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Original Article

Records of epacteriscid copepods (Copepoda: Calanoida) from anchialine caves of the Yucatan Peninsula, Mexico, with description of the male of *Bofuriella spinosa* Fosshagen and Iliffe, 2007

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ABSTRACT

The calanoid copepod family Epacteriscidae is one of the most representative cave-dwelling copepods worldwide, especially in the Caribbean region. We provide new records of two epacteriscid copepods from anchialine habitats of the Yucatan Peninsula (YP); both were previously known only from their type locality in Jamaica and Caicos Islands. We document the occurrence of *Edaxiella rubra* Fosshagen, Boxshall and Iliffe, 2001 in Cozumel Island and *Bofuriella spinosa* Fosshagen and Iliffe, 2007 in Playa del Carmen, the adjacent continental region of the YP. We found slight morphological differences compared to the original descriptions of both species, including some characters not previously described; also, the male of *B. spinosa* remained unknown and is herein described. These records show the growth of the epacteriscid copepod listings and expand the morphological knowledge of these species in the Yucatan Peninsula into the Western Caribbean, likely harboring one of the most

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diverse anchialine copepod fauna worldwide and currently going through intense anthropogenic pressure, thus enhancing the intrinsic value of these new findings. It is expected that new samplings will reveal the true diversity and distribution of the Mexican Caribbean anchialine copepod fauna, where knowledge of its biological diversity is still incipient.

KEYWORDS
Anchialine copepods, Epacteriscidae, morphology, new records, taxonomy

INTRODUCTION

Anchialine habitats have been colonized by different group of copepods, the most dominant cave-dwelling crustaceans. Cave-dwelling copepods include members of the orders Calanoida, Misophrioida, Cyclopoida, and Harpacticoida (Galassi et al., 2009). The calanoid copepod family Epacteriscidae is one of the most representative cave-dwelling copepods, especially in the Caribbean region (Fosshagen et al., 2001; Suárez-Morales et al., 2006). Up to date, epacteriscids comprise 19 known genera and 31 species (Walter and Boxshall, 2023) (Appendix – Tab. A1), but some genera are monotypic such as *Edaxiella* Fosshagen, Boxshall and Iliffe, 2001, known only from *Edaxiella rubra* Fosshagen, Boxshall and Iliffe, 2001, originally described from Jamaica (Fig. 1). Some species descriptions of epacteriscid copepods are based on a single specimen, like in *Bofuriella spinosa* Fosshagen and Iliffe, 2007, for which only the female holotype has been described. In the Yucatan Peninsula (YP), the only YP epacteriscid previously known was *Balinella yucatanensis* Suárez-Morales, Ferrari and Iliffe, 2006, described from one male and one female (Suárez-Morales et al. 2006).

Based on biological samplings in anchialine habitats of the YP, we provide morphological information about the copepods *E. rubra* and *B. spinosa* from anchialine caves in Cozumel Island, and the adjacent continental area of the YP, respectively. We provide an illustrated record of *E. rubra*, a complete description of the male of *B. spinosa*, and a key to the known species of *Bofuriella* Fosshagen, Boxshall and Iliffe, 2001. These records also represent a relevant expansion of the known geographic range of both species in the Western Caribbean.

METHODS

The biological samples were obtained on September and November 2022 from two anchialine caves from the YP, the insular Cenote Tres Potrillos (20°27′3.2″N 86°59′14.4″W) on Cozumel Island, and the epicontinental "Cenote" Arco Luminoso (20°34'9.59''N 87°12'51.73''W), on the eastern coast of the YP, Mexico (Fig. 1). According to Mejía et al. (2008) and Suárez-Morales et al. (2017a), Cenote Tres Potrillos has an entrance diameter of 3 m, a total depth of 38 m and includes a 40 m horizontal passage at 12 m depth, with the halocline lying at 11 m. In addition, Cenote Arco Luminoso is a 30 m deep system, with the halocline at a depth of 14 m. In both cases, the material was collected by cave-diving hauling a 45 µm mesh plankton net at the halocline zone for the respective sites. Samples were fixed with 96% ethanol (Boxshall et al. 2014). The geographic representation of the records (Fig. 1) was performed with ArcMap Ver. 10.4.1.

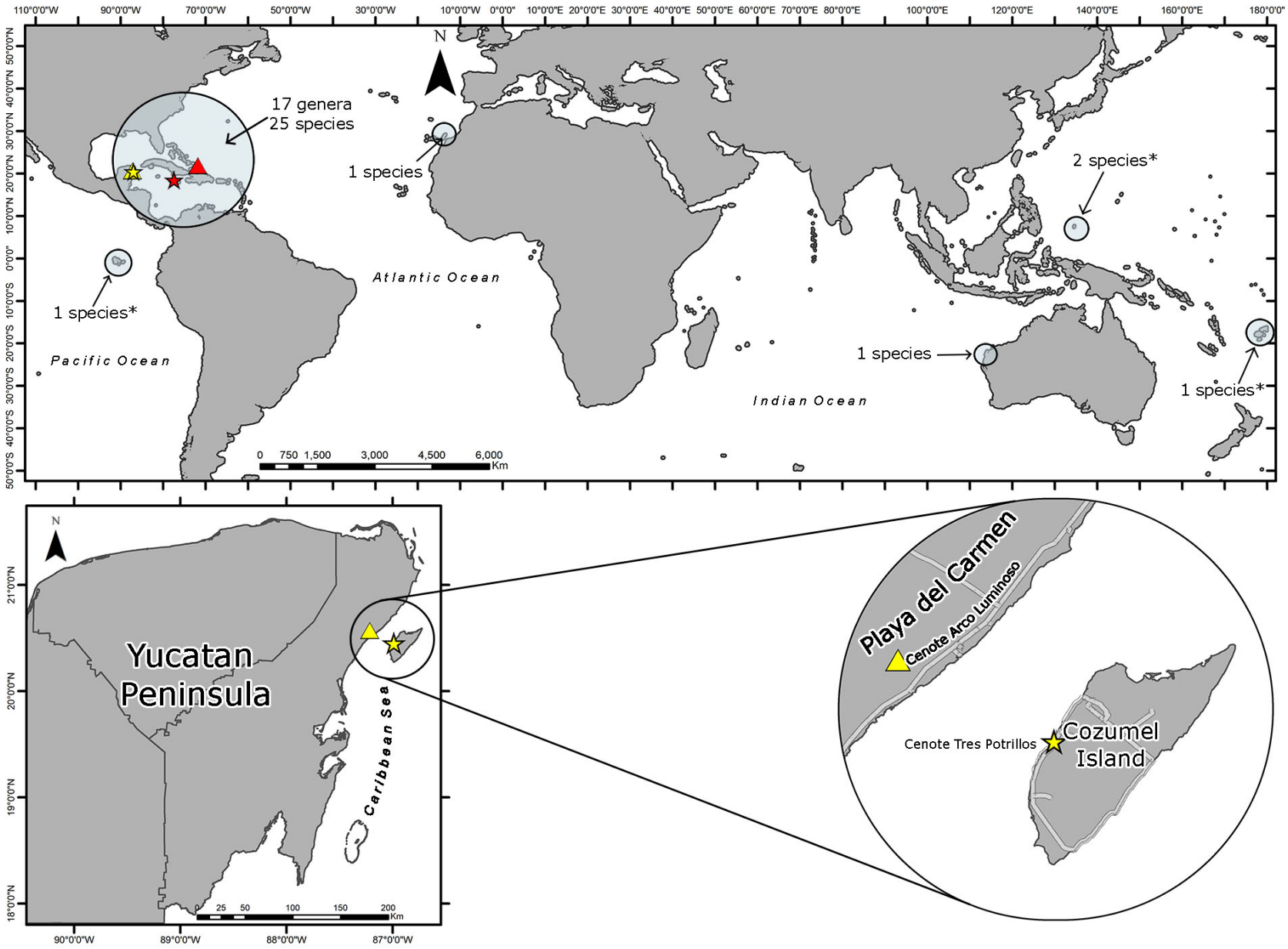

Figure 1. Known distribution of the Epacteriscidae worldwide. The known records are arrowed. * = species from *Enantiosis*. Star = *Edaxiella rubra*; triangle = *Bofuriella spinosa*. Yellow symbols represent the two new records documented in this survey and red symbols indicate their type locality.

The specimens were dissected on a slide with a drop of glycerol to observe the taxonomically important characters (Fosshagen et al., 2001). The appendages were mounted on semi-permanent slides sealed with Entellan ®. Illustrations were prepared using a light microscope (OLYMPUS BX53) with an attached camera lucida (OLYMPUS U-DA). Abbreviations related to appendages or morphological structures follows Huys and Boxshall (1991): A1: antennule, A2: antenna, Md: mandible, Mx2: maxilla, Mxp: maxilliped, Pcx: praecoxa, Cx: coxa, Bs: basis, Enp: endopod, Exp: exopod, P1 – P4: swimming legs 1 – 4, s: seta, sp: spine, ae: aesthetasc. To confirm species classification, the diagnostic structures evaluation followed Fosshagen et al. (2001) and Fosshagen and Iliffe (2007). The specimens analyzed in this study were deposited at the Colección de Zooplancton held at El Colegio de la Frontera Sur (ECOSUR), Chetumal, Quintana Roo, México (ECO-CHZ).

SYSTEMATICS

Order Calanoida G. O. Sars, 1903

Family Epacteriscidae Fosshagen, 1973

Genus *Edaxiella* Fosshagen, Boxshall and Iliffe, 2001

***Edaxiella rubra* Fosshagen, Boxshall and Iliffe, 2001**

(Figs. 2–3)

Material. One adult female (ECO-CHZ-11621) and one adult male (ECO-CHZ-11622), Mexico, Quintana Roo, Cozumel Island, Cenote Tres Potrillos (20°27′3.2″N 86°59′14.4″W); halocline at 11 m depth; mounted on separate semi-permanent slides with glycerol, sealed with Entellan ®;16 Sep 2022, coll. LM. Mejía-Ortiz and CO. Cortés-Gandara.

Description of female. Total body length, including caudal rami = 1.93 mm. Body surface ornamented with minute scale-like spinules (Fig. 2K). A1 27-segmented, reaching 3rd pediger, with segments 10-11 partially fused, segment 24 with two setae (Fig. 2A). Urosome 4-segmented, genital double-somite with well-developed gonopore, produced ventrally. Caudal rami with 5 setae. A2 with Exp almost twice as long as Enp (Fig. 2C). Md gnathobase with 5 paired teeth, with 14 accessory spines and pinnate dorsal seta (Fig. 2E), Md palp (Fig. 2D) and other appendages as originally described for the species (Fosshagen et al. 2001). P1 (Fig. 2F) Enp lacking small, pointed outer process as originally described, with row of setules on terminal segment (arrow, Fig. 2F). P2 – 4 Bs with distal spinous process (Figs. 2G–I), P4 with small, rounded lamella on Bs (Fig. 2I). Segmentation and armature as shown in Tab. 1.

P5 (Fig. 2J, K). Enp and Exp segments ornamented with minute scale-like spinules. Bs with short, slender outer seta. Exp and Enp 2-segmented. Exp1 with outer spine, armed with patterns of scale-like spines as shown in the closer view of Figure 2K; Exp2 with 3 spines, apical spine and 5 inner setae. Enp1 with inner seta, Enp2 with 3,2,2 setal formula.

Description of male. Total body length, including caudal rami = 1.91 mm (Fig. 3A). Body surface ornamented with tiny scale-like spinules. Prosome, left A1, P1 – 4 and all oral appendages as described for female. Urosome 5-segmented, caudal rami with 5 caudal setae. Right A1 23-segmented, segment 2 partially fused; geniculate at segments 19-20 (Fig. 3B).

P5 (Fig. 3C). Cx subtrapezoid. Bs broader than long, with seta inserted middle-distally. Exp and Enp 3-segmented and covered with scale-like spinule integumental patches. Exp rami modified, asymmetrical, Enp2 and 3 with row of setules on inner margin. Right P5 Exp3 with 3 elements: inner proximal seta, long pointed terminal process ornamented with spinules, and short outer spiniform process. Left P5 with elongate Exp2, with concave inner margin furnished with setules, and outer distal spine; Exp3 short, armed with 3 elements: inner medial spine, terminal pointed process with row of spinules, and outer spine.

Distribution. This species was originally described from Airstrip Caves, Discovery Bay, Jamaica, and it is the second cave-dwelling calanoid copepod recorded from anchialine systems of the YP, after *Stephos fernandoi* Suárez-Morales, Gutiérrez-Aguirre, Cervantes-Martínez and Illife, 2017 (Suárez-Morales et al. 2017b), and the third calanoid copepod found in Cozumel Island, where an epigean freshwater

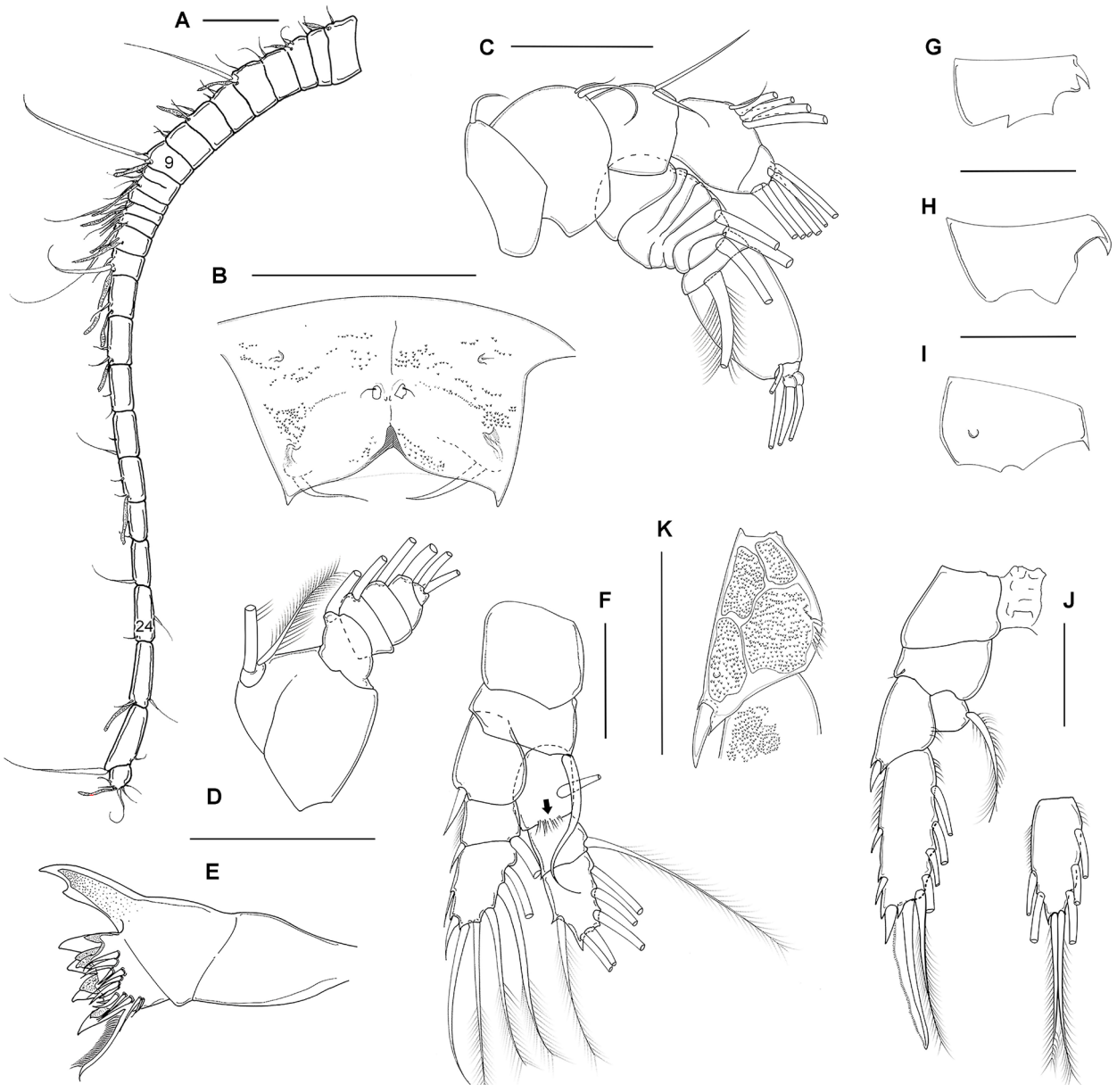

Figure 2. *Edaxiella rubra.* Adult female from Cenote Tres Potrillos. **A**, A1; **B**, rostrum; **C**, A2; **D**, mandibular palp; **E**, gnathobase; **F**, P1, arrow indicates the row of setae; **G**, P2 Bs; **H**, P3 Bs; **I**, P4 Bs; **J**, P5; **K**, detail of integumental ornamentation view on P5 Exp1. Scale bars = 100 μm.

diaptomid *Mastigodiaptomus ha* Cervantes, 2020 was also reported (Cervantes-Martínez et al. 2021).

Remarks. We identified this species as *E. rubra* by possession of the following structures that agree with its original description: both female and male individuals had a reddish color before fixation; rostrum with long filaments near distal tip of rostral base; the antenna has exopod segments compressed; mandible with raptorial gnathobase, mandibular palp with unarmed triangle-shaped basis, and small unsegmented endopod distally placed to basis, with two unequal setae; maxilla and maxilliped with long basis; armature of thoracic legs as originally described. Male fifth legs with 3rd exopods and left fifth leg 2nd exopod, partially modified. Female P5 unmodified, but with 2-segmented exopods and endopods in both rami, based on a single specimen.

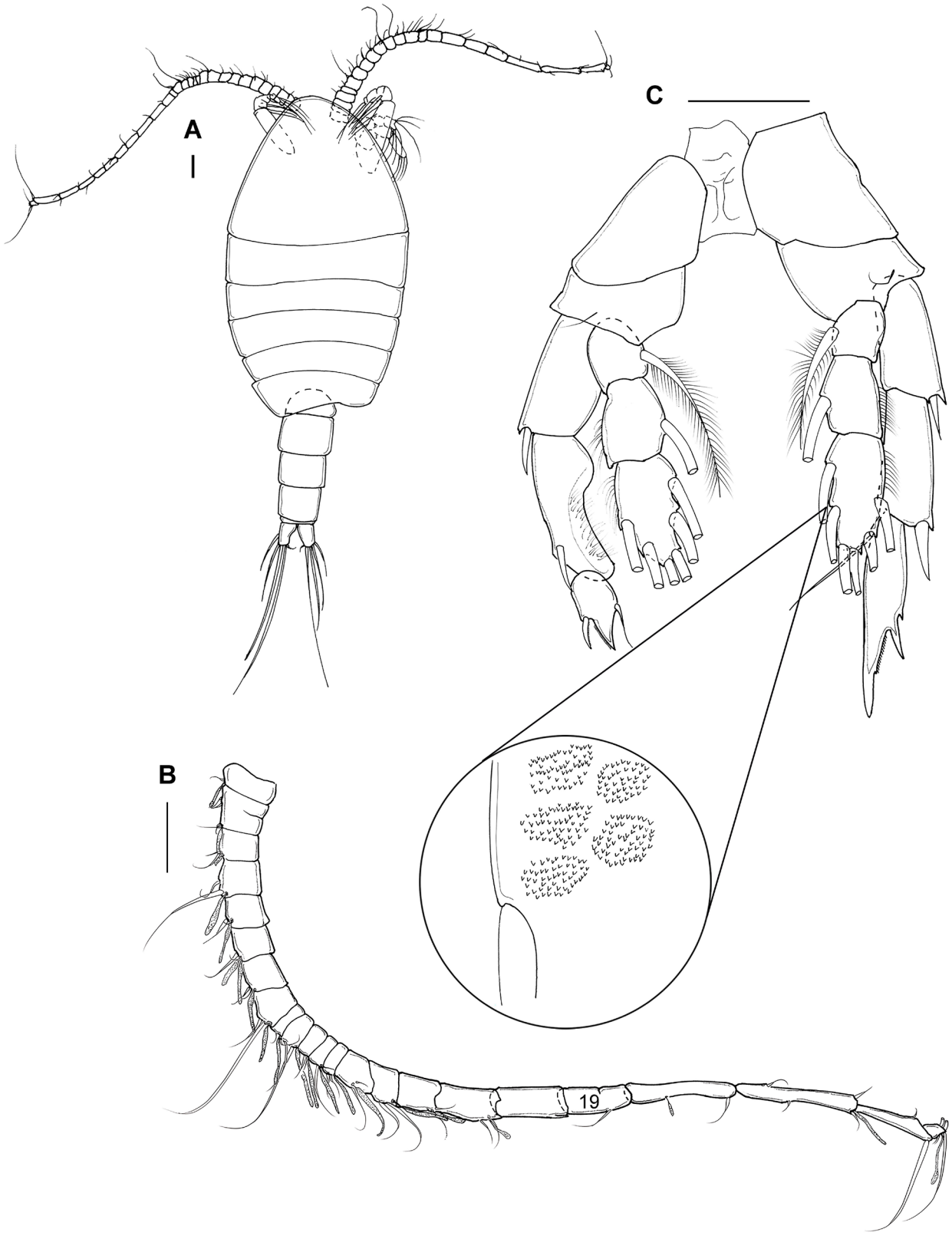

Figure 3. *Edaxiella rubra.* Adult male from Cenote Tres Potrillos. **A**, Habitus of male in dorsal view; **B**, A1; **C**, P5. Scale bars = 100 µm.

Table 1. Armature formula of swimming legs 1–4 of *Edaxiella rubra* from Cenote Tres Potrillos, Cozumel. Roman numerals = spines, Arabic numerals = setae.

	Cx	Bs	Exopod	Endopod
P1	0-1	0-1	I-0, I-1, II-2-3	0-1; 0-1; 0-3,2,1
P2	0-1	I-0	I-1, I-1, I-II-5	0-1; 0-2; 0-4,2,2
P3	0-1	I-0	I-1, I-1, II-II-5	0-1; 0-2; 0-4,2,2
P4	0-1	I-0	I-1, I-1, II-II-5	0-1; 0-2; 0-3,2,2

In addition, we found some morphological differences of the YP *E. rubra* with respect to the original description, including: (1) the integument of all body parts is covered with minute scale-like spinules, a character not reported before; (2) rostrum with relatively shorter filaments with a patch of setulae like elements (Fig. 2B), instead of the large pores described for the Jamaican specimens (Fosshagen et al., 2001: Figs. 1C, 14A); and (3) female fifth leg with 2-segmented ramus. We identified some ornamentation details that were not recorded previously, like: (1) the accessory spines on the proximal area of the mandibular gnathobase; and (2) male left fifth leg Exp2 with inner setules.

Genus *Bofuriella* Fosshagen, Boxshall and Iliffe, 2001

Bofuriella spinosa Fosshagen and Iliffe, 2007

(Figs. 4–5)

Material. One adult male (ECO-CH-Z11738), Mexico, Quintana Roo, Playa del Carmen, Cenote Arco Luminoso (20°34'9.59''N, 87°12'51.73''W), halocline at 14 m depth; mounted in two separate semipermanent slides with glycerol, sealed with Entellan ® (P5 were separated from the rest of the structures); coll. 30 Nov 2022 by M. Vázquez, E. Sosa, H. Salgado, and L.M. Mejía-Ortiz.

Description of male. Total body length = 1.99 mm including caudal rami. Prosome smooth, 1.58 times longer than urosome. Urosome 5-segmented, with anal somite almost half-length of proximal segment. Caudal rami with 6 setae (Fig. 4G). Rostrum with 2 short projections, left A1 26-segmented and maxillulae as in female.

Right A1 (Fig. 4A, B) 21-segmented, armed as follows: 1 (1s + 1ae), 2 (6s + 1ae), 3–16 (2s + 1ae), 17 (1s + 1sp), 18 (1s + sp), 19 (2s + 1ae + 1sp), 20 (4s + 1sp + 1ae), 21 (6s + 1ae). All segments well differentiated, geniculation at segments 18 and 19.

A2 (Fig. 4C). Cx with distal seta. Bs armed with two setae. Exp 8-segmented, almost twice as long as Enp, setal formula: 1, 1, 1, 1, 1, 1, 1, 4; Exp 1 with short seta. Enp 2- segmented. Enp1 with 2 setae; Enp2 bilobed, each lobe with 7 setae.

Md (Fig. 4D). Gnathobase with 5 bicuspidate denticles, armed with accessory spines and pinnate dorsal seta. Md palp with smooth Bs, Exp 4-segmented, setal armature: 0, 2, 1, 3; Exp1, 2 with pseudosegmentation. Enp 2-segmented; Enp1 with single seta, Enp2 with 4 setae.

Mx2 (Fig. 4E). Pcx and Cx each with 2 well-developed lobes. First lobe of Pcx with 5 setae, succeeding lobes armed with 3 setae each. Second lobe of Cx with proximal setules. Bs with 4 setae. Enp 3-segmented, with 4, 3, 4 setal armature.

Mxp (Fig. 4F). Pcx with single seta. Cx with 3 lobes, setal formula: 2,4,4. Bs with 3 marginal and 2 distal setae. Enp 5-segmented with setal formula: 4, 4, 3, 3, 4; Enp5 reduced, inserted distally on Enp4 segment.

P1 (Fig. 5A). Cx with inner seta. Bs with inner distal spinous process, long seta reaching limit of Exp2, and small outer basipodal seta. Exp and Enp 3-segmented. Exp with outer long distal spine on each segment. Exp2 with outer setules, Exp3 with 6 setae. Enp1 and 2 with inner distal acute projection and outer seta, Enp3 with inner seta, 3 apical and 2 outer setae. Setal armature as in Tab. 2.

P2 – P4 (Fig. 5B–D). Intercoxal plate smooth, without spinous terminal processes. Cx with inner distal seta. Bs with inner rounded distal process. Exp and Enp 3-segmented with the armature as described in Table 2. P4 with outer small seta on Bs (Fig. 5 D).

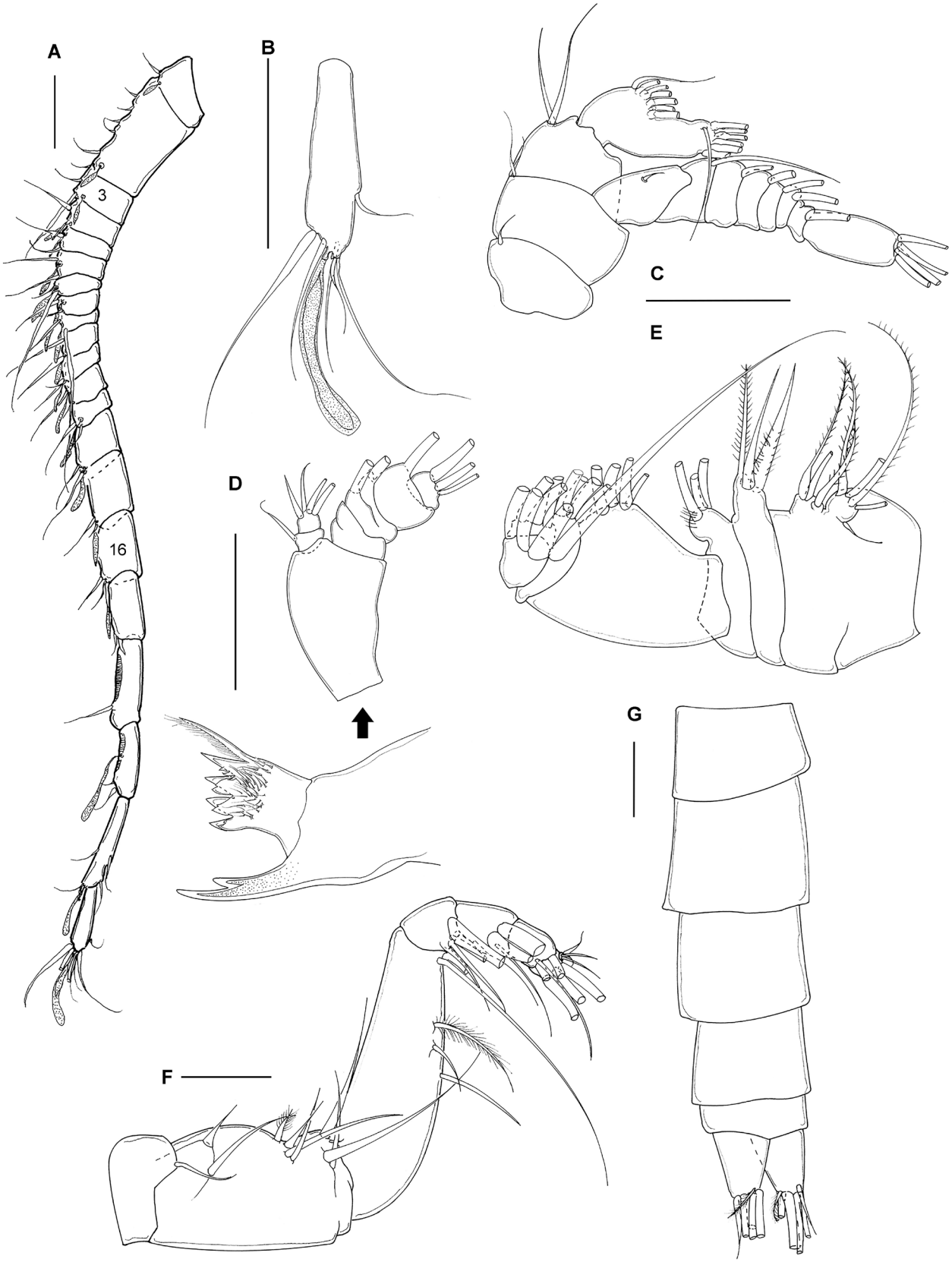

Figure 4. *Bofuriella spinosa.* Adult male from Cenote Arco Luminoso. **A**, A1; **B**, A1 segment 21; **C**, A2; **D**, Md, arrow indicates the mandibular palp; **E**, Mx2; **F**, Mxp; **G**, urosome. Scale bars = 100 μm.

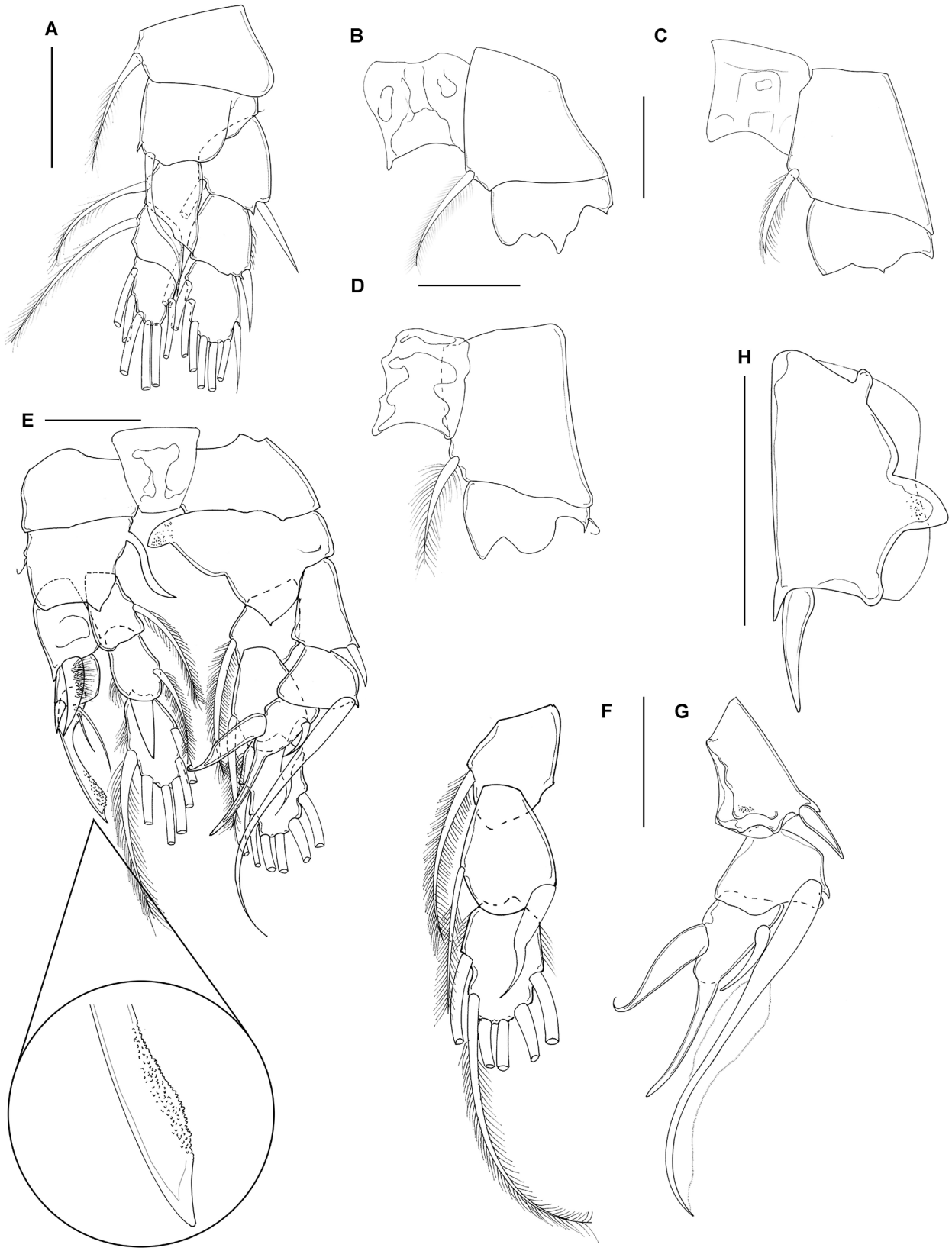

Figure 5. *Bofuriella spinosa.* Adult male from Cenote Arco Luminoso. **A**, P1; **B**, P2 Cx and Bs; **C**, P3 Cx and Bs; **D**, P4 Cx and Bs; **E**, P5; **F**, right P5 Enp; **G**, right P5 Exp; **H**, right P5 Exp1 in posterior view. Scale bars = 100 µm.

Right P5 (Fig. 5E–H). Cx subrectangular, broader than long. Bs with strong, peak-like inner projection proximally, and distal outer seta. Exp and Enp 3-segmented (Fig. 5E–G). Exp1 with outer distal spine, with strong projection as presented in Figure 5H; Exp2 broader than long, with short spinous projection and long distal modified outer spine, narrow with hyaline membrane on both margins, reaching well beyond distal end of Exp3; Exp3 with 3 elements: small curved outer spine, long and acute terminal process and strong inner spine ending in curved tip (Fig. 5G). Enp1 with plumose inner seta; Enp2 with plumose inner seta and curved spine; Enp3 with 6 plumose setae (Fig. 5F).

Left P5 (Fig. 5E). Cx subrectangular, broader than long. Bs with small outer seta and sinusoid inner spinous process. Exp and Enp 3-segmented. Exp1 with strong medial curved spine with setules, reaching beyond distal margin of Exp2; Exp2 subquadrate, ca. half the length of Exp1, with outer spine; Exp3 elongate, slender, with 2 long proximal unequally long setal elements, segment terminally covered with minute integumental papules. Enp1 with plumose seta, Enp2 with plumose seta and strong distal spine not reaching distal margin of succeeding segment. Enp3 armed with 6 plumose setae.

Distribution. *Bofuriella spinosa* is known from its type locality in Middle Caicos Islands (Fosshagen and Iliffe, 2007), with previous records in Turks and Caicos Islands (Gonzalez et al., 2020). This is the first record of *B. spinosa* outside its type locality and in caves of the Mexican Caribbean, also, the third epacteriscid reported from the YP (see Suárez-Morales et al., 2006).

Remarks. Currently, only three species of *Bofuriella* are known for the Caribbean Sea (see Appendix – Tab. A1), including *Bofuriella vorata* Fosshagen, Boxshall and Iliffe, 2001 and *Bofuriella paravorata* Fosshagen and Iliffe, 2007 from Bahamas (Fosshagen et al., 2001; Fosshagen and Iliffe, 2007). We identified our specimen as member of *Bofuriella* by following the emended generic diagnosis by Fosshagen and Iliffe (2007: 85): (1) antennary endopod almost 2/3 as long as the exopod and has a well-developed inner lobe; (2) mandibular palp with 2-segmented endopod, with 2 – 5 setae; (3) maxilla with well-developed praecoxal and coxal lobes on. We also identified this male individual as *B. spinosa* by its possession of (1) a short seta on exopod 1 of the antenna; (2) 5 setae on the endopod of the mandibular palp; and (3) large spines on leg 1 exopodal segments.

Based on the male description of *B. spinosa* from Mexico, we identified the following structures that allowed us to distinguish this species from its congeners *B. vorata* (see Fosshagen et al., 2001: fig. 26C) and *B. paravorata* (see Fosshagen and Iliffe, 2007: fig. 8C, D), for example: (1) exopod 2 of right fifth leg with long ramus that reaches beyond exopod 3; (2) exopod 3 of right fifth leg has three well differentiated thick spinal elements; (3) left fifth leg basipod with inner sinusoid spinous process, compared to the strong projection as described for both congeners; (4) exopod 3 of left fifth leg elongated and slender, with 2 unequal setae and terminal papules; and (6) endopod 3 of left fifth leg without the known row of flattened spinules. These comparisons along with other structures are shown in Tab. A2 (Appendix) in more detail. We also provide a key of *Bofuriella* species.

Table 2. Armature formula of swimming legs 1–4 of *Bofuriella spinosa* male from Cenote Arco Luminoso, Playa del Carmen. Roman numerals = spines, Arabic numerals=setae

	Cx	Bs	Exopod	Endopod
P1	0-1	0-1	I-1, I-1, III-2-3	0-1; 0-1; 0-2,3,1
P2	0-1	0-0	I-1, I-1, II-I-5	0-1; 0-2; 0-4,2,2
P3	0-1	I-0	I-1, I-1, II-I-5	0-1; 0-2; 0-4,2,2
P4	0-1	0-1	I-1, I-1, III-I-5	0-1; 0-2; 0-3,2,2

DISCUSSION

Epacteriscids are widely distributed in cave systems worldwide (Fosshagen et al., 2001) (Fig. 1), In the YP, epacteriscids are known to co-occur with other representative anchialine and primitive taxa, like the Remipedia, the most primitive living crustacean known in the world (Hoenemann et al., 2013), as well as other anchialine taxa. *Balinella yucatanensis* Suárez-Morales, Ferrari and Iliffe, 2006 was recorded co-occurring with the remipede *Speleonectes tulumensis* Yager, 1987 (Suárez-Morales et al., 2006). Moreover, our record of *E. rubra* from Cozumel Island and *B. spinosa* from Playa del Carmen is also related to other exclusively anchialine-inhabitant crustaceans from the Caribbean, such as the decapod *Barbouria cubensis* (Von Martens, 1872), known to dwell in the same systems studied herein (Mejía et al., 2008). It is known that epacteriscids share primitive morphological features, thus supporting its ancient origin and the early isolation of distinct anchialine faunistic branches of the western Caribbean Sea that became separated during different geological and biogeographic events (Galassi, 2009).

The YP has an extensive net of cave systems including over 2,200 sinkholes (Calderón-Gutiérrez et al., 2017). Several species of anchialine copepods have been reported from the YP, including the misophrioids: *Mexicophria cenoticola* Boxshall, Zylinski, Jaume, Iliffe and Suárez-Morales, 2014 and *Speleophria germanyanesi* Suárez-Morales, Cervantes-Martínez, Gutiérrez-Aguirre and Iliffe, 2017a, and the calanoids *Exumella tsonot* Suárez-Morales and Iliffe, 2005, *B. yucatanensis,* and *Stephos fernandoi* Suárez-Morales, Gutiérrez-Aguirre, Cervantes-Martínez and Iliffe, 2017b. In our study, we were able to identify two epacteriscid copepods in the YP, previously recorded from different regions of the Caribbean Sea that likely shared a similar copepod fauna that became isolated (Appendix – Tab. A1).

After this study, we can recognize that the epacteriscid fauna of the YP includes three species. The knowledge of the copepod diversity of the YP anchialine systems is growing and it is expected that new collections will reveal a high diversity as that reported for other invertebrates (Álvarez et al., 2023; Calderón-Gutiérrez et al., 2017). This reaffirms that these systems likely harbor one of the most diverse anchialine copepod fauna worldwide and are currently going through intense anthropogenic pressure, thus enhancing the intrinsic value of these new findings. It is necessary to include these fragile habitats in regional and governmental conservation strategies and protect them from anthropogenic disturbances.

Key to species of Bofuriella (based on Fosshagen et al. 2001, Fosshagen and Iliffe 2007, and this study).

1.– Enp of mandibular palp with 5 setae; A2 with short and large seta on Exp1 and 2 respectively; P1 Exp2 and 3 with large outer spines; male left P5 Bs with sinusoid spine on distal margin ..... *Bofuriella spinosa* Fosshagen and Iliffe, 2007

– Enp of mandibular palp with 2 setae; A2 with short seta on Exp 1 and 2; P1 Exp 2 and 3 armed with short outer spines; male left P5 Bs with pronounced projection on distal inner margin 2

2.– Male right P5 Exp3 with row of 8 unequal flattened spinous processes ..... *B. vorata* Fosshagen, Boxshall and Iliffe, 2001

– Male right P5 Exp3 with row of 12 unequal flattened spinous processes ..... *B. paravorata* Fosshagen and Iliffe, 2007

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ADDITIONAL INFORMATION AND DECLARATIONS

Author Contributions

Conceptualization and design: SJ, ESM, ACM, MAGA, LMMO. Performed research: SJ, ESM, ACM, MAGA, LMMO. Acquisition of data; SJ, ESM, ACM, MAGA, LMMO. Analysis and interpretation of data; SJ, ESM, ACM, MAGA, LMMO. Preparation of figures/tables/maps; SJ, ACM. Writing – original draft; SJ, ESM, ACM, MAGA, LMMO. Writing – critical review & editing: SJ, ESM, ACM, MAGA, LMMO.

Consent for publication

All authors declare that they have reviewed the content of the manuscript and gave their consent to submit the document.

Competing interests

The authors declare no competing interest.

Data availability

All study data are included in the supplementary material and collection data are archived within El Colegio de la Frontera Sur Zooplankton Collection and available on request from the corresponding author.

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Study association

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Study permits

To date, zooplankton is not under protection by national laws; and permits are not required for this kind of field.

APPENDIX

Table A1. Known genera and species of the copepod family Epacteriscidae. Coordinates are indicated when available in literature. * = type species of the genus; ** = type species of the Family; + = species recorded in this study. Data based on Andronov (2007), Boxshall and Jaume (2003), Barr (1984), Fosshagen (1973; 1985), Fosshagen et al. (2001), Fosshagen and Iliffe (2004, 2007), Jaume and Humphreys (2001), and Suárez-Morales et al. (2006).

Genus	Species	Records
Azygonectes Fosshagen and Iliffe, 2004	*A. intermedius* Fosshagen and Iliffe, 2004 *	Bahamas: Sanctuary Blue Hole (24°7'N 77°35'W), Basil Minn's Blue Hole (23°29N 75°46'W)
	A. plumosus Fosshagen and Iliffe, 2007	North Caicos Islands: Cottage Ponds. Caicos Islands – Providenciales, Old Blue Hill Caves
Balinella Fosshagen, Boxshall and Iliffe, 2001	*Ba. ornata* Fosshagen, Boxshall and Iliffe, 2001*	Bahamas: Norman's Pond Cave, Exuma Cays
	Ba. yucatanensis Suárez-Morales, Ferrari and Iliffe, 2006	Mexico: PY – Cenote Ponderosa (20°34.357'N 87°11.280'W), Cenote Mayan Blue (20°11.641'N 87°29.778'W), Cenote 27 pasos (20°24.190' N 87°19.744'W),
Bofuriella Fosshagen, Boxshall and Iliffe, 2001	*Bo. paravorata* Fosshagen and Iliffe, 2007	Bahamas: Big Fontain, Orange Creek, Cat Islands
	Bo. spinosa Fosshagen and Iliffe, 2007 +	Middle Caicos Islands: Conch Bar Cave Mexico: (this study) Cenote Arco Luminoso, Playa del Carmen (20°34'9.59''N 87°12'51.7''W)
	Bo. vorata Fosshagen, Boxshall and Iliffe, 2001*	Bahamas: Oven Rock Cave, Great Guana Cay, Exuma Cays
Bomburiella Fosshagen Boxshall and Iliffe, 2001	*Bb. gigas* Fosshagen, Boxshall and Iliffe, 2001*	Bahamas: Oven Rock Cave, Great Guana Cay, Stargate Blue Hole, South Andros
Bunderia Jaume and Humphreys, 2001	*Bu. misophaga* Jaume and Humphreys, 2001*	Australia: Cape Range peninsula – Bundera Sinkhole (22°25'S 113°46'E),
Caiconectes Fosshagen and Iliffe, 2007	*Ca. antiquus* Fosshagen and Iliffe, 2007*	North Caicos Islands: Cottage Ponds. Caicos Islands – Providenciales, Old Blue Hill Caves. Middle Caicos Islands: Conch Bar Cave
Cryptonectes Fosshagen and Iliffe, 2004	*Cr. brachyceratus* Fosshagen and Iliffe, 2004*	Bahamas: Salina Point, Acklins Island, Basil Minn's Blue Hole, Georgetown, Great Exuma Island, Exuma Cays, Norman's Pond Cave, Norman's Pond Cay, Virgo Blue Hole, Sweetings Cay, Grand Bahama Island
Edaxiella Fosshagen, Boxshall and Iliffe, 2001	*Ed. rubra* Fosshagen, Boxshall and Iliffe, 2001*+	Jamaica: Air Strip Caves, Discovery Bay. México (this study): Cenote Tres Potrillos (20°27'3.2''N 86°59'14.4''W)
Enantiosis Barr, 1984	*En. belizensis* Fossagen, Boxshall and Iliffe, 2001	Belize: Caye Caulker, Caye Chapel, Columbus Caye
	En. bermudensis Fossagen, Boxshall and Iliffe, 2001	Bermuda: Double Pond Cave, Green Bay Cave, Red Bay Cave, Shop Cave, Small FishPond Cave, Tucker's Town Cave, Walsingham Cave, Wonderland Cave.
	En. cavernicola Barr, 1984*	Bahamas: Lighthouse Cave, San Salvador
	En. conspinulata Fossagen, Boxshall and Iliffe, 2001	Palau: Western Caroline Islands: Ngeruktabel Island
	En. dicerata Fossagen, Boxshall and Iliffe, 2001	Fiji: Naurambuta Cave, Vatulele
	En. galapagensis Fossagen, Boxshall and Iliffe, 2001	Galapagos: Isla Santa Cruz – Deep Grieta at Tortuga Bay, Grieta de Caleta la Torta, Grieta north of trail to Tortuga Bay; Isla Floreana – Post Office Bay Cave
	En. longiprocessa Fossagen, Boxshall and Iliffe, 2001	Western Caroline Islands: Ngeruktabel Island
Enantronia Fosshagen, Boxshall and Iliffe, 2001	*Et. canariensis* Fosshagen, Boxshall and Iliffe, 2001*	Canary Islands: Jameos del Agua, Lanzarote
Enantronoides Fosshagen, Boxshall and Iliffe, 2001	*Er. bahamensis* Fosshagen, Boxshall and Iliffe, 2001*	Bahamas: Oven Rock Cave, Great Guana Cay, Exuma Cays
Epacteriscus Fosshagen, 1973	*Ep. cuspidantennula* Fosshagen, Boxshall and Iliffe, 2001	Belize: Caye Chapel
	Ep. dentipes Fosshagen, Boxshall and Iliffe, 2001	Belize: Caye Chapel
	Ep. rapax Fosshagen, 1973**	Florida: Broad Creek. Colombia: Punta de Betín
Erebonectes Fosshagen, 1985	*Er. nesioticus* Fosshagen, 1985*	Bermuda: Christie's Cave, Devonshire Cave, Jane's Cave, Church cave, Bitumen Cave
Erebonectoides Fosshagen, Boxshall and Iliffe, 2001	*Eb. macrochaetus* (Fosshagen and Iliffe, 1994)*	Caicos Islands
Gloinella Fosshagen, Boxshall and Iliffe, 2001	*G. yagerae* Fosshagen, Boxshall and Iliffe, 2001*	Cuba: Cueva de los Carboneros

Table A1. Cont.

Genus	Species	Records
Iboyella Boxshall and Jaume, 2003	*I. cubensis* Boxshall and Jaume, 2003*	Cuba: El Brinco, Playa Girón
Miheptneria Andronov, 2007	*Mi. abyssalis* Andronov, 2007*	Central-eastern Atlantic
Minnonectes Fosshagen and Illife, 2004	*Mn. melodactylus* Fosshagen and Illife, 2004*	Bahamas: Basil Minn's Blue Hole, Great Exuma Islands
Oinella Fosshagen, Boxshall and Iliffe, 2001	*O. longiseta* Fosshagen, Boxshall and Iliffe, 2001*	Bahamas: Oven Rock Cave, Great Guana Cay, Exuma Cays

Table A2. Comparison of male *Bofuriella* species described in this study and from Fosshagen et al. (2001) and Fosshagen and Iliffe (2007). * = comparison based on the Mexican specimen; – = undetermined data.

Character	*B. spinosa* Fosshagen and Iliffe, 2007*	*B. vorata* Fosshagen, Boxshall and Iliffe, 2001	*B. paravorata* Fosshagen and Iliffe, 2007
A2	With minute seta on Exp1 and large seta on succeeding segments (Fig. 4C)	With minute seta on Exp1 and 2	–
Md palp	2-segmented Enp with 5 setae with 1, 4 formula (Fig. 4D)	2-segmented Enp with two equal terminal setae	–
P1 Exp	Exp1-3 with large outer spines (Fig. 5A)	Exp1-3 with small spines	–
P2-4	With smooth intercoxal sclerite (Fig. 5B-D)	With 2 spinal processes on intercoxal sclerite	–
Right P5 Bs	With reduced inner projection (Fig. 5E)	With strong curved inner projection	With strong projection, less curved than *B. vorata*
Right P5 Exp2	Outer distal spinous process reduced, long distal ramus reaching beyond Exp3, with narrow hyaline membrane on both margins (Fig. 5G)	Strong outer distal spinous process, distal ramus reaching 2/3 of Exp3	Curved distal spinous process, distal ramus reaching 2/3 of Exp3
Right P5 Exp3	With 3 well differentiated thick spinous elements (Fig. 5G)	With 3 spinous elements: small outer distal spinous projection, long and acute terminal process, and inner seta-like spine	With 3 spinous elements: small outer distal spinous projection, long and acute terminal process, and inner spine
Right P5 Enp2	With outer curved spine (Fig. 5F)	With outer spinous process	As in *B. vorata*
Left P5 Bs	With sinusoid inner spinous process	With elongate strong inner projection	With rounded strong inner projection
Left P5 Exp1	With lamella and thick terminal spine with setules, reaching beyond Exp2	With long curved spine reaching almost 2/3 of Exp3	As in *B. vorata*
Left P5 Exp2	With short and thick spine	With irregular shaped process ending in acute tip	As in *B. vorata*
Left P5 Exp3	Elongated and slender, with 2 proximal setal elements unequally long, terminally curved with minute integumental papules	With spinous inner distal process	With thin spinous inner distal process
Left P5 Enp2	With long terminal spine	With inner distal spinous process	With reduced inner distal process
Left P5 Enp3	Without flattened spinules	With row of 8 flattened spinules	With row of 12 flattened spinules