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**Il-Hoi Kim, Eduardo Suárez-Morales &
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Caligid Copepods (Copepoda: Siphonostomatoida: Caligidae) as Zooplankters off the Venezuelan Coast, Western Caribbean Sea

Il-Hoi Kim¹ · Eduardo Suárez-Morales² · Brightdoom Márquez-Rojas³Received: 17 March 2018 / Revised: 22 November 2018 /
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Abstract

During a survey of the zooplankton community of a coastal system on the northern coast of Venezuela western Caribbean, female and male specimens of species of *Caligus* Müller, 1785 were collected. We obtained four species: *C. littoralis* Luque and Cezar 2000, *C. evelynae* Suárez-Morales et al. ZooKeys 201: 59–71, (2012a), *C. praetextus* Bere Amer Midl Nat 17: 577–625, (1936), and *C. rufimaculatus* Wilson, 1932. The male of the former species remained unknown and we present herein its first illustrated description. *Caligus littoralis* is the 13th species of *Caligus* known from waters of the Venezuelan coasts and the 60th species of the genus recorded in the Neotropical region. The specimens examined were caught exclusively from the plankton, their hosts remain unknown; this is not rare among a group of caligids that are chiefly found as planktonic forms. They are deemed to represent an alternative mode of life recently revealed as being more common among caligid copepods than previously thought.

Keywords Parasitic copepods · Marine zooplankton · Crustacean taxonomy

Introduction

The Caligidae is the most species-rich family of the copepod order Siphonostomatoida. It is represented by ectoparasitic forms that infect a wide variety of marine and brackish water teleosts. *Caligus* Müller, 1759 is the largest genus of the family, currently containing approximately 250 valid species (Hayes et al. 2012; Boxshall 2015). According to recent regional accounts (Morales-Serna et al. 2012, 2016), the genus *Caligus* is also currently the most diverse caligid genus parasitizing Neotropical teleosts. Several species have been recorded consistently as planktonic forms, they have not been known to be associated to a host; these species probably represent an alternative life cycle or ontogenetic behaviour (Venmathi Maran et al. 2012). This aspect of an essentially parasitic group of copepods certainly deserves further studies

in which records of individuals found exclusively in plankton surveys are examined in more detail.

Of the 1500 species of parasitic copepods of fish, almost 75% belong to this order. Within this order, the Caligidae, also known as sea lice or *Caligus*, contains 559 species in two highly diverse genera: *Lepeophtheirus* (162 species) and *Caligus* (268 species) (Ho and Lin 2004). This family has been studied extensively in coastal waters where they become important pests of fish species of commercial interest (Venmathi Maran et al. 2012). The genus *Caligus* Müller, 1785 contains the highest number of species that parasitize teleost hosts (Boxshall and Halsey 2004; Johnson et al. 2004).

Records of parasitic copepods of Venezuelan marine teleosts are relatively scarce because of the presumed high diversity of both teleosts and parasites in this region (Luque and Poulin 2007). The known Venezuelan caligid fauna currently includes 11 species of *Caligus* (Suárez-Morales et al. 2012a). Until 2003, up to 10 species of the *Caligus* were known from Venezuela (Ho and Bashirullah 1977; Legarde 1989; Williams and Bunkley-Williams 1996; Díaz-Díaz 2000; Zambrano et al. 2003). Subsequently, Suárez-Morales et al. 2012a, b described a new species and thus increased the number of species to 12. They provided a key to the species of the genus recorded in the country.

During a survey of the zooplankton community off the coast of Venezuela, several specimens of caligids were recovered. These specimens were taxonomically examined, illustrated and new, interesting data were revealed.

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Material and Methods

The collection of the zooplankton samples was carried out monthly from a small boat, from June 2009 to May 2010, using a standard plankton net (333 μm mesh) (Boltovskoy 1981), equipped with a flowmeter attached to the net mouth in order to determine the volume of filtered water. Because of the average body size of caligid species (usually over 2 mm long), this gear was deemed adequate to sample this fraction of the local copepod fauna. The trawls were performed obliquely at a speed of 2 knots for 15 min. No clogging of the plankton net was observed. Adult and juvenile individuals of caligid copepods of the genus *Caligus* were obtained from surface zooplankton samples collected in July and October 2009 from coastal waters off the coasts of Venezuela, in the western Caribbean (Fig. 1).

The biological material collected was fixed with 4% formaldehyde. Each sample was homogenized and divided into two subsamples by means of a Folsom splitter; one subsample was used to study the structure of the zooplankton community and the other to estimate wet weight biomass values (Postel et al. 2000). Temperature, salinity and surface oxygen were measured at each station by means of a YSI multiparameter probe.

Specimens of *Caligus* were sorted from the original plankton sample and processed for taxonomical analysis by

transferring them to glycerol and then pure glycerine. Drawings were prepared using a camera lucida mounted on a compound microscope. Terminology of the body parts and appendages followed Ho and Lin (2004). Specimens are deposited in Il-Hoi Kim's collection of copepods held at the Kangreung National University, South Korea.

Results

Taxonomic Account

Phylum Crustacea Brünnich, 1772

Subclass Copepoda Milne-Edwards, 1840

Order Siphonostomatoida Thorell, 1859

Family Caligidae Burmeister, 1835

Genus *Caligus* Müller, 1785

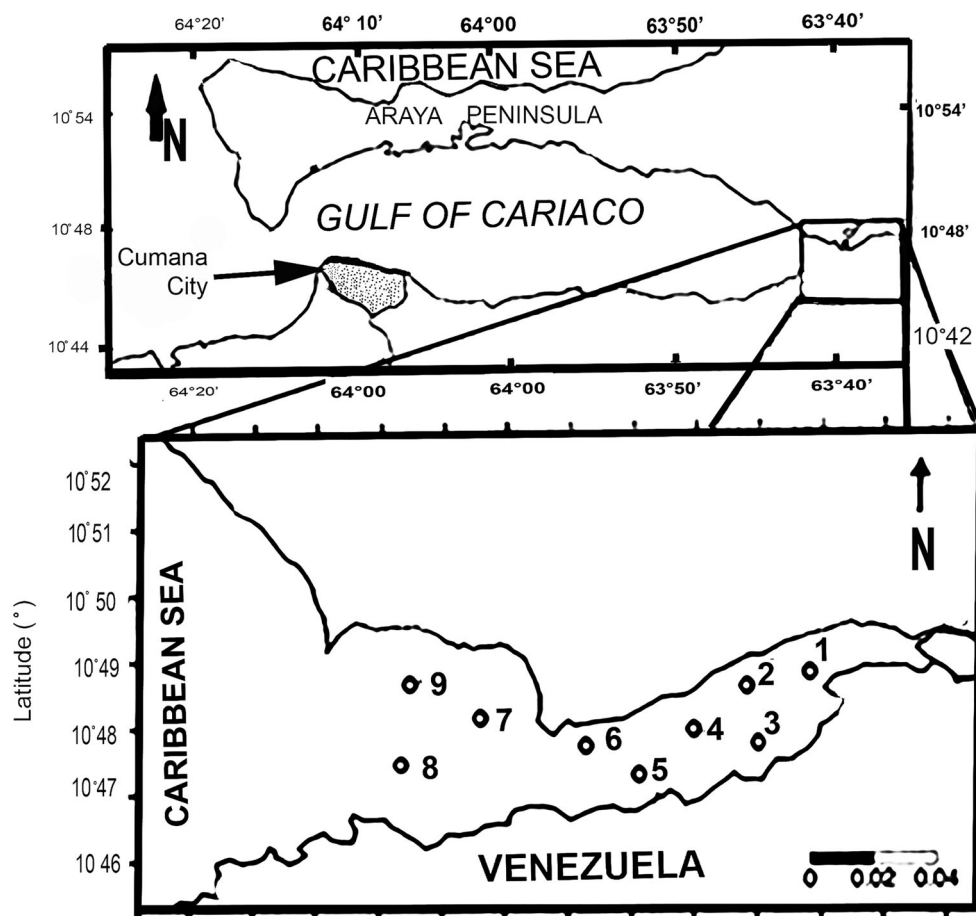
Caligus littoralis Luque and Cezar 2000

(Figs. 2–4)

Caligus littoralis Luque and Cezar 2000, p. 2, figs. 1–16.

Caligus sp.: Suárez-Morales, Kim and Escamilla 2012b, p. 807, figs. 3, 4.

Fig. 1 Surveyed area, the Gulf of Cariaco, Venezuelan Caribbean coast



Material examined: 1 ♀, 3 ♂♂ (1 ♂ dissected and figured), SACO GOLFO, EST.6, 22 July –2009; 4 ♀♀, 1 ♂, 2 chalimi, SACO GOLFO, EST.7, 11 August 2009; 3 ♀♀ (1 ♀ dissected and figured), 1 ♂, 3 preadults, and 4 chalimi, SACO GOLFO, EST.7, 18 September 2009; 5 ♀♀, SACO GOLFO, EST.3, 30 October 2009.

Female. Body wide (Fig. 1a, b), dorsoventrally flattened. Body length 2.26 mm in dissected fully grown adult (Fig. 1a), 1.92 mm in young adult individual (Fig. 1b). Cephalothoracic shield 1.40×1.23 mm, with conspicuous marginal membrane. Frontal plates carrying large lunules, with anterior marginal membrane. Naupliar eyes small, indistinctly visible. Ventral lateral ridge slender and weakly curved. Posterior sinus moderately deep. Fourth pedigerous somite narrow, incompletely defined from genital complex. Genital complex wider than long, 0.57×0.87 mm, with convex lateral margins and protruding posterolateral corners. Genital complex of young adult (Fig. 1b) 0.37×0.53 μm , same in shape as that of larger dissected specimen. Abdomen 1-segmented (Fig. 1c, d) much wider than long, 127×203 μm , with convex lateral margins and fine setules on all surfaces. Caudal rami 74×55 μm (length/width ratio 1.35), armed with 3 small and 3 large plumose setae.

Antennule (Fig. 1e) 2-segmented; first segment armed with 25 plumose and 2 naked setae; second segment 80 μm long, half as long as first segment, and armed with 12 naked setae and 2 aesthetascs. Antenna (Fig. 1f) 3-segmented. Proximal segment with broad, fusiform process near inner distal corner; middle segment with adhesion pad on outer side of dorsal surface; distal segment with 2 small setae (1 proximal and 1 near proximal third) and distally forming strongly curved claw. Postantennal process (Fig. 1f) gently curved, with 2 papillae each bearing 4 setules; another papilla posterior to postantennal process with 2 setules.

Oral cone typical for genus. Mandible (Fig. 1g) stylet-like, consisting of 3 parts, with 12 teeth on inner margin and membranous flange on outer margin of distal region. Maxillule (Fig. 1f) consisting of anterior sclerotized plate bearing conical posterior process, anterior papilla bearing 2 small and 1 larger setae, and unornamented posterior process. Maxilla (Fig. 2a) slender, consisting of proximal lacertus and distal brachium; lacertus unarmed; brachium longer than lacertus, with distal calamus, subdistal canna, and narrow flabellum; calamus twice as long as canna; flabellum located at 75% region of brachium length. Maxilliped (Fig. 2b) comprising corpus, shaft and terminal claw; corpus with process proximally (indicated by arrowhead) on posterior surface; shaft with 1 small distally; terminal claw strongly curved, with acute tip. Sternal furca (Fig. 2c) with slightly divergent, spatulate tines; box longer than tines. Pair of conical sclerotized processes (postmaxillary processes) present on ventral cephalothoracic wall on either side of sternal furca (Fig. 2c).

Leg 1 (Fig. 2d) with outer coxal seta. Basis with small, plumose inner distal seta. Exopod 2-segmented; proximal segment with single small seta on outer distal corner and inner row of setules; distal segment with 3 spines and 1 naked, transparent seta on distal margin and 3 large plumose setae on inner margin; spines on distal margin tipped with patch of spinules and accompanied by pectinate lamella near their base, inner two of them (second and third spines) with long flagellum (Fig. 2e); inner seta on distal margin naked and subequal in length to spines. Endopod vestigial, tapering with pointed tip.

Leg 2 (Fig. 2f) consisting of coxa, basis, and 3-segmented exopod and endopod. Coxa short, with long, plumose inner seta and outer membranous flap. Basis armed with small outer seta and membranous flap on inner and dorsal outer side. Exopod with armature formula I-1; I-1; II, I, 5; first segment with membranous flap on outer distal region; 3 spines on third segment very unequal, proximalmost one of them minute (Fig. 2g). Endopod with armature formula 0-1; 0-2; 6.

Leg 3 (Fig. 2h) consisting of protopod, velum and 2-segmented rami; protopod with membranous flap on outer and inner distal margins, and with plumose outer and inner setae. Velum broad, with setules along distal margin. Armature formula of exopod I-0; 9, that of endopod 0-1; 6. Four outer setae on second exopodal segment naked.

Leg 4 (Fig. 2i) consisting of coxo-basis, 2-segmented exopod. Coxo-basis with single outer subdistal seta. First exopodal segment about 133 μm long and armed with 1 outer spine. Second exopodal segment longer than first segment, about 148 μm long, with 3 unequal spines distally measuring 121, 59, and 18 μm , respectively, in length from inner to outer.

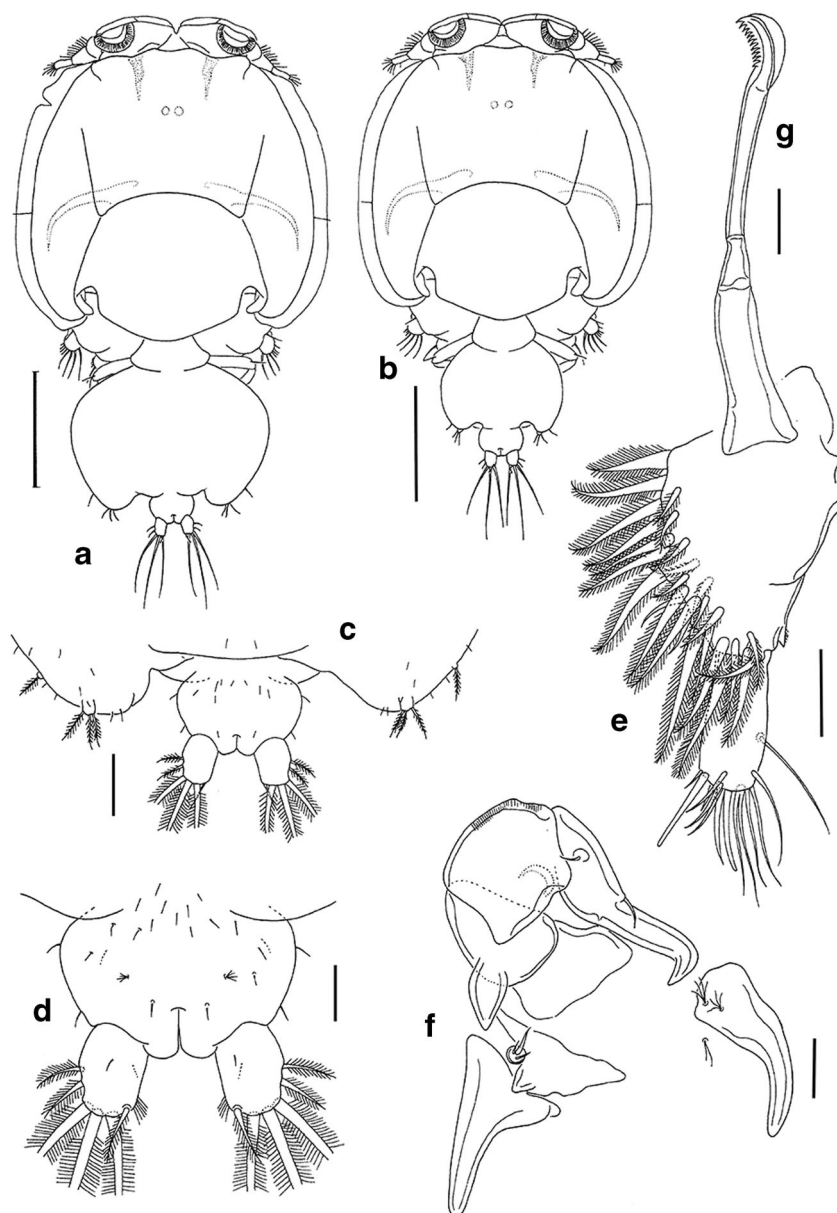
Leg 5 consisting of 1 seta and 1 lobe bearing 3 setae on outer distal corner of genital complex (Fig. 1c). Leg 6 not discernible.

Male. Body (Fig. 3a) 1.46 mm long, much smaller than that of female. Cephalothoracic shield 0.94×0.86 mm. Urosome (Fig. 3b) 3-segmented. Genital complex 254×311 μm . Abdomen 1-segmented, 127×155 μm gradually broadening distally. Caudal ramus 82×53 μm (length/width ratio = 1.55).

Antennule as in female, with same number of setae and aesthetascs. Antenna (Fig. 3c) 3-segmented; proximal segment with large adhesion pad; middle segment with 6 adhesion pads, 4 distal ones of them smaller; distal segment (Fig. 3d) with 1 seta proximally and 4 claw-like processes (one of them distinctly larger than other 3) and 1 seta distally.

Oral cone, mandible, and maxilla as in female. Maxillule (Fig. 3e) with corrugated posterior process on proximal sclerotized plate; posterior process with corrugation in distal half; one large corrugated lobe present medio-distal to maxillule (Fig. 3e). Maxilliped (Fig. 3f) corpus with patch of minute spinules on inner margin; proximal process of corpus much smaller than that of female; terminal claw obscurely defined

Fig. 2 *Caligus littoralis* Luque and Cezar 2000, female. **a**, habitus of fully grown adult, dorsal; **b**, habitus of young adult, dorsal; **c**, posterior part of urosome, ventral; **d**, abdomen, dorsal; **e**, antennule; **f**, antenna, postantennal process, and maxillule; **g**, mandible. Scale bars: **a, b**, 0.5 mm; **c**, 0.1 mm; **d-f**, 0.05 mm; **g**, 0.02 mm



from shaft, with membranous flap on posterior side (Fig. 3g). Sternal furca (Fig. 3h) with parallel lateral margins; distal tines straight, narrower than those of female, with rounded distal margin.

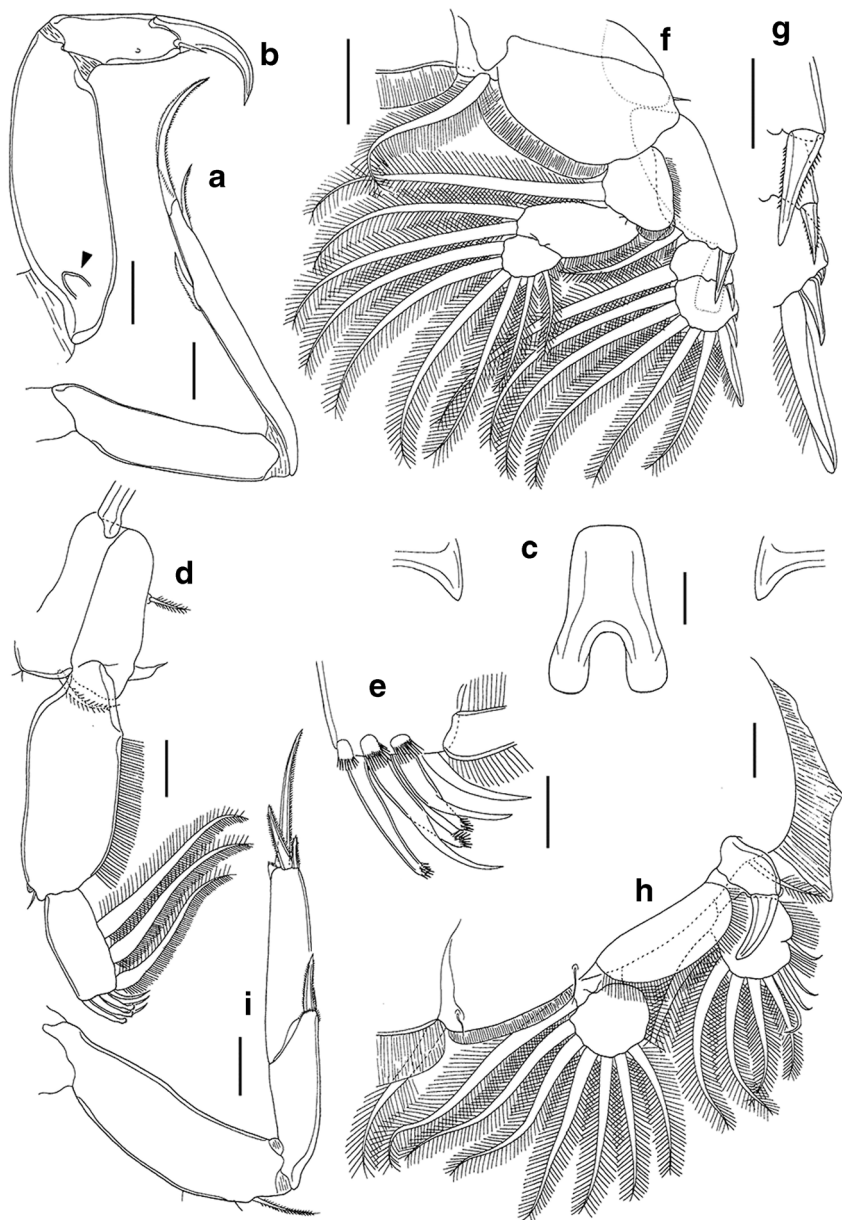
Legs 1–3 as in female. Leg 4 (Fig. 3i) armed as in female, but distal spines on exopod relatively larger than those of female, 124, 48, and 24 μm long, respectively, from inner to outer. Leg 5 similar to that of female. Leg 6 represented by 3 setae on distal margin of genital operculum (Fig. 3b).

Remarks.

Luque and Cezar (2000) originally described this species based on four females parasitic on the marine fish *Atherinella brasiliensis* (Quoy and Gaimard, 1825) (as *Xenomelaniris brasiliensis*) from the Brazilian coast. Several species of this genus, like *C. brevicaudatus* Scott, 1901 is part of a group of

11 species that share the possession of a 2-segmented fourth exopod carrying three unequal distal spines and no lateral spine, in combination with a 1-segmented abdomen (less than the half length of the genital complex) in the female. Four of these eleven species, *C. brevicaudatus*, *C. kalumai* Lewis, 1964, *C. littoralis* Luque and Cezar 2000, and *C. wilsoni* Delamare-Deboutteville and Nunes-Ruivo, 1958 are known only from female specimens (Demirkale et al. 2015). Males of *C. littoralis* remained unknown until our finding and subsequent description of male specimens collected from the Venezuelan coast; thus, this is the first account of the male of this species. According to Venmathi Maran and Ohtsuka (2008) males are usually more frequent in plankton samples than females at a rate of 80% vs. 20% because males are more easily detached from a host.

Fig. 3 *Caligus littoralis* Luque and Cezar 2000, female. **a**, maxilla; **b**, maxilliped; **c**, sternal furca and postmaxillary processes; **d**, leg 1; **e**, distal part of leg 1 exopod; **f**, leg 2; **g**, outer side of leg 2 exopod; **h**, leg 3; **i**, leg 4. Scale bars: **a–d**, **g–i**, 0.05 mm; **e**, 0.02 mm; **f**, 0.1 mm



In our specimens the exopod of leg 3 is 2-segmented because of the fusion of the second and third segments, unlike the 3-segmented condition in the original description from the female. Luque and Cezar (2000) overlooked the proximal process on the posterior surface of the maxilliped and the paired sclerotized processes lateral to the sternal furca.

Suárez-Morales et al. (2003) illustrated this species but it remained unnamed because the female specimen examined at that time was immature. The body length of this individual was not more than 2.5 mm as estimated from the illustration. Furthermore, the shape of the illustrated sternal furca of this immature female is very different from that of the newly obtained mature females.

The teleost *Atherinella brasiliensis*, host of *Caligus littoralis*, is considered to be common and locally abundant

in large estuarine systems on the north and east coast of South America (Andreatta et al. 1997; Gondolo et al. 2011).

Caligus evelynae Suárez-Morales et al. 2012a

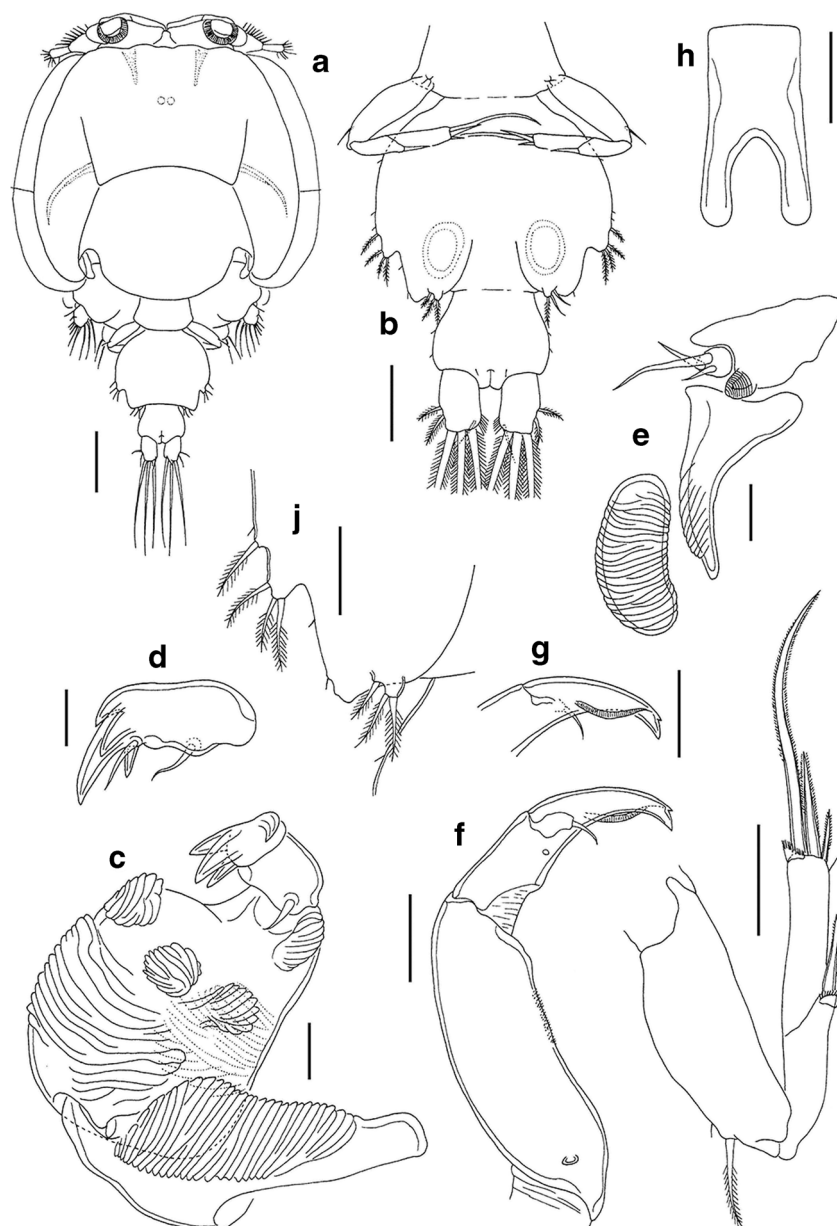
(Figs. 5, 6)

Caligus evelynae Suárez-Morales et al. 2012a, p. 61, figs. 1–3.

Material examined: 1 ♂, SACO GOLFO, EST.6, 22 July 2009.

Male. Body (Fig. 4a) 2.47 mm long. Cephalothoracic shield 1.54×1.11 mm, longer than wide; lunules large; ventrolateral ridge bifurcate, with short anterior branch and longer posterior branch. Urosome (Fig. 4b) 4-segmented. Fifth pedigerous somite 298 μ m wide, wider than genital complex. Genital complex distinctly longer than wide, 388×263 μ m. Abdomen 2-segmented, 106×154 and 288×197 μ m,

Fig. 4 *Caligus littoralis* Luque and Cezar 2000, Male. **a**, habitus, dorsal; **b**, urosome, ventral; **c**, antenna; **d**, terminal segment of antenna; **e**, maxillule and adjacent adhesion pad; **f**, maxilliped; **g**, terminal segment of maxilliped; **h**, sternal furca; **i**, leg 4; **j**, legs 5 and 6. Scale bars: **a**, 0.2 mm; **b**, 0.1 mm; **c–e**, 0.02 mm; **f–j**, 0.05 mm



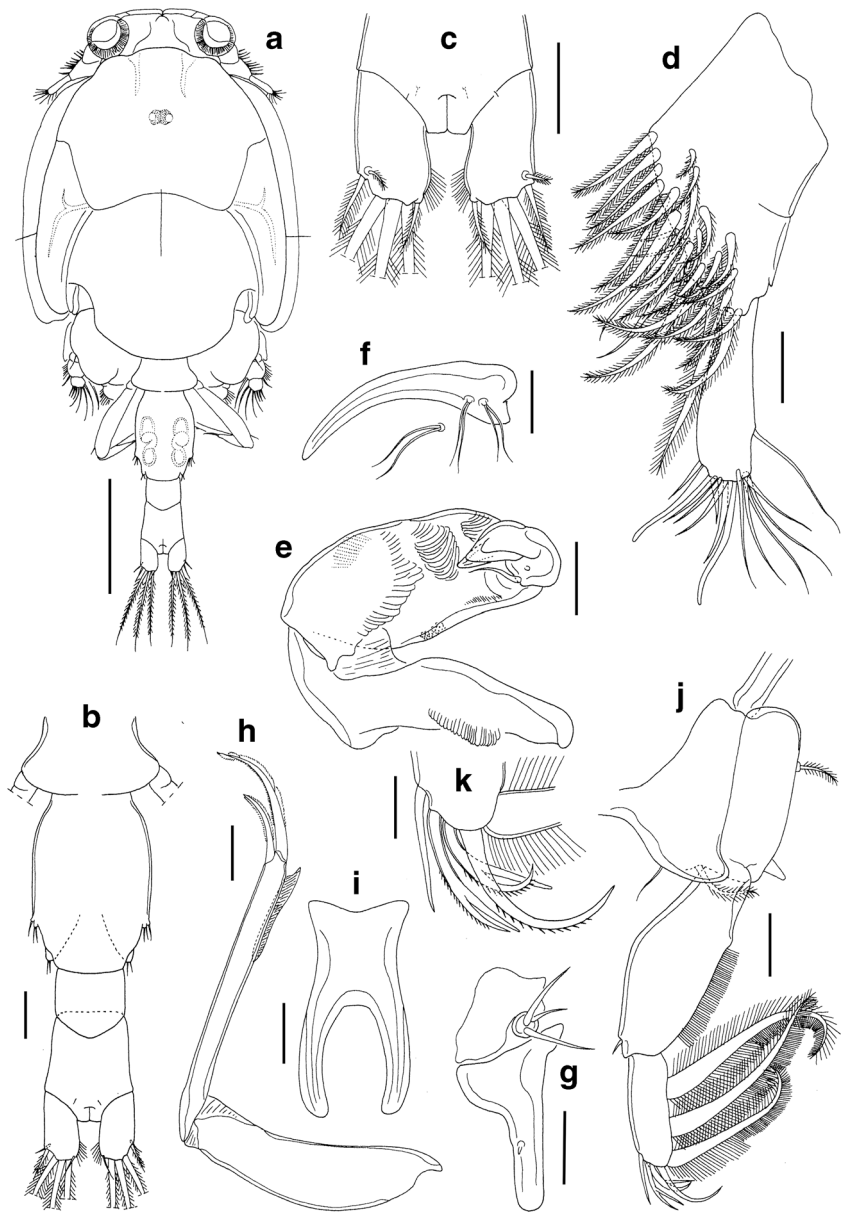
respectively. Anal somite with convex posterodorsal margin. Suture line between anal somite and caudal rami oblique. Caudal ramus (Fig. 4c) $120 \times 80 \mu\text{m}$ (length/width ratio = 1.50).

Antennule (Fig. 4d) armed with 29 setae (including 2 naked ones) on proximal segment and 12 setae plus 2 aesthetascs on distal segment; distal segment about 0.6 times as long as proximal segment. Antenna (Fig. 4e) with single small adhesion pad on proximal segment; middle segment with 6 adhesion pads, 2 of them negligible; distal segment with short distal claw, 1 proximal seta, and 2 flaps. Postantennal process (Fig. 4f) slender and weakly curved; proximal papillae each tipped with 2 distinct setules; papilla posterior to postantennal process also tipped with 2 distinct setae.

Mandible as usual in genus. Maxillule (Fig. 4g) armed with 2 longer and 1 short setae on anterior papilla; tine of posterior process with parallel lateral margins, 1 min setule, and blunt tip. Maxilla (Fig. 4h) slender; calamus and canna 116 and $67 \mu\text{m}$ long, respectively; flabellum located subdistally on canna. Maxilliped (Fig. 5a) with 1 small, conical process proximally on posterior surface and 1 well-sclerotized digitiform process on inner margin of corpus; shaft with 1 small setule subdistally on inner margin; terminal claw stout, with 1 seta on proximal region of inner margin. Sternal furca (Fig. 4i) with narrow, incurved tines; box as long as tines.

Leg 1 (Fig. 4j) with 2-segmented exopod and vestigial, tapering endopod. Distal exopodal segment armed with 3 large, plumose setae on inner margin and 2 setae and 2 middle spines on distal margin; 2 spines on distal margin bifurcate

Fig. 5 *Caligus evelynae* Suárez-Morales, Camisotti and Martín, 2012. Male. **a**, habitus, dorsal; **b**, urosome, dorsal; **c**, caudal rami, ventral; **d**, antennule; **e**, antenna; **f**, postantennal process; **g**, maxillule; **h**, maxilla; **i**, sterna furca; **j**, leg 1; **k**, distal part of leg 1 exopod. Scale bars: **a**, 0.5 mm; **b**, **c**, 0.1 mm; **d–j**, 0.05 mm; **k**, 0.02 mm



(Fig. 4k), and outermost seta naked and shortest among distal elements.

Legs 2 segmented and armed as in female in original description of this species; outer spine on first and second exopodal segments with marginal membrane along outer margin (Fig. 5b); outer spines on third exopodal segment small.

Leg 3 (Fig. 5c) as in female in original description. Exopod distinctly 3-segmented; first segment (Fig. 5d) with 2 small setules subdistally and membrane along distal margin; all armature elements (setae) on second and third segments whippy.

Leg 4 (Fig. 5e) as in female in original description, but 2 inner distal setae on second exopodal segment naked; all of elements on second exopodal segment accompanied with pectinate lamella at their base.

Leg 5 represented by 3 lateral setae (two of them mounted on papilla) on genital complex (Fig. 5f). Leg 6 represented by 3 small unequal setae (or 2 setae and 1 setule) on genital operculum (Fig. 5f).

Remarks

The host of this copepod species remains unknown. The single available male obtained in the present study is significantly smaller (2.47 mm long) than the allotype male (3.10 mm long) (Suárez-Morales et al. 2012a, b), thus suggesting that it is a young adult. The prominent, digitiform process on the inner margin of the maxilliped corpus and the characteristic forms of the four distal setae on the second exopodal segment of leg 1 are shared by the present specimen and the allotype. This character was enough to assign this preadult individual to this species. The finding of this new

specimen allows a modest expansion of its regional distribution because it was known only from the type locality (Bay of Amuay, Venezuelan Caribbean, 11°46'32"N, 70°13'51"W) (Suárez-Morales et al. (2012a, b). This is also the first report of this species after its original description.

Caligus praetextus Bere 1936

(Figs. 7, 8)

Caligus praetextus Bere 1936, p. 583, pl. 3, figs. 36–70, pl. 4, figs. 71–76; Cressey 1991, p. 12, figs. 153–163.

Material examined: 1 ♂, SACO GOLFO, EST. 3, 30 October 2009.

Male. Body (Fig. 6a) with broad prosome and slender urosome. Length 3.60 mm. Cephalothoracic shield 2.23×1.51 mm, distinctly longer than wide; ventrolateral ridge strongly curved; lunules relatively small. Urosome 4-segmented. Fifth pedigerous somite $454 \mu\text{m}$ wide. Genital complex $610 \times 407 \mu\text{m}$, 1.50 times as long as wide. First and second abdominal somites 203×298 and $440 \times 258 \mu\text{m}$, respectively. Caudal rami (Fig. 6b) convergent, $288 \times 108 \mu\text{m}$ (length/width ratio 2.67).

Antennule (Fig. 6c) armed with 29 setae on first segment and 11 setae plus 2 aesthetascs on second segment. Antenna (Fig. 6d) 3-segmented; distal segment trifurcate apically, with 1 seta proximally. Postantennal process (Fig. 6e) slender and gently curved, with 2 papillae proximally; additional papilla

present posterior to postantennal process; all of these papillae tipped with 2–4 setules.

Mandible as usual in genus. Maxillule (Fig. 6f) with tapering corrugated tine of posterior process. Maxilla (Fig. 6g) with calamus and canna of 165 and $102 \mu\text{m}$ long, respectively. Maxilliped (Fig. 6h) 3-segmented, but distal segments incompletely articulated; corpus with socket proximally to receive tip of distal claw and small, papilliform process on inner margin. Sternal furca (Fig. 6i) with slightly divergent tines; each tine slender and longer than box.

Leg 1 (Fig. 6j) with 2-segmented exopod and blunt, vestigial endopod. First exopodal segment expanded in middle. Second exopodal segment with 3 large, plumose setae on inner margin and 3 compound spines plus 1 seta on distal margin; 3 compound spines on distal margin lamellate with broad membrane on both sides, inner 2 of them (second and third spines) with flagellum; inner distal seta longer than spines with narrow membrane along inner margin (Fig. 6k).

Leg 2 (Fig. 7a) as described and illustrated by Cressey (1991); outer spine on second exopodal segment simple, without marginal membrane; outer proximal spine on third exopodal segment distinctly incurved (Fig. 7b).

Leg 3 (Fig. 7c) with 3-segmented exopod and 2-segmented endopod; protopod with small outer spinules on ventral (anterior) surface; first exopodal segment (Fig. 7d) with 2 setules and broad distal spine.

Fig. 6 *Caligus evelynae* Suárez-Morales, Camisotti and Martín, male. **a**, maxilliped; **b**, outer side of leg 2 exopod; **c**, leg 3; **d**, first exopodal segment of leg 3; **e**, leg 4; **f**, legs 5 and 6, ventral. Scale bars: **a**, **c**, **e**, 0.1 mm; **b**, **d**, **f**, 0.05 mm

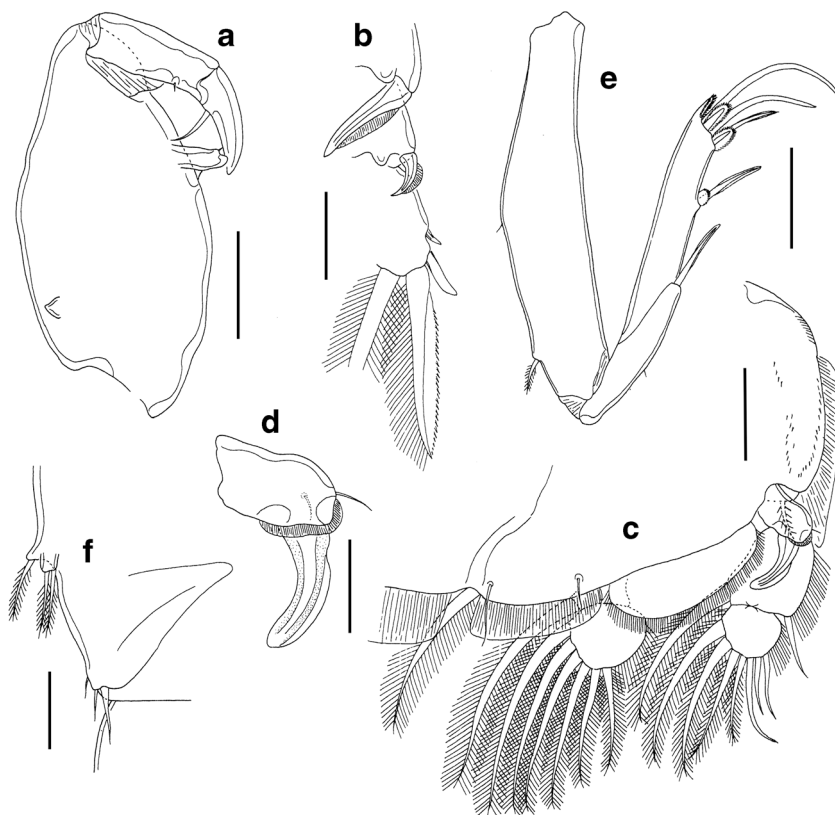
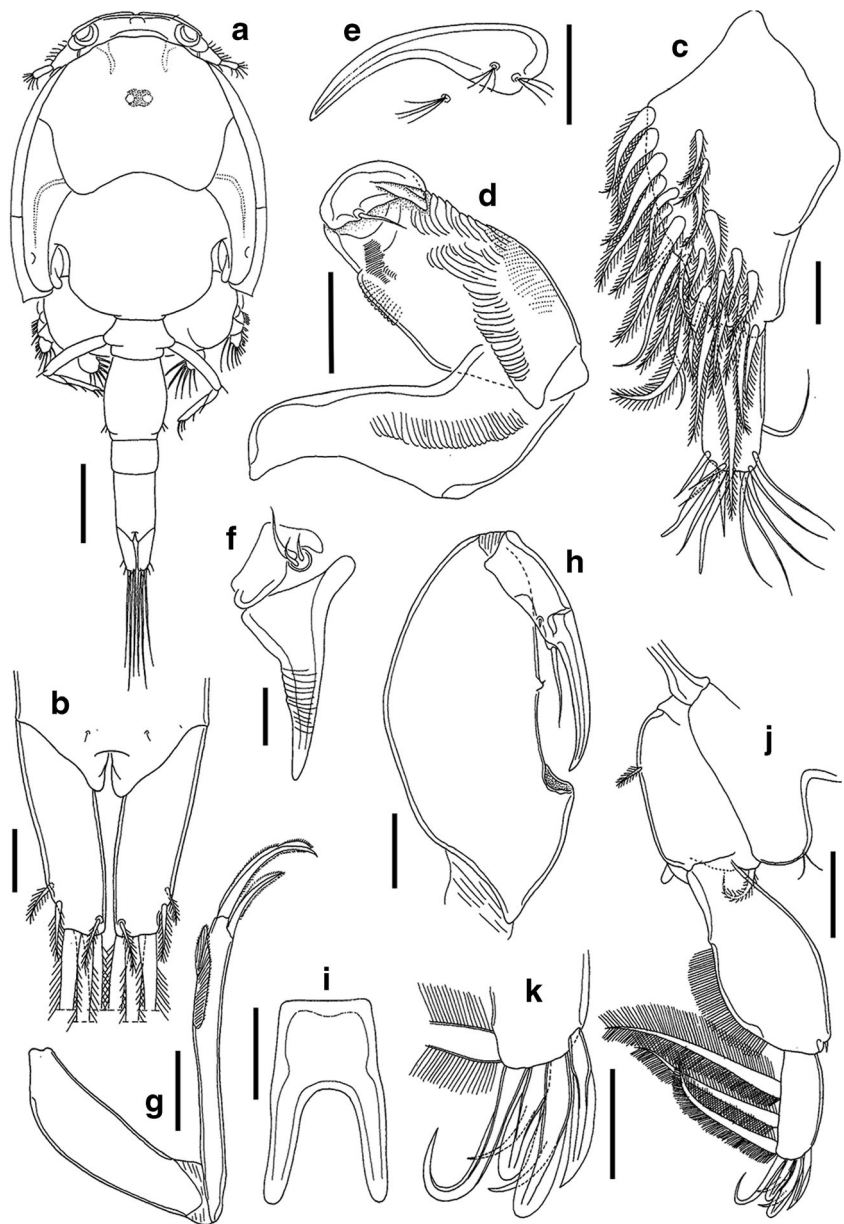


Fig. 7 *Caligus praetextus* Bere, Male. **a**, habitus, dorsal; **b**, caudal rami, dorsal; **c**, antennule; **d**, antenna; **e**, postantennal process; **f**, maxillule; **g**, maxilla; **h**, maxilliped; **i**, sternal furca; **j**, leg 1; **k**, distal part of leg 1 exopod. Scale bars: **a**, 0.5 mm; **b**, **d**, **e**, **g**–**j**, 0.1 mm; **c**, **f**, **k**, 0.05 mm



Leg 4 (Fig. 7e) consisting of coxo-basis and 2-segmented exopod; coxo-basis longer than exopod, with almost parallel lateral margins; exopod 2-segmented; second exopodal segment armed with 1 lateral and 3 distal spines, all of these spines accompanied with pectinate lamella near their base; 2 outer ones of 3 distal spines subequal, and innermost spine distinctly longer than other 2.

Leg 5 represented by 3 lateral setae on genital complex (Fig. 7g). Leg 6 represented by 3 small posterolateral setae on genital complex (Fig. 7g).

Remarks.

This caligid had been found as a parasite of various teleost species along the west coast of Florida, with little host specificity (Bere 1936; Cressey 1991). Cressey (1991) noted that

this species was easily recognized by the square sternal furca and the inwardly directed caudal rami. The possession of three compound spines distally, which are lamellate, on the second exopodal segment of leg 1 seems to be the most characteristic feature of this species.

***Caligus rufimaculatus* Wilson 1905**

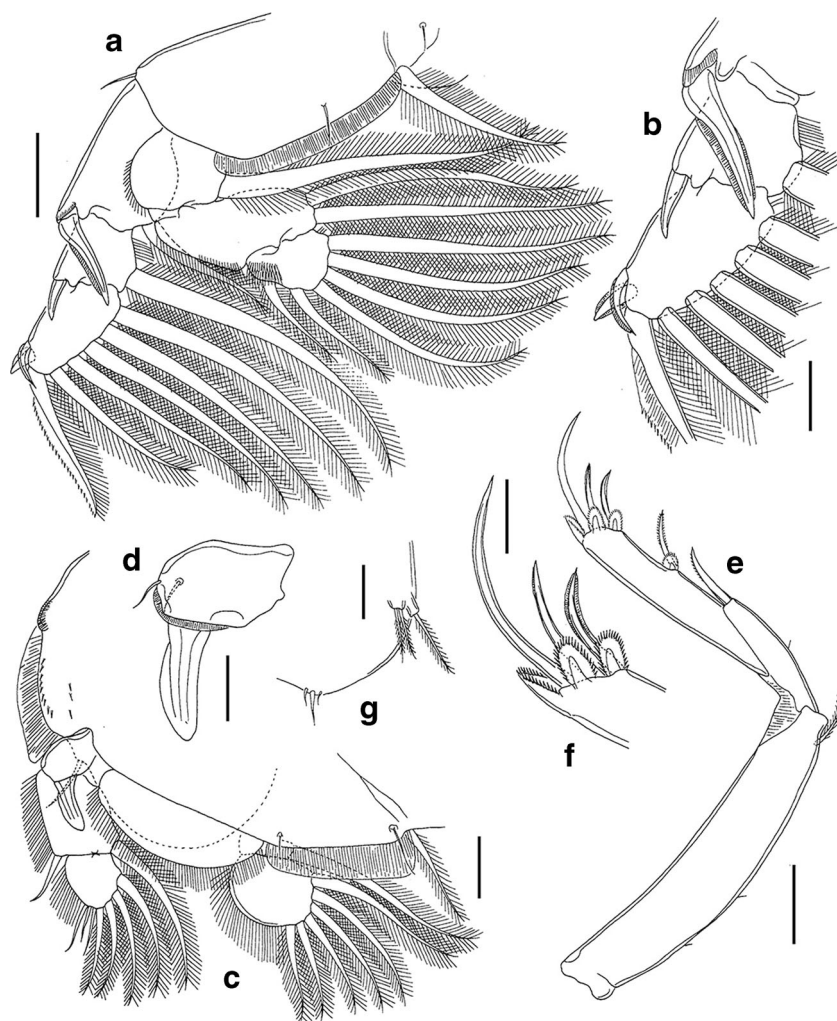
(Fig. 9)

Caligus rufimaculatus Wilson 1905, p. 561, pl. 5; Cressey 1991, p. 14, figs. 178–187; Suárez-Morales et al. 2003, p. 152, figs. 1–3.

Material examined. 1 ♂, TURPIALI TO, 06 June 2013.

Male. Body (Fig. 9a) 3.32 mm long. Cephalothoracic shield 2.05×1.82 mm. Urosome (Fig. 9b) 4-segmented.

Fig. 8 *Caligus praetextus* Bere, male individual. **a**, leg 2; **b**, distal segments of leg 2 exopod; **c**, leg 3; **d**, first exopodal segment of leg 3; **e**, leg 4; **f**, distal part of leg 4; **g**, legs 5 and 6. Scale bars: **a**, **c**, **e**, 0.1 mm; **b**, **d**, **f**, **g**, 0.05 mm



Fifth pedigerous somite 439 μm wide. Genital complex subrectangular, $493 \times 466 \mu\text{m}$, slightly wider than fifth genital somite, with convex lateral margins. First and second abdominal somites faintly articulated between them, measuring 135×297 and $338 \times 304 \mu\text{m}$, respectively. Caudal rami slightly divergent; each ramus $180 \times 132 \mu\text{m}$, length/width ratio = 1.36.

Antennule armed with 27 setae on first segment and 12 setae plus 2 aesthetascs on second segment. Antenna, mandible, maxilla as described previously by Suárez-Morales et al. (2003). Papillae on and posterior to postantennal process tipped with 2 setules each.

Maxillule (Fig. 9c) with weakly corrugated tine of posterior process; 3 setae on anterior papilla not so different in length. Maxilliped (Fig. 9d) with robust corpus bearing blunt inner subdistal protrusion; shaft and terminal claw indistinctly demarcated. Tines of sternal furca (Fig. 9e) divergent, narrow, straight, and truncate distally.

Leg 1 (Fig. 9f) with vestigial, tapering and bluntly tipped endopod. Second exopodal segment armed with 3 large

plumose setae on inner margin and 3 subequal spines plus 1 large naked seta on distal margin; the latter inner seta about twice as long as spines; 3 spinulose spines along outer margin, with long flagellum (Fig. 9g).

Leg 2 as in Suárez-Morales et al. (2003). Leg 3 with first exopodal segment (Fig. 9h) bearing 2 setules on outer subdistal region.

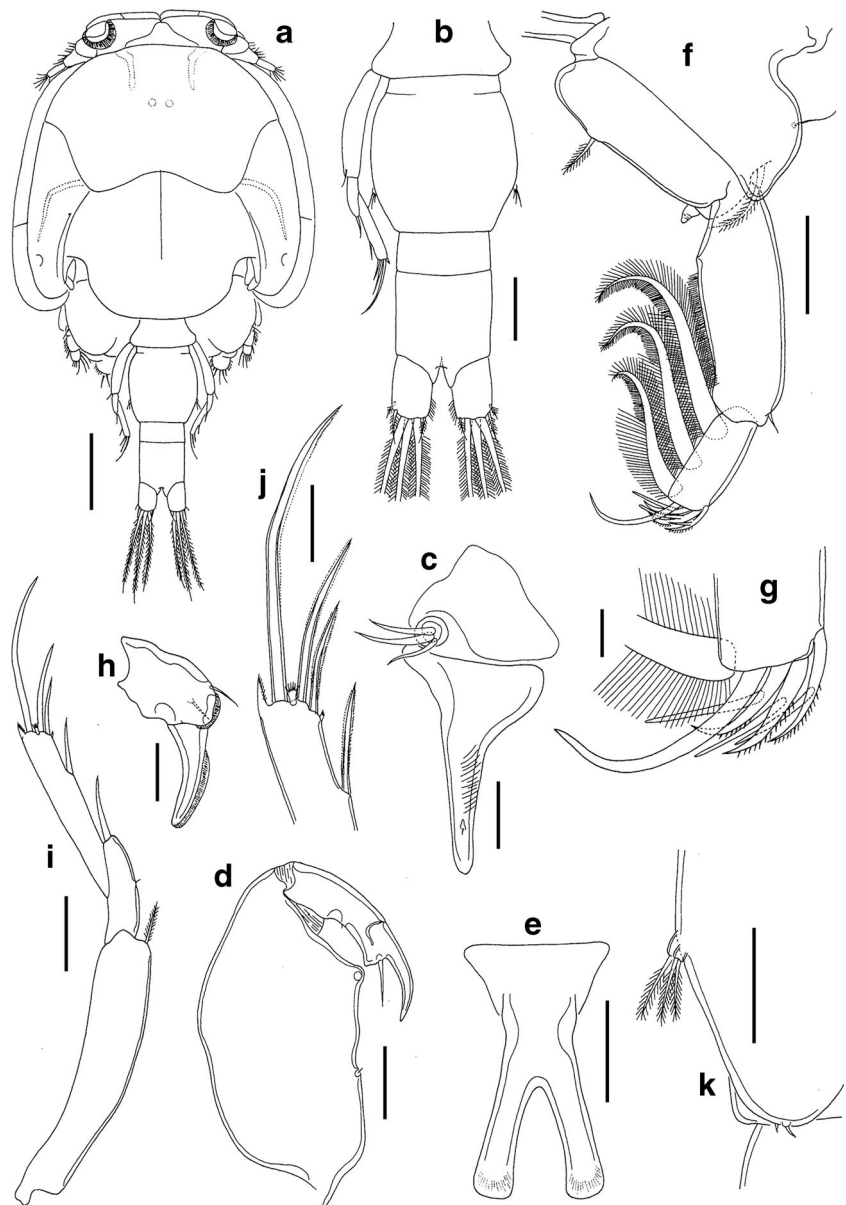
Leg 4 (Fig. 9i) slender. Exopod 2-segmented and armed 1 outer and 3 unequal distal setae; the latter 3 distal setae each accompanied with small pectinate lamella near base (Fig. 9j).

Leg 5 represented by 3 plumose setae on lateral margin of genital complex (Fig. 9k). Leg 6 represented by 2 small setae on genital operculum (Fig. 9k).

Remarks.

Cressey (1991) presumed that this species was confined to the Atlantic coast of the United States and the southwest Florida coast, but the finding of this species in the surveyed area and in the Yucatan Peninsula (Suárez-Morales et al. 2003) as well, suggest that it has a wider geographic

Fig. 9 *Caligus rufimaculatus* Wilson, male. **a**, habitus, dorsal; **b**, urosome, dorsal; **c**, maxillule; **d**, maxilliped; **e**, sterna furca; **f**, leg 1; **g**, distal part of leg 1 exopod; **h**, first exopodal segment of leg 3; **i**, leg 4; **j**, distal part of leg 4; **k**, legs 5 and 6. Scale bars: **a**, 0.5 mm; **b**, 0.2 mm; **c**, **h**, **j**, 0.05 mm; **d–f**, **i**, **k**, 0.1 mm; **g**, 0.02 mm



distribution that currently expands its known geographic range southwards from the Gulf of Mexico onto the western Caribbean waters off Venezuela.

Discussion

There are 58 species of *Caligus* reported from the Neotropical region (Morales-Serna et al. 2016). Of these, *C. rufimaculatus*, *C. chelifera* Wilson 1905, *C. evelynae*, *C. tetodontis* Barnard, 1948, *C. undulatus* Shen and Li, 1959, and the recently described *C. ilhoikimi* Suárez-Morales and Gasca 2016 from the Yucatan Peninsula, have been also found as planktonic forms only, detached from their hosts (Venmathi Maran and Ohtsuka 2008; Venmathi Maran et al. 2012; Suárez-Morales et al. 1998,

2012b; Ocaña-Luna and Álvarez-Silva 2001; Suárez-Morales and Gasca 2016; Ohtsuka et al. 2018). In the fish-parasitic families like Caligidae and Ergasilidae, adult females of some species are also free-swimming, and yet exhibit a dual mode of life, being able to switch between the host body surface and the water column (Ohtsuka et al. 2004a, b; Venmathi Maran et al. 2018).

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Compliance with Ethical Standards

Conflict of Interests We hereby declare that there was no conflict of interests during any part of the planification or development of this joint collaboration.

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