



A new species of *Acusicola* Cressey (Copepoda: Ergasilidae) from northeastern Brazil

H.M.P. Araujo¹ & G.A. Boxshall²

¹Departamento de Biologia, Universidade Federal de Sergipe, Cidade Universitária, 49.1000-000 São Cristóvão, Sergipe, Brazil

²Department of Zoology, The Natural History Museum, Cromwell Road, London SW7 5BD, UK

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Abstract

A new species of *Acusicola* is described based on adults of both sexes taken from plankton samples collected in the upper reaches of the Piauí River estuary, in the northeast of Brazil. Ovigerous females were present in the plankton. The new species, *Acusicola minuta* n. sp., can be distinguished from its congeners by its small body size, female antennal morphology and leg setation. The male described here as *A. minuta* n. sp. is the first known male attributed to the genus.

Introduction

The genus *Acusicola* was established by Cressey in Cressey & Collette (1970) to accommodate two species of ergasilid copepods parasitic on fishes: *A. tenax* (Roberts, 1965), originally placed in the genus *Ergasilus* von Nordmann, and a new species, *A. cunula* Cressey in Cressey & Collette, 1970. Currently it contains thirteen species and has been reported from the USA (Roberts, 1965), Central America (Motta Amado & Rocha, 1996; Cressey & Collette, 1970; El-Rashidy & Boxshall, 1999) and northern South America (Cressey & Collette, 1970; Thatcher, 1984; Thatcher & Boeger, 1983a,b; Motta Amado & Rocha, 1996). These species have been reported from a range of freshwater, brackish and marine fish hosts, but no *Acusicola* species has been previously been reported free swimming in the plankton.

The life-cycle of members of the family Ergasilidae is unique within the Copepoda in that all naupliar and copepodid stages and adults of both sexes are free-living and only the adult females are known to be parasitic. Mating apparently takes place before the female has settled on the host, with the male remaining free-swimming throughout its brief existence (Kabata, 1979). After mating the female locates and attaches to the host, typically a fish but rarely a bivalve mollusc, where the production of egg-sacs takes place.

Records of ovigerous female ergasilids in plankton samples have long been known (cf. Wilson, 1911; Montú, 1980) but have been regarded as exceptional. However, in the upper reaches of the Piauí River estuary adults of both sexes, including ovigerous females of *Acusicola* were found in plankton samples mainly collected during the rainy season. In this zone of the estuary, the salinity ranged between zero and 2‰ and the water temperature between 25.2 and 30 °C. This *Acusicola* is described below as a new species.

Materials and methods

Material was sorted from plankton samples collected monthly during the 12-month period July, 1985 to June, 1986 in the upper reaches of the Piauí River estuary, Sergipe State, in northeastern Brazil. Samples were taken by plankton net, mesh size 120 µm and mouth diameter of 30 cm, hauled horizontally at the surface. All samples were preserved immediately in buffered 4% formaldehyde before transfer to 70% ethanol. The copepods were dissected and examined in lactophenol as temporary slide preparations. Measurements were made with an ocular micrometer and drawings were made with the aid of camera lucida on an Olympus BH2 microscope using differential interference contrast. Types are stored in

the Zoological Museum of the Universidade de São Paulo (MZUSP) and in The Natural History Museum (BMNH), London.

Acusicola minuta n. sp. (Figures 1–4)

Type-material: Female holotype, Reg. No. 13.354 in MZUSP; 2 females and 9 males, paratypes, Reg. Nos 2000.1887-1897, in BMNH.

Type-locality: Piauí River estuary, State of Sergipe, Brazil.

Etymology: The specific name refers to small length of the species.

Description of adult female

Body slender, cyclopiform. Mean body length from anterior margin of prosome to posterior margin of caudal rami 0.58 mm. Cephalosome 1.08 times longer than wide, with incomplete transverse marking on mid-dorsal surface; nauplius eye located near frontal margin. Four free pedigerous somites decreasing in width from anterior to posterior (Figure 1A,B). Urosome (Figure 1B) comprising short fifth pedigerous somite, inflated genital double-somite and 3 free abdominal somites. Anal somite deeply incised. Genital double-somite, first and second free abdominal somites each ornamented with transverse row of minute spinules ventrally along posterior margin. Anal somite with minute spinules distally, on each side of medial incision. Caudal rami about 1.45 times longer than wide, ornamented with spinules distally, armed with 4 caudal setae; inner seta longest (Figure 1C). Egg-sac multiseriate, containing about 12 eggs (Figure 1B).

Antennule 5-segmented (Figure 2A), tapering distally, compound proximal segment largest: setal formula 12: 6: 4+ae: 2+ae: 7+ae. Antenna (Figure 2B,C) 4-segmented, comprising short coxobasis, 3-segmented endopod and terminal claw. First endopodal segment about 6 times longer than wide, comprising shorter proximal part supported by conspicuous sclerotised thickenings and longer distal part, bearing curved spine proximally on inner margin and with surface of inner margin membranous distally. Second segment with constriction at mid-length, unarmed, provided with 2 inner membranous expansions. Third segment (arrowed on Figure 2C) very short and represented by incomplete hoop of sclerotised cuticle. Terminal claw short, curved and with subterminal fossa.

Mandible armed with small anterior blade, large middle blade and slender posterior blade, variously armed with sharp teeth as in Figure 2D. Maxillule bearing 2 small setae distally, plus medial spine (Figure 2E); surface ornamented with minute spinules. Maxilla comprising large, unarmed syncoxa with 2 small pores and basis, with dense array of curved spinules distally (Figure 2F). Maxilliped absent.

Swimming legs 1–4 with all rami 3-segmented, except 2-segmented endopod of leg 1 and exopod of leg 4 (Figures 3A–D). Interpodal sternites (not figured) smooth, lacking ornamentation. Spine and seta formula as follows:

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

Setae on inner margin of endopod of leg 1 modified, reduced in size; apical spines of leg 1 endopod subequal, each serrate along outer margin. Outer margins of all segments of both rami of legs 1–4 ornamented with spinule rows, except first endopodal segments of legs 2 and 3 with pinnules. Inner margin of first exopodal segment of legs 1–4 with pinnules.

Fifth leg represented by 2 setae; each carried on separate papilla (Figure 1D).

Description of adult male

Body slender, cyclopiform. Mean body length from anterior margin of prosome to posterior margin of caudal rami 0.52 mm. Cephalosome 1.21 times longer than wide (Figure 4A); free pedigerous somites well defined, decreasing in width posteriorly. Urosome 6-segmented comprising short fifth pedigerous somite, genital and 4 free abdominal somites. Genital somite bearing sixth legs posterolaterally on ventral surface; each represented by opercular lobe closing off genital aperture, armed with long seta apically and ornamented with 2 curved spinule rows distally. Free urosomites each ornamented with transverse row of spinules near posterior margin. Caudal rami about 2.0 times longer than wide, bearing 4 setae along inner part of distal margin (Figure 4B).

Antennule segmentation and setation as in female. Antenna 4-segmented comprising short coxobasis, 3-segmented endopod and terminal claw (Figure 4C) as in female, but differing considerably from female in form. Coxobasis short, bearing strong seta at inner

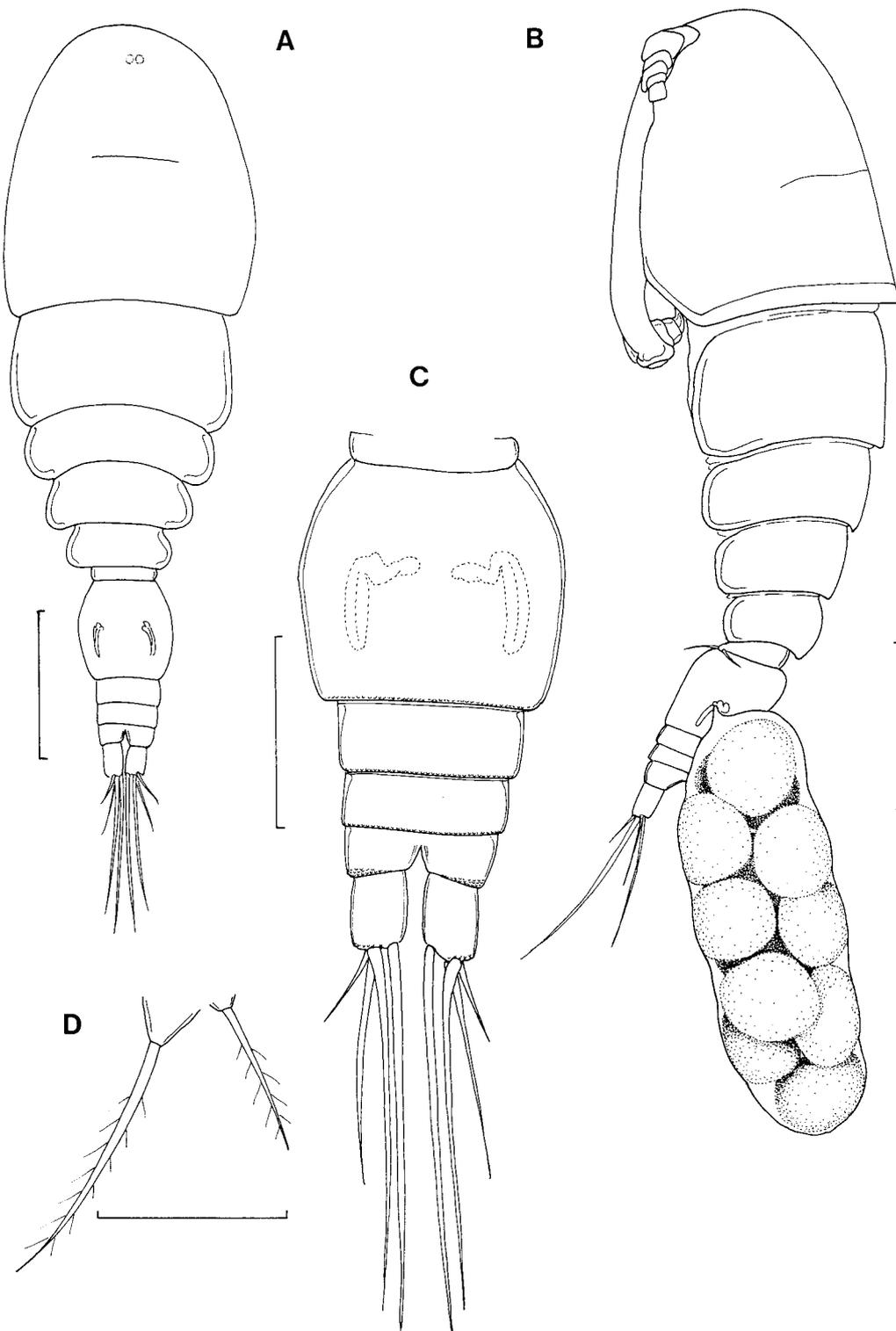


Figure 1. *Acusicola minuta* n. sp. Female. A, Habitus, dorsal; B, Habitus, lateral showing egg sac; C, Urosome, ventral without fifth legs; D, Leg 5, ventrolateral. Scale-bars: A-B, 100 μm ; C, 50 μm ; D, 25 μm .

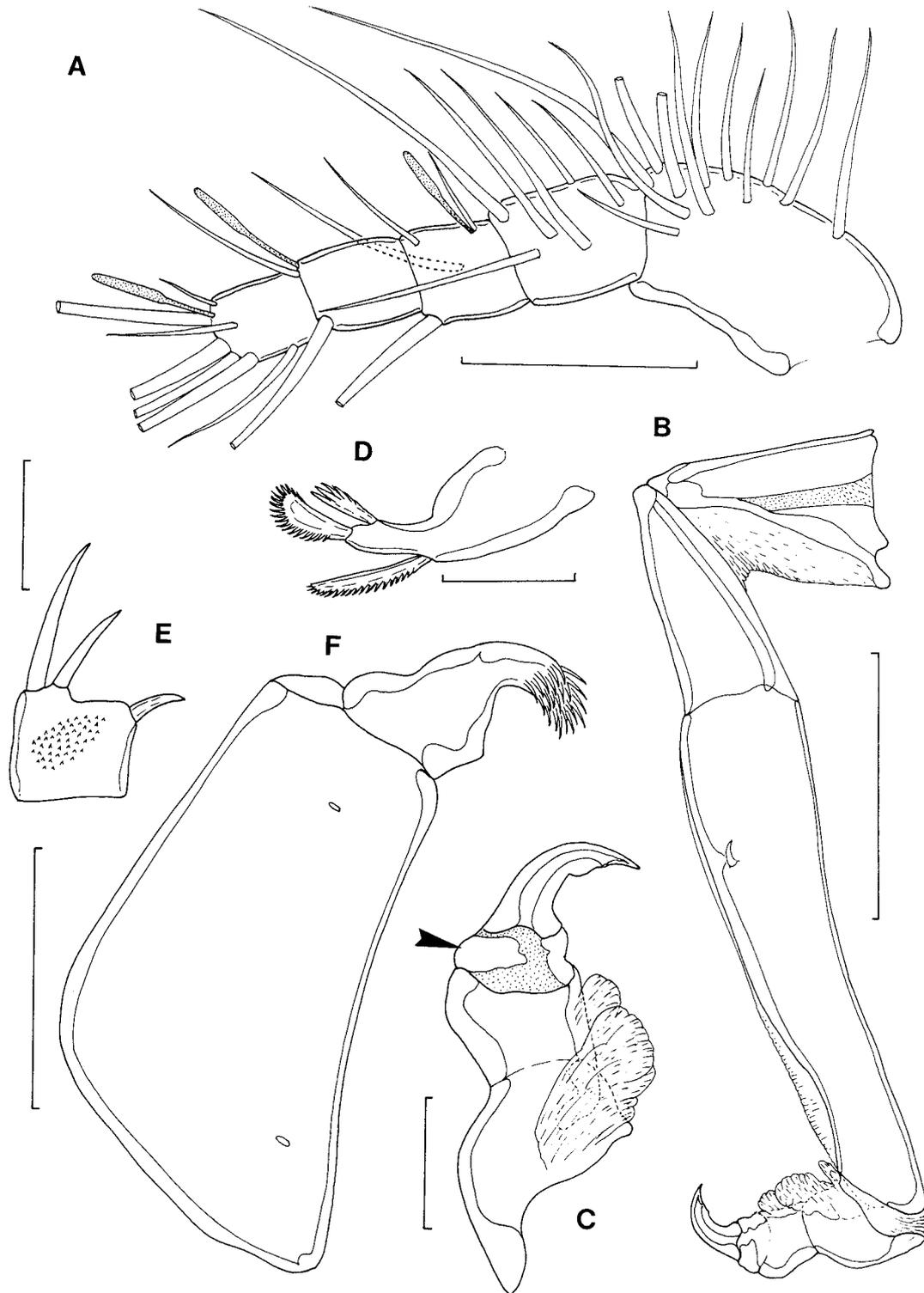


Figure 2. *Acusicola minuta* n. sp. Female. A, Antennule, with aesthetascs stippled and some setae cut off for drawing; B, Antenna; C, Distal subchela of antenna, with vestigial third endopodal segment arrowed; D, Mandible, ventral; E, Maxillule, ventral; F, Maxilla, ventral. Scale-bars: A, 25 μ m, B, 100 μ m, C-E, 25 μ m, F, 50 μ m.

distal angle. First endopodal segment about 4.2 times longer than wide, armed with small seta near middle of inner margin. Second segment slightly curved without distinct constriction at mid-length, armed with minute setae near middle and near distal tip of concave inner margin, and with outer distal spinule or seta; segment lacking inner membranous expansions. Third segment short, markedly narrower than second segment and unarmed. Terminal claw, curved, relatively more elongate than in female, with fossa located just distal to mid-point of concave margin. Mouthparts (mandible, maxillule and maxilla) as in female.

Maxilliped comprising 3 expressed segments plus terminal claw (proximal segment not shown in Figure 4D). Second segment (= basis) about 3 times longer than wide, ornamented with curved spinule row. Endopodal segment compound (as indicated by irregular thickness of cuticle), armed with subapical spine and bearing claw terminally. Claw very long, evenly curved, unornamented, but apparently with pore at apex.

Swimming legs as in female except for leg 1 (Figure 4E); first and second endopodal segments shorter than in female (cf. Figure 3A), with unmodified setae on endopod and with distal spines on apex of endopod unequal in length, outer being about half length of inner. Interpodal sternites smooth, lacking ornamentation as in female.

Fifth leg represented by 2 plumose setae, each carried on separate papilla (Figure 4F).

Remarks

Comparisons of the new species with known congeners can only be made from females, since males were hitherto unknown for the genus. Using female morphology alone the new species can be distinguished primarily on the basis of body size and form, antennal form and leg setation. The new species has one of the smallest adult body lengths of the described species, although four other species, *A. brasiliensis* Motta Amado & Rocha, 1996, *A. cunula*, *A. paracunula* Motta Amado & Rocha, 1996 and *A. spinulosa* Motta Amado & Rocha, 1996, also have body lengths less than 0.70 mm (see Table 1). Size, however, may not be a good species discriminant, since host size may influence the size of parasites and *A. minuta* n. sp. is known only from the plankton.

On the basis of its slender female body form, *A. minuta* n. sp. can readily be distinguished from *A. lycengraulidis* Thatcher & Boeger, 1983, *A. rotunda*

Motta Amado & Rocha, 1996 and *A. spinulosa* Motta Amado & Rocha, 1996, all three of which have a markedly inflated prosome.

The form of the female antenna in *A. minuta* n. sp., with an elongate first endopodal segment and a short distal subchela (second endopodal segment to claw), is shared only with *A. brasiliensis*, *A. cunula*, *A. paracunula*, *A. rogeri* and *A. tenax*. It differs strongly from the antennae of the following eight species, *A. joturicola* El-Rashidy & Boxshall, 1999, *A. lycengraulidis*, *A. mazatlanensis* El-Rashidy & Boxshall, 1999, *A. peltonidis* Thatcher & Boeger, 1983, *A. rotunda*, *A. spinuloderma* El-Rashidy & Boxshall, 1999, *A. spinulosa* and *A. tucunarensis* Thatcher, 1984, all of which have a relatively shorter first endopodal segment and longer subchela. Differences in the interpretation of antennal segmentation within the genus *Acusicola* were discussed by El-Rashidy & Boxshall (1999), whose system is followed here.

The similarities in female body size and form, and in the form of the female antenna, suggest that the new species is most closely related to *A. brasiliensis*, *A. cunula* and *A. paracunula*. It differs from all three in the spine and seta formula of the swimming legs. According to Motta Amado & Rocha (1996), *A. brasiliensis* carries an outer spine on the third exopodal segment of leg 3 (absent in *A. minuta*) and the inner apical spine on the leg 1 endopod is barbed proximally (not barbed in *A. minuta*). The same authors state that *A. paracunula* lacks the outer spine on the first exopodal segment of the second and third legs (present on both legs of *A. minuta*). According to Cressey & Collette (1970, p 363), *A. cunula* also has an outer spine on the third exopodal segment of leg 3 (absent in *A. minuta*).

Discussion

The genus *Acusicola* has hitherto been known only from females, so the identification of the male described here as the male of *A. minuta* n.sp. is tentative. The same plankton samples from the upper reaches of the Piauí River estuary also contained a variety of other ergasilids, including both sexes of *Ergasilus euripedesi* Montú, 1980, premetamorphic adult females of *Therodamas serrani* Krøyer, 1863 (Araujo & Boxshall, in press) and a new species of *Ergasilus* characterised by the presence of a rosette-like ornament on the endopod of leg 1 (Araujo & Boxshall, unpubl. data). The repeated co-occurrence of these

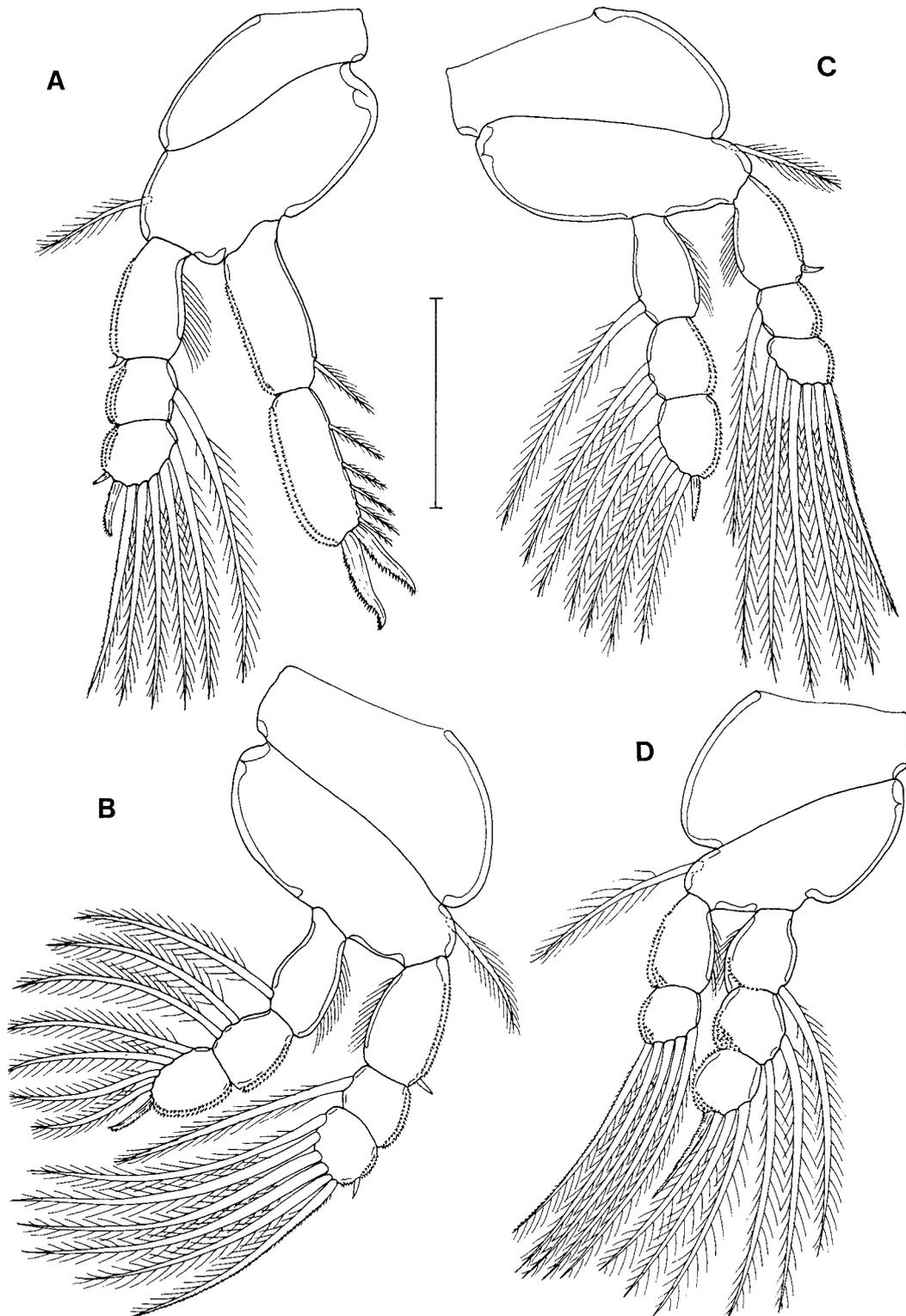


Figure 3. *Acusicola minuta* n. sp. Female. A, Leg 1, anterior; B, Leg 2, anterior; C, Leg 3, anterior; D, Leg 4, anterior. Scale-bar; A-D, 50 μ m.

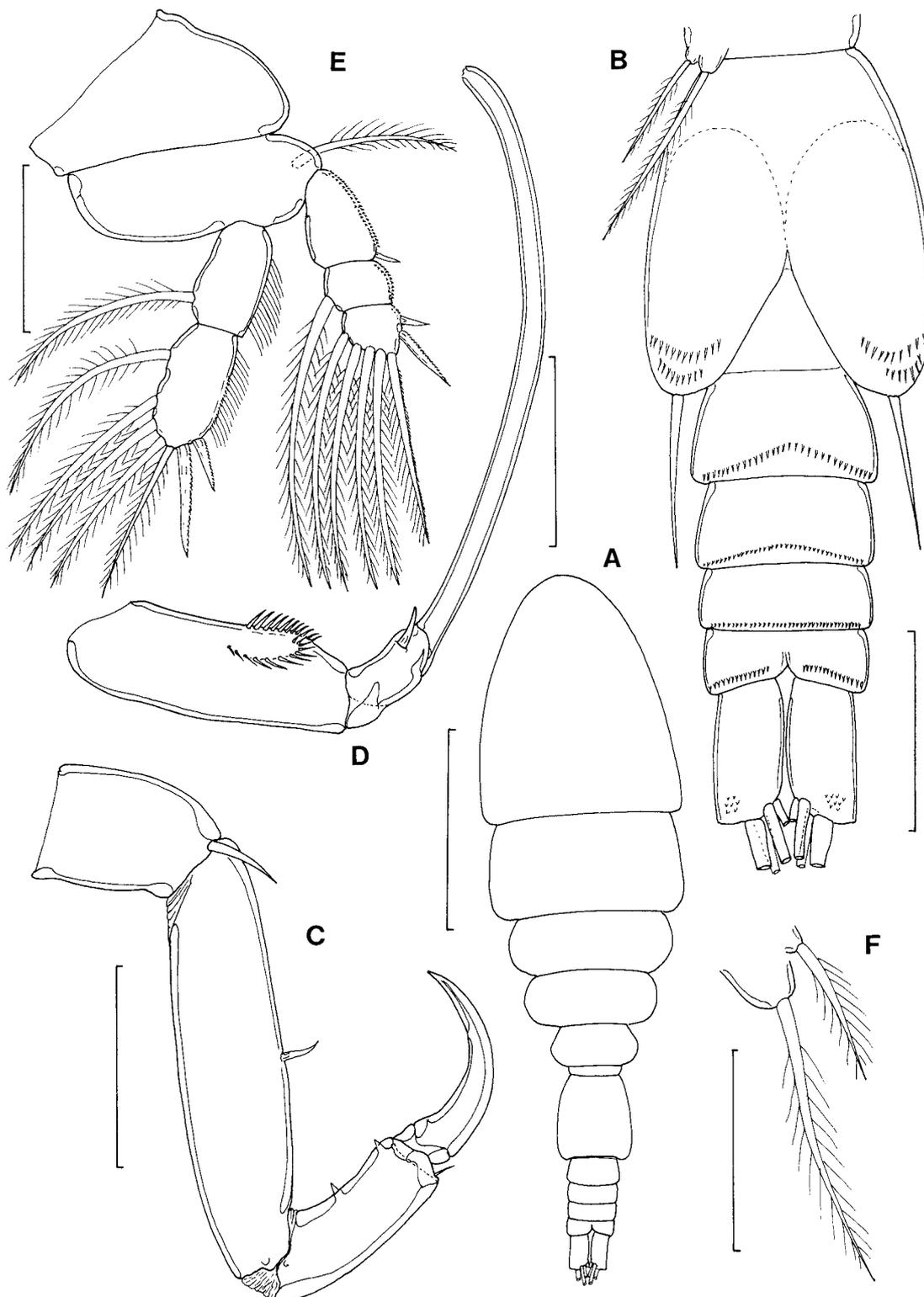


Figure 4. *Acusicola minuta* n. sp. Male. A, Habitus, dorsal; B, Urosome, Ventral; C, Antenna; D, Maxilliped, drawn without syncoxa; E, Leg 1, anterior; F, Leg 5. Scale-bars: A, 100 μ m, B-C, 25 μ m, D, 50 μ m, E-F, 25 μ m.

Table 1. Adult female body length (in mm) in species of *Acusicola*.

Species	Mean length	Locality	Data source
<i>A. brasiliensis</i>	0.57	Brazil	Motta Amado & Rocha, 1996
<i>A. cumula</i>	0.65	Brazil	Cressey & Collette, 1970
<i>A. joturicola</i>	1.26	Panama	El-Rashidy & Boxshall, 1999
<i>A. lycengraulidis</i>	0.89	Brazil	Thatcher & Boeger, 1983a
<i>A. mazatlanensis</i>	0.93	Mexico	El-Rashidy & Boxshall, 1999
<i>A. minuta</i>	0.58	Brazil	Present account
<i>A. paracumula</i>	0.63	Brazil	Motta Amado & Rocha, 1996
<i>A. pellowidisi</i>	1.13	Brazil	Thatcher & Boeger, 1983b
<i>A. rogeri</i>	0.80	Guatemala	Cressey & Collette, 1970 (as <i>Acusicola tenax</i>)
<i>A. rotunda</i>	0.96	Brazil	Motta Amado & Rocha, 1996
<i>A. spinuloderma</i>	1.02	Honduras, Mexico, Costa Rica, Panama, St Lucia	El-Rashidy & Boxshall, 1999
<i>A. spinulosa</i>	0.61	Brazil	Motta Amado & Rocha, 1996
<i>A. tenax</i>	0.78	Texas, USA	Roberts, 1965
<i>A. tucunarensis</i>	0.84	Brazil	Thatcher, 1984

males and females in the same plankton samples does not, by itself, indicate that this male is conspecific with *A. minuta* n.sp. The strongest evidence supporting this identification is the possession of the same spine and seta formula on swimming legs 1 to 4 in both sexes. All the co-occurring ergasilid species listed above have different leg setation patterns, from each other and from *A. minuta* n. sp. Even within the genus *Acusicola*, only the three species described by El-Rashidy & Boxshall (1999), *A. joturicola*, *A. mazatlanensis* and *A. spinuloderma*, plus *A. pellowidisi* share this same leg setation formula with *A. minuta* n. sp. In addition, the setation pattern of the antennules, the setation of the maxillules and maxillae, the smooth interpodal sternites, and the form of the fifth legs are similar in both sexes. On the basis of these morphological similarities, the males are tentatively identified as belonging to *A. minuta* n. sp. However, there are also marked differences between these males and females.

Differences in the segmentation of the urosome and the presence of maxillipeds in the male are typical of the sexual dimorphism reported for other ergasilid genera, such as *Neoergasilus* Yin, *Ergasilus* and *Thersitina* Norman (cf. Urawa et al., 1980; Ben Hassine, 1983; Gurney, 1913), in which both sexes are known. In these other genera, as in *Acusicola*, there are also marked differences in the adult antennae between males and females. This is a problem for the taxonomist because the primary generic level characteristics of *Acusicola* lie in the distinctive form of the antenna. So the tentative nature of the identification

of these males, as the males of *Acusicola* in general and of *A. minuta* n. sp. in particular, is largely due to the existence of sexual dimorphism in the antenna. In addition, the differences in leg 1 between the sexes (cf. Figures 3A and 4E) are here interpreted as sexual dimorphism, but this interpretation is also tentative since the extent of sexual dimorphism is so poorly understood in this family. Confirmation of this identification will require breeding experiments or study of new material using molecular methods. Assuming this identification is correct, it is remarkable to note the high level of similarity between males of different currently-recognised genera within the family Ergasilidae.

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References

- Araujo, H.M.P. & Boxshall, G.A. (in press) *Therodamas* Krøyer, 1863 (Copepoda: Ergasilidae) from the Piauí River estuary, State of Sergipe, Brazil. *Hydrobiologia*.
- Ben Hassine, O.K. (1983) *Les copepodids parasites de poissons Mugilidae en Méditerranée occidentale (côtes françaises et Tunisiennes)*. Morphologie, Bio-écologie, Cycles évolutifs. PhD Thesis, Université des Sciences et Techniques du Languedoc, 471 pp.
- Cressey R. & Collette, B.B. (1970) Copepods and needlefishes: a study in host-parasite relationship. *Fishery Bulletin of the National Oceanic and Atmospheric Administration, United States*, **63**, 347–432.
- El-Rashidy, H. & Boxshall, G.A. (1999) Ergasilid copepods (Poecilostomatoida) from the gills of primitive Mugilidae (grey mullets). *Systematic Parasitology*, **42**, 161–186.
- Gurney, R. (1913) Some notes on the parasitic copepod *Thersitina gasterostei*, Pagenstecher. *Annals and Magazine of Natural History*, **12**, 415–424, pls X–XIII.
- Kabata, Z. (1979) *Parasitic Copepoda of British fishes*. London: The Ray Society, No. 152, 468 pp.
- Montú, M.A. (1980) Parasite copepods of Southern Brazilian Fishes I. *Ergasilus euripedesi* n. sp. (Copepoda, Cyclopoidea). *Iheringia, Série Zoologie*, **56**, 53–62.
- Motta Amado, M.A.P. & da Rocha, C.E.F. (1996) New species of parasitic copepods of the genus *Acusicola* (Poecilostomatoida: Ergasilidae) from gill filaments of coastal and fresh water Brazilian fishes, and proposition of *Acusicola rogeri* n. sp. for *A. tenax* sensu Cressey & Collette (1970). *Hydrobiologia*, **324**, 183–193.
- Roberts, L.S. (1965) *Ergasilus tenax* sp. n. (Copepoda: Cyclopoida) from the white Crappie, *Pomoxis annularis* Rafinesque. *Journal of Parasitology*, **51**, 987–989.
- Thatcher, V.E. (1984) The parasitic crustaceans of fishes from the Brazilian Amazon, 7. *Acusicola tucunarensis* n. sp. (Copepoda: Cyclopidea) from *Cichla ocellaris*, with an emendation of the genus and the proposal of Acusicoliane [sic] subfam. nov. *Revista Brasileira de Biologia*, **44**, 181–189.
- Thatcher, V.E. & Boeger, W.A. (1983a) The parasitic crustaceans of fishes from the Brazilian Amazon, 8. *Acusicola lycengraulidis* sp. n. (Copepoda: Cyclopoida) from *Lycengraulis grossidens* Cuvier. *Acta Amazonica* **13**, 943–951.
- Thatcher, V.E. & Boeger, W.A. (1983b) The parasitic crustaceans of fishes from the Brazilian Amazon. 10. *Acusicola pellonidis* n. sp. (Copepoda: Cyclopidea) from *Pellona castelnaeana* (Valenciennes). *Amazoniana*, **8**, 273–279.
- Urawa, S., Muroga, K. & Kasahara, S. (1980) Studies on *Neoergasilus japonicus* (Copepoda: Ergasilidae) a parasite of freshwater fishes. II Development in copepodite stage. *Journal of the Faculty of Applied Biological Sciences, Hiroshima*, **19**, 21–38.
- Wilson, C.B. (1911) North American parasitic copepods belonging to the family Ergasilidae. *Proceedings of the United States National Museum*, **39**, 263–400.