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A new species of *Ergasilus* (Copepoda: Cyclopoida: Ergasilidae) from coastal fishes of the Mexican Pacific

Eduardo Suárez-Morales[1] and **Ana María Santana-Piñeros**[2]

[1]El Colegio de la Frontera Sur (ECOSUR), Chetumal, Quintana Roo 77900, Mexico;

[2]Universidad del Mar, Campus Puerto Angel, Oaxaca 70902, Mexico

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Abstract. A new species of the cyclopoid copepod genus *Ergasilus* von Nordmann, 1832 is described based on adult female specimens removed from the gills of the yellow snapper *Lutjanus argentiventris* (Peters) and the yellowfin snook *Centropomus robalito* Jordan et Gilbert from a Pacific coastal system of Mexico. The new species *Ergasilus davidi* sp. n. has a combination of characters that includes a two-segmented first leg endopod, a three-segmented fourth leg endopod, and the presence of a single seta on the first antennular segment. These characters are shared with 14 other congeners known mainly from Brazil and North America. It differs from these other species in the armature and ornamentation of legs 1 and 4, the shape of the body, and the structure and ornamentation of the antennae. Additional characters include a maxillar basis armed with blunt teeth, distally bent maxillular setae, and naked margins of first exopodal segments of legs 2–4. Previous regional records of *Ergasilus* sp. from both fish species are probably assignable to *E. davidi*. The prevalence and intensity of infection was estimated for both teleost species and agrees to previous data. Based on other records of the genus from several other teleost species in the surveyed area and adjacent zones of the Eastern Pacific, it is presumed that the new species could have a wider range of hosts. The new species represents the first *Ergasilus* described from Mexican waters of the Pacific. Overall, the genus remains poorly known in Central America and Mexico.

The copepod family Ergasilidae von Nordmann, 1832 is one of the major families of the Cyclopoida (Ho et al. 1992, Boxshall and Montú 1997) and is known to contain 26 genera of forms that are ectoparasites of teleosts in freshwater, brackish, and coastal marine waters (Amado et al. 1995, El-Rashidy and Boxshall 1999). There are over 260 known species within the Ergasilidae and most of them are found in freshwater environments. The genus *Ergasilus* von Nordmann, 1832 includes more than 180 species (Boxshall and Halsey 2004), some of them causing serious damage among cultured fishes (Lin and Ho 1998). Only the adult female ergasilids are parasitic (Amado et al. 1995); all pre-adult stages and the adult males are planktonic forms that can be captured during plankton surveys. In some instances the local density of these parasites favours the occurrence of adult females in the water column (Amado and Rocha 2001, Boxshall et al. 2002).

The knowledge of the ergasilid fauna in the Americas is markedly patchy. Some geographical areas have been surveyed intensively for many years; together with the North American ergasilid fauna, the Brazilian fauna in South America is probably the best known in the Americas (see Roberts 1970, Thatcher and Boeger 1983, 1984). However, Central America and Mexico represent a large continental area in which the ergasilid fauna remains practically unstudied.

The yellow snapper *Lutjanus argentiventris* (Peters) (Lutjanidae) and the yellowfin snook *Centropomus robalito* (Jordan et Gilbert) (Centropomidae) represent valuable resources along the Mexican coast of the Pacific Ocean. The biology and parasitology of these and other tropical fish species is being studied in detail in different coastal systems (Moravec et al. 2007, Violante-González et al. 2007); one of these is the Chantuto-Panzacola lagoonal complex in the Mexican State of Chiapas. The parasite fauna of both teleost species was investigated and numerous specimens of an undescribed species of *Ergasilus* were collected. The new species is described and compared with the related species of this genus. Data are presented on the abundance, intensity, and prevalence of the infection.

MATERIALS AND METHODS

A total of 4 080 adult female copepods were recovered from the parasitological examination of 50 specimens of *L. argentiventris* and 61 of *C. robalito* from the Chantuto-Panzacola System, State of Chiapas, Mexico, between March 2006 and May 2007. Copepods were collected directly from the host by removing them from the gill arches with the aid of forceps under a stereomicroscope to avoid damaging the antennae. The specimens were fixed in 70% ethanol after a brief treatment with a saline solution. Some specimens were dissected under the stereomicroscope; drawings were prepared using a camera lucida mounted on an E-200 Nikon compound

Address for correspondence: E. Suárez-Morales, El Colegio de la Frontera Sur (ECOSUR), Av. Centenario Km. 5.5, Chetumal, Quintana Roo 77900, Mexico. Phone: ++52 983 835 0 440 × 4304; E-mail: esuarez@ecosur.mx

microscope. Copepod body and appendage terminology follows Boxshall et al. (2002). The use of ecological and infection rate indicators including abundance, intensity, and prevalence follows Bush et al. (1997). Type specimens were deposited in the collection of Zooplankton held at El Colegio de la Frontera Sur (ECOSUR), Unidad Chetumal (ECO-CHZ), Quintana Roo, Mexico, the Collection of Parasitic Helminths (ECO-PA) of the same institution, and the Institute of Parasitology, Academy of Sciences of the Czech Republic, České Budějovice, Czech Republic.

DESCRIPTION

Family Ergasilidae von Nordmann, 1832
Genus *Ergasilus* von Nordmann, 1832

Ergasilus davidi sp. n. Figs. 1–3

Description of female: Total body mean length 1.92 mm (range: 1.72–2.2 mm, n = 15) measured from anterior end of cephalothorax to posterior margin of anal somite. Prosome 5-segmented. Cephalosome robust in dorsal view, 1.4 times longer than wide (length: 1.1 ± 0.3 mm in average); antennule and antenna visible in dorsal view. First pedigerous somite wide, nearly twice as long as second. Second to fifth pedigerous somites tapering posteriorly (Fig. 1B). Urosome comprising short fifth pedigerous somite, rounded genital double-somite wider (0.47 mm in average) than long (0.41 mm), with row of spinules on dorsal and ventral surfaces, and three free somites. Anal somite incised medially, about as long as preceding somite, armed with row of spinules on ventral surface (Fig. 2C). Caudal rami subrectangular, almost twice longer than wide, armed with four setae, medial terminal one noticeably thicker than remaining caudal setae. Antennule 6-segmented, tapering distally, setal formula from proximal to distal segments: 1, 11, 5, 3, 2 + 1 aesthetasc, 5 + 1 aesthetasc (Fig. 2B). Antenna long, slender, 4-segmented, with short coxobasis plus 3-segmented endopod and strongly curved terminal claw. Coxobasis robust, surface finely pilose, otherwise unarmed. First endopodal segment slightly curved, about as long as succeeding segment, surface as in coxobasis, with hyaline, blunt process on subdistal position. Second endopodal segment curved, armed with strong spiniform, conical process on proximal 1/3 of segment and minute distal seta. Terminal claw strongly curved, relatively long, about half the length of preceding segment, with proximal pilose patch (Fig. 1C). Mandible with anterior blade slender, with strong bristles along anterior margin; middle blade curved, armed with row of flat, foliose, distally curved teeth along posterior margin; third blade with row of blunt teeth on posterior margin, teeth larger distally, anterior margin naked. Maxillule represented by single lobe armed with couple of rigid setae on outer margin; both setae with bent tips. Maxilla comprising large tapering syncoxa, unarmed; basis short, represented by subrectangular lobe provided with array of strong, blunt teeth distally and subdistal row of spines (Fig. 2A).

Swimming legs 1–4 biramous; all legs 3-segmented, except 2-segmented first endopod and fourth exopod (Fig. 3 A–D). Legs 1–3 with outer margin of both rami furnished with rows of small spinules, except first exopodal segments of legs 2–4. Coxal plate of legs 1–4 wide, furnished with spinules arranged in irregular pattern (Fig. 3E). Basis of all legs bearing slender outer basipodal seta. First leg with endopod longer than exopod, latter reaching about half length of distal endopodal segment. First endopodal segment slightly longer than second segment, which bears large patch of strong spinules along inner surface; spinule array with mixed blunt and acute elements. Group of blunt spinules forming rosette-like array at mid-length, on lateral margin of segment; this cluster of spinules not clearly distinguishable in all specimens examined (see Fig. 2D, E). Inner apical spine of second endopodal segment 2.2 times longer than outer spine. Outer margin of both endopodal and exopodal segments of legs 2–4 with row of short setules except for smooth first exopodal segment of legs 2–4.

Spine and setal formula as follows:

	Coxa	Basis	Exopod	Endopod
Leg 1	0-0	1-0	I-0; 0-1; III,4	0-1; II,4
Leg 2	0-0	1-0	I-0; 0-1; I,6	0-1; 0-2; I,4
Leg 3	0-0	1-0	I-0; 0-1; I,6	0-1; 0-2; I,4
Leg 4	0-0	1-0	0-0; I,5	0-1; 0-2; I,3

Fifth leg reduced, represented by single lobe armed with two unequal, smooth setae.

Male: Unknown.

Type host: The yellow snapper *Lutjanus argentiventris* (Peters, 1869) (Lutjanidae, Perciformes). This species dwells in coastal and shelf areas of the Eastern Pacific, from the Gulf of California to Peru.

Other hosts: The yellowfin snook *Centropomus robalito* Jordan et Gilbert, 1882 (Centropomidae, Perciformes), a coastal and brackish water species, distributed between the Gulf of California to Colombia.

Site of infection: Gills of both hosts.

Type locality: Chantuto-Panzacola lagoon system (14°43'–15°40'N, 92°26'–93°20'W), State of Chiapas, Mexican coasts of the Pacific Ocean.

Etymology: This species is named after David González-Solís for his solid contributions to the knowledge of the parasitic fauna of Mexico.

Host-parasite data: Prevalence of infection on *L. argentiventris*: 42% (n = 21); on *C. robalito*: 11.5% (n = 7). Mean abundance on *L. argentiventris*: 80.9 ± 144.6; on *C. robalito*: 0.3 ± 1.1. Mean intensity on *L. argentiventris*: 192.7 ± 168.2; on *C. robalito*: 2.3 ± 2.6.

Material examined: Holotype female, undissected, ethanol-preserved, from *L. argentiventris*, vial deposited in ECO-CHZ003576; paratypes ECO-CHZ003577, 5 females, 2 undissected, from same host slide mounted in glycerine, sealed with Entellan®; 4 paratype females from same host,

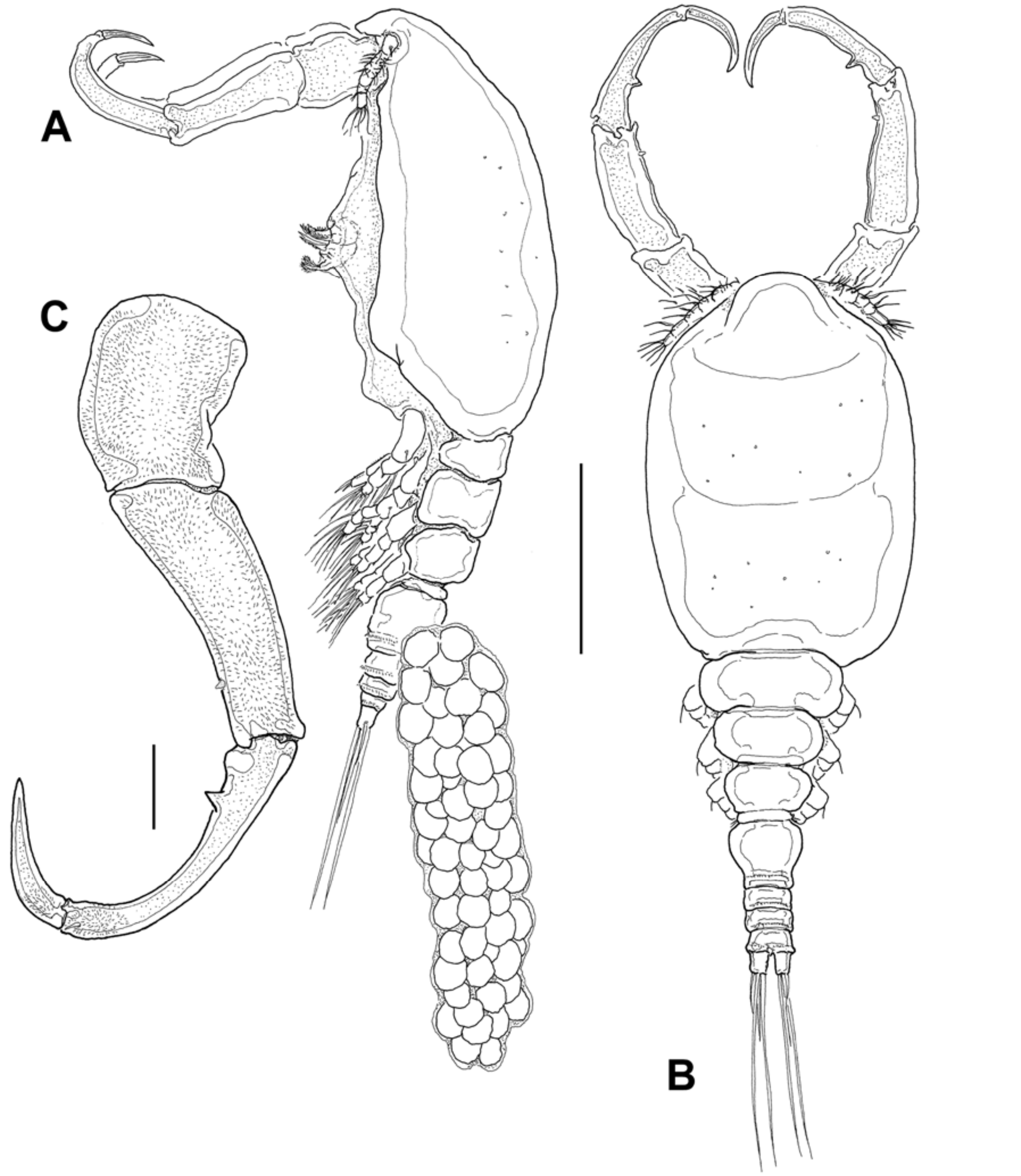

Fig. 1. *Ergasilus davidi* sp. n., adult female. **A** – habitus, lateral view; **B** – same, dorsal view; **C** – antenna. Scale bars: A, B = 400 μm; C = 50 μm.

two slides deposited in the Institute of Parasitology, Academy of Sciences of the Czech Republic, Czech Republic (Cat. No. Cr-9). Additional paratypes from *C. robalito*, 2 fe-males, undissected, semi-permanent slides mounted in glycerine, each deposited in ECO-CHZ003578 and ECO-PA-055. Additional specimens, including numerous females in original samples, deposited in the Laboratorio de Necton and Parasitología, El Colegio de la Frontera Sur, Chetumal, Mexico and Universidad del Mar, Campus Puerto Angel, Oaxaca.

Remarks

The specimens examined were identified as belonging to the genus *Ergasilus* owing to their possession of the diagnostic characters described by Hewitt (1978) and Boxshall and Montú (1997), including a biramous leg 4 with a 2-segmented exopod and 3-segmented endopod, 6-segmented antennule, antenna with a single claw, reduced maxillae, and maxillipeds absent in females. The new species, *E. davidi*, shows a combination

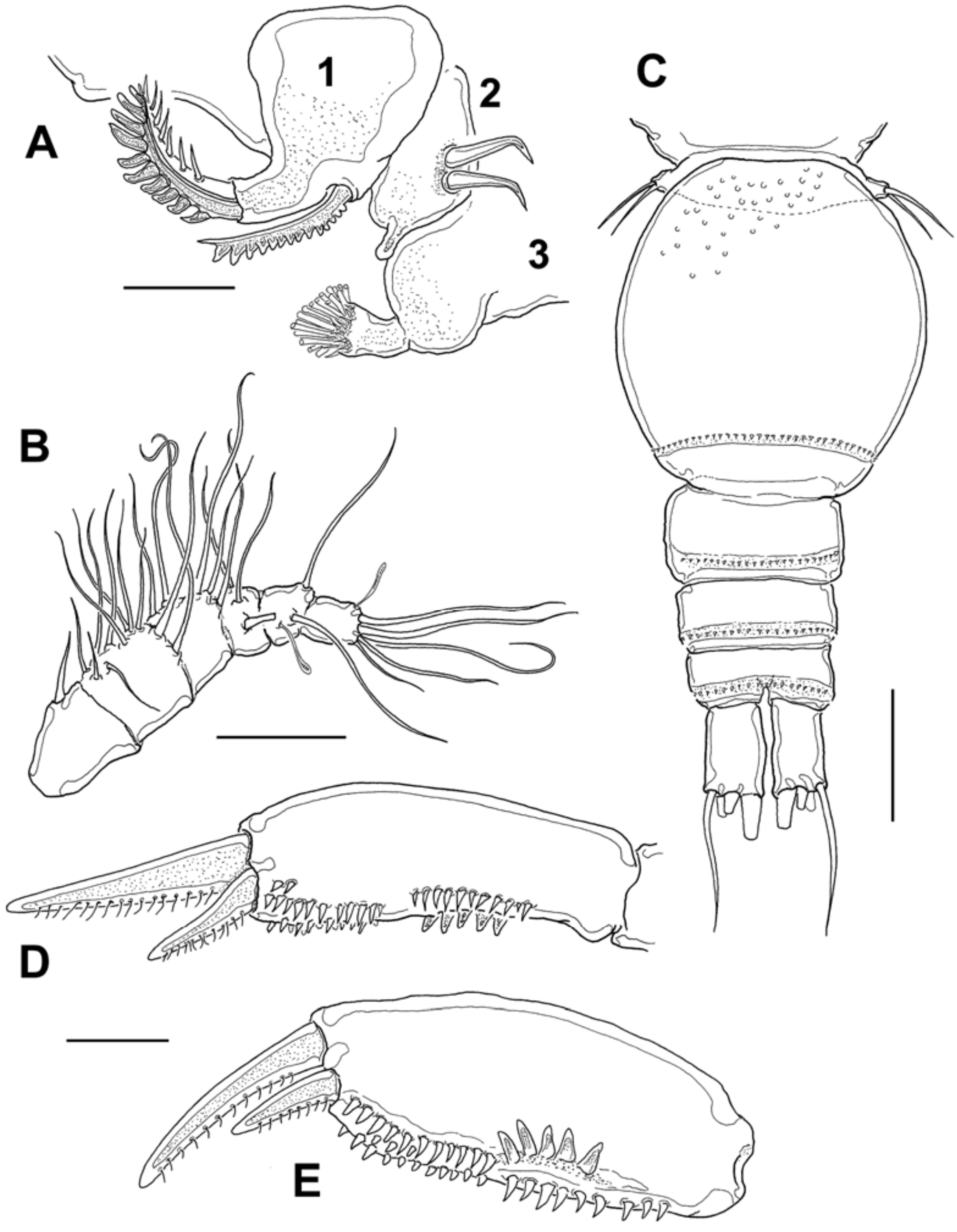

Fig. 2. *Ergasilus davidi* sp. n., adult female. **A** – mouthparts, 1 – mandible, 2 – maxillule, 3 – maxilla; **B** – antennule; **C** – urosome, ventral view; **D** – second endopodal segment of first leg, holotype; **E** – same of another specimen, showing a variant ornamentation. Scale bars: A, D = 25 μm; B = 50 μm; C = 100 μm.

of characters that includes: endopod of first leg with two segments, endopod of fourth leg with three segments, and first antennulary segment with a single seta. Boxshall et al. (2002) stated that the possession of a first leg with a 2-segmented endopod, as in the new species, is an apomorphy shared by 24 known species of *Ergasilus*. Further, out of this group of species, only half of them have also a 2-segmented endopod on the fourth swimming legs; these 12 species are listed by Boxshall et al. (2002). Because this character (2-segmented fourth leg endopod) is not present in the new species, we compared its morphology with the remaining group of species with 2-segmented first leg endopod and 3-segmented fourth leg endopod.

According to Boxshall et al. (2002) and Tavares and Luque (2005), the 12 species sharing this combination of characters include eight neotropical forms known from South America: *E. argulus* Cressey, 1970, *E. caraguatatubensis* Amado et Rocha, 1995, *E. colomesus* Thatcher et Boeger, 1983, *E. cyanopictus* Carvalho,

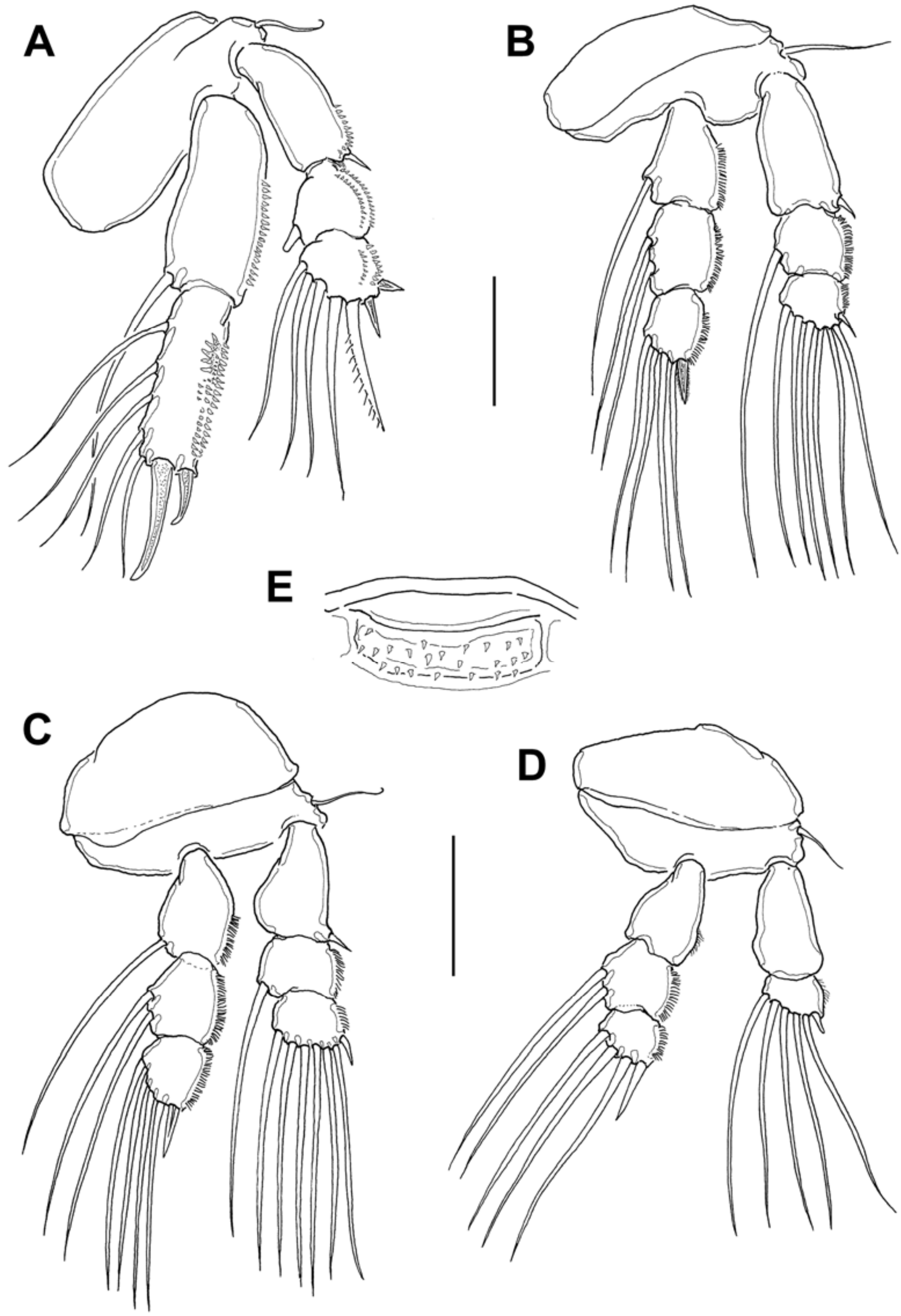

Fig. 3. *Ergasilus davidi* sp. n., adult female. **A** – first swimming leg; **B** – second swimming leg; **C** – third swimming leg; **D** – fourth swimming leg; **E** – coxal plate of second leg. Scale bars: A–E = 50 μm.

1962, *E. ecuadorensis* El-Rashidy et Boxshall, 2002, *E. foresti* Boxshall, Araujo et Montú, 2002, *E. pitalicus* Thatcher, 1984, and *E. youngi* Tavares et Luque, 2005. The group includes also five North American species: *E. cerastes* Roberts, 1969, *E. chautauquensis* Fellows, 1887, *E. clupeidarum* Johnson et Rogers, 1972, *E. megaceros* Wilson, 1914, and *E. versicolor* Wilson, 1911.

When compared with the closest North American species, *E. davidi* is particularly similar to *E. cerastes*, parasitic on freshwater catfishes; among other characters, they share the same general armature of legs and the presence of a rosette-like array of blunt spinules on the first endopod of the first swimming leg. In fact, when following Roberts' (1970) key for the identification of North American *Ergasilus*, the new species keys down to *E. cerastes* mainly by the presence of a prominent conical tooth on the inner margin of the third antennal segment (Fig. 1C). However, *E. cerastes* differs from the new species in the armature of the first antennulary segment, with 3 setae rather than one in *E. davidi*, in the presence of a tooth-like process on the-second antennal segment, this element being smaller and inserted in a different position in the new species, in the relative length of the fourth antennal segment, which is 0.6–0.7 as long as the third segment (Roberts 1969, 1970) vs. 0.4–0.5 in *E. davidi*, in the ornamentation of the mandibular blades (symmetrically denticulate in *E. cerastes* vs. foliose, curved elements arranged in relatively irregular pattern in the new species), and in the armature of the maxilla (with normal spinules vs. mixed pattern of blunt elements and acute spinules). Among the South American species compared herein, the new species has also some important affinities with the Brazilian species *E. foresti*, including the proportions of the antennal segments and the presence of a prominent conical process on proximal position, the distal inner setae of the second endopodal segment being shorter than the proximal setae, and the presence of a rosette-like arrangement of spiniform elements on the same segment (see Boxshall et al. 2002). However, both species differ in the general proportions of the body (narrow prosome in *E. foresti* vs. a wide, robust prosome in the new species), in the structure of the first endopodal segment of first legs (with expanded inner margin vs. normal condition in *E. davidi*), in the armature of the antennule (1, 11, 5, 4, 2 + 1ae, 7 + 1ae in *E. foresti* vs. 1, 11, 5, 3, 2 + 1 ae, 5 + 1 ae) and in the armature of the second antennal segment (a curved, blunt-ended inner spine in *E. foresti*, whereas this element is low, not curved in the new species). The size, structure and position of this element distinguish the new species also from other three South American species, *E. ecuadorensis*, *E. cyanopictus*, and *E. youngi*. In the former species the process is on the proximal third of the segment, not on the distal third as in *E. davidi*; also, it is acute, not blunt as in the new species (El-Rashidy and Boxshall 2002). In *E. cyanopictus*, *E. youngi*, and *E. versicolor* this process is medial (see Roberts 1970, El-Rashidy and Boxshall 2002, Tavares and Luque 2005). Also, the general shape of the prosome, narrow in *E. youngi*, inflated, violin-shaped in *E. ecuadorensis* and *E. cyanopictus* (El-Rashidy and Boxshall 2002, Tavares and Luque 2005), and medially constricted in *E. versicolor* (Roberts 1970), diverges from the morphology of the new species. Further, *E. ecuadorensis* has a genital somite armed with several (8) transverse rows of strong spines (El-Rashidy and Boxshall 2002) whereas this somite has a single row of spinules in *E. davidi*; also, the apical spines of *E. ecuadorensis* are clearly shorter and stronger than in *E. davidi*; their proportional lengths are also different. Additional characters useful to identify this new species include a maxillar basis armed with blunt teeth, distally bent maxillular setae, and naked margins of first exopodal segments of legs 2–4.

DISCUSSION

In all cases the parasites were attached to the gills, which are the main site of infection among the ergasilids (Roberts 1970, Boxshall and Montú 1997). An infection by *Ergasilus* sp. in the two fish species examined herein was reported by Violante-González et al. (2007) from Tres Palos, another coastal lagoon of the Mexican Pacific. It is probable that these records are referable to *Ergasilus davidi*. Further, the difference of the infection prevalence and intensity between the fishes from Tres Palos is similar to the values reported herein, with a higher prevalence in *Lutjanus argentiventris* (58.3% in Tres Palos vs. 42% in this survey) and lower in *Centropomus robalito* (29.8% vs. 11% in this survey). The intensity of infection also agrees with our results for *L. argentiventris* (205 ± 133 in Tres Palos vs. 192.7 ± 168.2 in Chantuto-Panzacola) and *C. robalito* (5.3 ± 9.2 in Tres Palos vs. 2.3 ± 2.6 in Chantuto-Panzacola). Violante-González et al. (2007) reported the occurrence of *Ergasilus* sp. on at least 10 other teleost species from Tres Palos, including mainly fresh and brackish water forms. It is expected that the taxonomic analysis of these specimens will provide valuable information about the parasitic fauna of Mexico and the Eastern Pacific region.

There are only a few records of species of *Ergasilus* from Mexico, with *E. versicolor* recorded from the striped mullet *Mugil cephalus* in Baja California (Valles-Ríos et al. 2000). The record of *E. versicolor* from the zooplankton of Chantuto-Panzacola (Alvarez-Silva et al. 2006) is assignable to *E. davidi*. Many reports of ergasilids from Mexico and Central America are published as *Ergasilus* sp. (Fitzsimmons 2000, Violante-González and Aguirre-Macedo 2007), probably concealing the occurrence of other genera; for instance, El-Rashidy and Boxshall (1999) reported several species of *Acusicola* Cressey et Collette, 1970 from Honduras, Costa Rica, Panama, and from different localities of Mexico. El-Rashidy and Boxshall (2001) reported a species of *Paraergasilus* Markevich, 1837 from two species of freshwater fishes in Mexico. The parasitic copepod fauna is yet to be studied in Mexico and Central America.

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