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TWO NEW SPECIES OF *CALIGUS* MÜLLER, 1785 (COPEPODA: SIPHONOSTOMATOIDA: CALIGIDAE) PARASITIC ON *XENOMELANIRIS BRASILIENSIS* (QUOY & GAIMARD, 1824) (OSTEICHTHYES: ATHERINIDAE) FROM THE COSTAL ZONE OF THE STATE OF RIO DE JANEIRO, BRAZIL

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Abstract: Two new species of Caligus *Müller, 1785:* C. littoralis *sp. nov. and* C. itacurussensis *sp. nov., parasitic on the body surface of the atherinid fish* Xenomelaniris brasiliensis *(Quoy & Gaimard, 1824) from the coastal zone of the State of Rio de Janeiro, Brazil, are described and illustrated. The new species are characterized by the one-segmented abdomen, which is sub-quadrangular with length about, or less than, 25% (*in C. littoralis *sp. nov.) and 50% (in* C. itacurussensis *sp. nov.) that of genital complex, and a two-segmented fourth exopod bearing a distal armature consisting of three unequal spines.*

Key-words: Copepoda, Caligidae, Caligus, *Atherinidae,* Xenomelaniris brasiliensis, *Brazil.*

Caligid copepods are predominantly external parasites of fishes, especially teleosts. *Caligus* Müller, 1785 is the largest genus of siphonostomatoid copepods. Currently, more than 200 species are known, and many of them parasitize commercially important fishes (Boxshall & Montú, 1997); from those, 20 species of *Caligus* parasitic on marine fishes are reported to the Brazilian coastal zone (Luque & Takemoto, 1996; Boxshall & Montú, 1997; Ho, 1998; Luque *et al.*, 1998).

In this study, two new species of *Caligus* parasitic on the atherinid fish *Xenomelaniris brasiliensis* from the coastal zone of the State of Rio de Janeiro are described.

Material and Methods

Some of the copepods studied were obtained in the Coleção de Crustacea of the Museu Nacional/UFRJ (MNRJ). Other specimens were taken directly from *Xenomelaniris brasiliensis* (Quoy & Gaimard, 1824) (Atherinidae) collected by the authors from Itacuruçá, Sepetiba Bay, coastal zone of the State of Rio de Janeiro in 1996. Fishes were identified using the key presented by Figueiredo & Menezes (1978). The copepods were fixed and preserved in ethanol 70°GL. For microscopic study, specimens were cleared in lactic acid 85% and the appendages were dissected with fine needles. The illustrations were made with the aid of a drawing tube mounted on

a Wild M-20 phase contrast microscope. Holotype and some paratypes were deposited in the Coleção de Crustacea do Museu Nacional/UFRJ (MNRJ), Quinta da Boa Vista, Rio de Janeiro, RJ, Brazil; the remaining paratypes were deposited in the Division of Crustacea, United States National Museum, Smithsonian Institution (USNM), Washington, DC, USA.

Siphonostomatoida Latreille, 1829
Caligidae Burmeister, 1835
Caligus Müller, 1875

***Caligus littoralis* sp. nov.**
(Figs. 1-16)

Holotype (MNRJ 7262, female)
Paratypes (MNRJ 7263, three females)

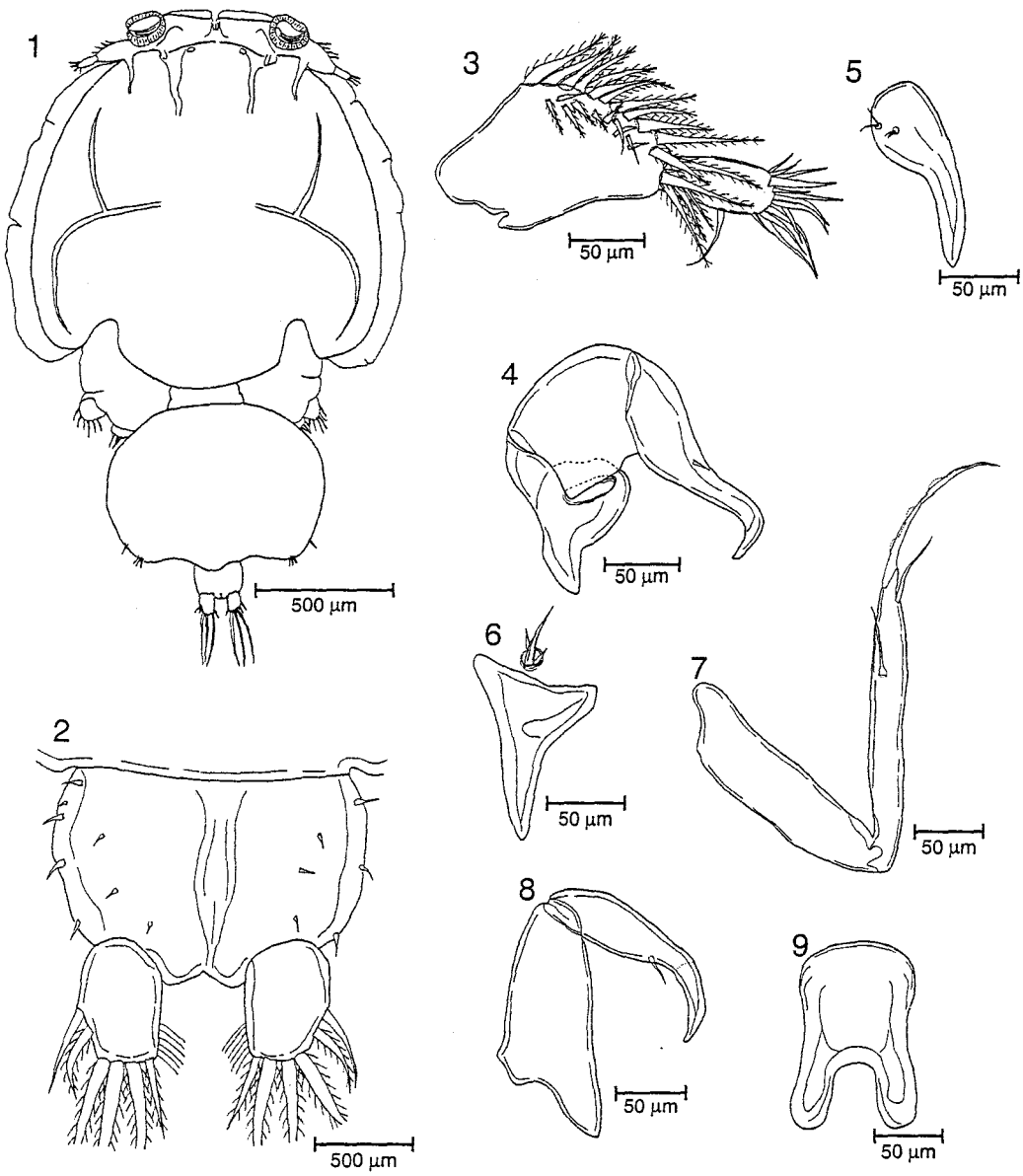
All taken from the body surface of *Xenomelaniris brasiliensis* (Quoy & Gaimard, 1824) (type host) from Maricá, Rio de Janeiro, Brazil (23°41'S, 43°34'W) (type locality) in 22 February 1992.

Female (Fig. 1).—Cephalothoracic shield suborbicular, about as wide as long, posterior margin of thoracic zone protruding slightly beyond tips of lateral zones. Genital complex wider than long, sloping anterolateral margins, rounded posterolateral corners. Abdomen (Fig. 2) one-segmented, subquadrangular, its length about, or less than, 25% that genital complex, with some spinules on dorsal surface. Caudal rami (Fig. 2) approximately of half the length of abdomen. Dimensions (in mm), based on four specimens, as follows: Total length 2.18-2.55 (2.34); cephalothorax length 1.37-1.60 (1.48), width 1.35-1.68 (1.51); genital complex length 0.37-0.68 (0.56), width 0.62-0.93 (0.78); abdomen length 0.12-0.19 (0.16), width 0.20; caudal rami length 0.06-0.08 (0.07), width 0.04-0.06 (0.05). Antennule (Fig. 3), distal segment is only half as long as proximal segment. Antenna (Fig. 4) with subtriangular, curved, posterior process. Postantennary process (Fig. 5) with rounded corners, slightly hamate, with 2 compound setules. Maxillule (Fig. 6) with wide base, tapering evenly to single tip; adjacent papilla with three unequal setae. Maxilla (Fig. 7) brachiform, two-segmented; lacertus slightly shorter than brachium; brachium slender, flabellum modified into long seta; calamus with outer delicate membrane, canna naked. Maxilliped (Fig. 8) with corpus broad at base, tapering distally, slightly greater than subchela; subchela with hooked claw and short seta. Sternal furca (Fig. 9) with rounded box; tines slightly divergent, shorter than box, round-tipped. First leg (Fig. 10) sympod subrectangular with two pinnate setae, one on outer distolateral corner and one on posterior margin; exopod 2-segmented, proximal segment rectangular, long, posterior margin with fringe of setules and small spine on distal corner; distal segment with four apical setae, first and fourth setae slightly shorter than others, second and third setae each with subdistal digitiform process, and three pinnate setae on posterior margin; endopod reduced to papilla. Second leg exopod (Fig. 11), proximal segment with prominent, slightly serrate spine and one pinnate seta; second segment with one spine and pinnate seta; distal segment with two spines, one smaller than other, one semipinnate distal seta, and five pinnate setae. Second leg endopod (Fig. 12) with fringe of setules on proximal, second, and part of distal segment; setation typical of the genus. Third leg exopod (Fig. 13), with hook reaching distal segment; second segment with two unequal pinnate setae, and distal segment with three naked setae, one longer than others, and three long pinnate setae. Third leg endopod (Fig. 14) with one pinnate seta on proximal segment and six pinnate setae on distal segment; lateral margin of distal segment with fringe of setules. Fourth leg (Fig. 15), sympod with long pinnate seta and two spinules; exopod 2-segmented, proximal segment with spine on distal corner; distal segment with three unequal spines, one with pecten at base. Fifth leg (Fig. 16) consists of three papillae with 2, 1, 1 pinnate setae.

Male.—unknown.

Etymology.—the specific name refers to the high occurrence of the hosts in the littoral zone.

Remarks.—*Caligus littoralis* sp. nov. can be compared with congeners sharing the following combination of characters: abdomen one-segmented, and fourth exopod two-segmented bearing armature consisting in three distal, unequal spines without lateral spine. From these species the more close to the new species are: *Caligus minimus* Otto, 1821; *C. balistae* Steenstrup & Lütken, 1861; *C. longipedis* Bassett-Smith, 1898; *C. brevicaudatus* Scott, 1901; *C. wilsoni* Delamare Deboutteville & Nunes Ruivo, 1958; *C. canthidermis* Yamaguti & Yamasu, 1959; *C. flexispina* Lewis, 1964; *C. kalumai* Lewis,

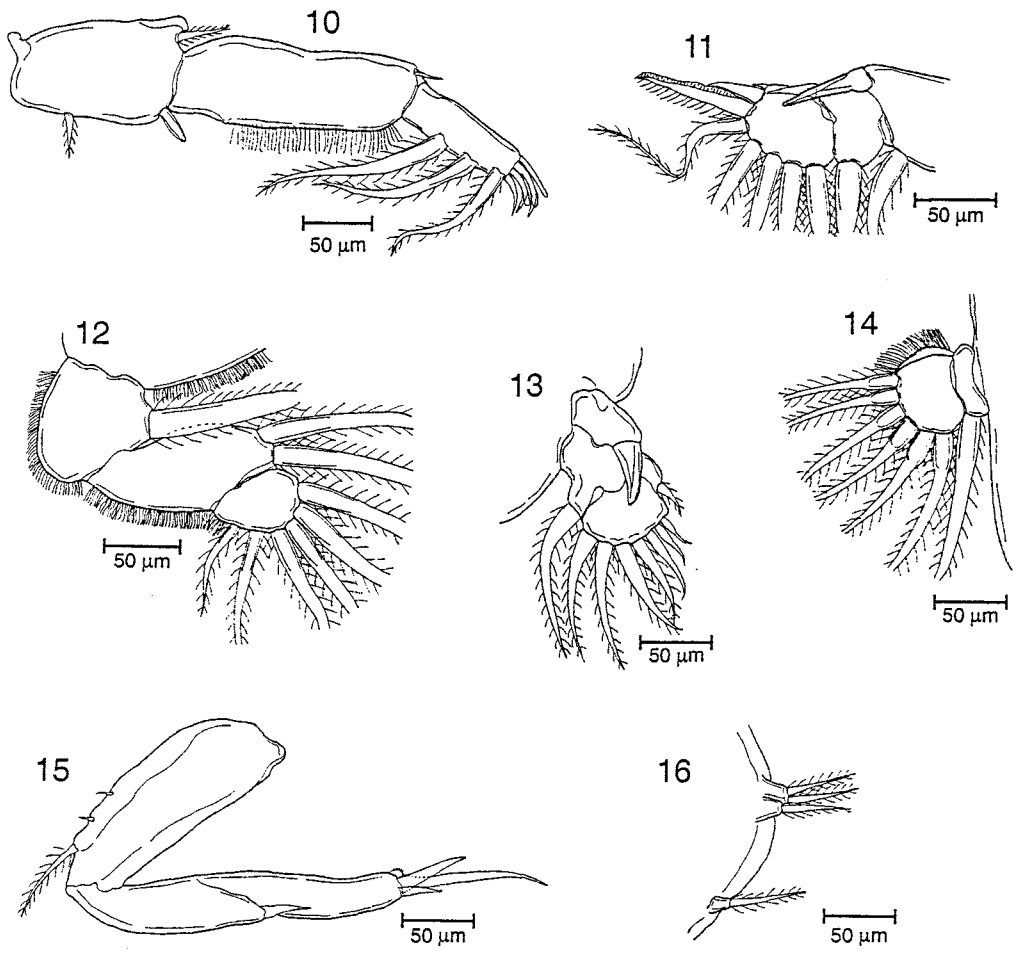


Figures 1-9. Caligus littoralis sp. nov.; female: 1. Entire, dorsal view; 2. Abdomen and caudal rami; 3. Antennule; 4. Antenna; 5. Postantennary process; 6. Maxillule; 7. Maxilla; 8. Maxilliped; 9. Sternal furca.

1964 and *C. antennatus* Boxshall & Gurney, 1980.

The new species differs from *C. minimus* in the shape of the sternal furca (with box twice as long as tines in *C. minimus*, box slightly longer than tines in *C. littoralis* sp. nov.), and by the distal armature of the fourth exopod (second and third distal spines subequal in *C. minimus;* unequal in *C. littoralis* sp. nov.).

Caligus littoralis sp. nov. can be differentiated from *C. balistae* by the shape of the genital complex (with slightly acute posterior corners in *C. balistae;* with rounded posterior corners in the new species), by the shape of the sternal furca (with tines longer than the box and acute in *C. balistae*; tines slightly shorter than box and round-tipped in *C. littoralis* sp. nov.), by the postantennary process shape (strongly hamate, elongate, with long setae in *C. balistae*; slightly hamate, shorter, with small setae, in the new species), and by the distal armature of the first



Figures 10-16. Caligus littoralis sp. nov.; female: 10. First leg, entire; 11. Second leg exopod; 12. Second leg endopod; 13. Third leg exopod; 14. Third leg endopod; 15. Fourth leg; 16. Fifth leg.

exopod (first seta shorter and fourth seta longer than other elements in *C. balistae*; second and third setae slightly longer than other elements in the new species).

Caligus longipedis can be separated from *C. littoralis* sp. nov. by the shape of the sternal furca (tines very spatulate in *C. longipedis*; not spatulate in the new species), and by the distal segment of the second endopod (with two crescent-shaped sclerotised areas in *C. longipedis*; without sclerotised areas in *C. littoralis* sp. nov.)

Caligus brevicaudatus differs from the new species by the distal armature of the first exopod (with three robust spines bearing accessory processes in *C. brevicaudatus*; without spines in *C. littoralis* sp. nov.), and by the spines of fourth exopod (serrate in *C. brevicaudatus*, not serrate in the new species).

Caligus littoralis sp. nov. can be separated from *C. wilsoni* by the shape of the sternal furca (small subtriangular box and spatulate tines in *C. wilsoni*; rounded box and not spatulate tines in the new species), and by the distal armature of the first exopod (with fourth seta longer than the other elements in *C. wilsoni*; with setae of subequal size in the new species).

Caligus canthidermis is differentiated from *C. littoralis* sp. nov. by the shape of the genital complex (with posterior corners acute in *C. canthidermis*; rounded in the new species), by the shape of the postantennary process (strongly hamate in *C. canthidermis*, slightly hamate in *C. littoralis* sp. nov.), by the shape of the sternal furca (with acute tines in *C. canthidermis*, with rounded

extremities in the new species), by the distal armature of the first exopod (with fourth seta longer than the other elements in *C. canthidermis*; with setae of subequal size in the new species) and by the spines of the fourth exopod (subequal in *C. canthidermis*, strongly unequal in the new species).

Caligus flexispina can be separated from the new species by the shape of the maxilliped (corpus greater than subchela in *C. flexispina*; subequal in the new species), by the distal armature of the first exopod (without accessory processes and fourth seta longer than the other elements in *C. flexispina*; with accessory processes and setae of subequal size in *C. littoralis* sp. nov.), and by the third exopod hook (not reaching the distal segment in *C. flexispina*; reaching the distal segment in the new species).

Caligus kalumai can be differentiated from *C. littoralis* sp. nov. by the shape of the genital complex (with posterior corners acute in *C. kalumai*; rounded in the new species), by the distal armature of the first exopod (second seta bifid and the others not bifid in *C. kalumai*; second and third setae with digitiform accessory processes in the new species), and by the hook of the third exopod (not reaching the distal segment in *C. kalumai*; reaching the distal segment in *C. littoralis* sp. nov.)

Caligus antennatus is easily differentiated from the new species by the shape of the antenna (with large conical process in *C. antennatus*; without in *C. littoralis* sp. nov.).

In addition, numerous spinules were observed in the abdomen of *C. littoralis* sp. nov. This character was not observed in the *Caligus* species mentioned above, although they may have been overlooked.

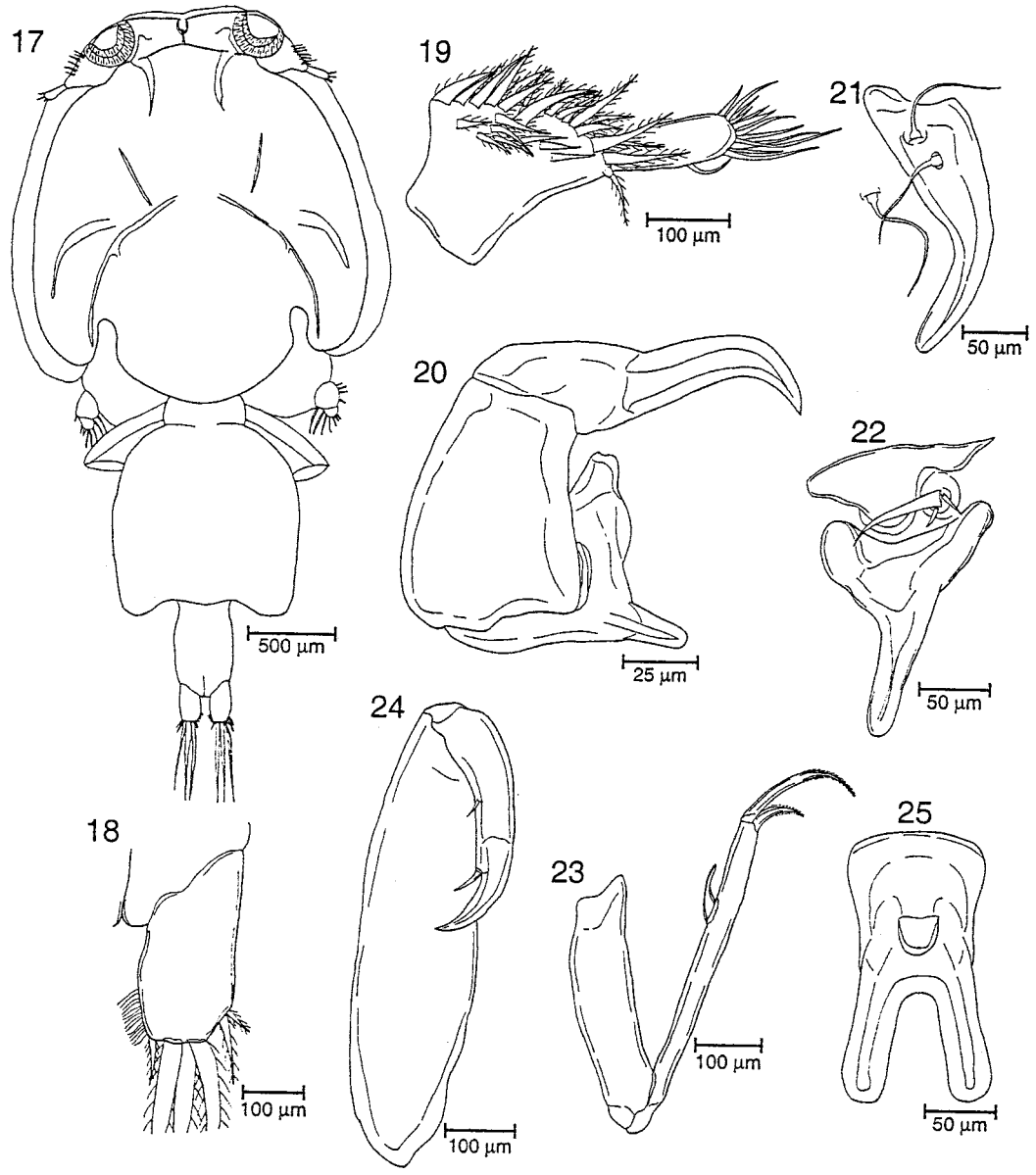
Caligus itacurussensis sp. nov.

(Figs. 17-37)

Holotype (MNRJ 13520, female)
Allotype (MNRJ 13521, male)
Paratypes (MNRJ 13522, four females; USNM 288086, two females)

All taken from the body surface of *Xenomelaniris brasiliensis* (Quoy & Gaimard, 1824) (type host) from Itacuruçá, Sepetiba Bay, Rio de Janeiro, Brazil (22°51S, 43°56W) (type locality) in 22 Feb. 1992.

Female (Fig. 17).—Cephalothoracic shield suborbicular, longer than wide, posterior margin of thoracic zone extending beyond tips of lateral zones. Lunules prominent, almost half width of frontal plates. Genital complex longer than wide, with rounded corners. Abdomen one-segmented, subrectangular, its length about, or less than, 50% that of genital complex. Caudal rami (Fig. 18) with three small and three longer pinnate setae, approximately one third of abdomen length. Dimensions (in mm), based on six specimens, as follows: Total length 3.32-4.35 (3.89); cephalothorax length 1.76-2.38 (2.15), width 1.72-2.07 (1.96); genital complex length 0.85-1.20 (1.09), width 0.72-1.35 (1.06); abdomen length 0.39-0.58 (0.52), width 0.25-0.39 (0.35); caudal rami length 0.12-0.19 (0.15), width 0.10-0.12 (0.11); egg-sac length (N=4) 1.76-4.13 (3.10), diameter 0.35-0.38 (0.37). Antennule (Fig. 19), proximal segment subtriangular, longer than distal segment. Antenna (Fig. 20) with robust, acute, posterior process. Postantennary process (Fig. 21) slender, curved, with rounded tip; bearing three long and slender setules, one of them on adjacent body surface. Maxillule (Fig. 22), dilated base, adjacent papilla with three setae, one longer than others. Maxilla (Fig. 23) brachiform, two-segmented; lacertus unarmed, shorter than brachium; brachium slender, membranous flabellum; calamus and canna with outer delicate membrane. Maxilliped (Fig. 24) with fusiform corpus, unarmed, shorter than corpus; subchela with hooked claw, seta on shaft. Sternal furca (Fig. 25) with trapezoidal, rounded box; tines divergent, slightly longer than box, round-tipped. First leg (Fig. 26) sympod subrectangular with two pinnate setae; exopod with rectangular proximal segment, posterior margin covered with fringe of setules and small seta on distolateral corner; distal segment with apical armature composed by three setae, two with acute processes, one naked longer than others; posterior margin with three progressively longer pinnate setae with fringe of setules on lateral margin; endopod small, represented by digitiform process. Second leg exopod (Fig. 27) with characteristic spines on distolateral corners of proximal and second segments, basal spine longer than second; distal segment with small spine on anterior margin, two semipinnate, fringed setae, and five long, pinnate setae. Second leg endopod (Fig. 28) bearing fine hair-like setules on lateral margin of proximal segment; lateral margin of second segment covered by fringe of spiniform setules. Third leg



Figures 17-25. Caligus itacurussensis sp. nov.; female: 17. Entire, dorsal view; 18. Caudal ramus; 19. Antennule; 20. Antenna; 21. Postantennary process; 22. Maxillule; 23. Maxilla; 24. Maxilliped; 25. Sternal furca.

exopod (Fig. 29), hook with rounded tip, not reaching distal segment; second segment with small spiniform seta and one pinnate seta; distal segment with three small, spiniform setae, and four pinnate setae; second and distal segment with fringed lateral margins. Third leg endopod (Fig. 30) with one and six pinnate setae on proximal and distal segment, respectively. Fourth leg (Fig. 31) sympod with two setules and pinnate seta; exopod 2-segmented, proximal segment with spine on distal corner, distal segment with three progressively shorter spines with pecten at base. Fifth leg (Fig. 32) consisting of two papillae with 1, 2 pinnate setae, respectively.

Male (Fig. 33).—Cephalothoracic shield similar to that of female. Genital complex suboval. Abdomen indistinctly two-segmented, subrectangular, slightly broader posteriorly, its length about or less than, 70% that of genital complex. Dimensions (in mm), based on one specimen, as follows: Total length 3.61; cephalothorax length 2.28, width 2.11; genital

complex length 0.60, width 0.58; abdomen length 0.43, width 0.27; caudal rami length 0.21, width 0.12. Appendages similar to those of female, with the following exceptions: Antenna (Fig. 34) with long adhesion pad on proximal segment; distal segment with two small adhesion pads and conspicuous claw, with two subtriangular spines and two slender naked setae of unequal size. Postantennary process (Fig. 35) apparently more sharply hamate and acute than that of female. Maxilliped (Fig. 36) with robust corpus broad at base, tapering distally; protuberant myxal area with adhesion pad and flange accommodating claw tip; subchela with relatively short claw and seta, shaft with small seta. Fifth leg (Fig. 37) comprising three setae on posterolateral corner of genital complex. Sixth leg (Fig. 37) represented by two pinnate setae distomedial to fifth.

Etymology.—the specific name refers to the type locality of the new species.

Remarks.—Caligus itacurussensis sp. nov. can be compared with the same group the species selected to determine *C. littoralis* sp. nov. *Caligus balistae* differs from the new species by the shape of the genital complex (with slightly acute posterior corners in *C. balistae;* with rounded posterior corners in the new species), by the shape of the sternal furca (with tines curved, longer than the box and acute in *C. balistae*; with trapezoidal, rounded box, and round-tipped tines in *C. itacurussensis* sp. nov.), and by the distal armature of the first exopod (with naked setae in *C. balistae*; setae with accessory processes in the new species).

Caligus longipedis can be separated from *C. itacurussensis* sp. nov. by the shape of the sternal furca (tines spatulate in *C. longipedis*; not spatulate in the new species), by the distal segment of the second endopod (with two crescent-shaped sclerotised areas in *C. longipedis*; no sclerotised areas in *C. itacurussensis* sp. nov.)

Caligus itacurussensis sp. nov. can be separated from *C. wilsoni* by the shape of the sternal furca (small subtriangular box and spatulate tines in *C. wilsoni*; trapezoidal, rounded box and not spatulate tines in the new species), and by the distal armature of the second exopod (with one spine and one semipinnate seta in *C. wilsoni*; with one spine and two semipinnate setae in the new species).

Caligus canthidermis differs from the new species by the shape of the genital complex (with posterior corners acute in *C. canthidermis*; rounded in the new species), by the shape of the sternal furca (with acute-tipped tines in *C. canthidermis*, rounded in the new species), by the distal armature of the first exopod (setae without accessory processes in *C. canthidermis*; with accessory processes in *C. itacurussensis* sp. nov.).

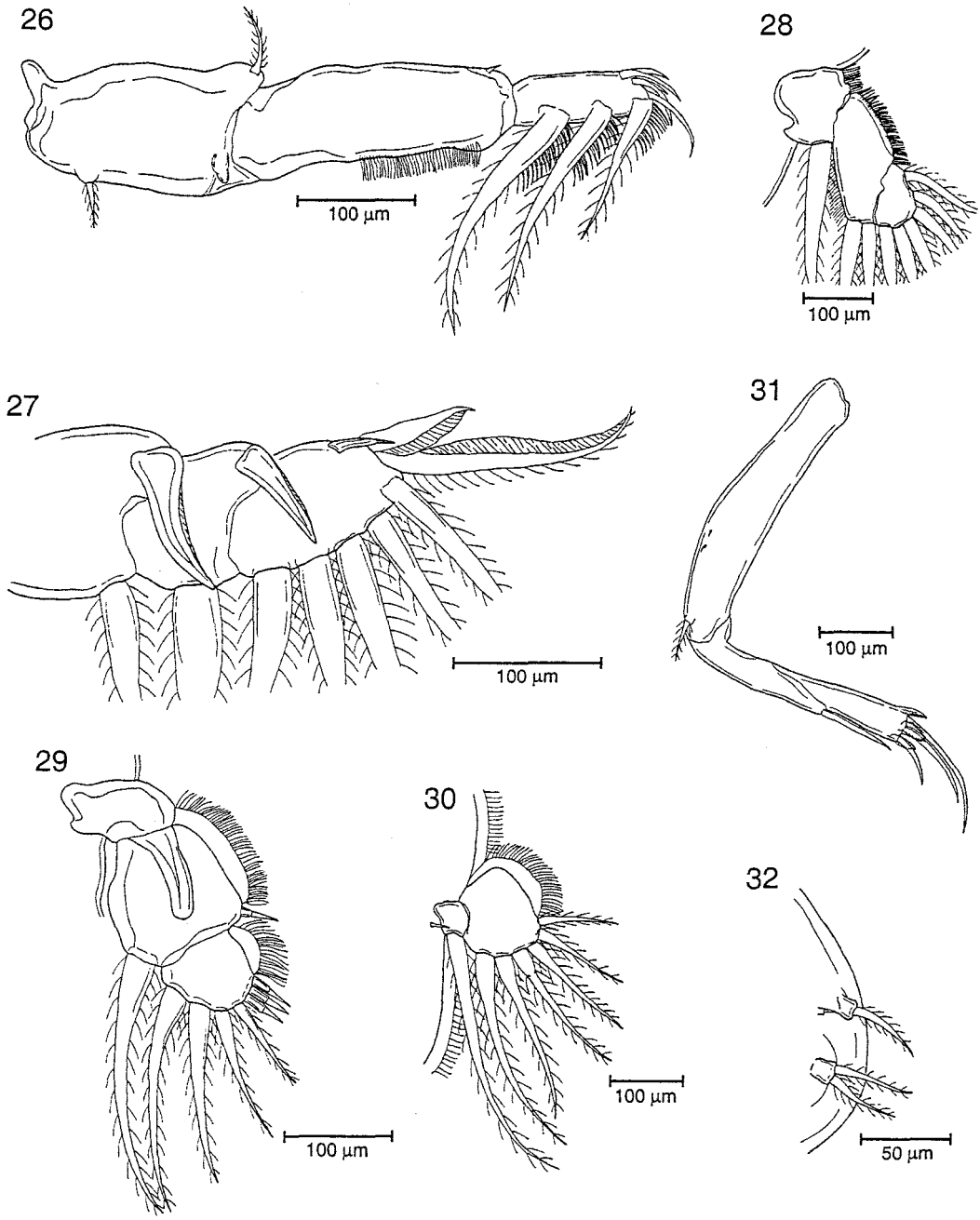
Caligus flexispina can be differentiated from *C. itacurussensis* sp. nov. by the shape of caudal rami (quadrangular and short in *C. flexispina*; rectangular and longer in the new species), by the distal armature of the first exopod (setae without accessory process in *C. flexispina*; with accessory processes in the new species), and by the shape of the third exopod hook (pointed in *C. flexispina*; rounded in *C. itacurussensis* sp. nov.).

Caligus kalumai is separate from *C. itacurussensis* sp. nov. by the shape of the genital complex (with rounded lateral projections in *C. kalumai*; without projections in the new species), by the shape of the sternal furca (with tines shorter than box in *C. kalumai*; with tines and box of subequal size in the new species), and by the distal armature of the first exopod (with all elements of equal size in *C. kalumai*; with fourth seta longer than others in *C. itacurussensis* sp. nov.).

Caligus antennatus is easily differentiated from the new species by the shape of the antenna (with large conical process in *C. antennatus*; without in *C. itacurussensis* sp. nov.).

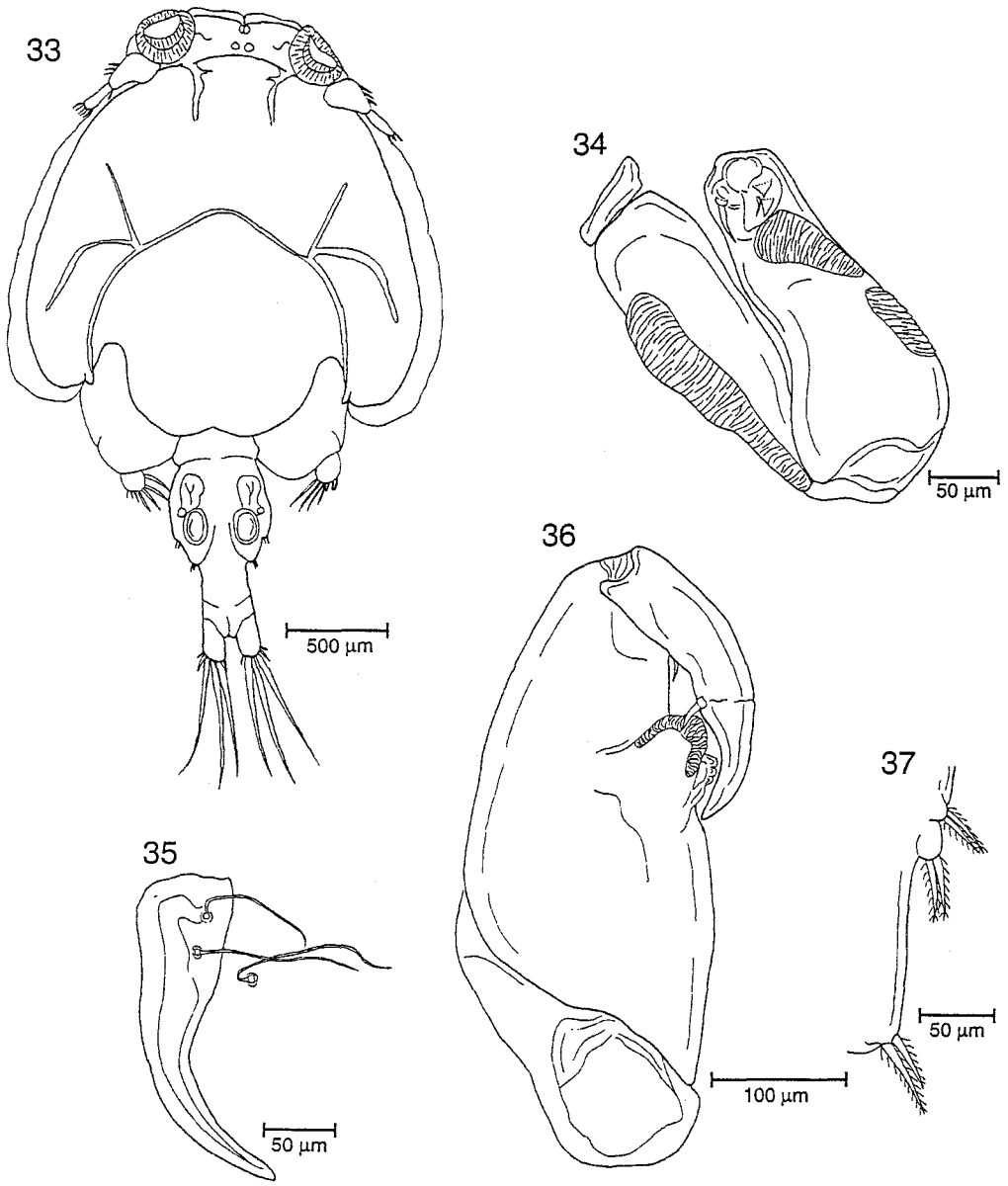
Caligus itacurussensis sp. nov. differs from *C. littoralis* sp. nov. by the length of the abdomen (approximately 50% of the genital complex length in *C. itacurussensis* sp. nov.; 25% in *C. littoralis* sp. nov.), by the shape of the maxilliped (corpus and subchela of subequal proportions in *C. littoralis* sp. nov.; corpus greater than the subchela in *C. itacurussensis* sp. nov.), by the distal armature of the first exopod (with four seta longer than the other elements in *C. itacurussensis* sp. nov.; with all elements of the subequal size in *C. littoralis* sp. nov.), and by the third exopod hook (not reaching the distal segment in *C. itacurussensis* sp. nov.; reaching the distal segment in *C. littoralis* sp. nov.).

Also, the new species described above resembles *Caligus teres* Wilson, 1905 parasitic on elephant-fish *Callorhinchus callorhynchus* L. (Wilson, 1908; Fagetti & Stuardo, 1961; Fernandez *et al.*, 1986) and the atherinid fish *Odonthestes* sp. (see Fernandez & Villalba, 1986) from austral Chilean littoral. The description



Figures 26-32. Caligus itacurussensis sp. nov.; female: 26. First leg; 27. Second leg exopod; 28. Second leg endopod; 29. Third leg exopod; 30. Third leg endopod; 31. Fourth leg; 32. Fifth leg.

made by Wilson (1908) and the redescription by Fagetti & Stuardo (1961) showed that the principal difference with the new species proposed above is the armature of the fourth exopod (with lateral spine on the distal segment in *C. teres*, without lateral spine in the new species), and second exopod armature. Because, both Wilson and Fagetti & Stuardo's descriptions showed poor detailed illustrations, specimens of *C. teres* collected in the type locality were borrowed from the Collection of Museo de Zoologia de Concepción, Chile for full comparison with Brazilian specimens. The presence of the lateral spines on the fourth exopod in Chilean specimens from *Odonthestes* sp. and *C. callorhynchus* was confirmed. Also, the distal



Figures 33-37. Caligus itacurussensis sp. nov.; male: 33. Entire, dorsal view; 34. Antenna; 35. Postantennary process; 36. Maxilliped; 37. Fifth and sixth legs.

armature of the second exopod in *C. teres* is composed of two small spines and one membranous semipinnate seta, in the new species the armature include a small spine on anterior margin and two membranous semipinnate setae. Another difference observed was the shape of the sternal furca (with acute tines in *C. teres*, with rounded tines in the new species).

Appendix

Additional Specimens Examined

Specimens of *Caligus teres* Wilson, 1905 were examined also; two females and two males from the Museo de Zoología de la Universidad de Concepción, Chile (MZUC 14940, 14945) taken from *Odonthestes* sp. (Atherinidae) from Estero Lenga, Concepción, Chile in October 1962, and two females (MZUC 2067) taken from *Callorhynchus callorhynchus* L. from Golfo de Arauco, Chile in October 1962.

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