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Six new epigean species of *Caecidotea* (Isopoda: Asellidae) distributed along the Trans-Mexican Volcanic Belt in Central Mexico

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Abstract

Six new epigean freshwater species of the genus *Caecidotea* in Mexico are described. These species were collected in waterbodies located along the Trans-Mexican Volcanic Belt (TMVB) and the eastern slope of the country: *Caecidotea buzwilsoni* **sp. nov.**, *Caecidotea chicoensis* **sp. nov.**, *Caecidotea alvarezi* **sp. nov.**, *Caecidotea mintzita* **sp. nov.**, *Caecidotea zacapuensis* **sp. nov.**, and one additional species *Caecidotea villalobosi* **sp. nov.** is described from the Papaloapan basin at the Atlantic Slope of Mexico. The taxonomic treatment for each species includes a detailed description, figures of characters of diagnostic importance and comments. We also provide an updated map of *Caecidote*a records in Mexico. This work substantially increases the number of epigean *Caecidotea* known to occur in Mexico to 11 species, a new total of 99 species described to North America.

Key words: Taxonomy, Crustacea, Peracarida, Freshwater isopods, Epigean

Introduction

Located in Central Mexico, the Trans-Mexican Volcanic Belt (TMVB), is a mosaic of highlands of volcanic origin that arose during the Pliocene-Quaternary period, which spans from the Pacific Ocean to the Gulf of Mexico (Campos-Enríquez *et al*. 2015). This region covers an area of 160,000 km^2, with an approximate length of ~1,000 km, reaching elevations up to 5,000 m (Sigala *et al*. 2017). A series of river basins and climatic regions exist along its rugged topography (Espinoza & Ocegueda 2007). The evolution of the hydrogeomorphology of the TMVB has determined the structure, diversification and distribution of freshwater biodiversity and is likely a factor in the high incidence of endemism among a varied array of taxa, such as amphibians, arachnids, crustaceans, fishes, reptiles and plants (Alvarez *et al*. 2014; Alvarez & Villalobos 2016; Castro-Franco *et al*. 2006; Flores-Villela 1993; Martínez-Aquino *et al*. 2014; Miller 2005; Ruíz-Sánchez & Specht 2013; Schönhuth *et al*. 2011; Pedraza-Lara *et al.* 2012).

Currently, 93 species and three subspecies of the isopod genus *Caecidotea* Packard, 1871 are known from the freshwater environments of Canada, United States, Mexico, and Guatemala. Most of these species (n = 73) were described from hypogean environments while the others (n = 20) were described from epigean waters (García-Vázquez *et al*. 2019). A total of nine species have been recorded in Mexico, four from underground environments of karstic areas: *C. chiapas* Bowman, 1975, *C. pasquinii* (Argano, 1972), *C. vomeroi* Argano, 1977 and *C. zullini* Argano, 1977, while the other five are from surface waters distributed over the TMVB: *C. camaxtli* García-Vázquez, Rodríguez-Almaraz & Pedraza-Lara, 2019, *C. puebla* (Cole & Minckley, 1968), *C. williamsi* Escobar-Briones & Alcocer, 2002 and *C. xochimilca* Rocha-Ramírez & Peñaloza-Daniel, 2011. In addition, *C. communis* (Say, 1818) has been recorded for several regions from Mexico, including the TMVB.

In the present work, we describe six new epigean *Caecidotea* species distributed along the TMVB in the states of Guanajuato, Hidalgo, Jalisco, Michoacan and one species occurring at the Atlantic slope in the state of Veracruz. We also present an updated map of the distribution of *Caecidotea* in Mexico.

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Material and methods

Isopods were hand collected with fine forceps and stored in cryotubes with 95% ethanol. The specimens of each species were analyzed and illustrated with a Leica dissecting microscope (model S8APO) with a Camera Leica MC170 HD and digitized with a Kanvus Life 106 graphic tablet using Inkscape v0.92.3 at the Forensic Entomology Laboratory, Forensic Science Program, School of Medicine, National Autonomous University of Mexico (UNAM). Methods for preparations of Scanning Electron Microscopy (SEM) micrographs were detailed in García-Vázquez *et al*. (2019). The appendages were examined using a Hitachi SU1510 at the Scanning Electronic Microscope Laboratory, Biology Institute, IBUNAM. After the analysis, the specimens were deposited in the National Crustacean Collection (CNCR), IBUNAM. We provide for each new species the material examined, description, etymology, and remarks.

The anatomical details of the appendix masculine follows the nomenclature used in García-Vázquez *et al.* (2019) and these structures are named according to their position in reference to the ventral groove: caudal, mesial and cannula (Lewis & Bowman 1981) (Fig. 1).

An updated map of the distribution of the *Caecidotea* genus in Mexico was created in ArcMap v10.2.1 incorporating locality records available in the literature (Cole & Minckley 1968; Argano 1972; Bowman 1975; Argano 1977; Escobar-Briones & Alcocer 2002; Rocha-Ramírez & Peñaloza-Daniel 2011; García-Vázquez *et al*. 2019; García-Vázquez 2020) plus the records of the six new species.

Abbreviations: CNCR—National Crustacean Collection; IBUNAM—Biology Institute National Autonomous University of Mexico; UNAM—National Autonomous University of Mexico; TMVB—Trans-Mexican Volcanic Belt.

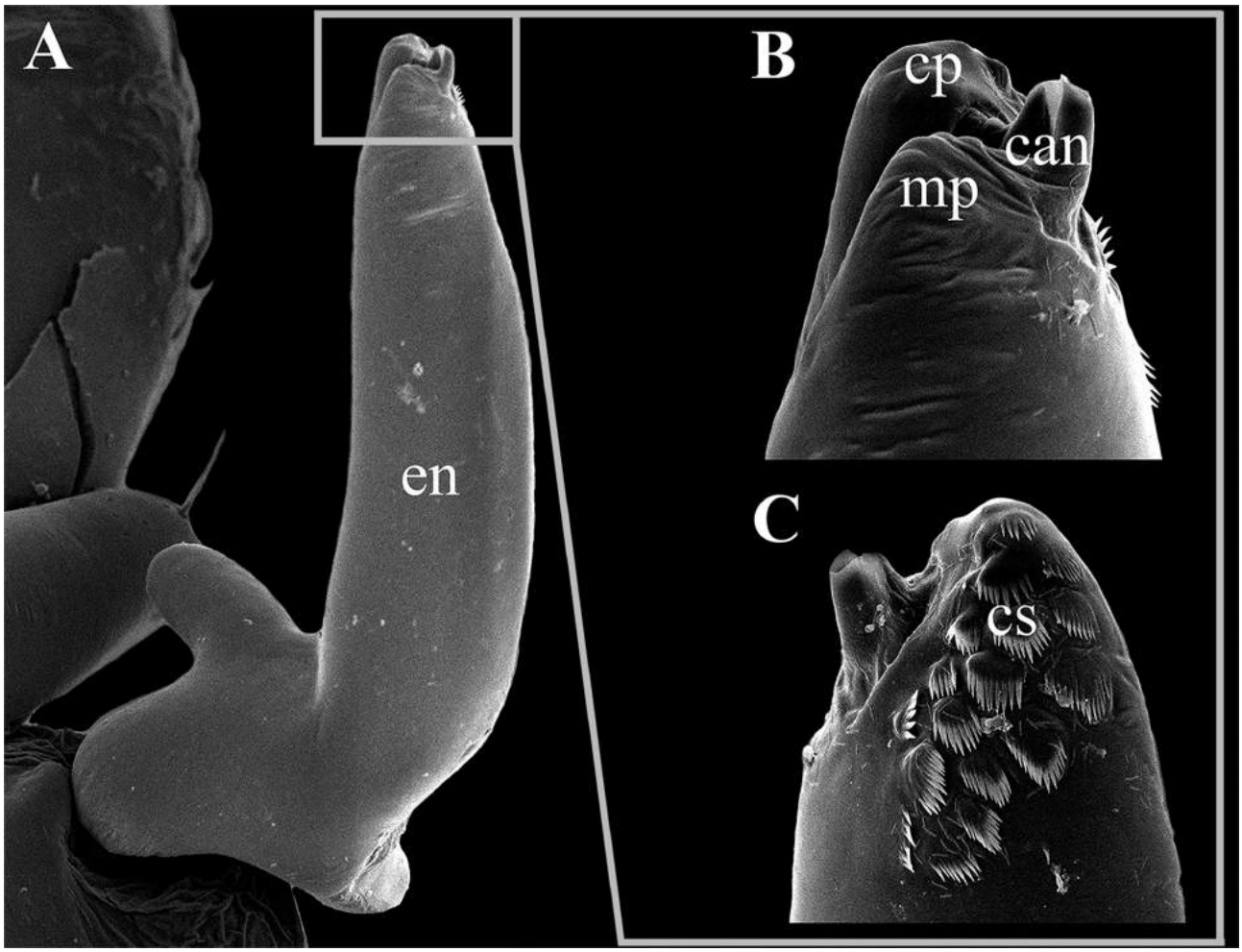

FIGURE 1. Anatomical details of the appendix masculine. A, en = endopod; B, cp = caudal process, can = cannula, mp = mesial process; C, cs = cuticular scales (Modified from García-Vázquez *et al.* 2019).

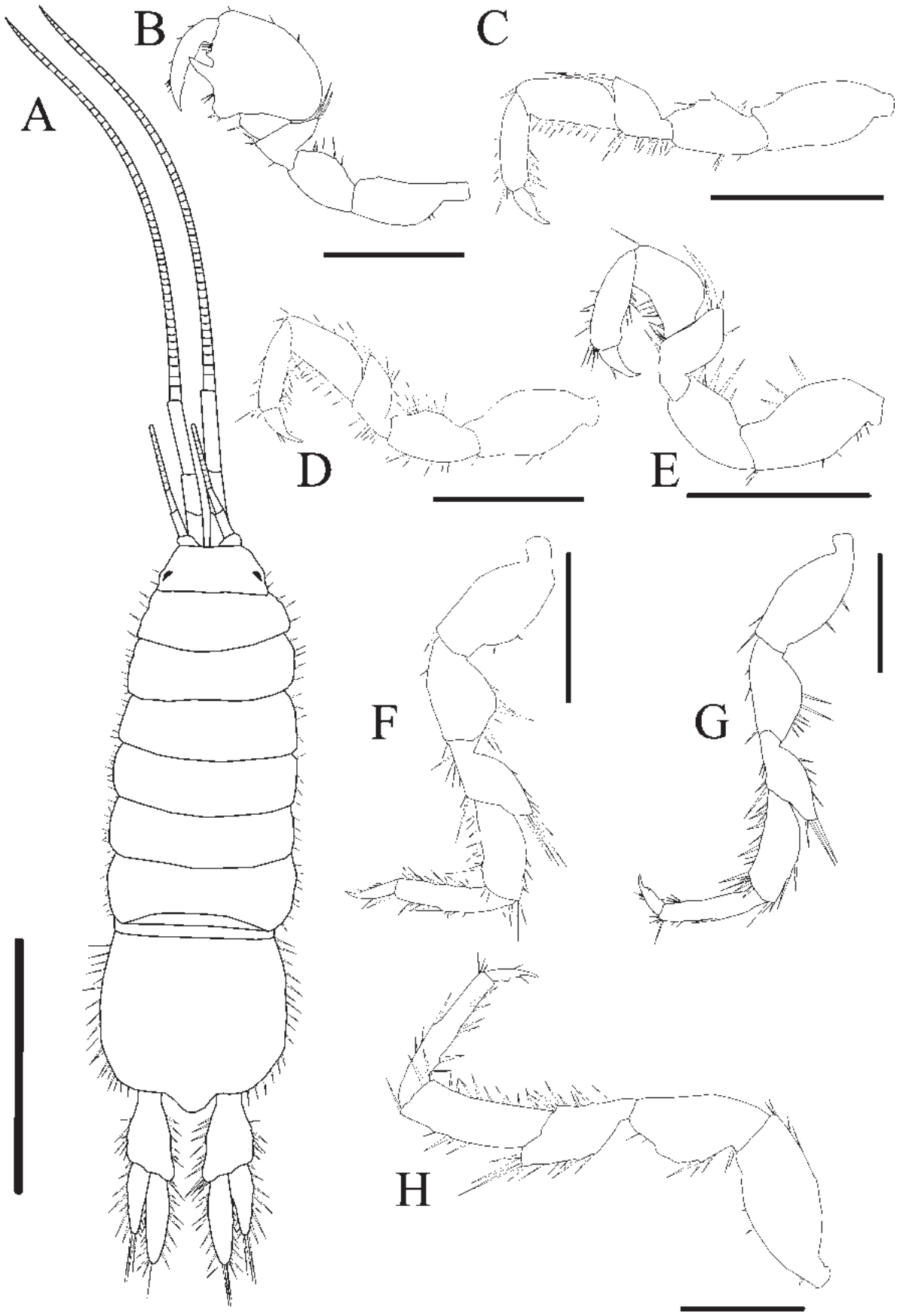

FIGURE 2. *Caecidotea alvarezi* **sp. nov.** Holotype male (CNCR 35519), total length 5.0 mm. A, male habitus. Paratype male (CNCR 35520), total length 4.7 mm. B, pereiopod I; C, pereiopod II; D, pereiopod III; E, pereiopod IV; F, pereiopod V; G, pereiopod VI; H, pereiopod VII. Scale bars: A = 2.0 mm, B–H = 1.0 mm.

Results

Taxonomy

Order Isopoda Latreille, 1817

Suborder Asellota Latreille, 1802

Family Asellidae Rafinesque, 1815

Genus *Caecidotea* Packard, 1871

***Caecidotea alvarezi* sp. nov.**
(Figs 2–5)

Material examined: ***Holotype*****,** male (CNCR 35519), length 5.0 mm, shore of the Chapala Lagoon, Jamay, 20°17'07.00"N, 102°42'36.97"W, elev. 1524 m, Municipality of Jamay, Jalisco, Mexico, 19 March 2018, coll. L. García-Vázquez and C. Pedraza-Lara.

Paratypes, male (CNCR 35520), length 4.7 mm; same data of collection and collectors as holotype; dissected parts pereiopod I, pereiopod IV, pleopod II; dissected structures for right pleopod drawings I, III, IV and V in the specimen tube. Females present in the same container.

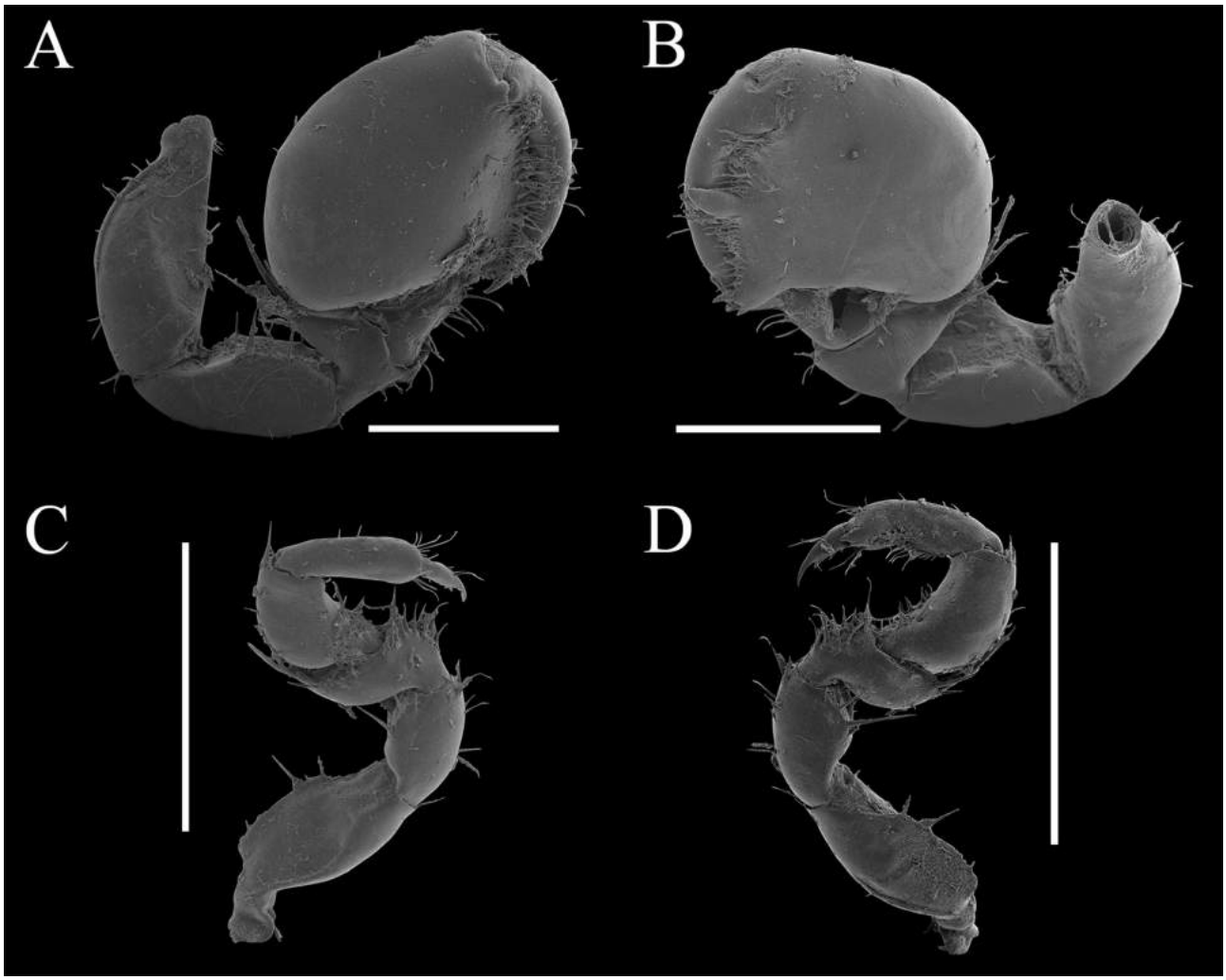

FIGURE 3. *Caecidotea alvarezi* **sp. nov.** Paratype male (CNCR 35520), total length 4.7 mm. A, right pereiopod I dorsal view; B, right pereiopod I ventral view; C, right pereiopod IV dorsal view; D, right pereiopod IV ventral view. Scale bars: A–B = 500 μm, C–D = 1.0 mm.

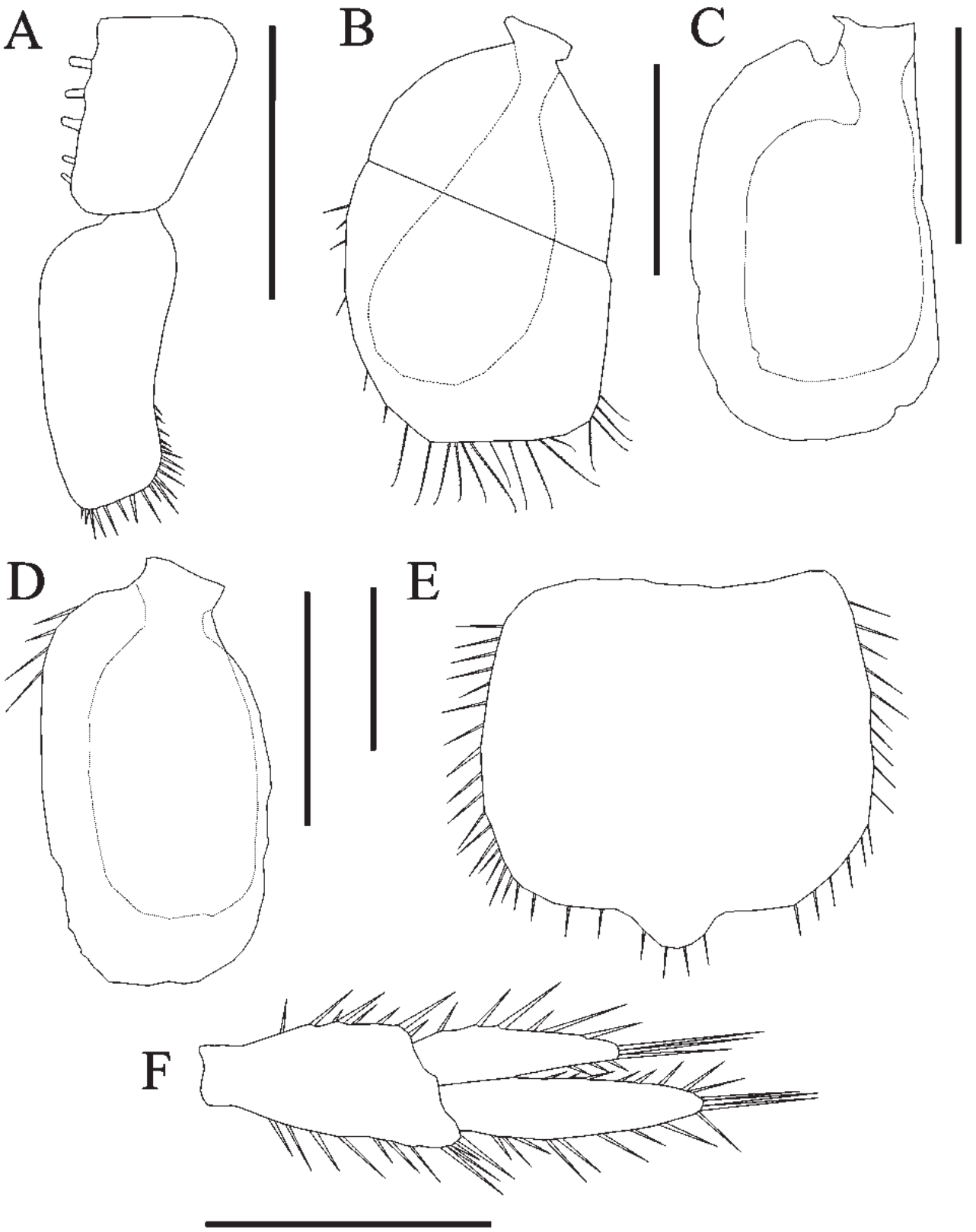

FIGURE 4. *Caecidotea alvarezi* **sp. nov.** Paratype male (CNCR 35520), total length 4.7 mm. A, pleopod I; B, pleopod III; C, pleopod IV; D, pleopod V; E, pleotelson; F, right uropod. Scale bars: A–F = 1.0 mm.

Diagnosis. Male body 2.8 times longer than wide. Head trapezoidal, width 0.6 length, anterior margin straight; eyes 3 times longer than wide, postmandibular lobes not produced. Pleotelson lateral margins parallel, caudomedial lobe produced, broad, rounded. Pleopod II exopod with cuticular scales directed distally, as long as those in medial margin cannula; endopod with flagella, mesial process almost high as cannula. Uropods long as pleotelson length.

Description. Male (CNCR 35519) 5.0 mm (Fig. 2); head width 2.8 length, anterior margin straight. Eyes present, oval, dark pigmented, length 0.6 width. Postmandibular lobes not produced. Subrectangular pereionites lateral margins ornamented with setae, pereionites 1–2 rounded, pereionites 3–5 straight, pereonites 6–7 rounded, posterior angle produced.

Pereionite 1 length 1.1 pereionite 2 length; pereonite 1 0.9 pereionite 3 length; pereionites 6–7 wider, widening in posterior angle.

Antennula flagellum with 10 articles, longer than distal antenna podomere middle; last four segments with aestethascs in formula 1–1–1–0. *Antenna* flagellum with 50 articles; proximal article wider than long; following articles decreasing in length.

Pereiopod I (Figs 2B, 3A–B) propodus slender, dactylus longer than palm with five simple setae on outer surface, irregular inner edge; palmar margin with row simple setae; proximal process with robust spine length 0.3 mesial process length; mesial process acute, exceeding dactylus width. *Pereiopods II–III* (Fig. 2C–D) similar length. *Pereiopod IV* (Figs 2E, 3C–D), propodus with spine in dactylus; dactylus length 0.5 propodus length with 3 spines on lower margin. *Pereiopod V* (Fig. 2F) basis 1.3 propodus length. *Pereiopod VI* (Fig. 2G) similar length to pereiopod VII length, basis length 1.4 propodus length. *Pereiopod VII* (Fig. 2H) 0.5 body length.

Pleopod I (Fig. 4A) length 1.1 pleopod II length; protopod trapezoidal, proximal margin straight, length 1.5 width, inner margin with 5 retinacula, distal segment subrectangular, outer margin concave, length 2.3 width, margins with 20 simple setae.

Pleopod II (Fig. 5A–F), protopod subrectangular, proximal edge rounded; exopod oval, in dorsal view with two vertical rows cuticular scales adjacent to inner margin, distal margin with 20 short plumose setae; slender endopod, as long as 3.8 width, similar to exopod 0.7 protopod length, curved mesial surface with flagella, internal and external process prominent, with suture close to base; endopod apex with 3 processes: cannula short, shaped as ribbed blade, not closed, tip truncated rounded, almost reaching apex caudal process, ventral groove present, extending proximally from base to cannula more than 3.0 its length; mesial process evident, with transverse grooves on surface; caudal process robust, conical, rounded apex, armed on subapical dorsal surface with 7–17 cuticular scales directed proximally.

Pleopod III (Fig. 4B), exopod oval with distal margin setose, length 1.1 endopod length, width 1.6 endopod width, transverse suture in proximal half, 15 plumose setae on distal margin, external margin with 6 simple setae; endopod short oval, 0.9 exopod length.

Pleopod IV (Fig. 4C), exopod as long as 1.7 width, with pronounced notch, on outer margin, close to pleopod joint; endopod 0.9 exopod length.

Pleopod V (Fig. 4D), exopod oval, as long as 1.8 width; transverse suture not obvious; endopod length 0.9 exopod length, width 0.7 exopod width.

Pleotelson (Fig. 4E), subsquare, width 1.1 length, lateral margins parallel, with simple setae, caudomedial lobe broad rounded.

Uropods (Fig. 4F), length equal to pleotelson length, armed with robust setae; length 0.5 endopod length; endopod linear, length 0.8 protopod length, exopod length 1.1 protopod length.

Habitat. This species was collected on the shoreline of the Chapala lagoon within the roots of the water lily *Eichornia crassipes*, along with other crustaceans (e.g., crayfish of the genus *Cambarellus* and amphipods of the genus *Hyalella*).

Distribution. Only known from the type locality.

Etymology. This species is named in honor to Dr. Fernando Alvarez, curator of the National Crustacean Collection, in recognition to his career in the study of Mexican crustaceans.

Remarks. *C. alvarezi* **sp. nov.** is similar to the species *C. williamsi* Escobar-Briones & Alcocer, 2002 from Laguna de Alchichica, Puebla. The two species, however, can be distinguished by the number of retinacula in pleopod I (3 in *C. williamsi* and 5 in *C. alvarezi* **sp. nov.**) and the shape of pereiopod I. *C. williamsi* has only mesial process, while *C. alvarezi* **sp. nov.** has both mesial and proximal processes.

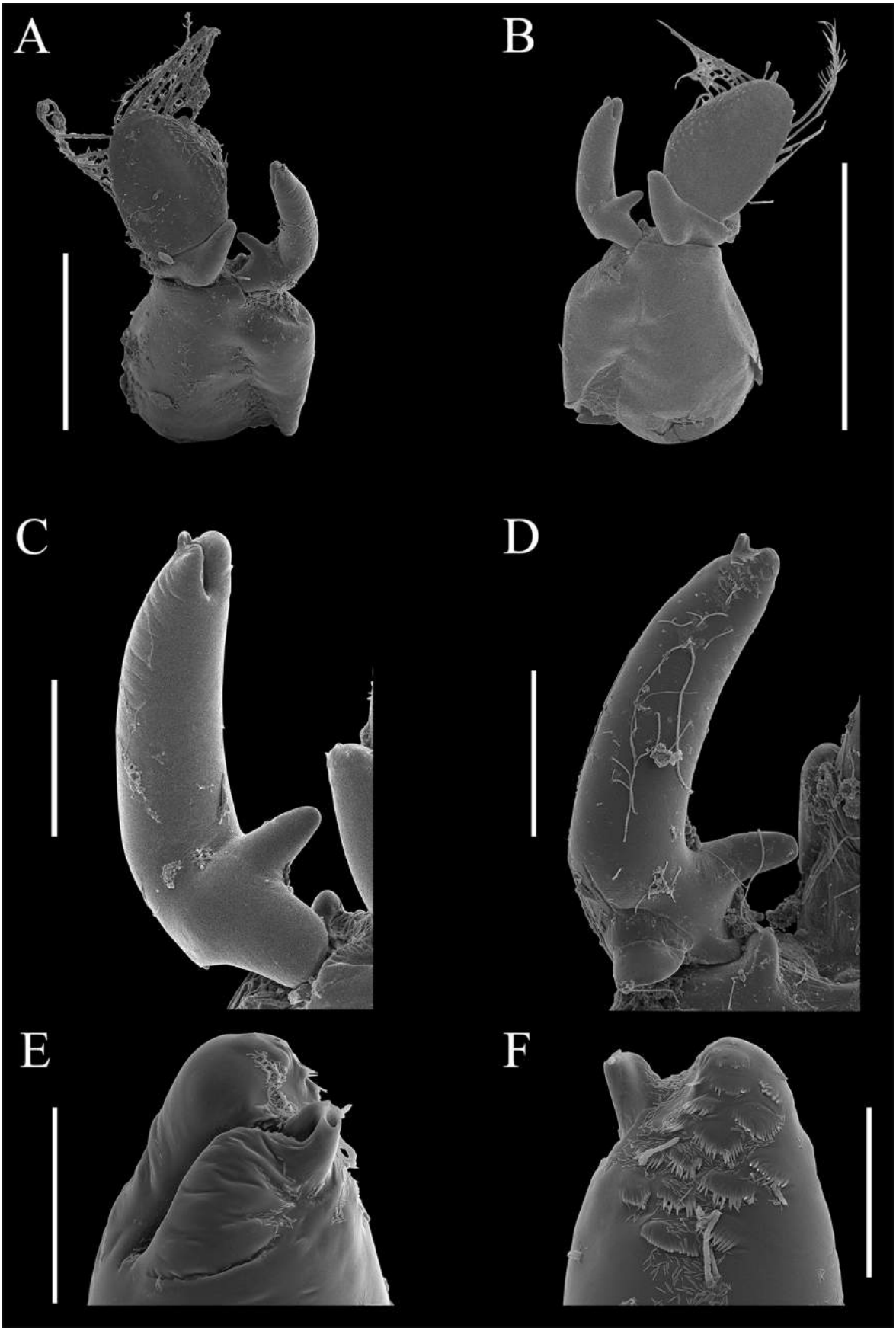

FIGURE 5. *Caecidotea alvarezi* **sp. nov.** Paratype male (CNCR 35520), total length 4.7 mm, A, pleopod II ventral view; B, pleopod II dorsal view; C, endopod pleopod II ventral view; D, endopod pleopod II dorsal view; E, apex of the endopod pleopod II ventral view; F, apex endopod pleopod II dorsal view. Scale bars: A = 500 μm, B = 300 μm, C–D = 100 μm, E–F = 40 μm.

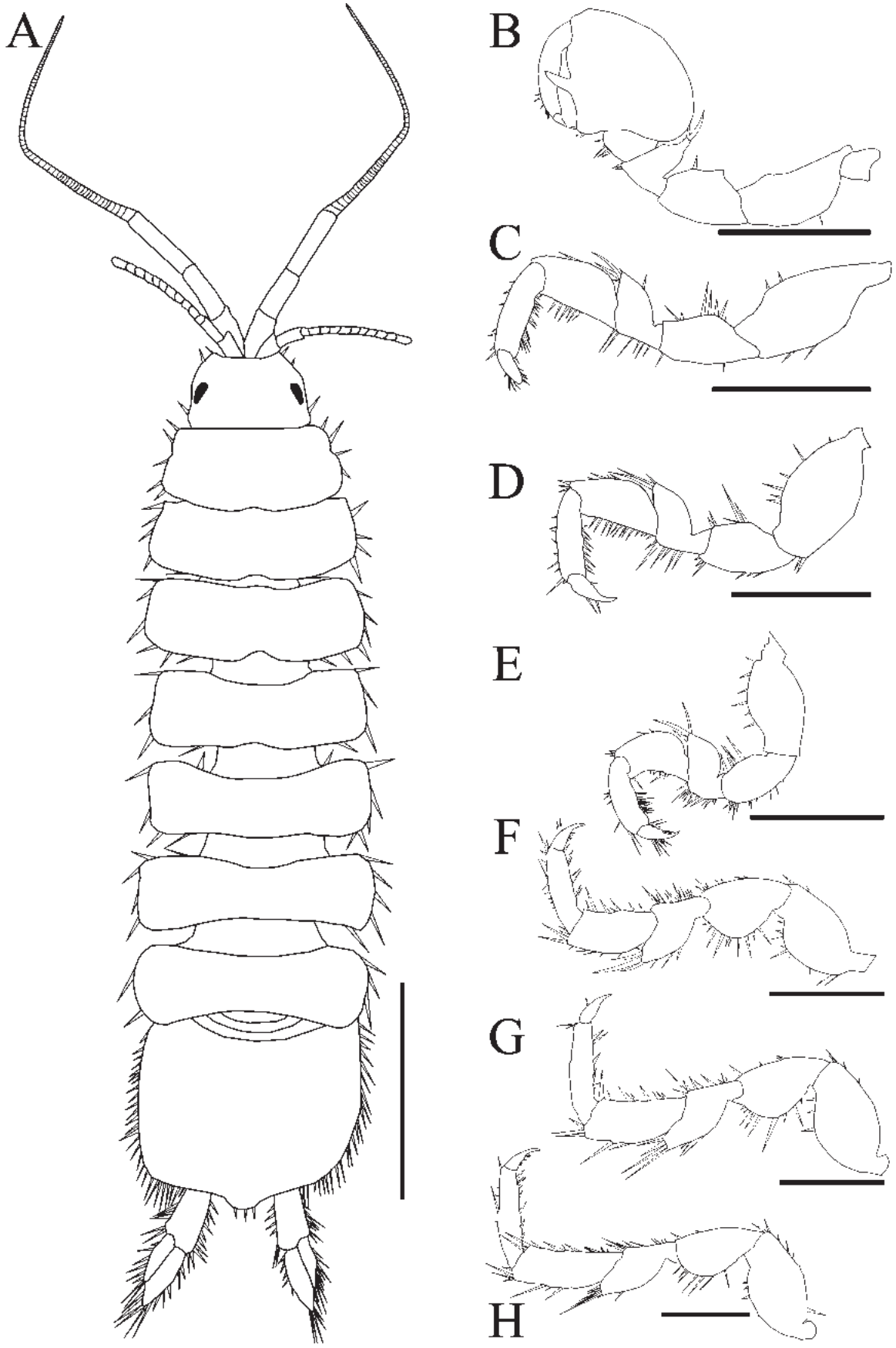

FIGURE 6. *Caecidotea buzwilsoni* **sp. nov.** Holotype male (CNCR 35528), total length 8.0 mm, A, male habitus. Paratype male (CNCR 35529) total length 7.6 mm, B, pereiopod I; C, pereiopod II; D, pereiopod III; E, pereiopod IV; F, pereiopod V; G, pereiopod VI; H, pereiopod VII. Scale bars: A = 2.0 mm, B–H 1.0 mm.

***Caecidotea buzwilsoni* sp. nov.**
(Figs 6–9)

Material examined: ***Holotype*** male (CNCR 35528), length 8.0 mm, Laguna de Yuriria, 20°13'11"N, 101°11'05"W, elev. 2275 m, Municipality Yuriria, Guanajuato, Mexico, 22 October 2019, coll. L. García-Vázquez and C. Pedraza-Lara.

Paratypes, male (CNCR 35529), length 7.6 mm, same data of collection and collectors, as holotype; dissected parts pereiopod I, pereiopod IV, pleopod II; dissected structures for right pleopod drawings I, III, IV and V in the specimen tube. 15 Males and 10 females (CNCR 35530).

Diagnosis. Male body length 3.2 width. Head trapezoidal, width 1.9 length, anterior margin straight; eyes large oval, length 2.0 width. Pleopod IV exopod suture transverse complete. Uropod endopod elongated, oval, length 2.2 width; exopod lanceolate, slender, length 2.7 width.

Description. Male (CNCR 35528) 8.0 mm (Fig. 6A); head width 1.9 length, anterior margin concave. Eyes present, oval, dark pigmented, length 2.0 width. Postmandibular lobes not produced. Subrectangular pereionites, ornamented with marginal setae.

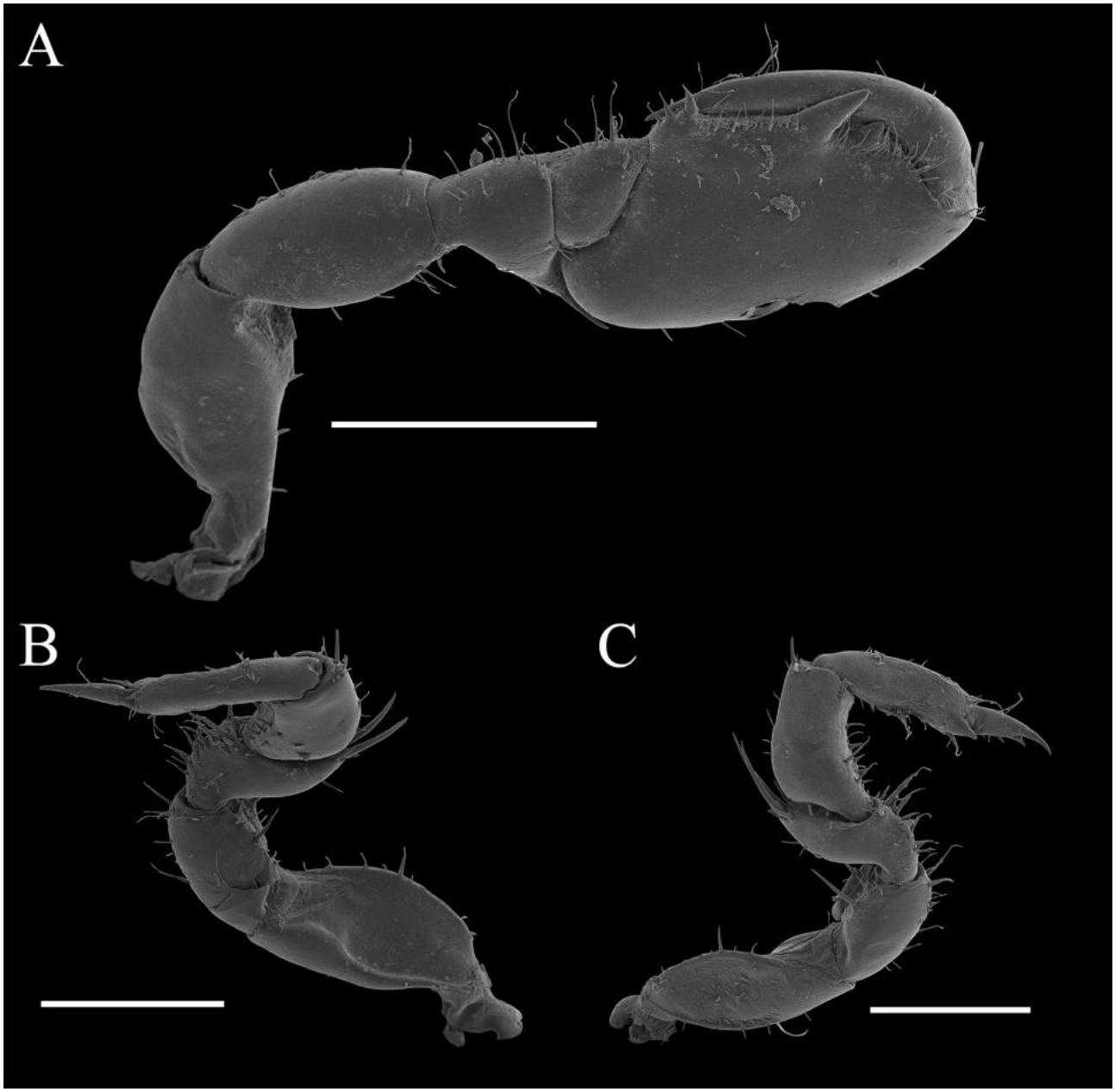

FIGURE 7. *Caecidotea buzwilsoni* **sp. nov.** Paratype male (CNCR 35529), total length 7.6 mm, A, right pereiopod I ventral view; B, pereiopod IV dorsal view; D, right pereiopod IV ventral view. Scale bars: A, C–D = 500 µm, B = 400 µm.

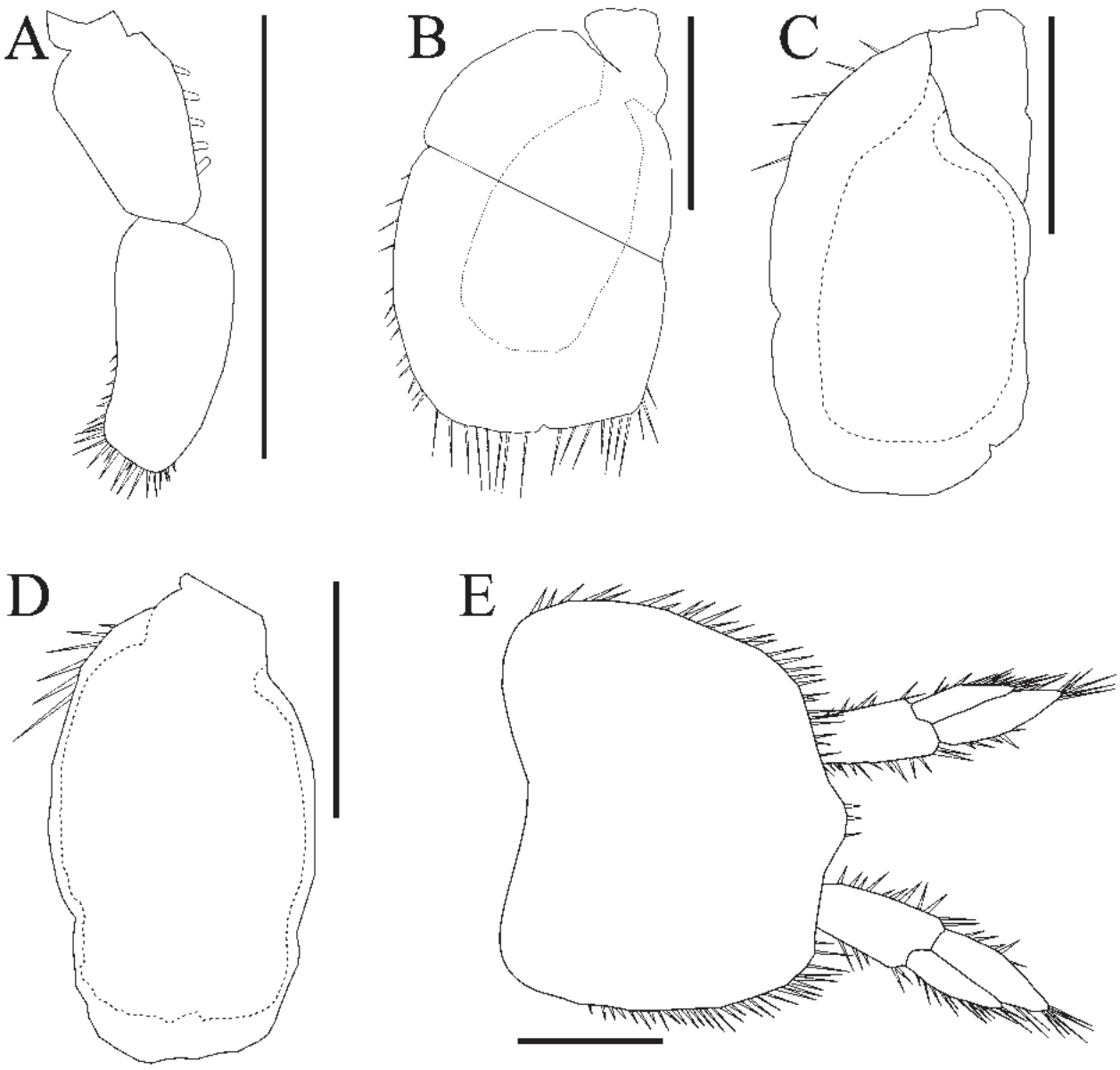

FIGURE 8. *Caecidotea buzwilsoni* **sp. nov.** Paratype male (CNCR 35529), total length 7.6 mm, A, pleopod I; B, pleopod III; C, pleopod IV; D, pleopod V; E, pleotelson and uropods. Scale bars: A–E = 1.0 mm.

Pereionite 1 length 1.2 pereionite 2 length; pereionites 6–7 wider, with diagonal margins, widening in posterior angle.

Antennula flagellum with 11 articles, longer than distal antenna podomere middle; last four segments with aestetascs in formula 1–1–1–1. *Antenna* flagellum with 67 articles; proximal article wider than long; following articles increasing in length.

Pereiopod I (Figs 6B, 7A), triangular propodus, dactylus curved, propodus palm longer than dactylus; palm with inner and outer edges, ornamented with simple setae; proximal process with 3 robust setae; mesial process acute, not exceeding dactylus width; distal process Subacute length 0.3 mesial process length. *Pereiopods II–III* (Figs 6C–D), with similar length. *Pereiopod IV* (Figs 6E, 7B–C), propodus with spine in dactylus; dactylus length 0.6 propodus length, with four spines on lower margin. *Pereiopod V* (Fig. 6F), basis length 1.3 propodus length. *Pereiopod VI* (Fig. 6G), similar length to pereiopod VII, basis length 1.2 propodus length. *Pereiopod VII* (Fig. 6H), length 0.7 body length.

Pleopod I (Fig. 8A) length 2.3 pleopod III length; protopod oval, proximal margin straight; protopod 1.7 width, inner margin with 5 retinacula, distal segment subrectangular, outer margin medially straight, length 2.0 width, margins with 23 simple setae.

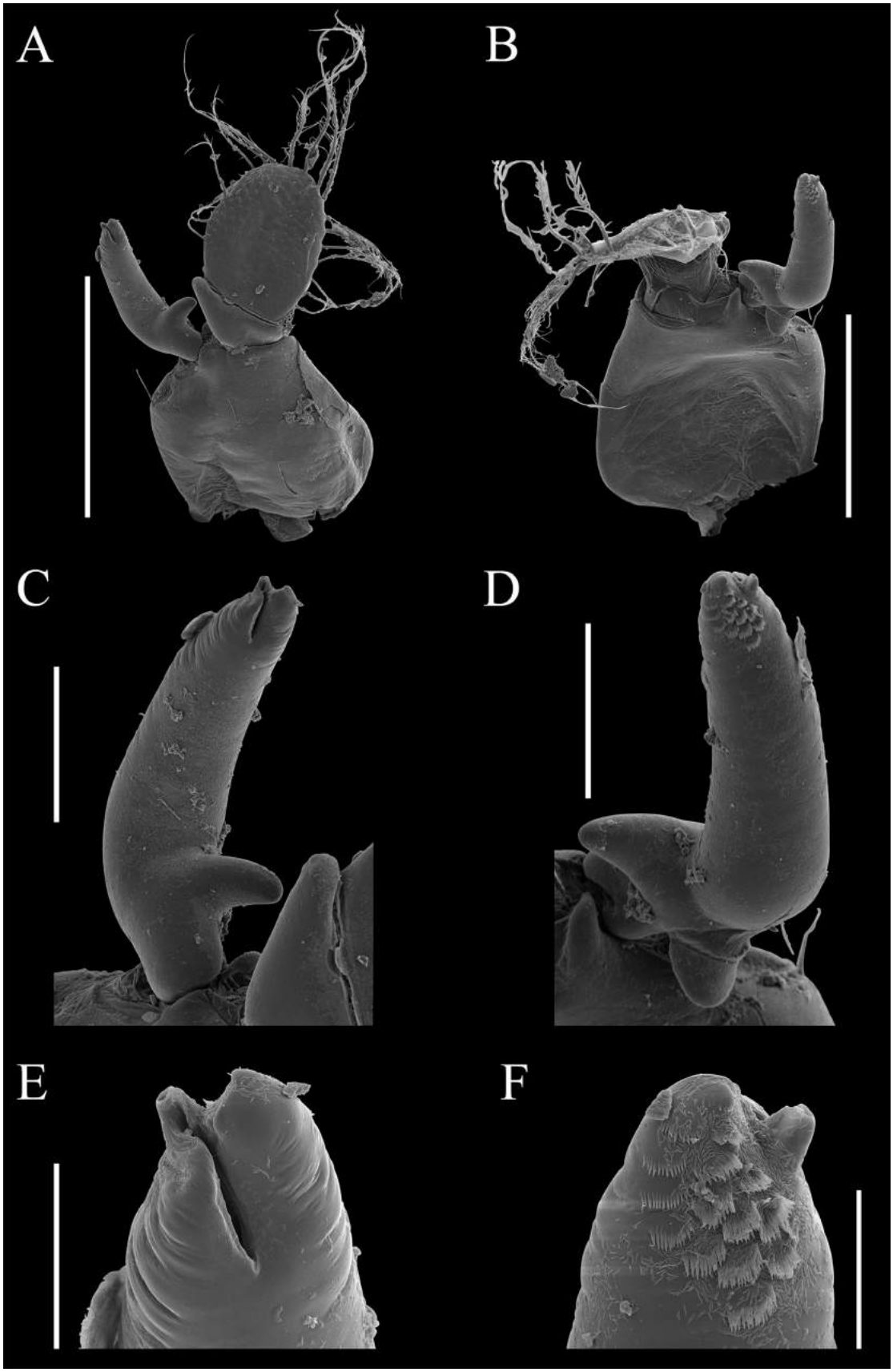

FIGURE 9. *Caecidotea buzwilsoni* **sp. nov.** Paratype male (CNCR 35529), total length 7.6 mm, A, pleopod II ventral view; B, pleopod II dorsal view; C, endopod pleopod II ventral view; D, endopod pleopod II dorsal view; E, apex of the endopod pleopod II ventral view; F, apex endopod pleopod II dorsal view. Scale bars: A = 400 μm, B = 300 μm, C–D = 100 μm, E = 40 μm, F= 30 μm.

Pleopod II (Fig. 9A–F), protopod subsquare, proximal edge rounded; in dorsal view, exopod base with one distal spine on inner edge, exopod oval with small cuticular scales directed distally on inner dorsal margin, exopod distal margin with 21 plumose setae; slender endopod, with pubescent surface, mesial portion curved, length 3.5 width, similar length to exopod 0.6 protopod length, internal and external process prominent, external with suture close to base, endopod apex with 3 processes: cannula conical, short, with truncated apex lower than caudal process, extending proximally from cannula more than 3.0 its length; mesial process evident; caudal process robust, conical, rounded apex, armed on subapical dorsal surface with 1–17 cuticular scales directed proximally; cuticular scales with pubescence, similar to short villi.

Pleopod III (Fig. 8B), exopod oval with distal margin setose, length 1.2 endopod length, width 1.8 endopod width, transverse suture in proximal half, 18 distal plumose setae, external margin 13 simple setae; endopod short oval, length 0.8 exopod length.

Pleopod IV (Fig. 8C), exopod oval, as long as 1.9 width, external proximal margin with transverse suture, close to pleopod joint; endopod 0.9 exopod length.

Pleopod V (Fig. 8D), exopod oval, length 1.8 width, transverse suture not evident; endopod length 0.9 length, width 0.9 exopod width.

Pleotelson (Fig. 8E), subsquare, width 1.2 length, lateral margins parallel, with simple setae, caudomedial lobe broad rounded.

Uropods (Fig. 8E), length 0.8 pleotelson length, armed with robust setae; endopod oval, as long as protopod; exopod length 0.9 protopod length.

Habitat. This species was collected between roots of the water lily *Eichornia crassipes*, which floated in a channel of approximately 2 meters wide by one meter deep.

Distribution. Known only from the type locality.

Etymology. This species is named in honor to Dr. George D. F. Wilson (Buz), Saugatuck Natural History Laboratory, in recognition to his career with the isopods and for being a mentor and for his friendship with the first author.

Remarks. *Caecidotea buzwilsoni* **sp. nov.** represents the first record of *Caecidotea* for the Mexican state of Guanajuato. Its morphology is similar to *Caecidotea zacapuensis* **sp. nov.** both species can be differentiated by the transverse suture of pleopod IV, which in *Caecidotea zacapuensis* **sp. nov.** is incomplete while in *Caecidotea buzwilsoni* **sp. nov.** is complete.

Caecidotea chicoensis **sp. nov.**

(Figs 10–13)

Material examined: *Holotype*, male (CNCR 35516), length 9.5 mm, National Park Mineral del Chico, spring behind the visitor center, 20°11’01”N, 98°42’57”W, elev. 2985 m, Municipality Mineral del Chico, Hidalgo, Mexico, 12 December 2018, coll. L. García-Vázquez and M. C. Jordán-Hernández.

Paratypes, male (CNCR 35517) length 9.5 mm; same data of collection and collectors as holotype; dissected parts pereiopod I, pereiopod IV, pleopod II; dissected structures for right pleopod drawings I, III, IV and V in the specimen tube. Females present in the same container.

Diagnosis. Male body 3 times its width. Head rectangular, width 2.7 length, anterior margin concave; eyes small, oblique oval, length 1.5 width, postmandibular lobes produced. Pleotelson lateral margins parallel, caudomedial lobe subacute produced. Pleopod II protopod ventral surface with cuticular scales on dorsal edge; exopod with ornamentation on ventral surface; endopod medial surface with elongated transverse striations. Uropods irregular, lanceolate.

Description. Male (CNCR 35516) 9.5 mm (Fig. 10A); head rectangular, width 2.7 times length, anterior margin concave. Eyes present, oval, dark pigmented, length 0.4 width. Postmandibular lobes produced. Subrectangular pereionites lateral margins straight with setae, as well as on dorsal surface.

Pereionite 1 length 1.0 pereionite 2 length; pereionite 1 0.9 pereionite 3 length; pereionites 6–7 with subrectangular margins, posterior narrowing.

Antennula flagellum with 11 articles, reaching distal antenna podomere middle, when projecting forward; last four segments with aestetascs in formula 0–1–1–1. *Antenna* flagellum with 67 articles; proximal article longer than wide, following articles decreasing in length.

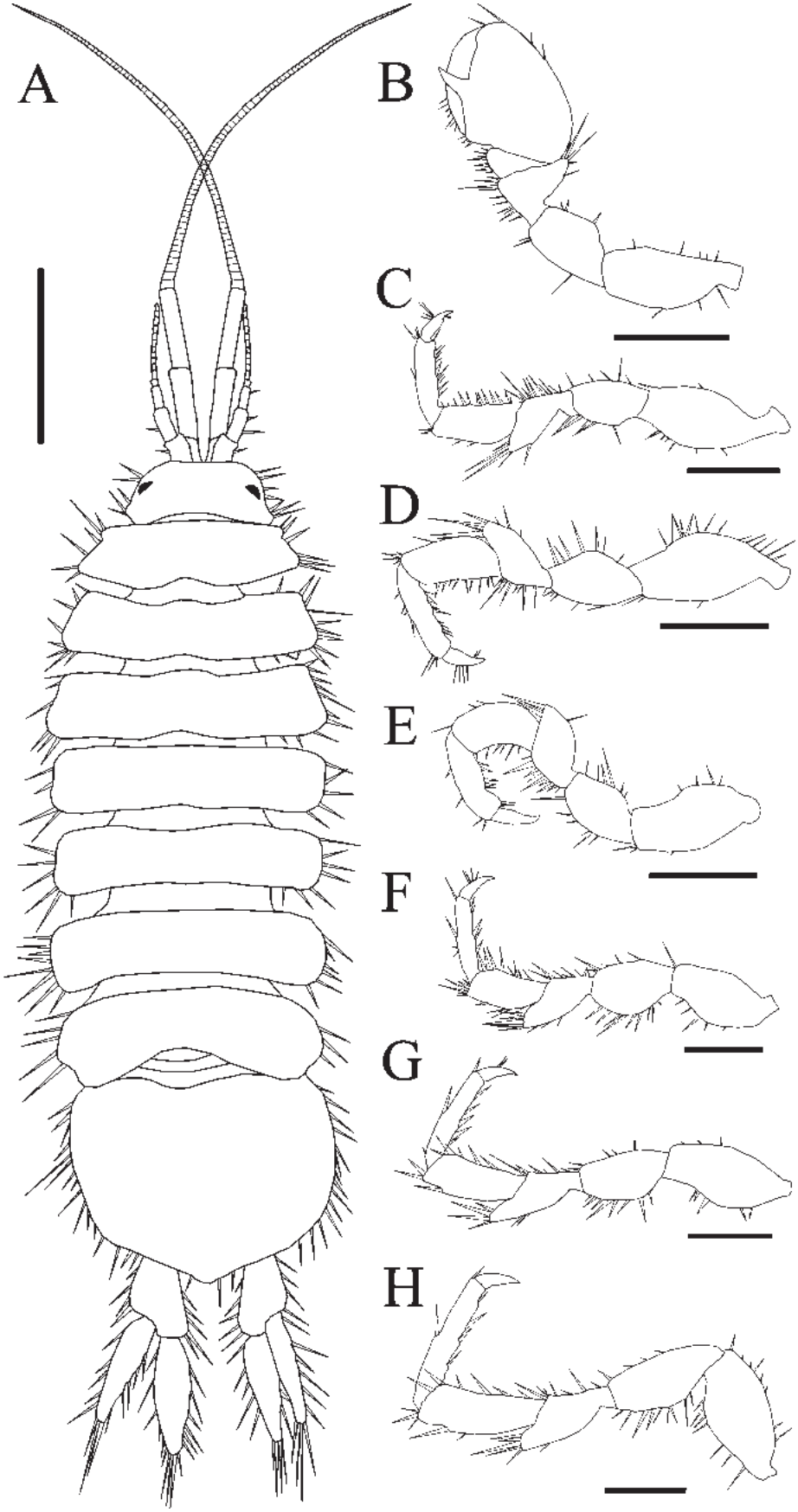

FIGURE 10. *Caecidotea chicoensis* **sp. nov.** Holotype male (CNCR 35516), total length 9.5 mm, A, male habitus. Paratype male (CNCR 35517) total length 9.5 mm, B, pereiopod I; C, pereiopod II; D, pereiopod III; E, pereiopod IV; F, pereiopod V; G, pereiopod VI; H, pereiopod VII. Scale bars: A= 2.0 mm, B–H = 1.0 mm.

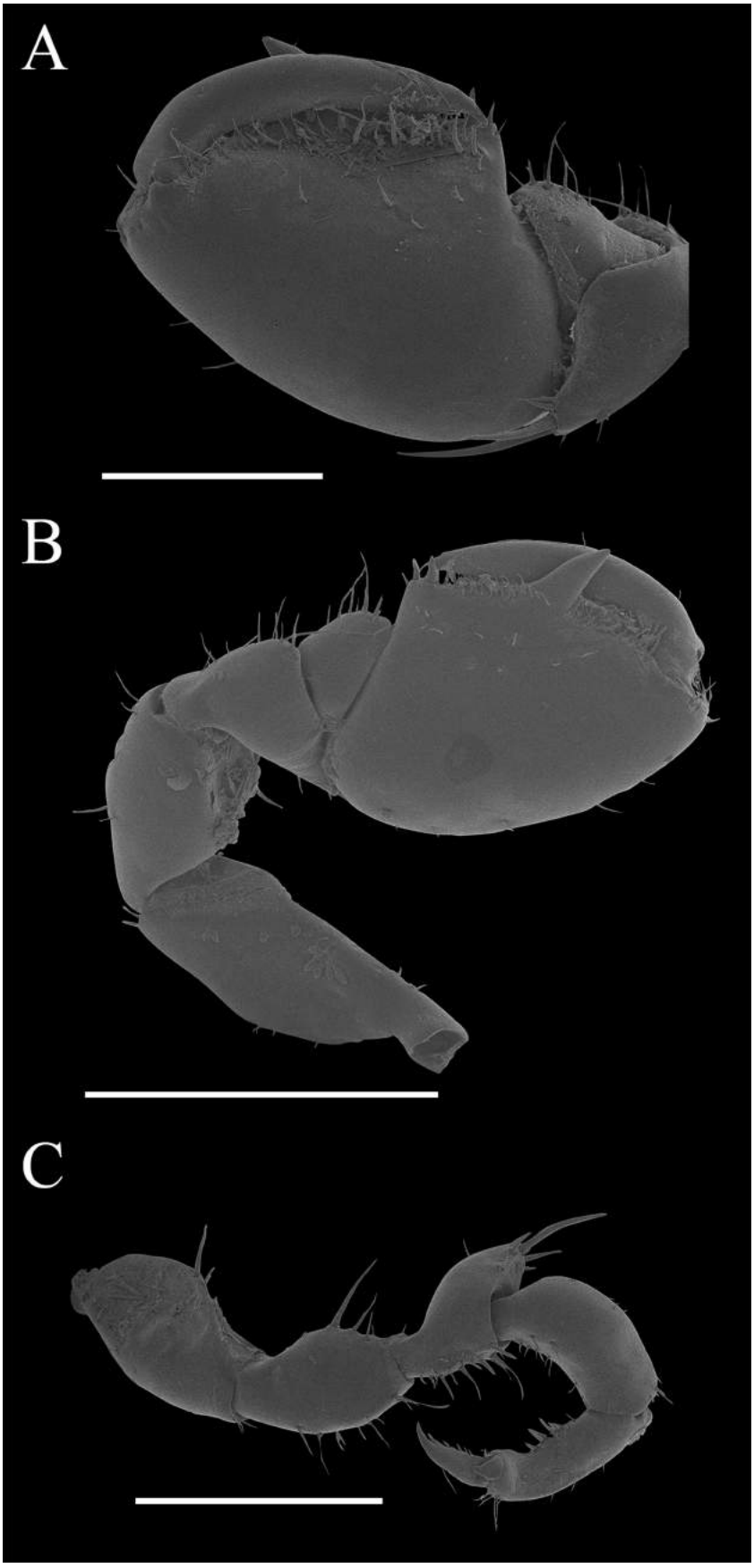

FIGURE 11. *Caecidotea chicoensis* **sp. nov.** Paratype male (CNCR 35517), total length 9.5 mm, right pereiopods, A, pereiopod I dorsal view; B, pereiopod I ventral view; pereiopod IV ventral view. Scale bars: A, C = 1.0 mm, B = 500 μm.

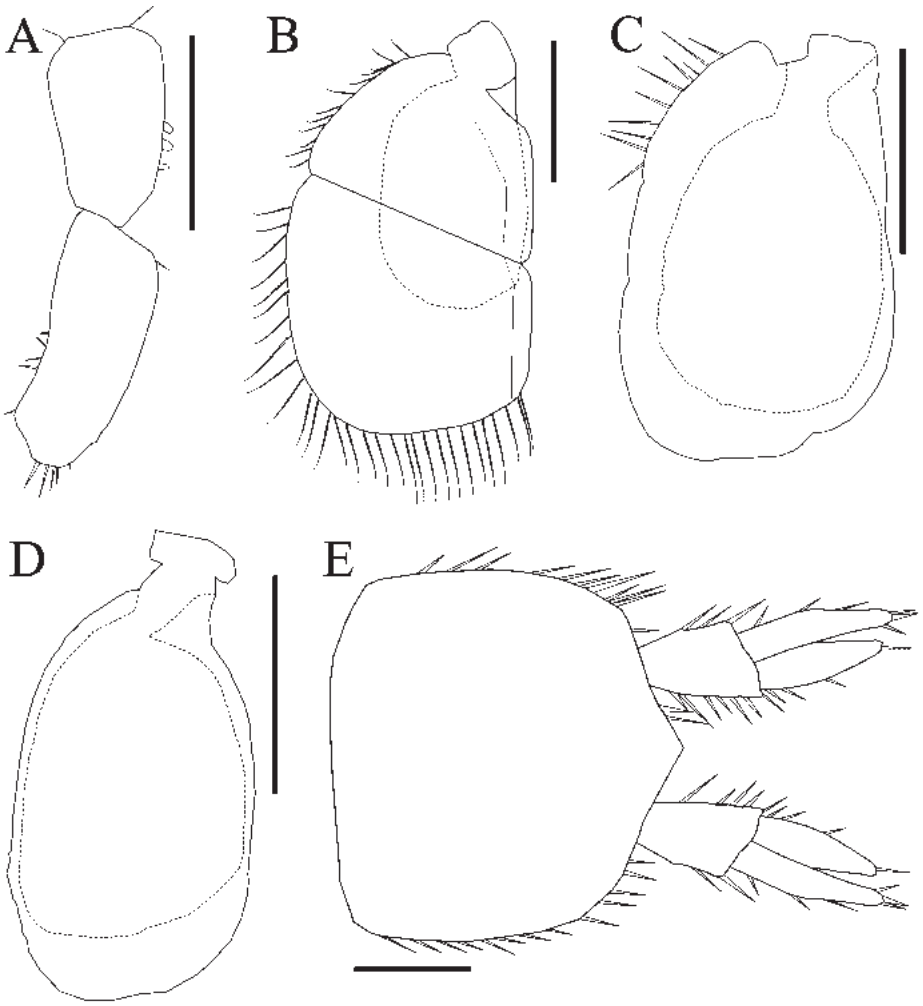

FIGURE 12. *Caecidotea chicoensis* **sp. nov.** Paratype male (CNCR 35517), total length 9.5 mm, A, pleopod I; B, pleopod III; C, pleopod IV; D, pleopod V; E, pleotelson and uropods. Scale bars: A–F = 1.0 mm.

Pereiopod I (Figs 10B, 11A–B) propodus slender triangular, dactylus outer edge with simple setae as long as palm, irregular inner edge; inner and outer palmar margin with row simple setae; proximal process with 3 robust setae; mesial process acute, exceeding dactylus width. *Pereiopods II–III* (Fig. 10C–D) similar length. *Pereiopod IV* (Figs 10E, 11C), propodus with spine in dactylus; dactylus robust; dactylus length 0.5 propodus length, lower margin with five strong spines. *Pereiopod V* (Fig. 10F), basis similar length to propodus. *Pereiopod VI* (Fig. 10G) as long as pereiopod VII, basis length similar to carpus length. *Pereiopod VII* (Fig. 10H) 1.2 body length.

Pleopod I (Fig. 12A) as long as pleopod II; protopod subrectangular, proximal margin rounded, length 1.6 width, inner margin with 3 retinacula, distal segment subrectangular, outer margin concave, length 2.6 times width, margins with 10 simple setae.

Pleopod II (Fig. 13A–F), protopod subrectangular, distal edge with cuticular scales; exopod base triangular with distal spines; exopod oval, with small cuticular scales, distal margin with 20–25 long plumose setae; slender endopod, as length 4.6 width, 1.1 exopod length 0.8 times protopod length, mesial surface curved, with irregular reticulations, internal and external process prominent; endopod apex with 3 processes: cannula subcylindrical, apex truncated with transverse striations on mesial surface, caudal process present; mesial process subtriangular, striated surface; caudal process robust, subconical, rounded apex, armed with 2–6 cuticular scales directed proximally.

Pleopod III (Fig. 12B), exopod oval with distal margin setose, length 1.4 endopod length, width 1.6 endopod width, transverse suture in proximal half, 20 plumose setae on distal margin, external margin with 40 simple setae; endopod short oval, 0.7 exopod length.

Pleopod IV (Fig. 12C), exopod length 1.6 width, external margin with 10 proximal setae; endopod length 0.9 exopod length.

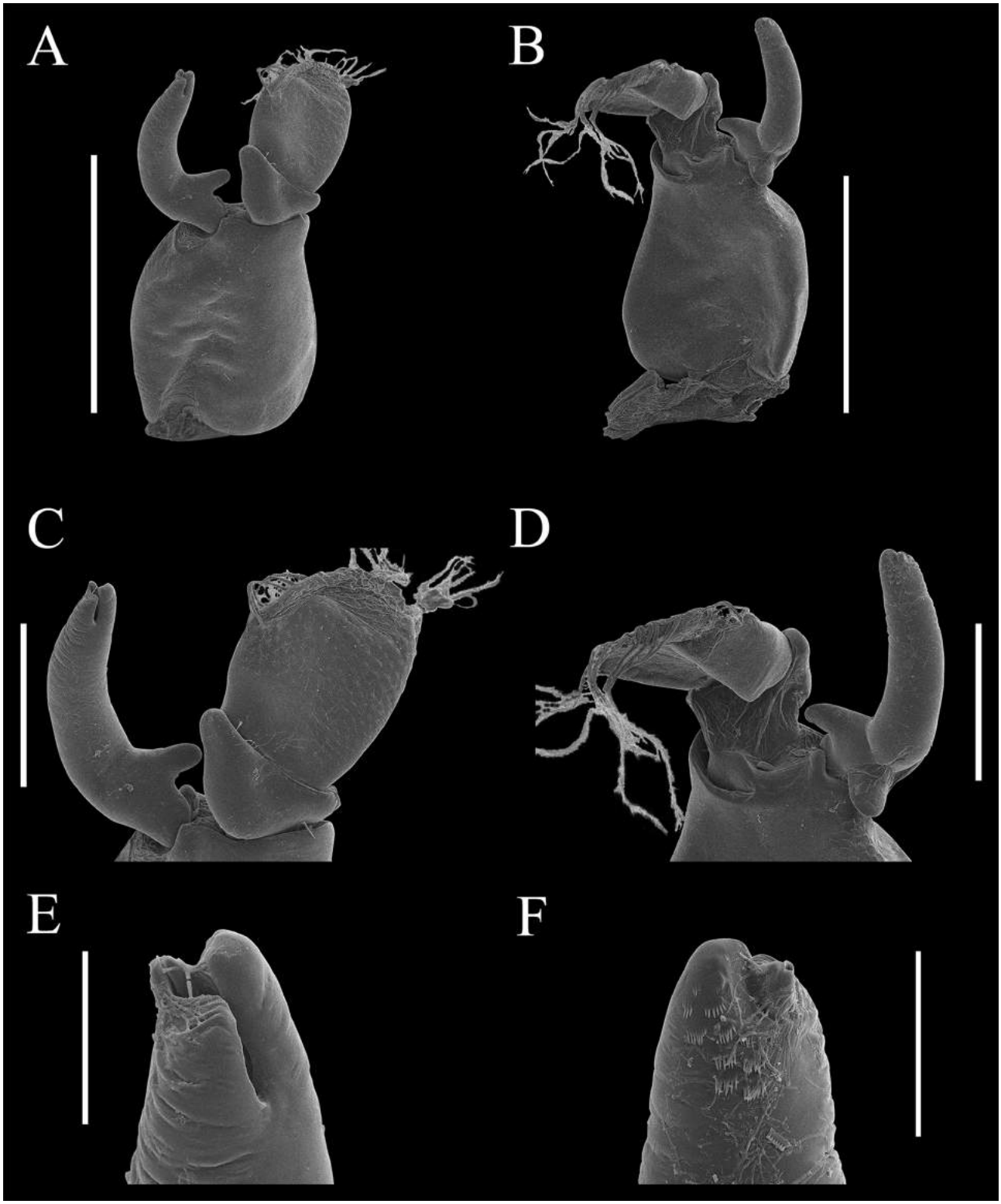

FIGURE 13. *Caecidotea chicoensis* **sp. nov.** Paratype male (CNCR 35517), total length 9.5 mm, A, pleopod II ventral view; B, pleopod II dorsal view; C, endopod pleopod II ventral view; D, endopod pleopod II dorsal view; E, apex of the endopod pleopod II ventral view; F, apex endopod pleopod II dorsal view. Scale bars: A–B = 50 µm, C = 200 µm, D = 100 µm, E–F = 50 µm

Pleopod V (Fig. 12D), exopod oval, length 1.9 width, transverse suture not evident; endopod length 0.9, width 0.9 exopod length.

Pleotelson (Fig. 12E), as wide as long, lateral margins parallel, rounded with several simple setae, caudomedial lobe produced subacute.

Uropods (Fig. 12E), subsquare, length 0.9 pleotelson width, armed with robust setae; endopod irregular, lanceolate, length 1.1 pleotelson length, exopod as long as protopod.

Habitat. The specimens of *Caecidotea chicoensis* **sp. nov.** were located in a small spring, approximately 1 meter in diameter, located behind the visitor center of Mineral del Chico National Park. The water that emerges from the spring runs through a small channel approximately 50 cm wide; algae growths and anuran larvae were also found.

Distribution. Only known from the type locality.

Etymology. This species is named after the Mineral del Chico National Park.

Remarks. *Caecidotea chicoensis* **sp. nov.** can be distinguished from other Mexican species of *Caecidotea* by the presence of elongated striations on the medial surface of pleopod II endopod.

***Caecidotea mintzita* sp. nov.**
(Figs 14–17)

Material examined: ***Holotype***, male (CNCR 35510), length 7.6 mm, Channel that flows next to the Mintzita spring, 19°38'53.74"N, 101°16'15.53"W, elev. 1892 m, Municipality La Mintzita, Michoacan, Mexico, 20 March 2018, coll. L. García-Vázquez and C. Pedraza-Lara.

Paratypes, male (CNCR 35511), length 7.0 mm; same data of collection and collectors as holotype; dissected parts pereiopod I, pereiopod IV, pleopod II; dissected structures for right pleopod drawings I, III, IV and V in the specimen tube. Females present in the same container.

Diagnosis. Male body length 3.7 times width; postmandibular lobes not produced; antennula flagellum exceeds last antennal segment, with pectinate setae in each article; antenna flagellum reaches anterior edge pereionite 6; antenna flagellum with 73 articles. Uropods 1.2 times pleotelson length.

Description. Male (CNCR 35511) 7.6 mm (Fig. 14A); head width 1.6 length, anterior margin concave. Eyes present, oval, dark pigmented, length 0.5 times longer than wide. Postmandibular lobes not produced. Subrectangular pereionites ornamented with lateral setae.

Pereionite 1 length 1.0 pereionite 2 length; pereionite 1 1.1 pereionite 3 length; pereionites 6–7 with subrectangular margins, widening posterior.

Antennula flagellum with 11 articles, reaching distal edge antenna podomere; last four segments with aestetascs in formula 1–1–1–1. *Antenna* flagellum with 73 articles with pectinate setae in each article; proximal article longer than wide; last 15 elongated.

Pereiopod I (Figs 14B, 15A–B) dactylus as long as palm, with simple setae; inner and outer palmar margin with row simple setae; proximal process with 3 robust setae; mesial process acute exceeding dactylus, distal process subacute; 0.5 mesial process length. *Pereiopods II–III* (Fig. 14C–D) similar length. *Pereiopod IV* (Figs 14E, 15C) propodus with spine in dactylus, robust 0.6 times dactylus width, dactylus length 0.6 propodus length, dactylus with row 3 strong spines. *Pereiopod V* (Fig. 14F) basis length 1.2 propodus length. *Pereiopod VI* (Fig. 14G) similar length to pereiopod VII, basis length 1.2 propodus length. *Pereiopod VII* (Fig. 14H) 0.6 body length.

Pleopod I (Fig. 16A) length 1.1 pleopod II length; protopod subrectangular, proximal margin rounded, length 1.5 width, inner margin with 4 retinacula, subrectangular distal segment, outer margin curved, length 2.0 width, margins with 21 simple setae.

Pleopod II (Fig. 17A–F), protopod subrectangular, proximal edge rounded, distal border with cuticular scales; exopod base with 2 spines in right upper corner; exopod oval with cuticular scales, distal margin with 20–22 plumose setae; slender endopod, mesial curved, length 3.9 width, exopod length 0.7 protopod length, internal and external process prominent, endopod apex with 3 processes: cannula conical, similar to a rolled blade; mesial process evident; caudal process robust, subconical, with rounded apex, armed on subapical dorsal surface with 4–18 cuticular scales.

Pleopod III (Fig. 16B), exopod oval with distal margin setose, length 1.1 endopod length, width 1.6 endopod width, transverse suture in proximal half, distal margin with 12 plumose setae, external margin with 34 simple setae; endopod short oval, 0.8 exopod length.

Pleopod IV (Fig. 16C), length 1.6 width, outer margin exopod with 6 proximal setae, endopod length 0.9 exopod length.

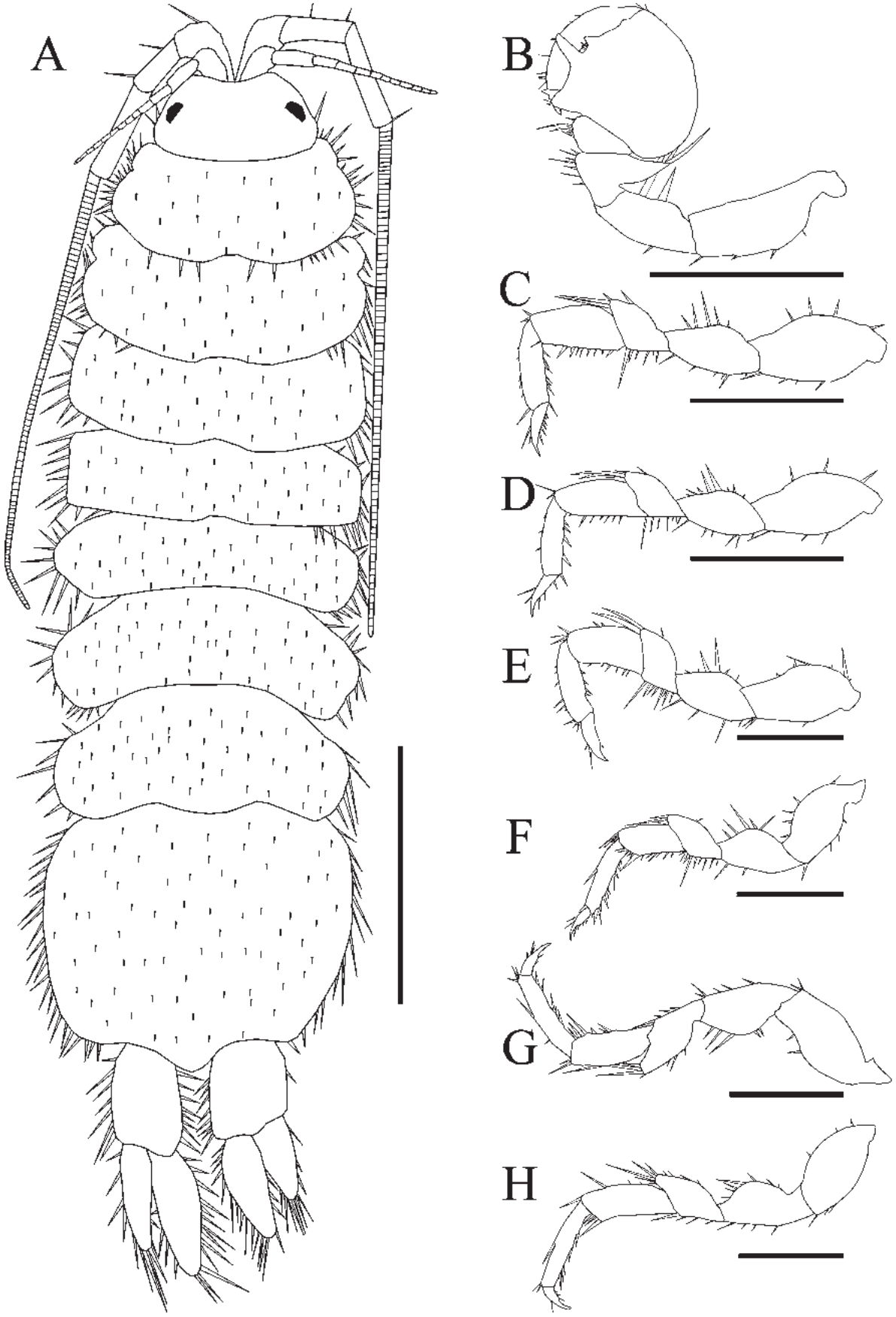

FIGURE 14. *Caecidotea mintzita* **sp. nov.** Holotype male (CNCR 35510), total length 7.6 mm, A, male habitus. Paratype male (CNCR 35511) total length 7.0 mm, B, pereiopod I; C, pereiopod II; D, pereiopod III; E, pereiopod IV; F, pereiopod V; G, pereiopod VI; H, pereiopod VII. Scale bars: A = 2.0 mm, B–H = 1.0 mm.

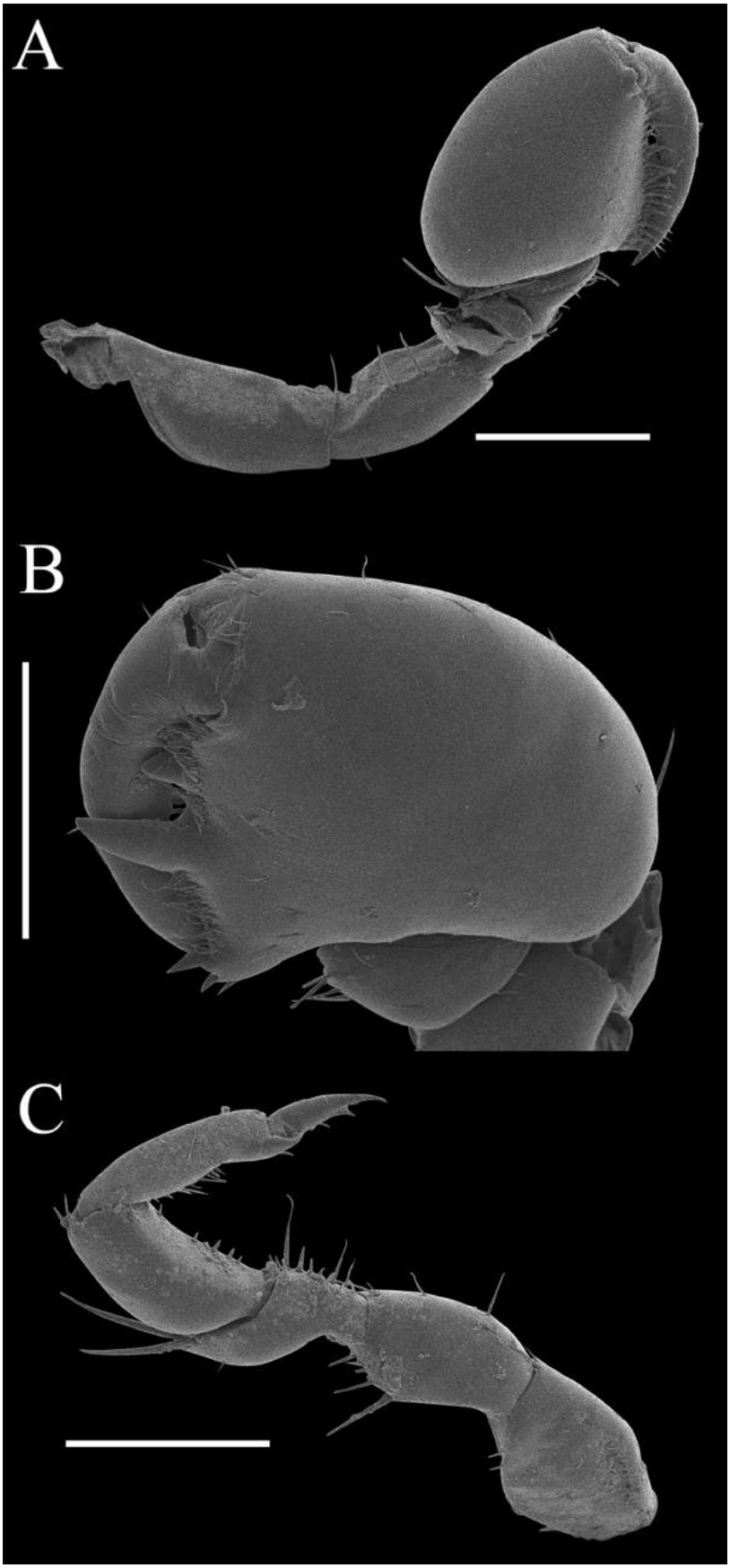

FIGURE 15. *Caecidotea mintzita* **sp. nov.** Paratype male (CNCR 35511), total length 7.0 mm, right pereiopods, A, pereiopod I dorsal view; B, pereiopod I ventral view; C, pereiopod IV ventral view. Scale bars: A, C = 500 μm, B = 400 μm.

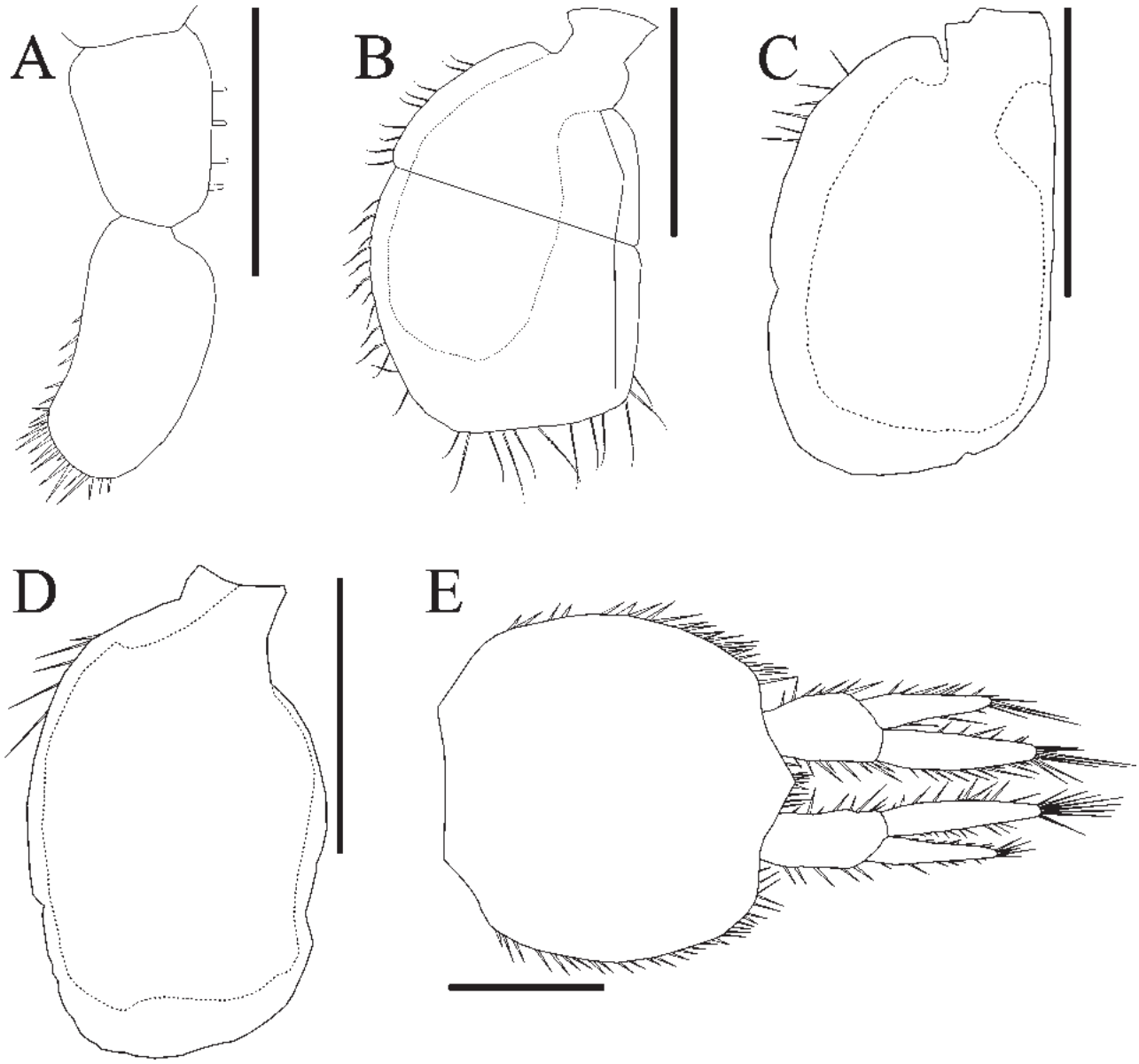

FIGURE 16. *Caecidotea mintzita* **sp. nov.** Paratype male (CNCR 35511), total length 7.0 mm, A, pleopod I; B, pleopod III; C, pleopod IV; D, pleopod V; E, pleotelson and uropods. Scale bars: A–E = 1.0 mm.

Pleopod V (Fig. 17D), exopod oval, as long as 1.9 width; transverse suture not evident; outer margin with 5 proximal setae, endopod as long 0.9 as wide exopod.

Pleotelson (Fig. 17E), subsquare, width 1.0 length, lateral margins curved, with several simple setae, caudomedial lobe subacute produced.

Uropods (Fig. 17E), 1.2 pleotelson length, armed with robust marginal setae; endopod length 1.3 exopod length; exopod as long as protopod.

Habitat. The specimens of *Caecidotea mintzita* **sp. nov.** were collected in a channel that flows next to La Mintzita spring, 60 cm wide and 40 cm deep, just below of submerged rocks and at the roots of the riparian vegetation.

Distribution. Only known from the type locality.

Etymology. This species is named after the Mintzita spring.

Remarks. *Caecidotea mintzita* **sp. nov.** is similar morphologically to the species *C. xochimilca* Rocha-Ramírez & Peñaloza-Daniel, 2011. The former species can be differentiated by the endopod apex cuticular scales conformation, which is 4–18 while in *C. xochimilca* 3–10 cuticular scales. The endopod length is 1.1 protopod length in *C. xochimilca* while in *Caecidotea mintzita* **sp. nov.** the endopod length 1.3 exopod length.

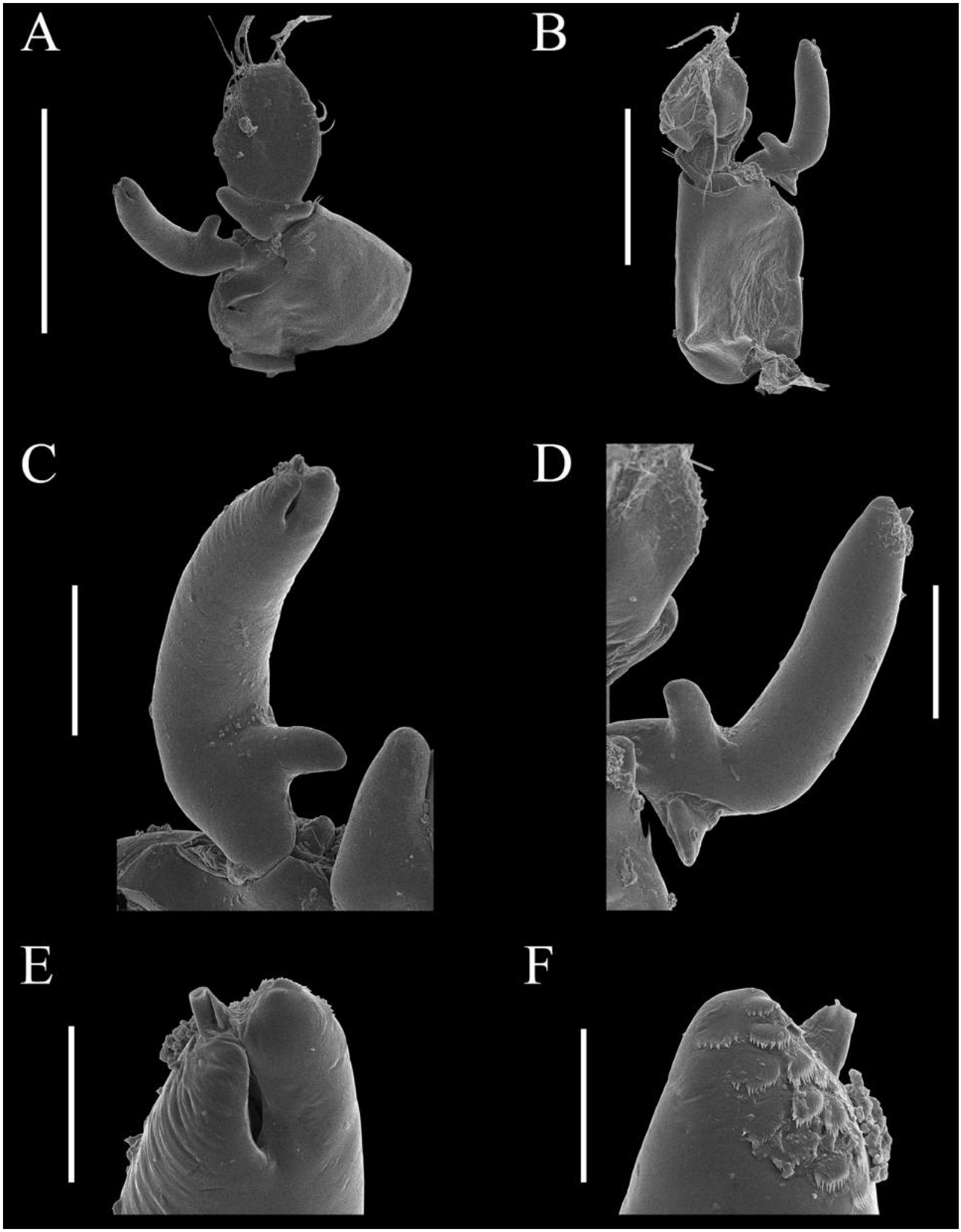

FIGURE 17. *Caecidotea mintzita* **sp. nov.** Paratype male (CNCR 35511), total length 7.0 mm, A, pleopod II ventral view; B, pleopod II dorsal view; C, endopod pleopod II dorsal ventral view; D, endopod pleopod II ventral view; E, apex of the endopod pleopod II ventral view; F, apex endopod pleopod II dorsal view. Scale bars: A = 400 μm, B = 300 μm, C = 100 μm, D = 40 μm, E = 30 μm.

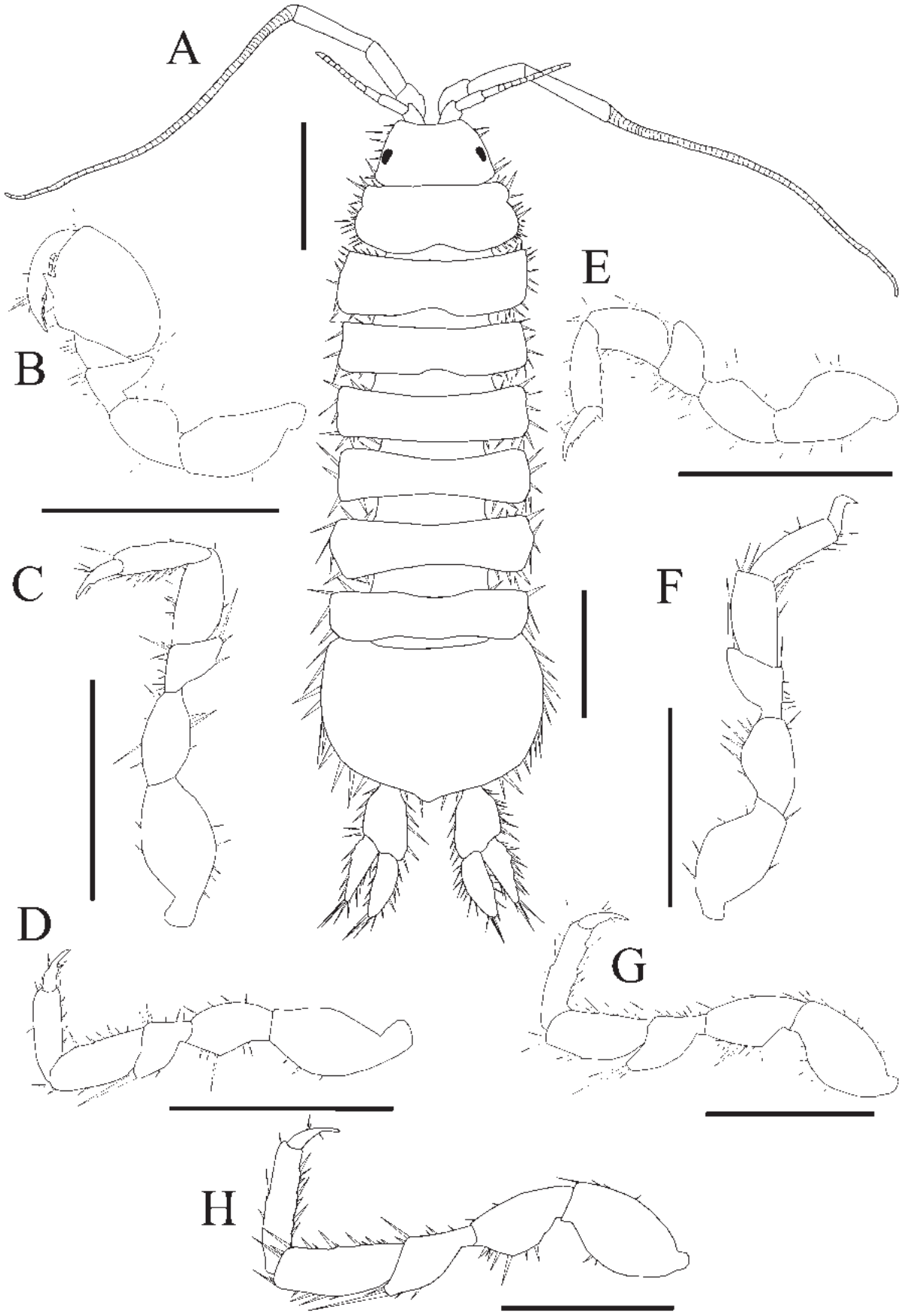

FIGURE 18. *Caecidotea villalobosi* **sp. nov.** Holotype male (CNCR 35506), total length 11 mm, A, male habitus. Paratype male (CNCR 35507) total length 10 mm, B, pereiopod I; C, pereiopod II; D, pereiopod III; E, pereiopod IV; F, pereiopod V; G, pereiopod VI; H, pereiopod VII. Scale bars: A = 2.0 mm, B–H = 1.0 mm.

***Caecidotea villalobosi* sp. nov.**
(Figs 18–21)

Material examined: ***Holotype***, male (CNCR 35506), length 11 mm; Lago de Catemaco, Coyame, 18°26'12"N, 95°01'27"W, elev. 359 m, Municipality Catemaco, Veracruz, Mexico, 2 November 2017, coll. L. García-Vázquez and C. Pedraza-Lara.

Paratypes, male (CNCR 35507), length 10.0 mm; same data of collection and collectors as holotype; dissected parts pereiopod I, pereiopod IV, pleopod II; dissected structures for right pleopod drawings I, III, IV and V in the specimen tube. 2 males and 3 females (CNCR 35508, CNCR 35509), Laguna Mahahual, 18°39'36"N, 95°18'30W, Municipality San Andrés Tuxtla, Veracruz, Mexico, coll. J. L. Villalobos, E. Moreno and I. Toledano.

Diagnosis. Male body 3.2 times longer than wide. Head width 1.4 length, anterior margin concave, lateral margins straight; eyes width 2.1 length, postmandibular lobes not produced; Pereiopod I with dactylus inner edge serrated; dactylus pereiopod IV serrated.

Description. Male (CNCR 35506) 11 mm (Fig. 18A); head trapezoidal, head width 1.4 length, anterior margin concave. Eyes present, oval, dark pigmented, width 2.1 length. Postmandibular lobes not produced. Subrectangular pereionites, lateral margins with setae.

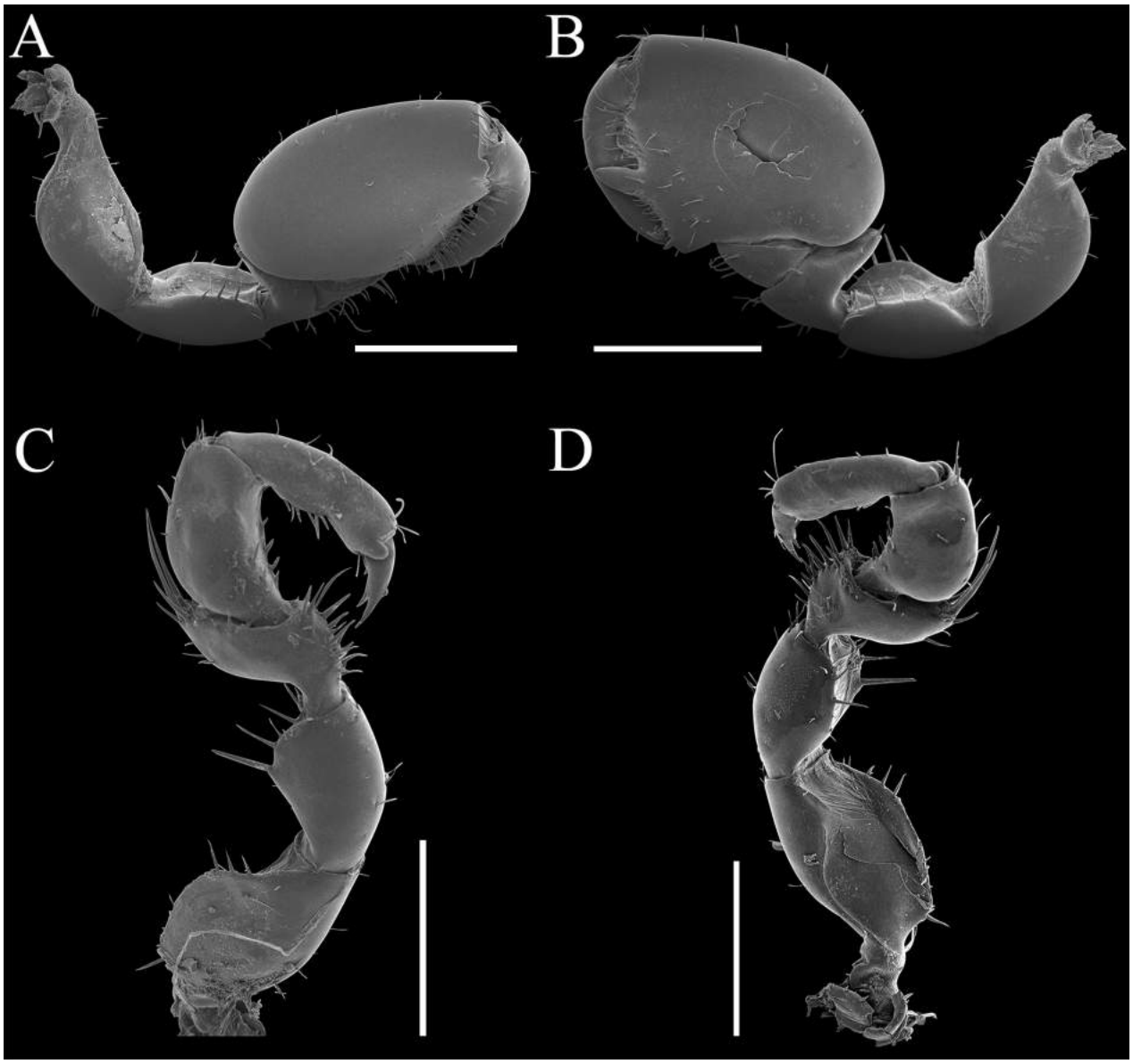

FIGURE 19. *Caecidotea villalobosi* **sp. nov.** Paratype male (CNCR 35507), total length 10 mm, A, right pereiopod I ventral view; B, right pereiopod I dorsal view; C, right pereiopod IV ventral view; D, right pereiopod IV dorsal view. Scale bars A–D = 500 µm.

Pereionite 1 length 0.9 pereionite 2 length; pereionite 1 1.1 pereionite 3 length; pereionites 6–7 with oval margins; posterior widening.

Antennula flagellum with 9 articles, longer than distal antenna podomere middle; last four segments with aestetascs with formula 1–0–1–0. *Antenna* flagellum with 57 articles with pectinate setae; proximal article longer than wide; following articles decreasing in length.

Pereiopod I (Figs 18B, 19A–B) dactylus with robust seta on dactylus, inner edge serrated; proximal process with 3 robust setae; acute mesial process not exceeding dactylus width, bicuspid distal process. *Pereiopods II–III* (Figs 18C–D) similar length. *Pereiopod IV* (Figs 18E, 19C–D), propodus with robust finger-like projection in dactylus, dactylus length 0.9 propodus length, dactylus serrated. *Pereiopod V* (Fig. 18F) length basis 1.4 propodus length, dactylus curved hooked. *Pereiopod VI* (Fig. 18G) smaller than pereiopod VII, basis length 1.3 propodus length, dactylus with spine on lower margin. *Pereiopod VII* (Fig. 18H) length 0.4 body length.

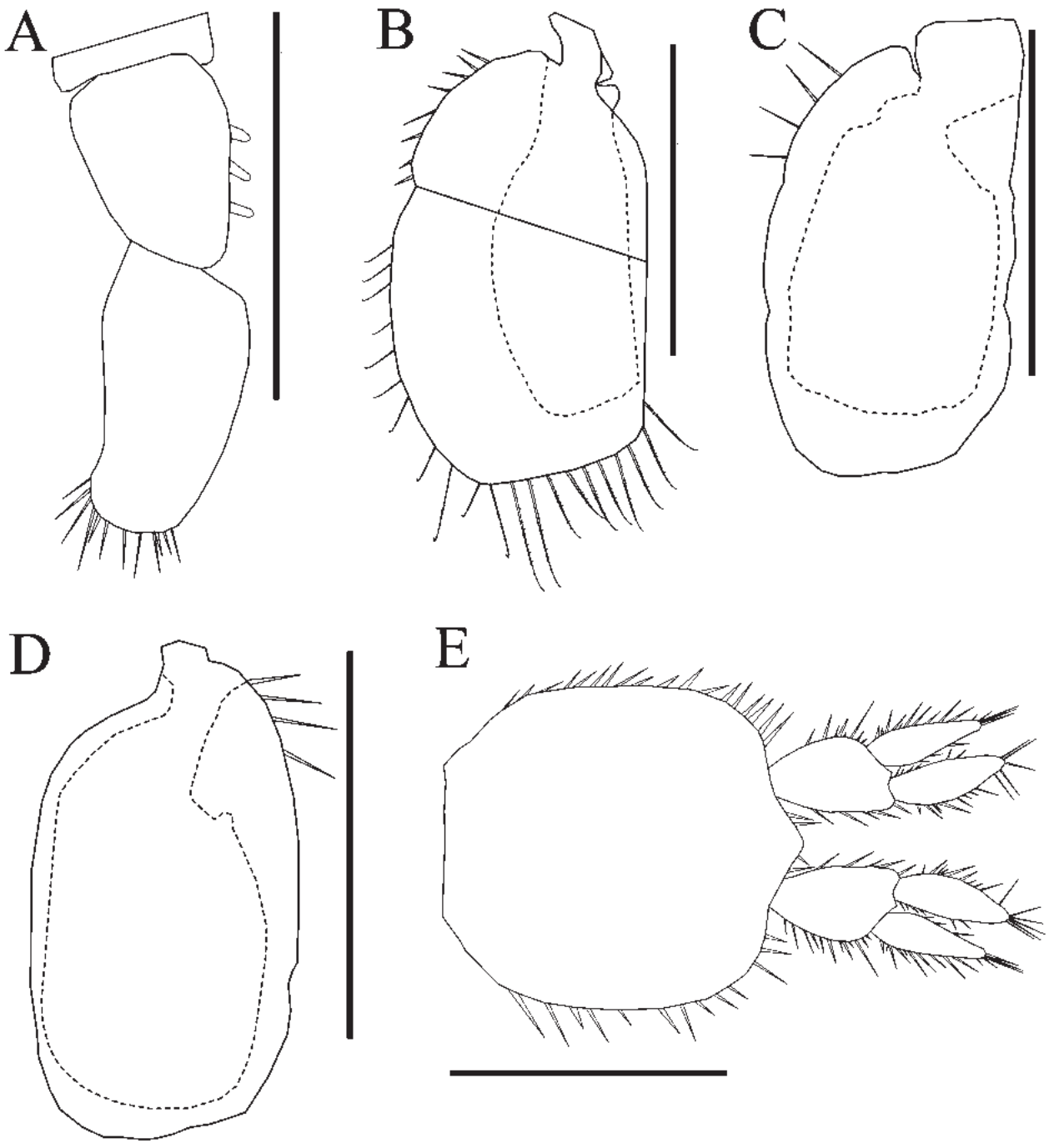

FIGURE 20. *Caecidotea villalobosi* **sp. nov.** Paratype male (CNCR 35507) total length 10 mm, A, pleopod I; B, pleopod III; C, pleopod IV; D, pleopod V; E, pleotelson and uropods. Scale bars: A–E = 1.0 mm.

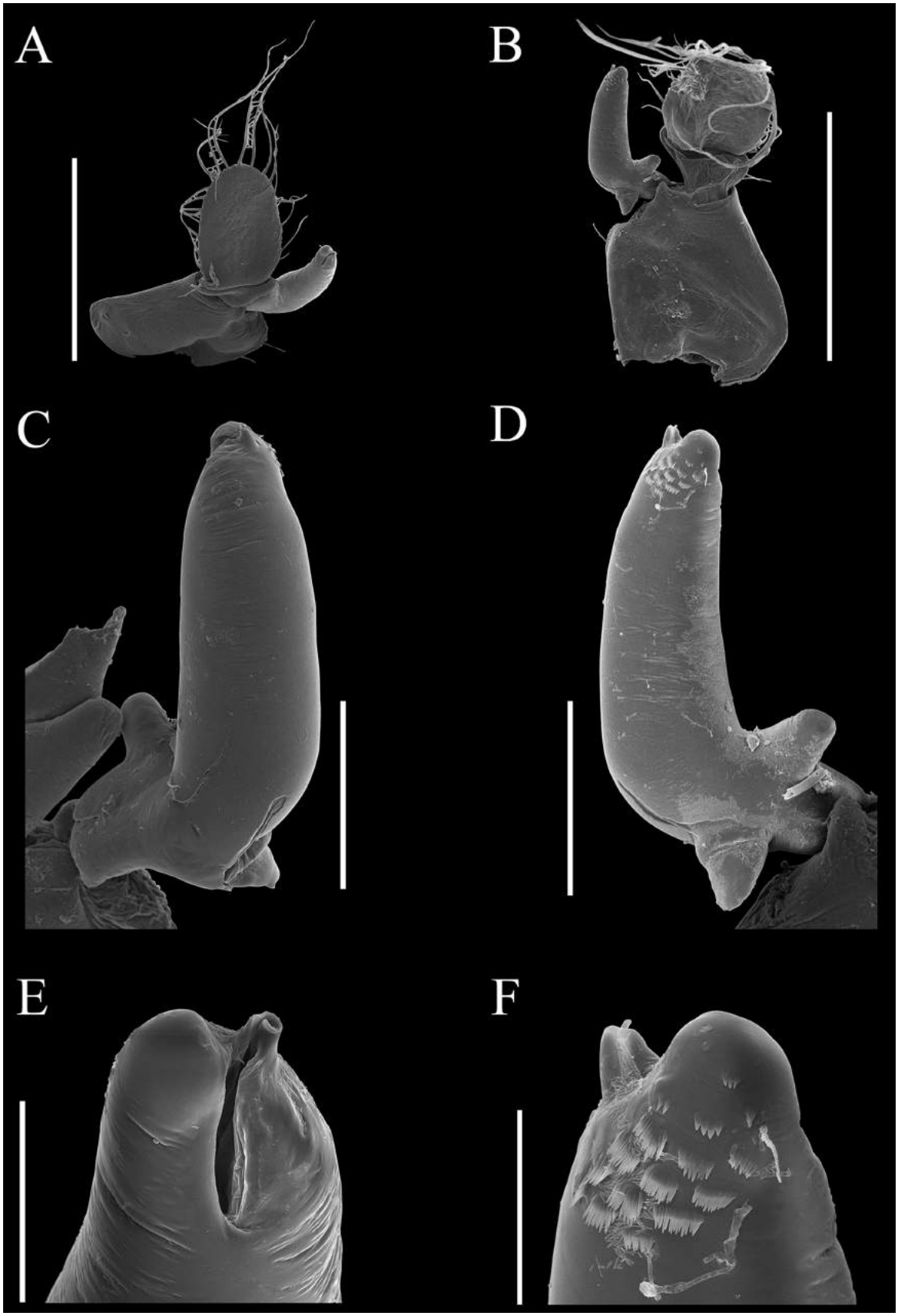

FIGURE 21. *Caecidotea villalobosi* **sp. nov.** Paratype male (CNCR 35507), total length 10 mm, A, pleopod II ventral view; B, pleopod II dorsal view; C, endopod pleopod II dorsal ventral view; D, endopod pleopod II ventral view; E, apex of the endopod pleopod II ventral view; F, apex endopod pleopod II dorsal view. Scale bars: A–B = 400 μm, C–D = 100 μm, E = 40 μm, F = 30 μm.

Pleopod I (Fig. 20A) length 1.1 pleopod II length; basal segment oval, proximal margin straight, length 1.3 width, internal margin with 3 retinacula, distal segment oval, outer margin curved in apical portion, length 1.8 width, margins with 12 simple setae.

Pleopod II (Fig. 21A–F), protopod subsquare, inner proximal edge straight, with simple short distal seta, dorsal distal edge with cuticular scales; exopod base with spine on right distal border, exopod oval, with rows cuticular scales, distal margin with 15–19 long plumose setae; slender endopod, as long as 3.5 width, exopod length 0.7 protopod length; inner surface curved; internal and external processes prominent, apex with 3 terminal processes: caudal process rounded, cannula short subcylindrical, with a circular apex; mesial process present; endopod subapical portion armed with 14–16 cuticular scales.

Pleopod III (Fig. 20B), exopod oval with distal margin setose, length 1.2 endopod length, width 1.9 endopod width, transverse suture in proximal half, 21 marginal plumose setae, external margin with 8 simple setae; endopod oval, 1.2 exopod length.

Pleopod IV (Fig. 20C), exopod length 1.5 width, external margin with 4 proximal setae, endopod length 1.1 exopod length.

Pleopod V (Fig. 20D), exopod oval, exopod length 1.9 width; external margin with 4 simple setae; transverse suture not evident; endopod notched on outer proximal edge, endopod width 1.2 exopod width.

Pleotelson (Fig. 20E), subsquare, width 1.1 length, lateral margins parallel, with simple setae, caudomedial lobe produced subacute.

Uropods (Fig. 20F), length 0.7 pleotelson length, armed with robust setae; endopod and exopod lanceolate, endopod length 1.0 exopod length, exopod length 1.1 protopod length.

Habitat. The *Caecidotea villalobosi* **sp. nov.** specimens were collected on the shore of Catemaco Lake, below rocks submerged in water, as well as on the roots of the water lily *Eichornia crassipes*. It is important to mention that this species is not abundant in the region.

Distribution. Known from the type locality and Laguna Mahahual, San Andrés Tuxtla, Veracruz.

Etymology. This species is named after Dr. José Luis Villalobos Hiriart for being an exemplary mentor for the first author and for being an exceptional carcinologist, as well as his contributions to the knowledge of Mexican crustaceans.

Remarks. Argano (1977) reported *C. communis* (Say, 1818) in the Catemaco lake in similar conditions where we collected *Caecidotea villalobosi* **sp. nov.**, between the roots of a water lily and under submerged rocks on the shore of the lake. Argano mentioned that *C. communis* has a wide distribution in Mexico and also takes up Bowman's (1975) hypothesis about an artificial introduction to Mexico due to human action. However, morphological comparisons with the species *C. communis sensu* Williams (1970), allow it to be clearly distinguished by the following characters: rounded head, anterior margin concave; pleotelson in *C. communis* is subcircular, as long as wide; caudomedial lobe obtuse produced; pleopod I wider and subrectangular, with 24 simple setae in distal margin, while *Caecidotea villalobosi* **sp. nov.** has 12 simple setae. The number of retinacula is 5 in *C. communis* while *Caecidotea villalobosi* **sp. nov.** has 3 retinacula; Regarding the apical elements of the pleopod II endopod, the cannula of *C. communis* is thin, simple, and elongated, surpassing the distal edge of the caudal process, which lacks cuticular scales. The cannula of *Caecidotea villalobosi* **sp. nov.** is short, subcylindrical, does not reach the distal edge of the caudal process and has cuticular scales.

***Caecidotea zacapuensis* sp. nov.**

(Figs 22–25)

Material examined: ***Holotype***, male (CNCR 35522), length 7.5 mm, Laguna de Zacapu, 19°49'37.00"N, 101°47'23.00"W, elev. 1993 m, Municipality Zacapu, Michoacan, Mexico, 20 March 2018, coll. L. García-Vázquez and C. Pedraza-Lara.

Paratypes, male (CNCR 35523), length 7.6 mm; same data of collection and collectors as holotype; dissected parts left pereiopod I, left pereiopod IV, pleopod II; dissected structures for right pleopod drawings I, III, IV and V in the specimen tube. 20 Males and 15 females (CNCR 35524).

Diagnosis. Male body length 3.4 width. Head trapezoidal, width 2.4 length, anterior margin concave; eyes length 3.8 width. Pleopod III with 36 plumose marginal setae. Exopod pleopod IV with proximal incomplete transverse suture. Uropods length 0.7 pleotelson length.

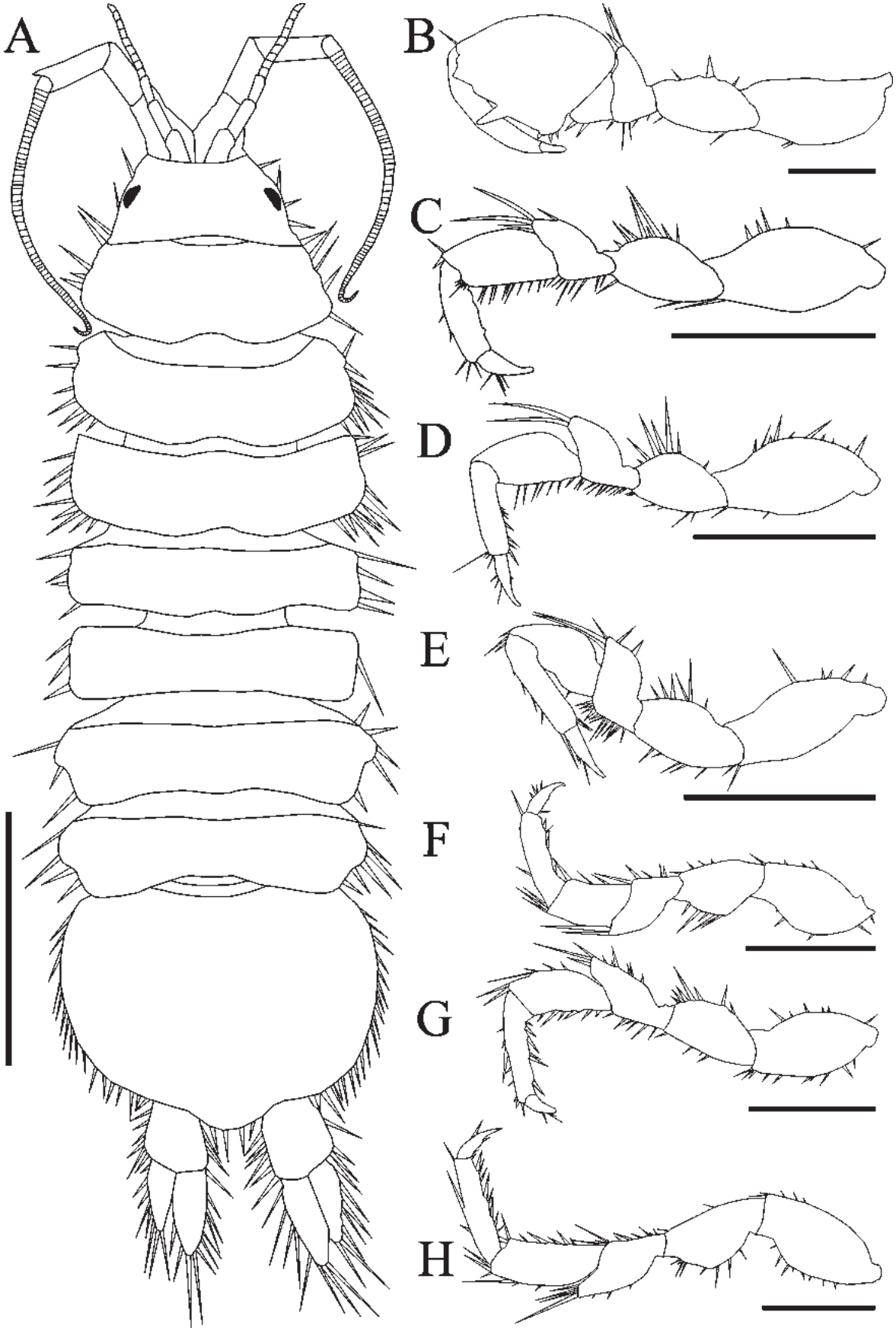

FIGURE 22. *Caecidotea zacapuensis* **sp. nov.** Holotype male (CNCR 35522), total length 7.5 mm, A, male habitus. Paratype male (CNCR 35523) total length 7.0 mm, B, pereiopod I; C, pereiopod II; D, pereiopod III; E, pereiopod IV; F, pereiopod V; G, pereiopod VI; H, pereiopod VII. Scale bars: A= 2.0 mm, B–H = 1 .0 mm.

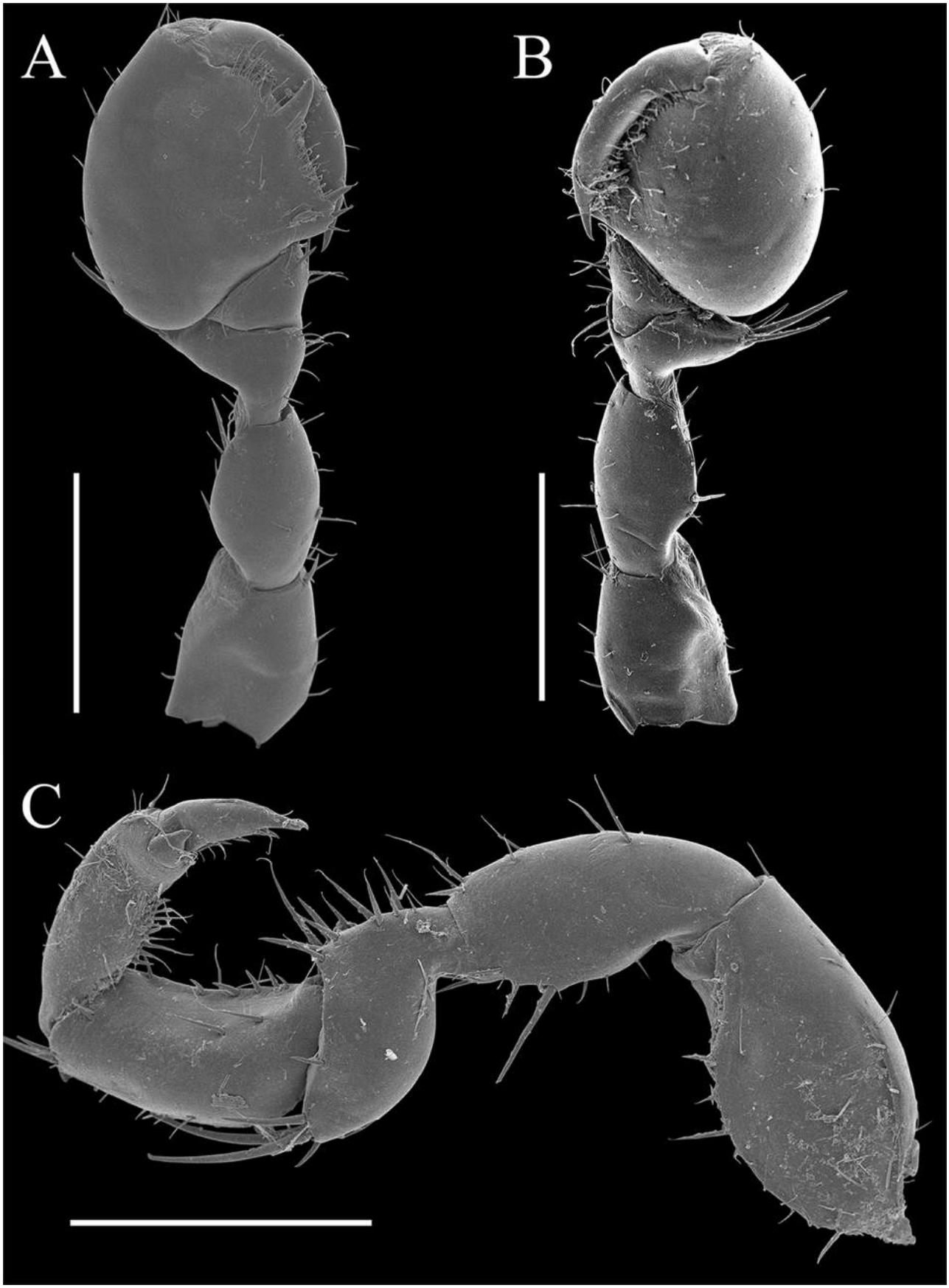

FIGURE 23. *Caecidotea zacapuensis* **sp. nov.** Paratype male (CNCR 35523), total length 7.0 mm, A, left pereiopod I ventral view; B, left pereiopod I dorsal view; C, left pereiopod IV ventral view. Scale bars: A–C = 500 µm.

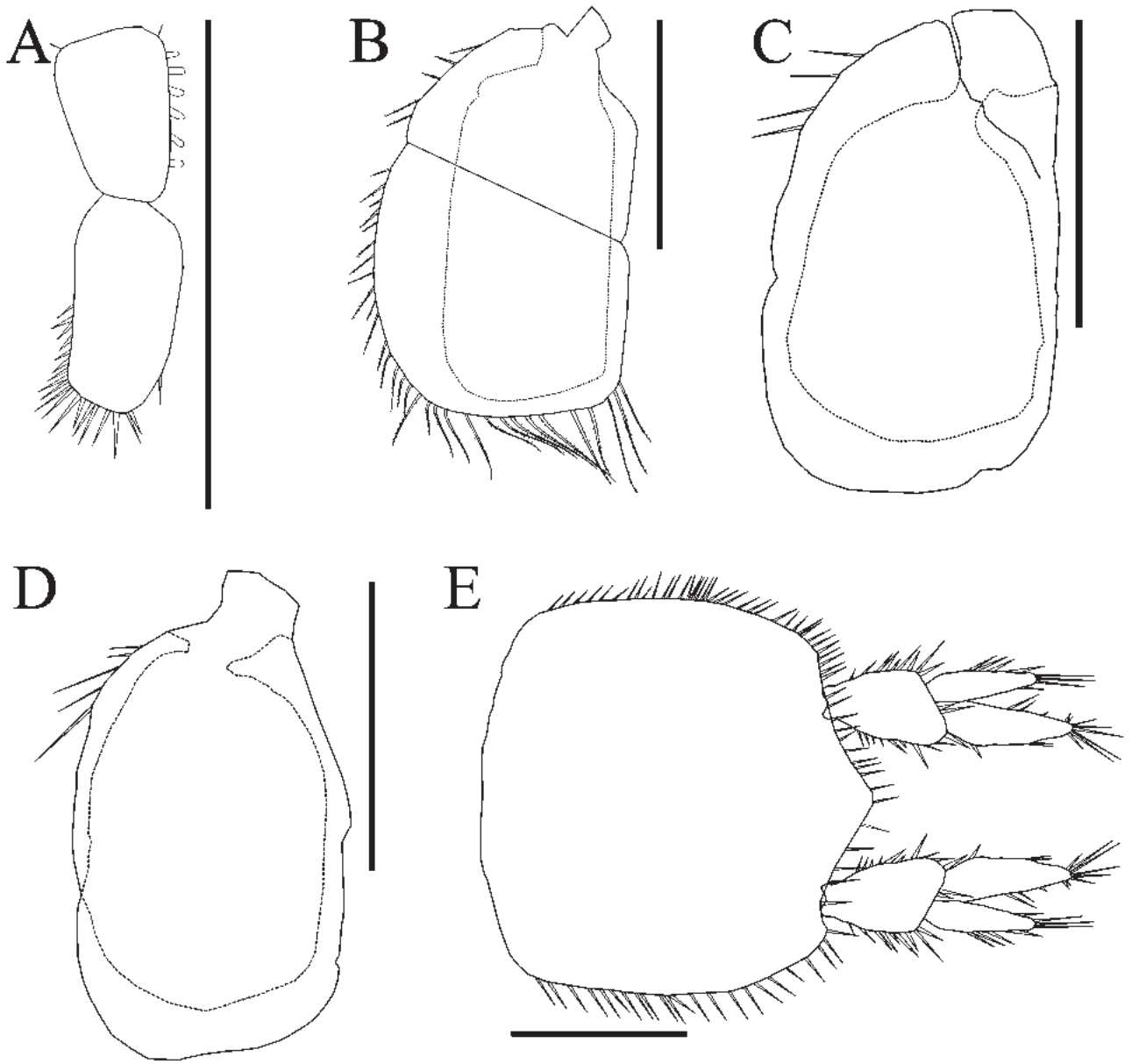

FIGURE 24. *Caecidotea zacapuensis* **sp. nov.** Paratype male (CNCR 35523), total length 7.0 mm, A, pleopod I; B, pleopod III; C, pleopod IV; D, pleopod V; E, pleotelson and uropods. Scale bars: A–E = 1.0 mm.

Description. Male (CNCR 35522) 7.5 mm (Fig. 22A); head trapezoidal, width 2.4 length, anterior margin concave; eyes present, oval, dark pigmented, length 3.8 width. Postmandibular lobes not produced. Subrectangular pereionites lateral margins with simple setae, pereionites 1–5 straight, pereionites 6–7 rounded.

Pereionite 1 length 1.2 pereionite 2 length; pereionite 1 1.1 pereionite 3 length; pereionites 6–7 with lateral margins rounded, widening posterior.

Antennula flagellum with 10 articles, longer than distal antenna podomere middle; last four segments with aestetascs in formula 1–0–1–1. *Antenna* flagellum with 65 articles; proximal article width 1.2 length; following articles decreasing in length.

Pereiopod I (Figs 22B, 23A–B) dactylus outer edge with 10 simple setae; dactylus longer than palm; palmar margin with row simple setae; proximal process with 3 robust spines; mesial process acute, as wide as dactylus; distal process small acute triangular. *Pereiopods II–III* (Fig. 22C–D) similar length. *Pereiopod IV* (Figs 22E, 23C) propodus with spine in dactylus, dactylus length 0.6 propodus length, dactylus with 4 slender spines on lower margin. *Pereiopod V* (Fig. 22F) basis length 1.2 propodus length. *Pereiopod VI* (Fig. 22G) similar length to pereiopod VII, basis length 1.3 propodus length. *Pereiopod VII* (Fig. 22H) length 0.6 body length.

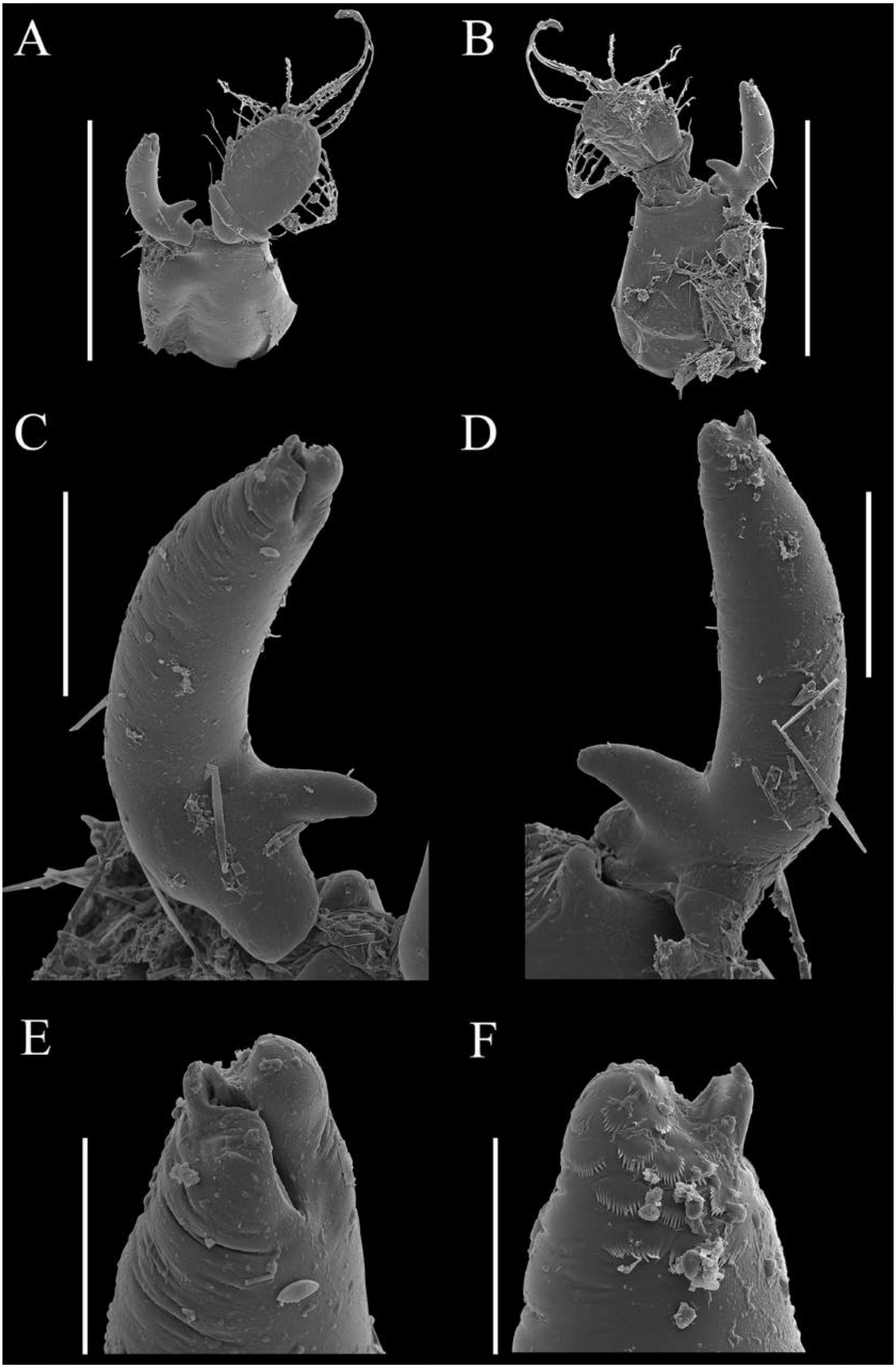

FIGURE 25. *Caecidotea zacapuensis* **sp. nov.** Paratype male (CNCR 35523), total length 7.0 mm, A, pleopod II ventral view; B, pleopod II dorsal view; C, endopod pleopod II dorsal ventral view; D, endopod pleopod II ventral view; E, apex of the endopod pleopod II ventral view; F, apex endopod pleopod II dorsal view. Scale bars: A–B = 500 μm, C–D = 100 μm, E = 50 μm, F = 40 μm.

Pleopod I (Fig. 24A) length 2.2 pleopod III length; basal segment oval, proximal margin straight, length 1.4 width, inner margin with 6 retinacula, distal segment oval, external margin medially straight, length 1.9 width, margins with 20 simple setae.

Pleopod II (Fig. 25A–F), protopod subrectangular, proximal edge rounded, internal margin with 2 simple spines; exopod oval with small cuticular scales on inner and outer margin, exopod margin with 22 plumose setae; endopod slender, curved mesial surface, length 3.2 width, length 0.9 exopod length, length 0.7 protopod length, internal and external processes prominent; endopod apex with 3 processes: cannula short subcylindrical surpassing caudal process, like a semi-rolled sheet; mesial process evident; caudal process robust, subconical, with rounded apex, armed on subapical dorsal surface with 2–17 cuticular scales.

Pleopod III (Fig. 24B), exopod oval, length 1.5 width, width 1.6 endopod length, transverse suture in proximal half, 36 plumose setae in distal and proximal margins; endopod subrectangular, length 0.9 exopod length.

Pleopod IV (Fig. 24C), exopod length 1.6 width, external proximal margin with incomplete transverse suture, close to pleopod joint; endopod length 0.8 exopod length.

Pleopod V (Fig. 24D), exopod oval, length 1.8 width, transverse suture not evident; endopod length 0.9 exopod length, width 0.8 exopod width.

Pleotelson (Fig. 24E), subsquare, length 1.0 width, lateral margins parallel, with simple marginal setae, caudomedial lobe produced subacute.

Uropods (Fig. 24E), length 0.7 pleotelson length, armed with robust marginal setae, apical endopod setae, exopod length 1.2 endopod length; protopod length 1.1 exopod length.

Habitat. This species was located on the shore of the Zacapu lake, between the roots of the aquatic vegetation, in the water lily *Eichornia crassipes*.

Distribution. Known only from the type locality.

Etymology. This species is named after the municipality Zacapu, where it inhabits.

Remarks. The pleopod IV of *Caecidotea zacapuensis* **sp. nov.** is similar to the one of *Caecidotea buzwilsoni* **sp. nov.** from Yuriria Lagoon. Both can be differentiated using the transverse suture in pleopod IV: incomplete in *Caecidotea zacapuensis* **sp. nov.**, and complete in *Caecidotea buzwilsoni* **sp. nov.**

Update on the distribution of the *Caecidotea* species in Mexico

A map (Fig. 26) was created from the records in this study, plus existing records from the literature for previously described species: *C. chiapas* Bowman, 1975, *C. pasquinii* (Argano, 1972), *C. vomeroi* Argano, 1977, *C. zullini* Argano, 1977, *C. camaxtli* García-Vázquez *et al.* 2019, *C. communis* (Say, 1818), *C. puebla* (Cole & Minckley, 1968), *C. williamsi* Escobar-Briones & Alcocer, 2002 and *C. xochimilca* Rocha-Ramírez & Peñaloza-Daniel, 2011. García-Vázquez, (2020) shows that *Caecidotea* species are mainly distributed over the TMVB in the central region of Mexico, reaching southeast Chiapas. The genus has not been recorded from Northern and Southeast of Mexico but its absence there should be confirmed with future sampling work directed to this fauna.

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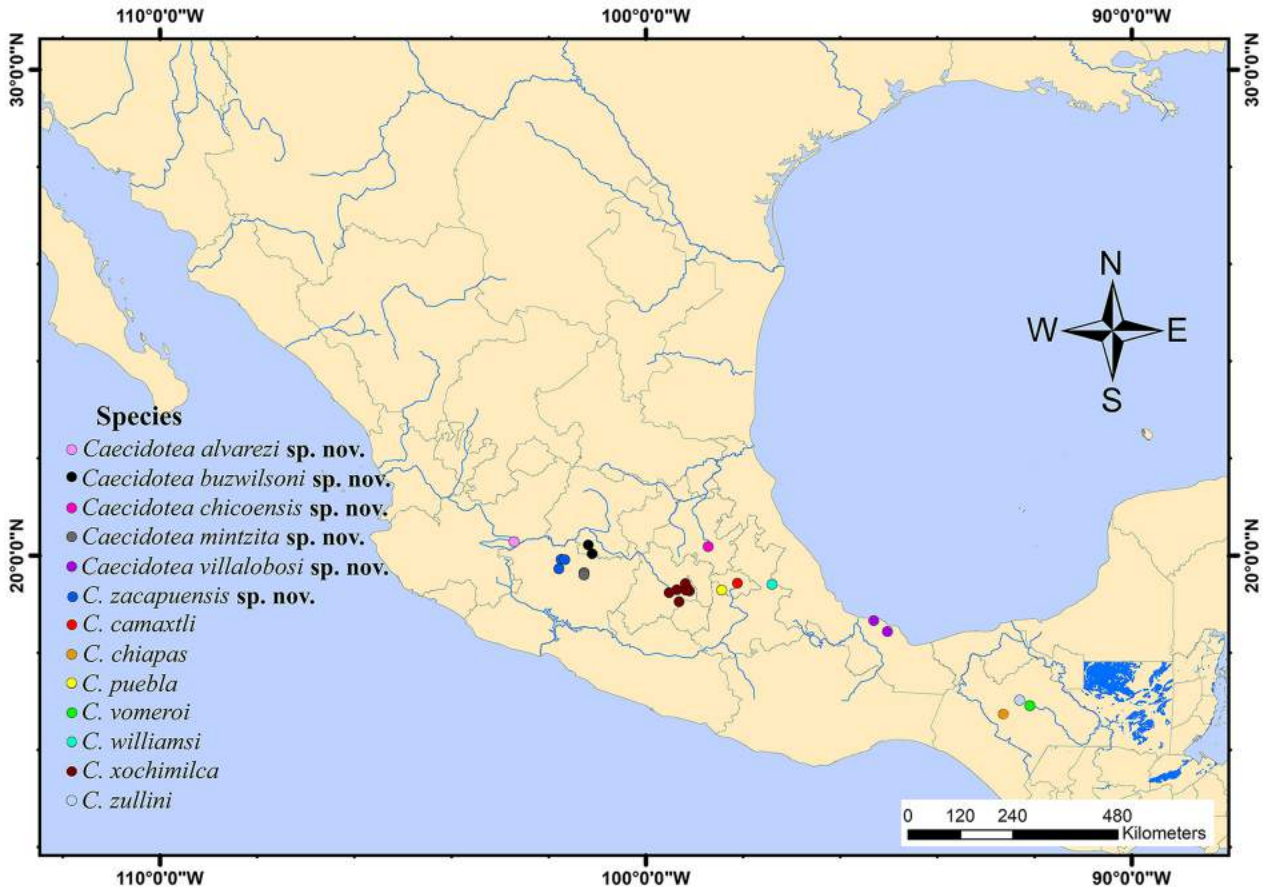

FIGURE 26. Distribution of the *Caecidotea* species in Mexico.

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