinules at inner margin and short spinules on outer margin. Tiny spinules at base of the three short spines on second segment. Endopod 2-segmented; first segment with hairs along outer edge, spinules on outer distal corner and 1 plumose inner seta; second segment with hairs along outer edge, spinules on outer distal corner, 1 terminal spine and 6 terminal to inner setae.

Leg 2 (Fig. 6B) intercoxal plate with 2 patches of stout spinules. Coxa with rows of tiny spinules on antero-ventral surface, a row of spinules at outer distal corner and 1 plumose inner seta. Basis with naked dorsal seta. Exopod 3-segmented; first segment lightly elongated; with spinules along outer edge, hairs at inner edge and 1 spine on outer distal corner; second segment with 1 outer spine and 1 inner seta; third segment with 3 outer to terminal spines and 4 terminal to inner setae. Exopod spines as in leg 1. Endopod as in leg 1, except for second segment with 2 terminal spines fringed bilaterally with tiny spinules and 4 terminal to inner setae.

Leg 3 (Fig. 6C) similar to leg 2; except for coxa only with 1 plumose inner seta, basis with plumose dorsal seta and a row of spinules close to inner proximal corner, and second segment of endopod armed with 2 terminal spines and 2 terminal setae.

Leg 4 (Fig. 6D) intercoxal plate with 2 patches of stout spinules. Coxa unarmed. Basis with 1 dorsal plumose seta. Exopod 2-segmented; first segment with spinules on posterior half of outer edge, hairs close to inner distal corner and 1 spine at outer distal corner; second segment with 3 outer to terminal spines and 4 terminal to inner setae. Exopod spines as in previous legs. Endopod 2-segmented; first segment with hairs along outer edge and 1 plumose inner seta; second segment with hairs along outer edge, 2 terminal spines and 1 terminal seta. Spines of the endopod with different morphology; one being short, fringed bilaterally with spinules; another one relatively longer, fringed with spinules on outer margin.

Leg 5 (Fig. 5I) 2-segmented; proximal segment armed with a distal, plumose seta; free segment with a row of spinules and 2 long setae at tip.

Leg 6 not seen.

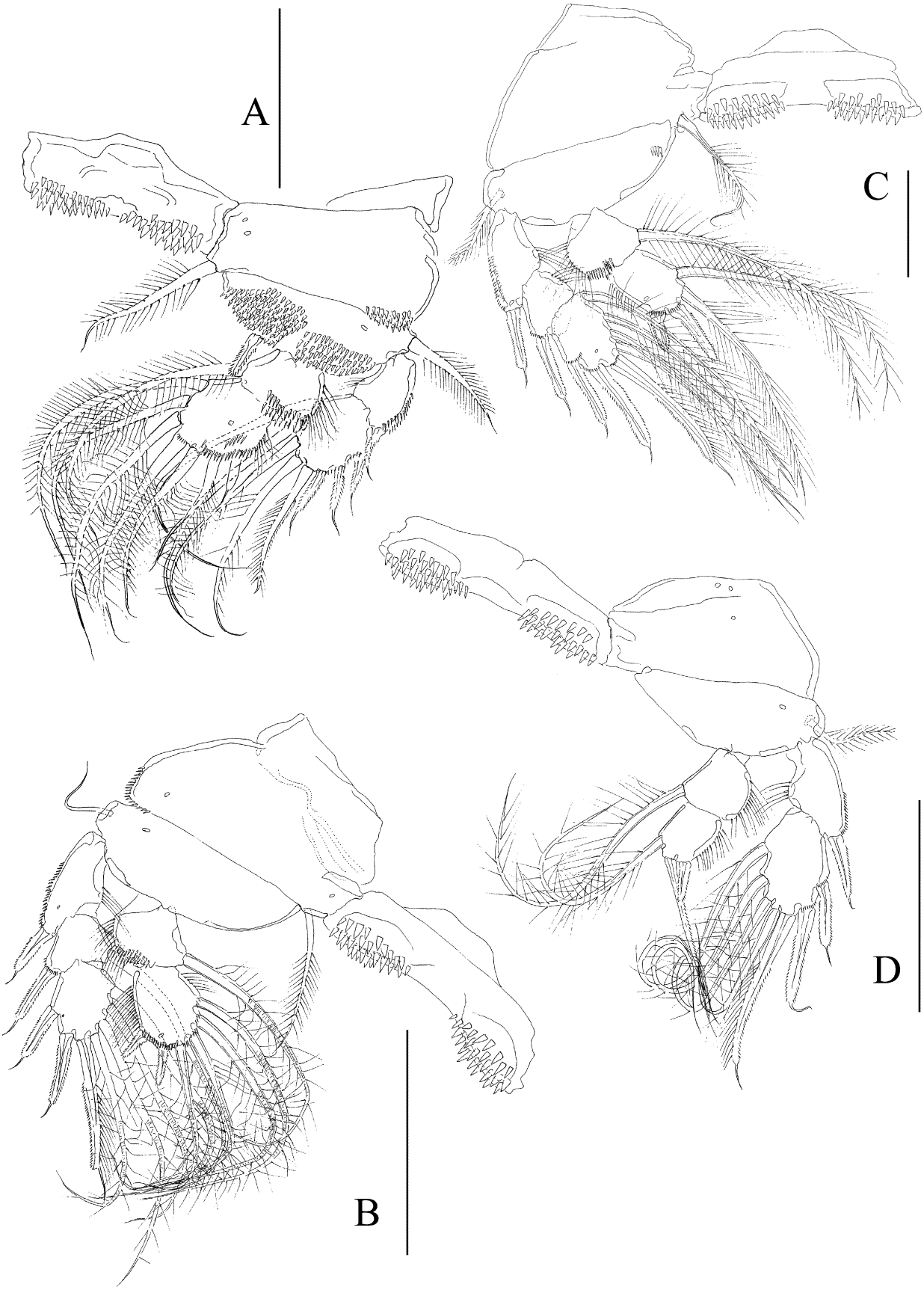

FIGURE 6. *Acantholochus zairae* **sp. n.**, male. **A**, leg 1; **B**, leg 2; **C**, leg 3; **D**, leg 4. Scale bars: A = 70 µm, B = 100 µm, C = 50 µm, D = 100 µm.

Armature of legs 1–4 as follows:

	Coxa	Basis	Exopod	Endopod
Leg 1	0–1	1–I	I–0; IV, 4	0–1; I, 6
Leg 2	0–1	1–0	I–0; I-1; I, II, 4	0–1; II, 4
Leg 3	0–1	1–0	I–0; I, 0; II, I, 4	0–1; II, 2
Leg 4	0–0	1–0	I–0; II, I, 4	0–1; II, 1

Remarks. Females of the new species described herein can be distinguished from *Acantholochu*s spp. by a) the possession of 1 seta (instead of two) on the second endopodal segment of leg 2; b) the terminal exopodal segment of leg 4 with 6 elements (instead of eight); c) the maxillule with naked setae (instead of plumose); d) the strong, large claw of the maxilla (it is armed with two distal blunt spines or two falciform processes in the eight known species of *Acantholochus*); e) the small and naked setae (instead of long and plumose) of maxilliped; and f) by the terminal endopod segment of leg 4 not being enlarged as in the other species (except for *A. australiensis*). The morphology of the exopodal spines of legs 2–4 results peculiar since they are fringed with long spinules on the outer margin, in others species such ornamentation is smaller. In addition, the 6-segmented antennule could be another characteristic to separate the new species from *A. asperatus* (7-segmented), *A. crevalleus* (5-segmented), *A. divaricatus* (5-segmented), *A. nasus* (7-segmented) and *A. nudiusculus* (5-segmented).

Only two species of *Acantholochus* have been reported from fishes from the Pacific coast of Mexico. These are *A. nasus* and *A. nudiusculus*. The former was found attached in the nasal sinuses of *Anisotremus davidsoni* (Steindachnar) and *Orthopristis reddingi* Jordan & Richardson from off Baja California (Mexico) (Cressey 1984); the latter was found attached in the nasal sinuses of *Scomberomorus sierra* Jordan & Starks and *S. cocolor* Lockington from Baja California and Sonora (northwestern Mexico) (Cressey & Cressey 1980). Therefore, *A. zairae* **sp. n.** would be the third species of *Acantholochus* recorded for Mexican Pacific and a contribution to the knowledge of the parasitic copepods of bullseye puffer fish. Given that parasitic copepods of fishes from Mexican waters have been a poorly studied subject, there is not doubt that many species are waiting to be discovered and to reveal important clues about ecological-evolutionary problems.

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