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RESEARCH ARTICLE

Catalogue for identification of the most common lacustrine and riverine cyclopoid copepod (Crustacea) species in plankton of La Plata Basin, South America

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ABSTRACT. A practical guide for the taxonomic identification of 25 species and subspecies of free-living cyclopoid copepods from the La Plata Basin, the second largest river basin in South America, is presented. Samples were collected at 43 sites across the main river sub-basins and selected reservoirs during the rainy and dry seasons of 2010. We also provide a key for the identification of female cyclopoid copepods, taxonomic diagnoses with general remarks for each species, drawings, digital photographs, and scanning electron micrographs. Considering all the cyclopoids known from different habitats in South America (i.e., groundwater, phytotelmata, mosses, interstitial), our inventory of free-living planktonic and littoral species accounts for approximately 30% of the total cyclopoid diversity known in South America. This guide offers unprecedented coverage in terms of taxonomic data, and illustrations of American free-living cyclopoids. It will be a useful laboratory tool for limnologists and biologists.

KEYWORDS. Freshwater, illustrations, keys, SEM, taxonomy.

INTRODUCTION

Several authors have highlighted the scarcity of copepod taxonomists in the Neotropical region (Castilho-Noll et al. 2023), a point that is particularly relevant in a region harboring very high biodiversity. Recently, a large book was published to support the identification of the Neotropical aquatic invertebrates (Damborenea et al. 2020); it contains a chapter for the identification of the main orders of copepods that are represented in freshwater. The work by Reid (1985), although published almost four decades ago, is still considered one of the most useful taxonomic references for South American cyclopoids. It is possible to identify many genera and species of Neotropical Cyclopoida using the mentioned work and also publications by Kiefer (1926, 1933), Gaviria (1994), Einsle (1996), Rocha (1998), Gutiérrez-Aguirre and Suárez-Morales (2001), Holyńska (2000), Holyńska et al. (2003), Mirabdullayev et al. (2003), Ueda and Reid (2003), Silva and Matsumura-Tundisi (2005), Gutiérrez-Aguirre et al. (2006), and Suárez-Morales and Gutiérrez-Aguirre (2020a), among others.

After 1990, the use of new observation and imaging techniques revealed the importance of the previously neglected integumental micro-ornamentation for cyclopoid species identification (e.g., Rocha 1998, Gutiérrez-Aguirre and Suárez-Morales 2001, Gutiérrez-Aguirre et al. 2006). Additional examples of new characters are the size and shape of the distal hyaline membrane and pores on the last endopod of the first leg in some species of *Microcyclops* (Rocha 1998).

Cyclopoid copepods appeared relatively recently (Neogene) (Selden et al. 2010) compared to other orders, with up to 7,800 species now recognized worldwide. Some of these species are widespread in South America, the Neotropics, the Southern hemisphere, or are truly cosmopolitan (Reid 1985, 1989, Ueda and Reid 2003, Suárez-Morales and Gutiérrez-Aguirre 2020a). A recently published taxonomic catalogue contains 199 species of inland Cyclopoida in the entire Neotropical region separated by subfamilies (Suárez-Morales and Gutiérrez-Aguirre 2020b, Suárez-Morales and Mercado-Salas 2020), a wider coverage than the key by Reid (1985), which comprises approximately 90 South American species.

We present herein an illustrated catalogue for the identification of 25 species of Cyclopoida from the La Plata Basin, the second-largest river basin in South America. Almost all these species are widely distributed on the continent. Our study provides an identification key, diagnoses, taxonomic drawings, SEM images, and general remarks on distribution, ecology, and taxonomic highlights that enable easier identification of these species. This study aims to encourage the training of more copepod taxonomists in the region or improve the expertise of the researchers who will use this material.

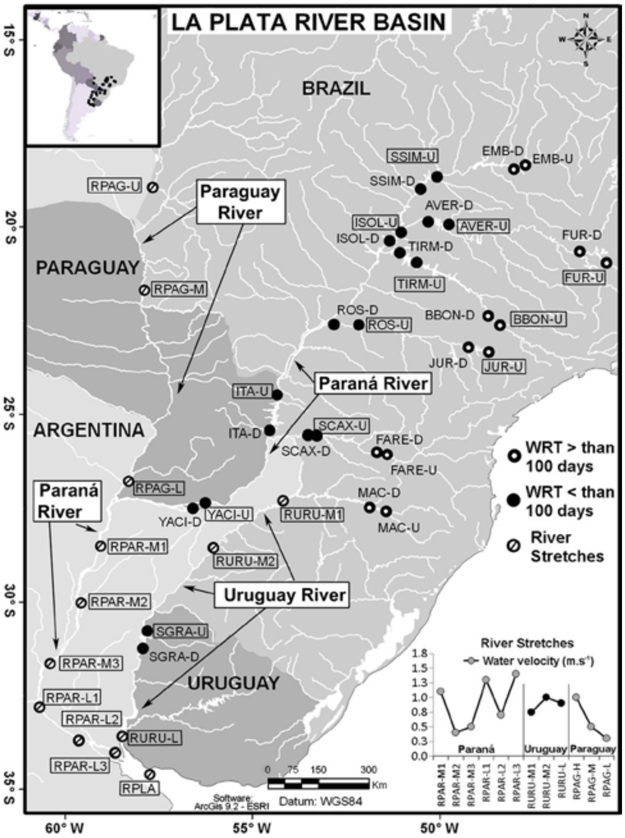


Figure 1. Map showing the locations of the sampling sites in the La Plata Basin, with the respective location codes in Table 1, divided into reservoirs (the first and last reservoir of each regulated river that we sampled, especially in the tributaries of the Paraná River main channel) and the lotic stretches in the main channel of the Paraná, Paraguay and Uruguay rivers. Water retention time (WRT) data are indicated for reservoirs, fewer or more than 100 days. The graph in the lower right corner shows the water velocity at each river site.

MATERIAL AND METHODS

Sampling was carried out in 13 lotic stretches and 15 reservoirs across the La Plata Basin (Paraná, Paraguay, and Uruguay rivers), including the upstream and dam compartments of the first and last reservoir on each regulated river (Fig. 1, Table 1) and in two seasons of the year 2010 (summer, rainy period and rivers in high-water phase: January and February; and winter, dry period and rivers in low-water phase: June and July). The geographical coordinates of the 43 sampling points, and detailed descriptions of their limnological features were provided by Perbiche-Neves et al. (2014) and Nogueira et al. (2021). The sampling sites lie between coordinates 18°S and 34°S and 45°W to 60°W.

The samples were obtained with a conical plankton net with a 68 µm mesh, equipped with an anti-reflux bulkhead. The net was hauled vertically in the limnetic areas of the reservoirs and in the main channels of the rivers, and adjacent to banks of mixed aquatic macrophytes, dominated by *Eichhornia crassipes* (Mart.), *Eichhornia azurea* (Sw.) Kunth, *Egeria najas* Planch., *Egeria densa* Planch., *Salvinia auriculata* Aubl., *Pistia stratiotes* L., and *Myriophyllum* sp., among others. Two samples were obtained at each site, one for qualitative analysis, fixed with 4% formaldehyde; and one for scanning electron microscopy (SEM), fixed with 2.5% glutaraldehyde.

In the laboratory, copepods were analyzed under stereoscopes (Zeiss Stemi SV6 and Zeiss Discovery V20) and compound microscopes (Zeiss Standard 20 and 25). The

Table 1. List of abbreviations used in our study, for sampling sites and for morphological structure.

Sampling site	Abbreviation	Sampling site	Abbreviation
Emborcação Reservoir upstream	EMB-U	Paraná River Middle stretch 2	RPAR-M2
Emborcação Reservoir downstream	EMB-D	Paraná River Middle stretch 3	RPAR-M3
São Simão Reservoir upstream	SSIM-U	Paraná River Lower stretch 1	RPAR-L1
São Simão Reservoir downstream	SSIM-D	Paraná River Lower stretch 2	RPAR-L2
Furnas Reservoir upstream	FUR-U	Paraná River Lower stretch 3	RPAR-L3
Furnas Reservoir downstream	FUR-D	La Plata River	RPLA
Água Vermelha Reservoir upstream	AVER-U	Paraguay River Upper stretch	RPAG-U
Água Vermelha Reservoir downstream	AVER-D	Paraguay River Middle stretch	RPAG-M
Barra Bonita Reservoir upstream	BBON-U	Paraguay River Lower stretch	RPAG-L
Barra Bonita Reservoir downstream	BBON-D	Uruguay River Middle stretch 1	RURU-M1
Três Irmãos Reservoir upstream	TIRM-U	Uruguay River Middle stretch 2	RURU-M2
Três Irmãos Reservoir downstream	TIRM-D	Salto Grande Reservoir upstream	SGRA-U
Jurumirim Reservoir upstream	JUR-U	Salto Grande Reservoir downstream	SGRA-D
Jurumirim Reservoir downstream	JUR-D	Uruguay River Lower stretch	RURU-L
Rosana Reservoir upstream	ROS-U		
Rosana Reservoir downstream	ROS-D		
Foz do Areia Reservoir upstream	FARE-U	Morphological structure	Abbreviation
Foz do Areia Reservoir downstream	FARE-D	First swimming leg	P1
Salto Caxias Reservoir upstream	SCAX-U	Second swimming leg	P2
Salto Caxias Reservoir downstream	SCAX-D	Third swimming leg	P3
Ilha Solteira Reservoir upstream	ISOL-U	Fourth swimming leg	P4
Ilha Solteira Reservoir downstream	ISOL-D	Fifth swimming leg	P5
Itaipu Reservoir upstream	ITA-U	Antennule	A1
Itaipu Reservoir downstream	ITA-D	Antenna	A2
Yaciretá Reservoir upstream	YACI-U	First segment of biramous appendices	Coxa
Yaciretá Reservoir downstream	YACI-D	Second segment of biramous appendices	Basis
Paraná River Middle stretch 1	RPAR-M1	Thoracic somite	Prosomite

organisms were dissected with fine-tip stylets (electrolysis-sharpened tungsten wire) to obtain the taxonomically valuable appendages, which were mounted on semi-permanent slides in glycerin or 70% lacto-phenol. Only adult female individuals were analyzed. The measurements provided in this guide were obtained from single specimens and differences are to be expected, because own natural variation between individuals, methods of preservation and measurement.

The organisms were identified with the aid of specialized literature (Dussart 1984, Dussart and Frutos 1985, 1986, Reid 1985, 1989, Einsle 1996, Rocha 1998, Karaytug 1999, Alekseev 2002, Ueda and Reid 2003, Suárez-Morales and Gutiérrez-Aguirre 2020a, 2020b, Suárez-Morales and Mercado-Salas 2020).

All the samples are deposited in the Collection of Microcrustaceans of Continental Waters-CMAC, of the Departmento de Zoologia, Universidade Estadual Paulista (UNESP), Campus de Botucatu, Brazil. For some species we deposited specimens in the Museum of Zoology of São Paulo State University (MZUSP): two females of *Macrocyclops albidus albidus* (MZUSP30601), two females of *Eucyclops neumani* (MZUSP30602), and two females of *Microcyclops ceibaensis* (MZUSP30603).

For the identification key and diagnoses, only the main morphological characteristics are used to discriminate genera and species (viz. Reid 1985, Einsle 1996, Rocha 1998, Karaytug 1999, Ueda and Reid 2003). Throughout the identification guide, abbreviations (Table 1) are used for the sampling points where the species occurred and for the morphological structures, especially those most relevant to the taxonomy of these organisms, as indicated in Figs 2 and 3.

The taxonomically relevant morphological structures were illustrated using a phase-contrast microscope (Zeiss Standard) with an attached camera lucida. The drawings were scanned and corrected for blotches and other imperfections in Adobe Photoshop 7.0 software.

Some specimens were prepared for SEM analysis. The SEM images were acquired at the "Center for Electron Microscopy (CME)" at the Universidade Estadual Paulista

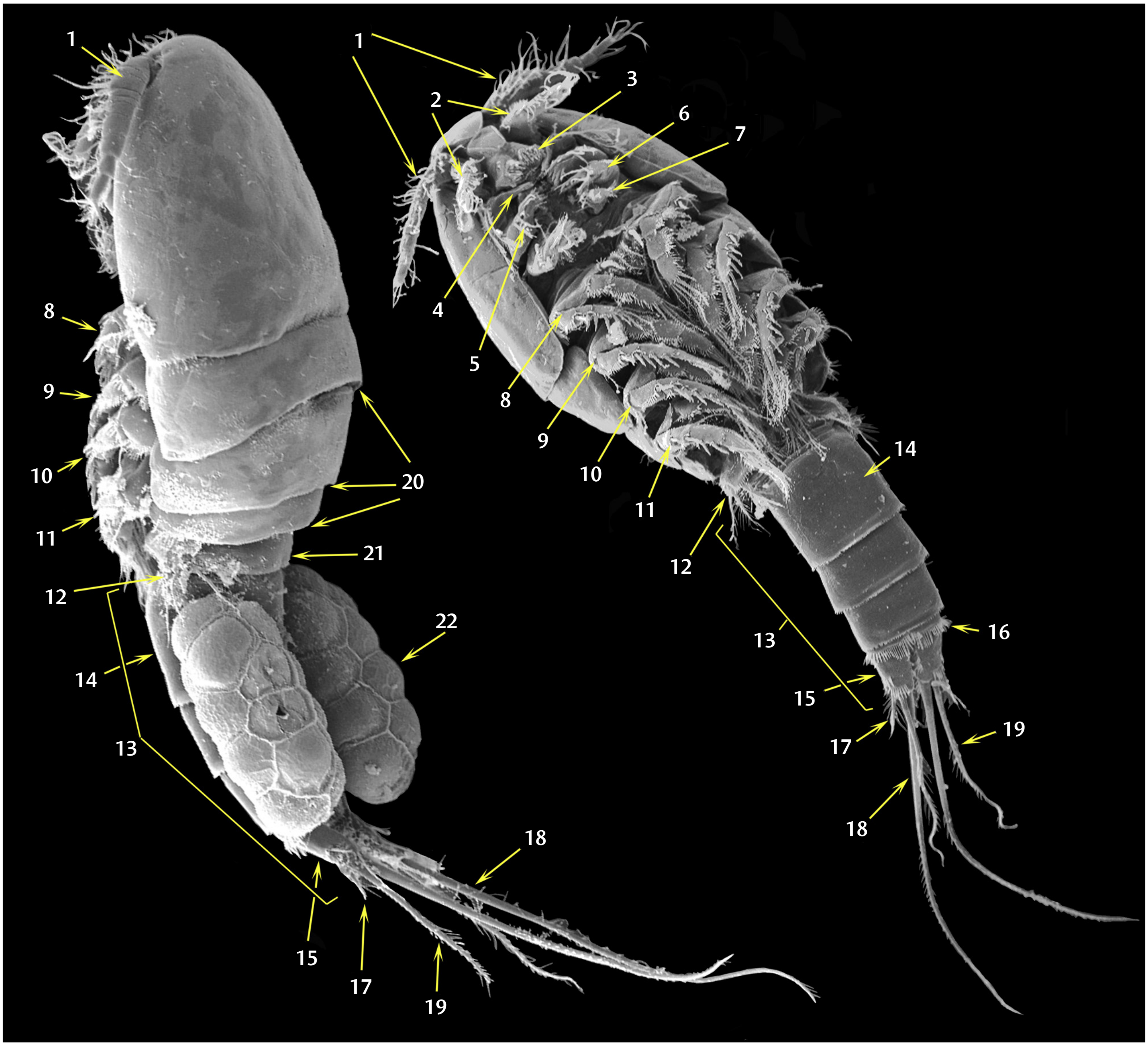


Figure 2. Morphological structures used in our study of a free-living freshwater cyclopoid in dorsolateral (A) and ventrolateral (B) views. (1) Antennule; (2) antenna; (3) labrum; (4) mandible; (5) maxillula; (6) maxilla; (7) maxilliped; (8–12) P1–P5; (13) urosome; (14) genital double-somite; (15) caudal ramus. (16) posterior margin of anal somite; (17) outer terminal caudal seta; (18) inner middle terminal caudal seta; (19) outer middle terminal caudal seta; (20) posterior margins of prosomites (thoracic somites or pedigers) 2–4; (21) prosomite 5; (22) egg sacs.

Júlio de Mesquita Filho (UNESP), Botucatu, Brazil. Each sample containing individuals of the same species from the same sampling location was placed in hollow cylindrical polyethylene tubes. The selected specimens were washed in phosphate buffer solution at 0.1 M and pH 7.3 (three times, each for five minutes), then immediately fixed by immersion in osmium tetroxide at a concentration of 0.5% (in water) for 20 minutes, and dehydrated by immersion in ascending concentrations of ethanol: 7.5%, 15%, 30%, and 50% (twice in each concentration, for five minutes); then in a concentration of 70% (3 times, for 10 minutes); and 90% and 100% (twice in each concentration, for five minutes).

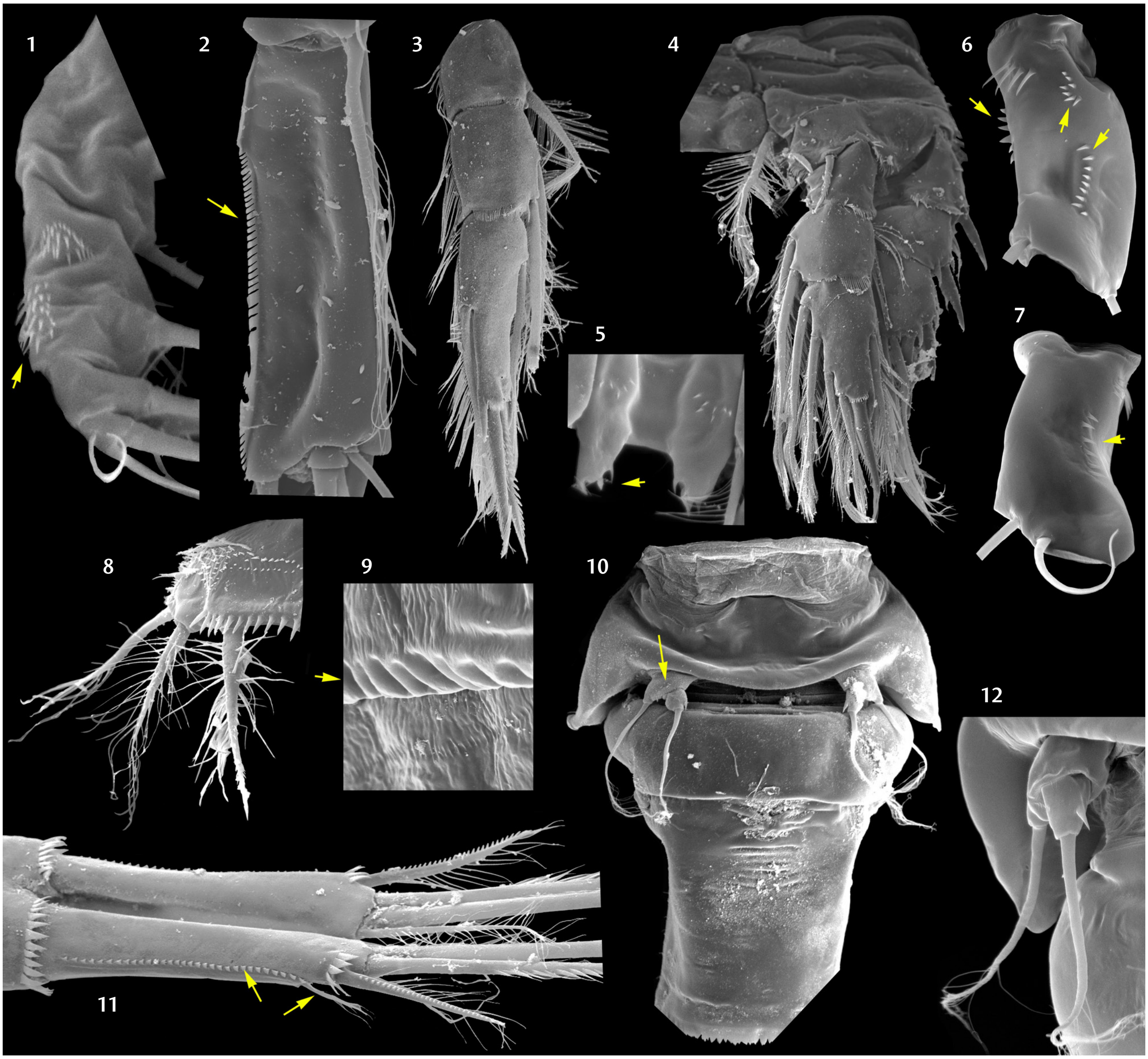


Figure 3. Morphological structures used in our study of a free-living freshwater cyclopoid. (1) Maxilla, arrow indicate patches of spinules; (2) antennule, last segment, arrow indicates serrated hyaline membrane; (3) P4, endopod; (4) left P4 with intercoxal sclerite, anterior view; (5) intercoxal sclerite, arrow indicates spinule ornamentation; (6) basis of antenna, posterior view, arrows indicate spinule row; (7) basis of antenna, anterior view, arrow indicates spinule row; (8) P5; (9) posterior margin of second prosomite, arrow indicates ornamentation; (10) prosomite 5 and genital double-somite, arrow indicate P5 on prosomite 5; (11) caudal ramus, dorsolateral view, arrows indicate spinule row on outer margin (left) and lateral seta (right); (12) P5.

Subsequently, the material was placed in a Balzers Union (type: CTD-020) critical-point dryer, where the ethanol was replaced by liquid carbon dioxide, with evaporation by increasing the temperature to 40°C and pressure to 70 bars. The material was dissected, when necessary, and glued to the stubs with adhesive tape and gold-coated in a Balzers Union Med-10 metallizer. The observations were made on a Philips MEV (model: SEM-515), with a camera attached.

TAXONOMY

A total of 25 species and subspecies of cyclopoid copepods were found at 43 sampling sites in the La Plata Basin during two seasons (Table 2). We were conservative in considering dubious those subspecies that require revisions using integrative taxonomy. The most frequent species in different aquatic environments were: *Thermocyclops decipiens*, *Thermocyclops minutus*, *Acanthocyclops robustus*, and *Mesocyclops meridianus*. Habitat information was provided by Perbiche-Neves et al. (2014, 2021).

Key for identification of females – subfamilies, genera, and species for the La Plata Basin

1. Terminal segment of P5 with 2 spines or setae; natatory legs 2- or 3-segmented .... 2 – Cyclopinae (*Mesocyclops*, *Thermocyclops*, *Microcyclops*, *Metacyclops*, *Acanthocyclops*, and *Megacyclops*)

1'. Terminal segment of P5 with 3 spines or setae; natatory legs 3-segmented........................... 17 – Eucyclopinae (*Tropocyclops*, *Homocyclops*, *Macrocyclops*, *Paracyclops*, *Eucyclops*, and *Ectocyclops*)

2. Cyclopinae. a. P4 endopod and exopod 2-segmented.. .... 3 (*Metacyclops* and *Microcyclops*)

2'. P4 endopod and exopod 3-segmented......8 (*Thermocyclops*, *Mesocyclops*, *Acanthocyclops*, and *Megacyclops*)

3. Distal segment of P5 short, as long as wide, with short apical spine and seta 2–3 times longer than this spine; A1 11–13-segmented .... 4 (*Metacyclops*)

3'. Single segment of P5 long, 2 times longer than wide, with short apical spine and 1 seta .... 5 (*Microcyclops*)

4. Inner terminal seta of caudal ramus shorter than outer terminal seta (0.7:1); short P5 apical seta, reaching 1/3 length of genital double-somite ....*Metacyclops laticornis* (Lowndes, 1934)

4'. P5 distal segment as long as wide; inner median terminal seta of caudal ramus shorter than outer terminal seta (0.7:1); inner median terminal seta of caudal ramus less than twice as long as caudal ramus .... *Metacyclops mendocinus mendocinus* (Wierzejski, 1892)

5. Terminal segment of P1 endopod with 1 pore; spinules on distal margin of terminal P1 endopod without clearly decreasing or increasing in size; second or fourth prosomite plus first urosomite with some ornamentation (scalloped or finely serrate membranes) on distal margin 6

5'. Terminal segment of P1-endopod with 2 or 3 pores on surface, anterior view; no scaloped membrane present on distal margin of second prosomite or finely serrate membranes in fourth prosomite plus in first urosomite 7

6. Second prosomite with ornate scalloped membrane on distal margin, other prosomite membranes smooth; terminal segment of P4 endopod as long as or shorter than terminal spine ....*Microcyclops anceps anceps* (Richard, 1897)

6'. Dorsal margin of first to third prosomites smooth; distal margins of fourth prosomite and first segment of urosome with serrulate hyaline membrane; terminal spine of P4 endopod 1.2 times longer than this last segment ....*Microcyclops finitimus* Dussart, 1984

7. Terminal segment of P1 endopod with 2 pores; spinules on distal margin of terminal P1 endopod clearly decreasing in size outward direction; dorsal margin of prosomites slightly serrated; urosomal somites with serrated hyaline fringes; caudal ramus up to 3 times longer than wide...................................... ....*Microcyclops ceibaensis* (Marsh, 1919)

7'. Terminal segment of P1-endopod with 3 pores; size-graduated spinules at insertion of apical spine on terminal segment of P1 endopod; caudal ramus 2-2.5 times longer than wide; outer middle terminal caudal setae 2 times longer than inner seta of caudal ramus; finely serrate membranes on prosomites 4 and 5 .... *Microcyclops mediasetosus* Dussart & Frutos, 1985

8. P5 inner spine shorter than distal segment .... 9 (*Acanthocyclops* and *Megacyclops*)

8'. P5 inner spine longer than distal segment................ 10 (*Thermocyclops* and *Mesocyclops*)

9. Inner margin of caudal ramus smooth; caudal ramus 4 times longer than wide; terminal segment of P4-endopod 2.3 times longer than wide ....*Acanthocyclops robustus robustus* (G.O. Sars, 1863)

9'. Terminal segment of P4-endopod 1.5 times longer than wide; inner margin of caudal ramus finely haired; caudal ramus 2.5–2.6 times longer than wide ....*Megacyclops viridis viridis* (Jurine, 1820)

10. Inner seta of P5 terminal segment inserted approximately at midlength of inner margin; last segment of antennule 3–5 times longer than wide......................... .... *Mesocyclops* (11)

10' Inner seta of P5 terminal segment inserted distally or subdistally; last segment of antennule 2 times longer than wide ....*Thermocyclops* (15)

11. P1 basis with medial spine.. 12

11'. P1 basis without medial spine 14

Table 2. List of species and some subspecies found in our study, with the location codes for occurrence sites. See Fig. 1 for location codes on the map.

Species	Location
Acanthocyclops robustus robustus (G. O. Sars, 1863)	MAC-M, MAC-B, BBON-B, BBON-M, FARE-M, FARE-B, SCAX-M, RPAR-M3, RURU-M2, SGRA-M, RPLA
Ectocyclops herbsti Dussart, 1984	FUR-M, AVER-M, JUR-M, RPAR-M1, RPAR-M2, RPAR-M3, RPAR-B3, RPAG-M, RPAG-B, RURU-M2, RURU-B
Eucyclops (Denticyclops) leptacanthus Kiefer, 1956	RPAR-M1, RPAR-M2, SGRA, RURU-B,
Eucyclops neumani neumani (Pesta, 1927)	RPAR-M3, RPAR-B1, RPAR-B3, RPLA, SGRA, RPAG-B
Eucyclops prionophorus Kiefer, 1931	ROS-M, YACI-M, RPAR-M1, RPAR-M2, RPAR-M3, RPAR-B1, RPAR-B2, RPAR-B3, SGRA-M, RURU-B, RPAG-B
Eucyclops serrulatus serrulatus (Fischer, 1851)	SSIM-M, AVER-M, TIRM-M, SCAX-M, ISOL-M, RPAR-M1, RPAR-M2, RPAR-B1, RPAR-B2, RPAR-B3, RPAG-A
Homocyclops ater (Herrick, 1882)	RPAR-M2, RPR-B3
Macrocyclops albidus albidus (Jurine, 1820)	FUR-M, BBON-M, TIRM-M, ISOL-M, ITA-M, RPAR-M1, RPAR-M2, RPAR-M3, RPAR-B1, RPAR-B3, RPLA, RURU-M2, RPAG-A, RPAG-M, RPAG-B
Megacyclops viridis viridis (Jurine, 1820)	SGRA-M
Mesocyclops aspericornis (Daday, 1906)	RPAG-M
Mesocyclops ellipticus Kiefer, 1936	RPAG-H; RPAG-M
Mesocyclops longisetus longisetus (Thiébaud, 1912)	RURU-L, FARE-D
Mesocyclops meridianus (Kiefer, 1926)	AVER-U, BBON-U, BBON-D, JUR-U, FARE-U, FARE-D, ISOL-U, YACI-U, YACI-D, RPAR-M1, RPAR-L2, RPAR-L3, SGRA-D, RPAG-M, RPAG-L
Mesocyclops ogunnus (Onabamiro, 1957)	SSIM-U, AVER-D, BBON-U, TIRM-U, TIRM-D, JUR-D, ITA-D
Metacyclops laticornis (Lowndes, 1934)	JUR-U, RPAG-M
Metacyclops mendocinus mendocinus (Wierzejski, 1892)	FARE-U
Microcyclops anceps anceps (Richard, 1897)	RPAR-M2, RPAR-L1, RPAR-L2, RPAG-H
Microcyclops ceibaensis (Marsh, 1919)	RPAR-L1, RPAR-L3
Microcyclops finitimus Dussart, 1984	TIRM-U
Microcyclops mediasetosus Dussart & Frutos, 1985	RPAR-L3
Paracyclops chiltoni (G. M. Thomson, 1883)	FUR-M, JUR-M, RPAR-M1, RPAR-L1, RPAR-L2, RPAG-M
Thermocyclops decipiens Kiefer, 1929	SSIM-U, SSIM-D, FUR-U, FUR-D, AVER-U, AVER-D, BBON-U, BBON-D, TIRM-U, TIRM-D, JUR-U, JUR-D, ROS-U, FARE-U, FARE-D, SCAX-U, SCAX-D, ISOL-U, ISOL-D, ITA-U, ITA-D, YACI-U, YACI-D, RPAR-M1, RPAR-M2, RPAR-L1, RPAR-L3, RPLA, MAC-U, MAC-D, RURU-M1, SGRA-U, SGRA-D, RURU-L, RPAG-H, RPAG-M, RPAG-L
Thermocyclops inversus Kiefer, 1936	EMB-D, JUR-U, ITA-U, ITA-D
Thermocyclops minutus (Lowndes, 1934)	EMB-U, SSIM-U, SSIM-D, FUR-U, FUR-D, AVER-D, TIRM-U, ROS-U, ISOL-U, ISOL-D, ITA-D, YACI-D, RPAR-M1, RPAR-M2, SGRA-D, RURU-M2, RURU-D, RPAG-L
Tropocyclops prasinus meridionalis Kiefer, 1931	SCAX-U, SCAX-D, RPAR-L2

12. P5 apical spine 2 times longer than medial spine ....*Mesocyclops longisetus longisetus* (Thiébaud, 1912)
12'. P5 apical and medial spines subequal or equal in length 13
13. P4 intercoxal sclerite with 2 large toothlike spinules .. ..*Mesocyclops ellipticus* Kiefer, 1936
13'. P4 intercoxal sclerite without large spinules .... *Mesocyclops meridianus* (Kiefer, 1926)
14. Caudal ramus with setules along inner margin............ .... *Mesocyclops aspericornis* (Daday, 1906)
14'. Caudal ramus without setules or only few setules in proximal portion of inner margin................................. .... *Mesocyclops ogunnus* Onabamiro, 1957
15. P4 intercoxal sclerite with 2 well-developed processes bearing small spinules ....*Thermocyclops decipiens* Kiefer, 1929
15'. P4 intercoxal sclerite smooth or with 2 small processes without teeth... 16
16. Inner terminal spine of P4-endopod slightly shorter than or the same length as the outer terminal spine .. ..*Thermocyclops inversus* Kiefer, 1936
16'. Inner terminal spine of P4-endopod 7 times longer than very short outer terminal spine .... *Thermocyclops minutus* (Lowndes, 1934)
17. Eucyclopinae. a. Caudal rami with spinules along outer margin, transverse spinule rows may be present..... ....18 (*Eucyclops*, *Paracyclops*, and *Ectocyclops*)
17'. Caudal rami without spinule row(s) on outer margin or only transversely.. ....23 (*Tropocyclops*, *Homocyclops* and *Macrocyclops*)
18. Caudal rami serrulate, i.e., with spinules along all or part of outer margin .... 19 (*Eucyclops*)

18'. Caudal rami not serrulate but with horizontal or transverse spinule rows on dorsal and ventral surface 22
19. Caudal rami 8 times longer than wide, with spinules along entire outer margin or only on distal part of outer margin (Figs 8B, 9D); terminal segment of P4 endopod 2 times longer than wide; outer spine of P4 terminal endopod 1.4 times longer than inner spine .. ..*Eucyclops neumani neumani* (Pesta, 1927)
19'. Caudal rami less than 8 times longer than wide 20
20. Caudal ramus 5 times longer than wide; entire, or distal half of outer margin serrulate.................................. ....*Eucyclops serrulatus serrulatus* (Fischer, 1851)
20'. Caudal ramus less than 4 times longer than wide; outer margin entire serrulate 21
21. Caudal ramus 3.3–4 times longer than wide; lateralmost terminal caudal seta 1.65 times longer than caudal rami length; inner spine of terminal P4-endopod 1.3 times longer than outer spine; hyaline membrane of last 3 segments of antennule smooth....................... ....*Eucyclops prionophorus* Kiefer, 2931
21'. Caudal ramus 3.6–4 times longer than wide; lateralmost terminal caudal seta 1.5 times longer than caudal rami length; inner spine of terminal P4-endopod 1.5 times longer than outer spine ....*Eucyclops* (*Denticyclops*) *leptacanthus* Kiefer, 1956
22. P5 1-segmented and not fused to thoracic segment, with one spine and 2 setae of equal length; single transverse row of spinules on dorsal surface of caudal rami; P5 outer seta length almost similar to inner spine ....*Paracyclops chiltoni* (G.M. Thomson, 1883)
22'. P5 segment partially fused to thoracic segment, with 3 setae of different length; several transverse rows of spinules on surface of caudal rami................................ ....*Ectocyclops herbsti* Dussart, 1984
23. Antennule with 12 segments; terminal segment of P5 with 2 setae and 1 spine; inner terminal spine of P4-endopod 2–3 times longer than segment, caudal ramus 1.7–2.1 times longer than wide; total body length not passing 900 µm .... *Tropocyclops prasinus meridionalis*
23'. Antennule with 17 segments; total body length greater than 1,000 µm ....*Homocyclops* or *Macrocyclops* 24
24. 1-segmented P5; genital double-somite 1.1 times wider than long...............*Homocyclops ater* (Herrick, 1882)
24'. 2-segmented P5, last segment with 2 spines and 1 seta, rows of small spinules; terminal segment of P4-endopod with 2 inner setae, distal seta small, not passing end of this segment... ....*Macrocyclops albidus albidus* (Jurine, 1820)

Identification of the cyclopoid genera recorded here can be accomplished by observation of the P5 morphology (Fig. 4). Some leg types are clearly distinct, as in *Eucyclops* and *Macrocyclops*, but differences are more subtle in other genera, e.g., *Thermocyclops* and *Mesocyclops*. In these genera, for example, only the insertion position of the lateral and middle setae is different, with the lateral and middle setae inserted on the same level in *Thermocyclops* or inserted in different regions of the P5 surface in *Mesocyclops*. Additionally, besides these last genera has a hyaline membrane on the two distal segments of antennule, in *Mesocyclops* the membrane on the last segment has one or more notches, and in *Thermocyclops* this membrane has no notch.

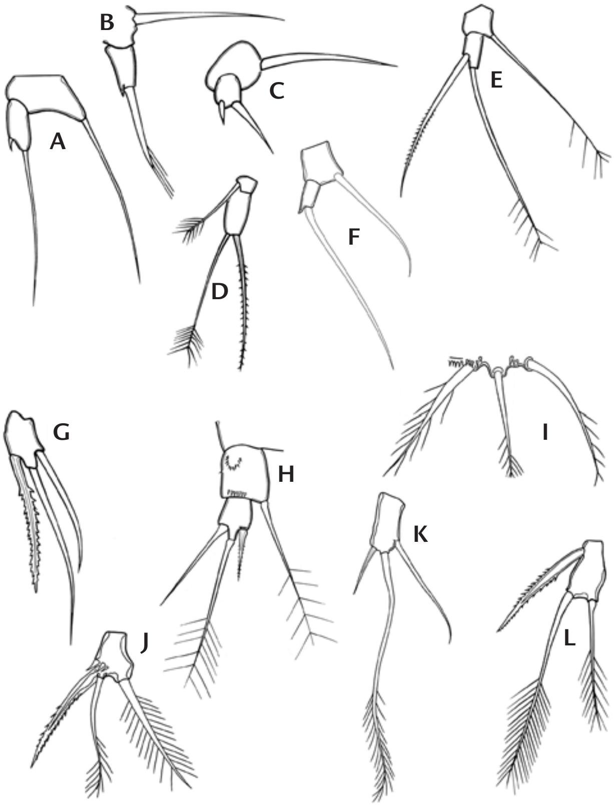


Figure 4. P5 of cyclopoid genera into the families found in our study separated in Cyclopinae (A–F) and Eucyclopinae (G–L): (A) *Acanthocyclops*; (B) *Microcyclops*; (C) *Metacyclops*; (D) *Thermocyclops*; (E). *Mesocyclops*; (F) *Megacyclops*; (G) *Eucyclops*; (H) *Macrocyclops*; (I) *Ectocyclops*; (J) *Paracyclops*; (K) *Homocyclops*; (L) *Tropocyclops*.

Acanthocyclops robustus robustus (G.O. Sars, 1863)
Figs 5, 6

Diagnosis. Adult female, 1,260 µm in length excluding caudal setae. Genital double- somite 1.1 times longer than wide, ducts divided horizontally into two parts (Fig. 5A). Antenna basis with two rows of spinules (Figs 5B, C, 6E, F). Basis of P4 has well-developed spinous process on distal margin (Fig. 6B, C). Coxopodite with few short rows of small spinules (Figs 5D, 6C); terminal outer spine of P4 endopod 1.2 times longer than median spine (Figs 4B, H, 5E). Inner spine of P5 shorter than whole segment (Fig. 6A, D). Caudal rami approximately 4 times longer than wide (Fig. 6G).

Remarks. Illustrated specimen from the Machadinho Reservoir, Uruguay River. Einsle (1996) stated that this "European" species has wide seasonal and spatial variability. In South America, its morphology and variability need to be better investigated, as some taxonomic characters do not fully agree with the description of *A. robustus robustus*. Molecular techniques should be used to compare the South American populations with populations from other continents. This species is distributed in southeastern and southern Brazil, and also occurs in Uruguay and Argentina. *A. robustus robustus* is found in the Tietê and Iguaçu rivers, but has not been recorded in the Paranapanema River,

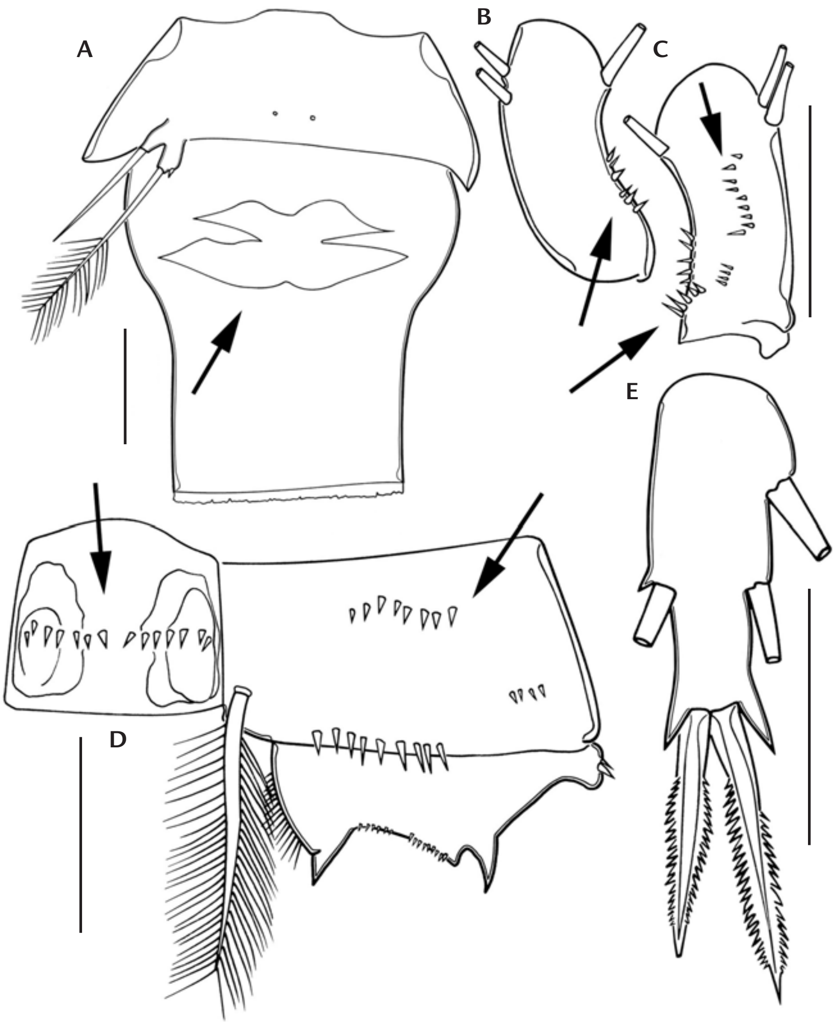


Figure 5. *Acanthocyclops robustus robustus*, female: (A) genital double-somite, ventral view, arrow indicates genital receptacle; (B) antenna basis, posterior view, arrow indicates one row of spinules; (C) antenna basis, anterior view, arrows indicate two rows of spinules; (D) intercoxal sclerite, coxa and basis of P4, arrows indicate row of spinules; (E) last segment of P4-endopod. Sacale bars: 50 µm.

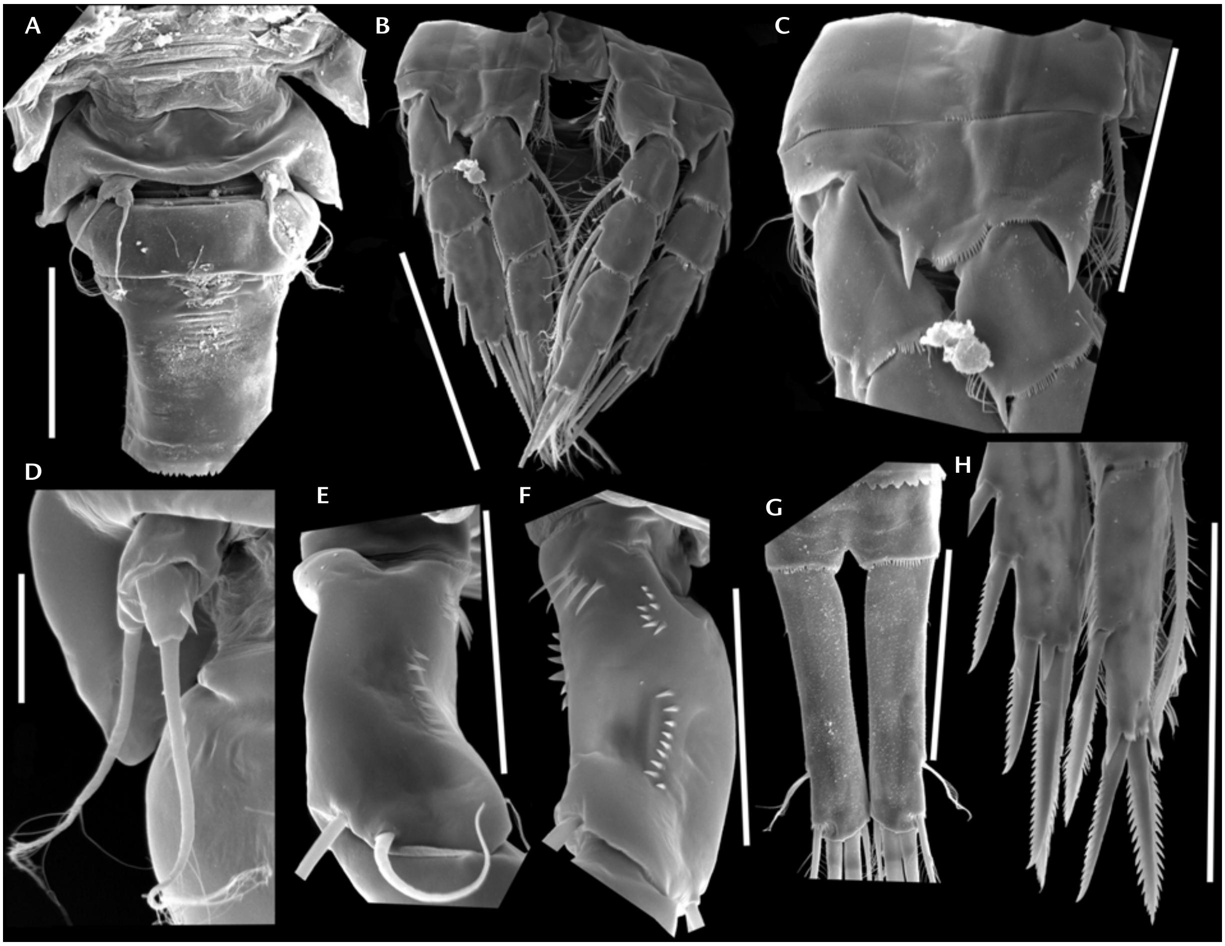


Figure 6. *Acanthocyclops robustus robustus*, female: (A) genital double-somite and P5, ventral view; (B) P4; (C) right P4, coxa, basis, and first segment of endopod and exopod; (D) right P5; (E) basis of antenna, posterior view; (F) basis of antenna, anterior view; (G) caudal rami, ventral view; (H) last segments of P4–exopod and endopod. Scale bars: A, B, G = 100 µm; C, E, F = 50 µm; D = 20 µm.

which is located between them. It is considered that *A. robustus robustus* prefers lower and moderate temperatures. It was found in the Barra Bonita Reservoir (Tietê River), a relatively shallow reservoir with few months of low temperatures during the year. It seems to be abundant in eutrophic reservoirs (Perbiche-Neves et al. 2016).

Ectocyclops herbsti Dussart, 1984

Figs 7, 8

Diagnosis. Adult female, 990 µm in length excluding caudal setae. Body fusiform (Fig. 8A, B). P5 short and fused to somite, closely adjoined to body surface, all setae similar in size and reach to or passing midlength of genital double-somite (Figs 7A, 8D). Caudal ramus short, 1.2 to 1.8 times longer than wide, with at least three transverse rows of spinules, each row of different size (Figs 7B, C, 8C).

Remarks. Species with a wide geographic distribution in the Americas, often found in littoral regions, aquatic macrophytes and rivers, seldom occurring in the zooplankton of reservoirs. The body shape is fusiform. Animals with a dark (black or brownish) color, usually with debris attached to the body somites and appendages due to their benthic habit. This genus requires thorough taxonomic revision.

Eucyclops (Denticyclops) leptacanthus Kiefer, 1956

Fig. 9

Diagnosis. Adult female, 750 µm in length excluding caudal setae. Inner spine of the terminal endopod of P4

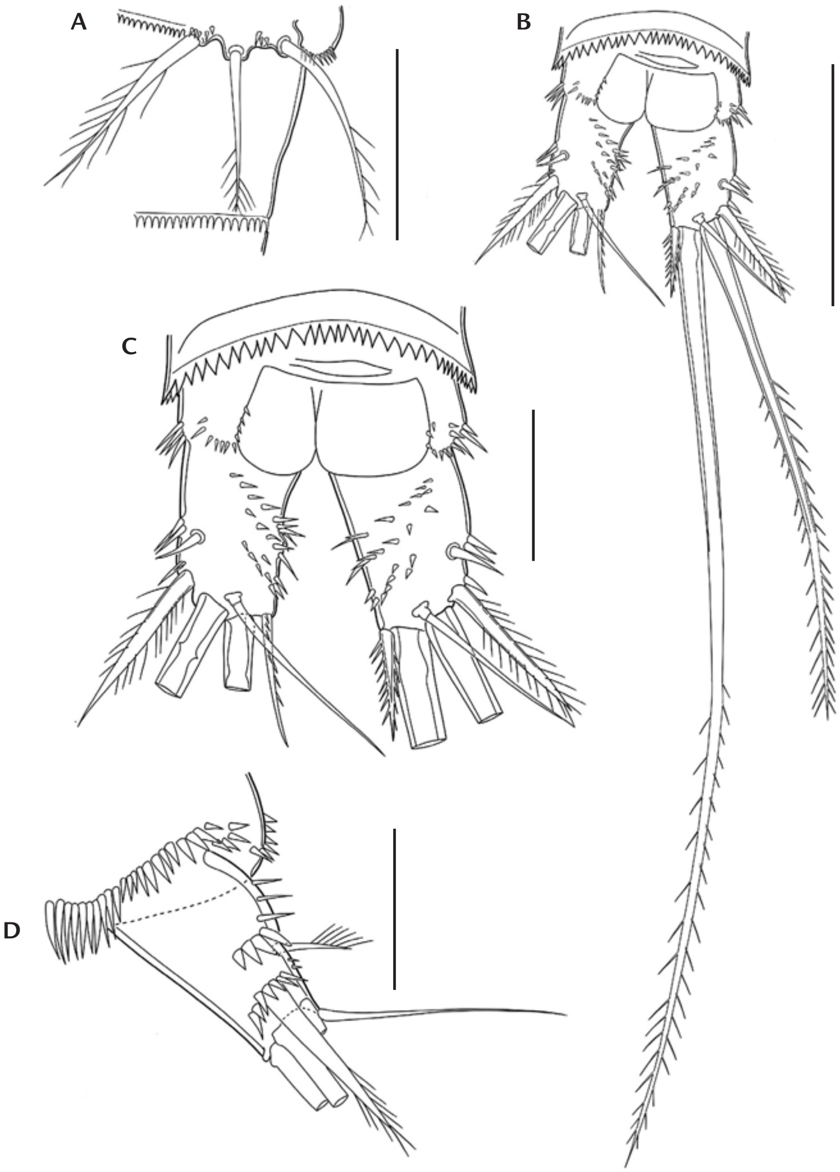


Figure 7. *Ectocyclops herbsti*, female: (A) P5; (B) caudal rami and caudal setae; (C) caudal rami, dorsal view; (D) left caudal ramus, dorsolateral view. Scale bars: A, C, D = 50 µm; D = 100 µm.

1.3–1.4 times longer than the outer spine of the same segment (Fig. 9A). Caudal rami 3.6–4 times longer than wide (Fig. 9B). Genital double-somite divided horizontally, both portions having equal or similar widths (Fig. 9C).

Remarks. Species with a wide geographic distribution in the Americas. It is often found in littoral zones, among aquatic macrophytes and in rivers, and is seldom found in the pelagic zone of reservoirs. Animals with a dark (black or brownish) color, usually with debris attached to the segments and appendages due to their benthic habit. A distinctive character that allows its separation from other closely related species is the proportional width and length of the caudal rami.

Eucyclops neumani neumani (Pesta, 1927)

Figs 10, 11

Diagnosis. Adult female, 1,340 µm in length excluding caudal setae. P5 inner seta shorter than the median and outer setae (Figs 10A, 11B); genital double-somite with lateral

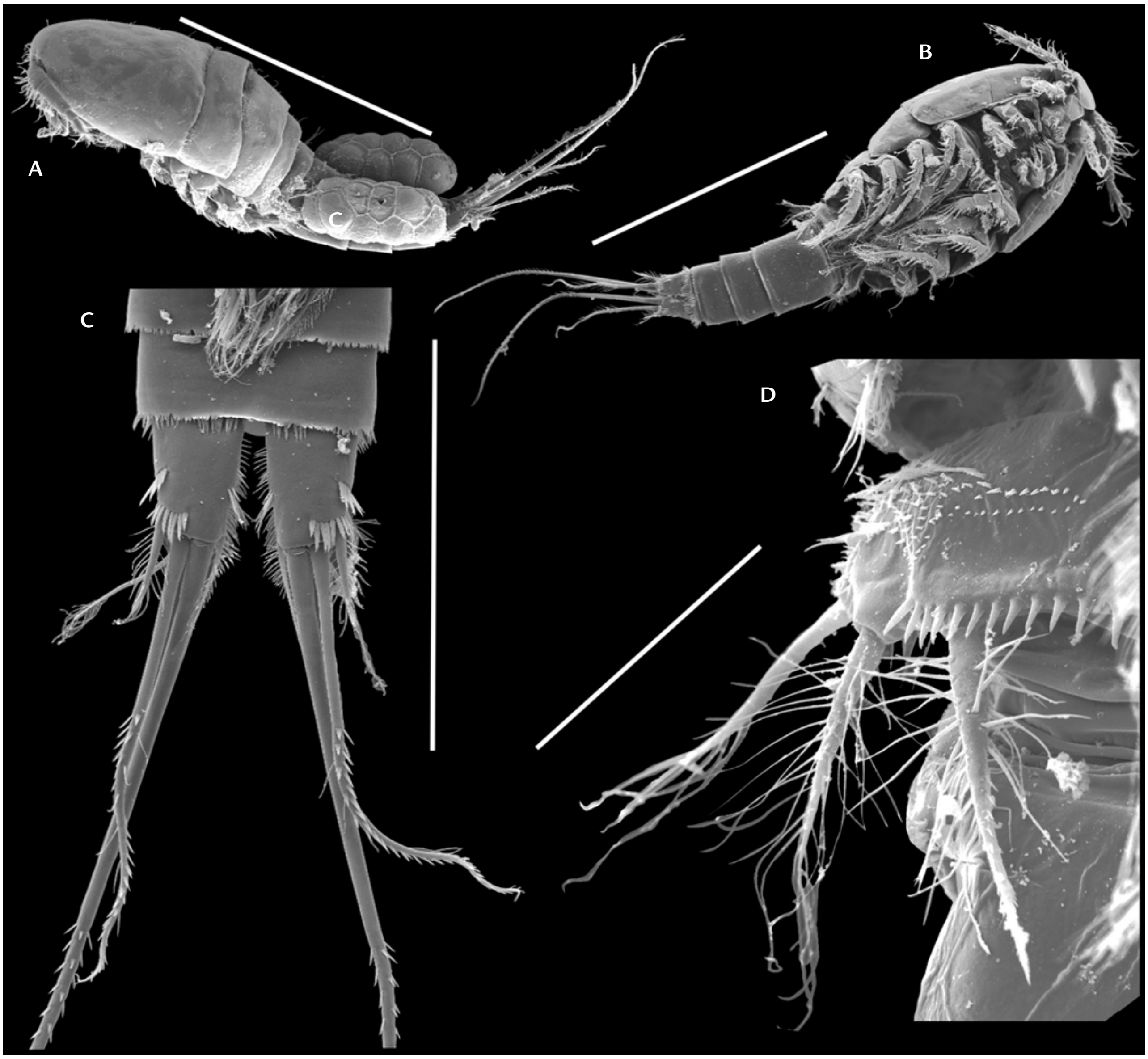


Figure 8. *Ectocyclops herbsti*, female: (A) habitus, lateral view; (B) habitus, ventral view; C. anal somite and caudal rami, ventral; (D) P5, ventral view. Scale bars: A, B = 100 µm; C = 200 µm; D = 50 µm.

projections beating tuffs of setules, divided horizontally and the lower part is wider than the upper part. (Fig. 10A). Long caudal rami, 8 times longer than wide, spinules along the entire outer margin or only on the distal margin (Figs 10A, B, 11C, D). Dorsal row of spinules on each side of the anus at last urosomal segment (Fig. 10C). P4 endopod terminal segment is 2 times longer than wide, outer terminal spine of this segment is 1.4 times longer than the inner spine (Fig. 10D).

Remarks. A species with a wide geographic distribution in the Americas. It is often found in coastal regions, aquatic macrophytes and rivers, and it is seldom found in the plankton of reservoirs. Animals with a dark (black or brownish) color, usually with debris attached to the segments and appendages, due to their benthic habit. This species can be easily distinguished by the long caudal rami, compared to the other congeners. The subspecies *Eucyclops neumani titicacae* Kiefer, 1957, recorded from Peru, Colombia and Venezuela, was raised to species rank by Fuentes-Reinés and Suárez-Morales (2013).

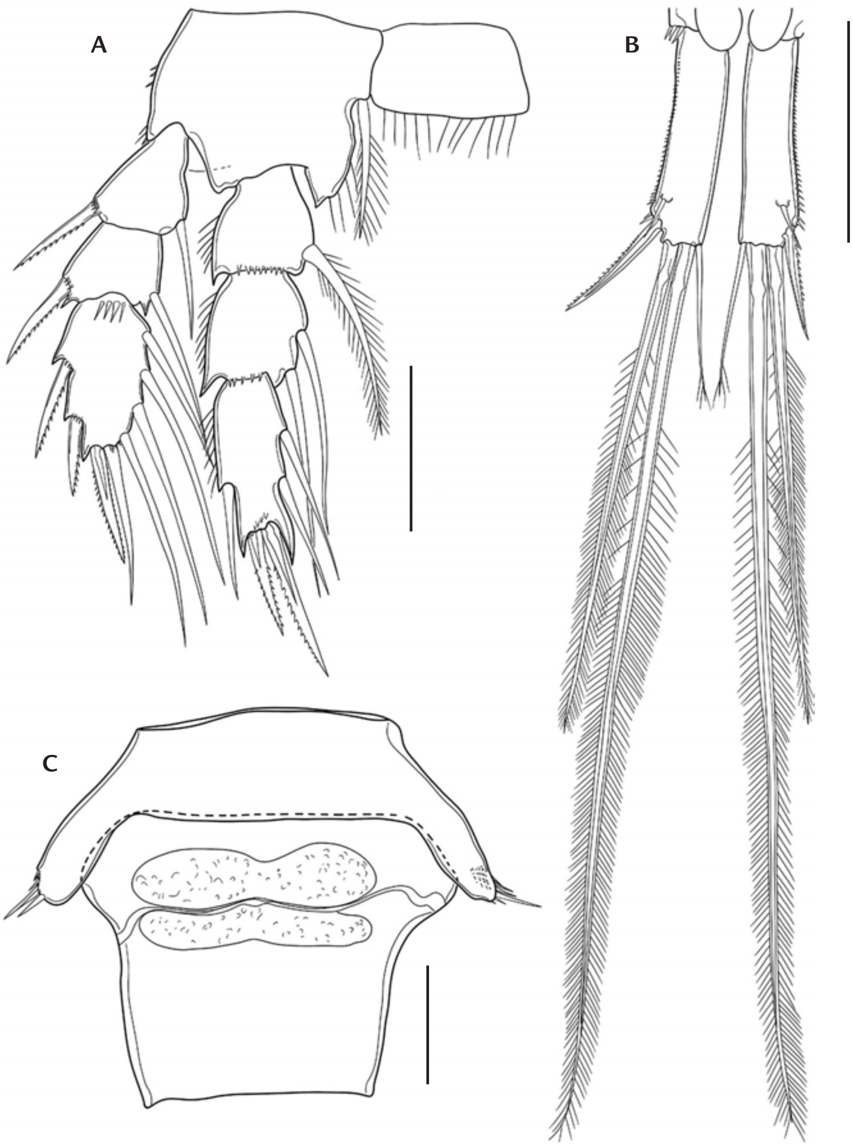


Figure 9. *Eucyclops leptacanthus*, female: (A) P4; (B) caudal rami; (C) genital double-somite. Scale bars: A, C = 50 µm; B = 100 µm.

Eucyclops prionophorus Kiefer, 1931

Figs 12, 13

Diagnosis. Adult female, 870 µm in length excluding caudal setae. Simple duct projections in the genital double-somite, not divided by an internal integumental scar as in *Eucyclops (Denticyclops) leptacanthus* (Fig. 12A). Hyaline membrane on the last antennule segment with a finely serrulate pattern (Fig. 13A). Caudal ramus 4.6 times longer than wide, outer ornamentation (spinules) without gradual change in size (Figs 12B, 13B, C). Inner terminal spine of the last segment of of P4 endopod 1.3 times longer than the segment (Fig. 12C, D).

Remarks. Species with a wide geographic distribution in the Americas. It is often found in coastal regions, among aquatic macrophytes and in rivers, and it is seldom found in the plankton of reservoirs. Animals with a dark (black or brownish) color, usually with debris attached to the appendages and body surface due to their benthic habit. This species can be distinguished from congeners by the spinules along the entire outer margin of the caudal rami, and by its proportional width and length.

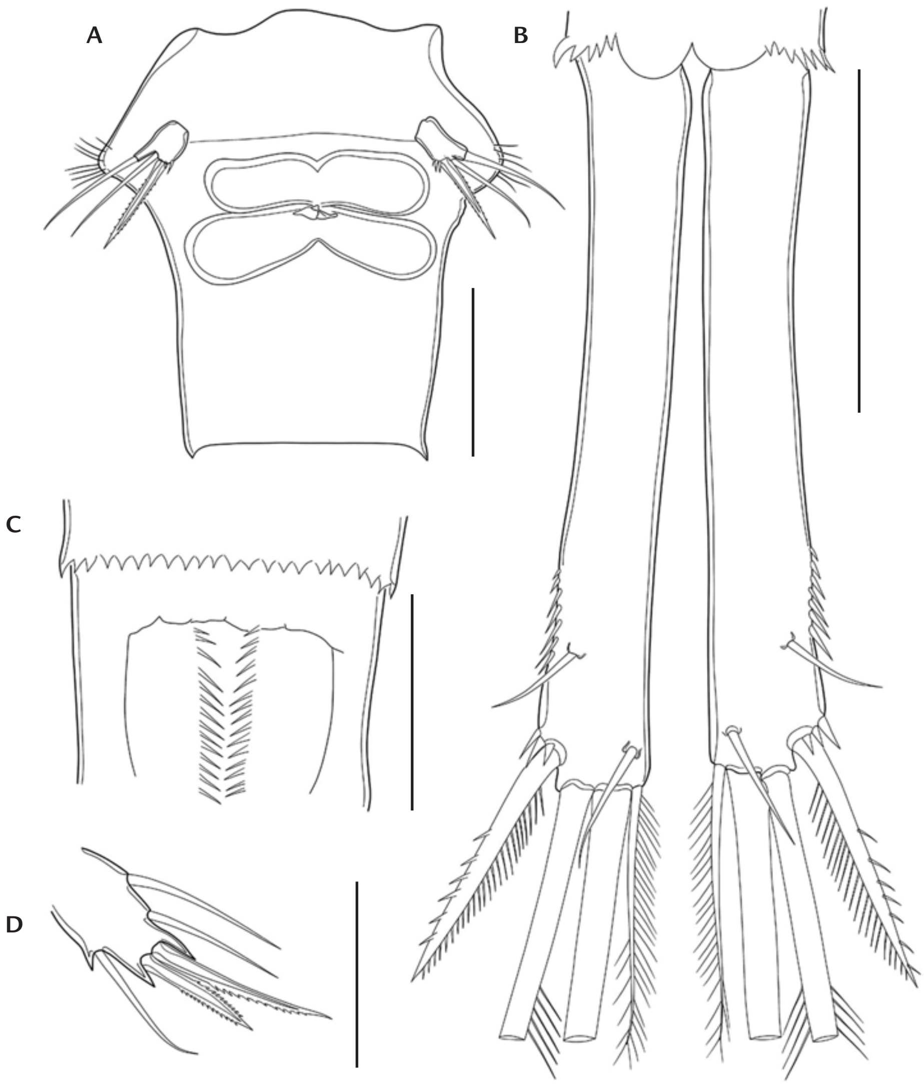


Figure 10. *Eucyclops neumani neumani*, female: (A) genital double-somite and P5, ventral view; (B) caudal rami; (C) anal somite, dorsal, showing spine rows along anus; (D) P4 endopod terminal segment. Scale bars: 100 µm.

Eucyclops serrulatus serrulatus (Fischer, 1851)

Figs 14, 15

Diagnosis. Adult female, 1,390 µm in length excluding caudal setae. Caudal ramus 5 times longer than wide (Fig. 15A, D, E); row of spines extending over half or up to the entire outer margin of the caudal ramus (Figs 14A, D, 15D, E). Seminal receptacle ducts horizontally divided into two parts (Fig. 14B). P5 middle seta 1.8–1.9 times longer than the inner spine (Figs 14C, 15B, C). Inner spine of the terminal P4-endopod segment 1.2 times shorter than the outer spine (Fig. 12D).

Remarks. Species with a wide geographic distribution in the Americas, often found in coastal regions, aquatic macrophytes and rivers. It is seldom found in pelagic regions of reservoirs or lakes. Animals dark or brown-colored and usually with debris attached to the body segments and appendages, due to the benthic or littoral habit. This species can be distinguished from the other congeners by the proportions of the caudal rami and the extent of the spinules along the outer margin. The division of the genital double-somite and the proportions of the spines and setae on the P5 are also distinctive characters. Possibly, a complex of cryptic or semi-cryptic species is hidden under similar morphologies.

Figure 11. *Eucyclops neumani neumani*, female: (A) habitus, lateral view; (B) prosomites 4 and 5, genital double-somite and P5 (indicated by arrows), lateral view; (C) caudal ramus in lateral view; (D) caudal ramus in lateral view. Scale bars: A = 500 µm; B, C = 100 µm; D = 50 µm.

Homocyclops ater (Herrick, 1882)

Fig. 16

Diagnosis. Adult female, 1,730 µm in length excluding caudal setae. Broad and robust body. Maxilliped has few rows of spinules on the exopod (Fig. 16A). Genital double-somite 1.2 times wider than long (Fig. 16B). Seminal receptacle has lateral projections (Fig. 16B). Antennule is 17-segmented. P5 middle seta longer than the outer and inner setae (Fig. 16C). P4-endopod outer terminal spine 0.8–0.9 times the length of the segment (Fig. 16D).

Remarks. Species with wide geographic distribution and usually found in low numbers in zooplankton samples. Large-bodied copepod, often associated with aquatic macrophytes and littoral zones. In samples from macrophytes, several individuals were collected.

Macrocyclops albidus albidus Jurine, 1820)

Figs 17, 18

Diagnosis. Adult female, 1,280 µm in length excluding caudal setae. Caudal ramus without ornamentation on the inner margin, 2.0 times longer than broad (Figs 17A, 18A).

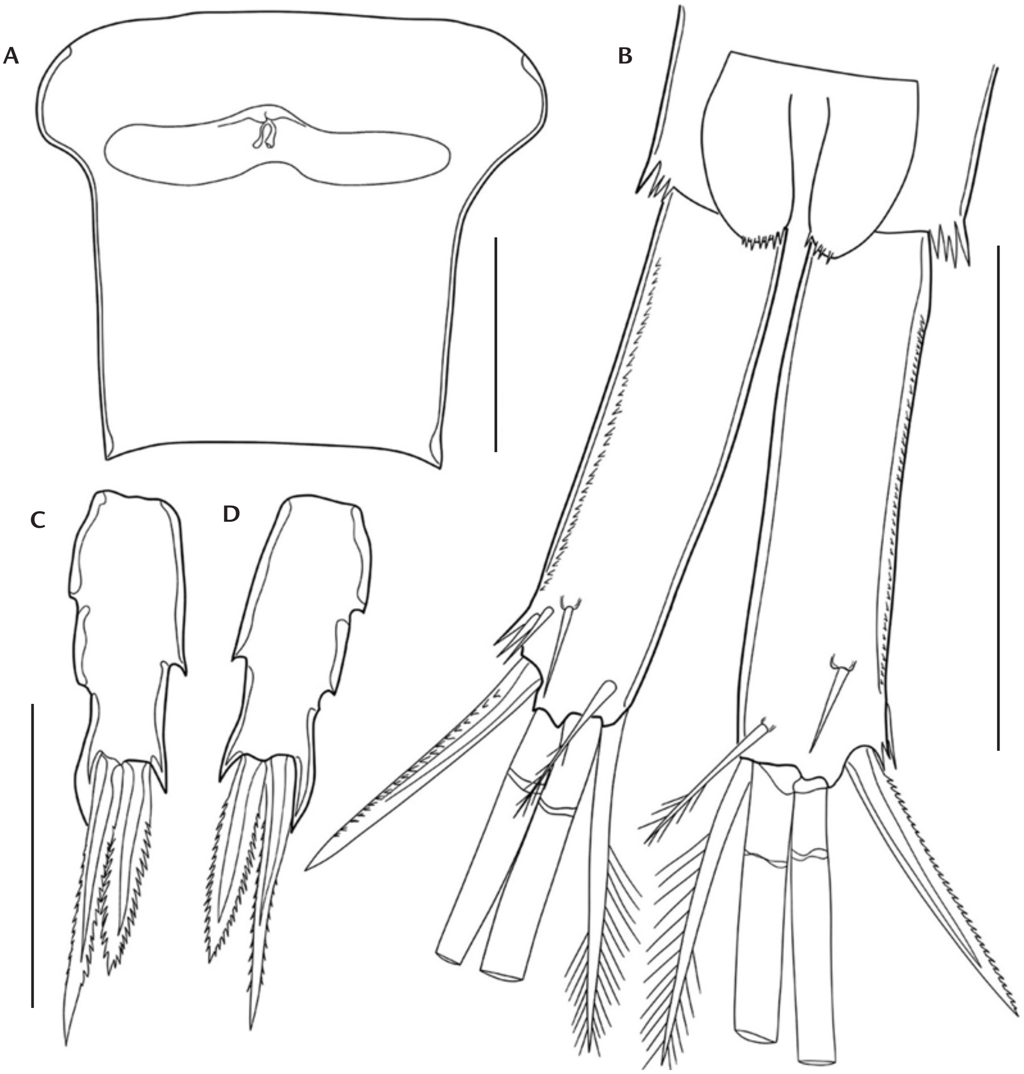


Figure 12. *Eucyclops prionophorus*, female: (A) genital double-somite, ventral view; (B) caudal rami; (C) P4 right, anterior view; (D) P4 left, anterior view. Scale bars: A, C, D = 50 µm; B = 100 µm.

Hyaline membrane of the last segment of the antennule smooth (not serrulate). P4-intercoxal sclerite with three rows of spinules. Inner and outer P4 terminal spines of the same length (Figs 15B, 18C). First segment of P5 with row of small spinules on the surface being an outer proximal row, an inner curved medial row and an inner distal row (Figs 17C, 18B).

Remarks. Cosmopolitan species, usually found in low numbers in samples from rivers, littoral zones, aquatic macrophytes and various environments such as caves, dolomitic lakes, puddles, and others. In these environments, peaks of high abundance can occur. It is seldom found in reservoirs zooplankton.

Megacyclops viridis viridis (Jurine, 1820)

Fig. 19

Diagnosis. Adult female, 1,950 µm in length excluding caudal setae. Caudal ramus 2.5–2.6 times longer than wide, lateral outer setae inserted in the distal third; row of spinules on the distal margin of the third urosomal segment (Fig. 19A). P5 ending in an inner acuminate tip (Fig. 19B, C, E). Inner spine of the P4-endopod terminal segment slightly longer than the outer one (Fig. 19D).

Remarks. Large, cosmopolitan species, seldom appearing in high numbers. Specimens found in aquatic macrophyte banks. It is very rare in reservoir zooplankton,

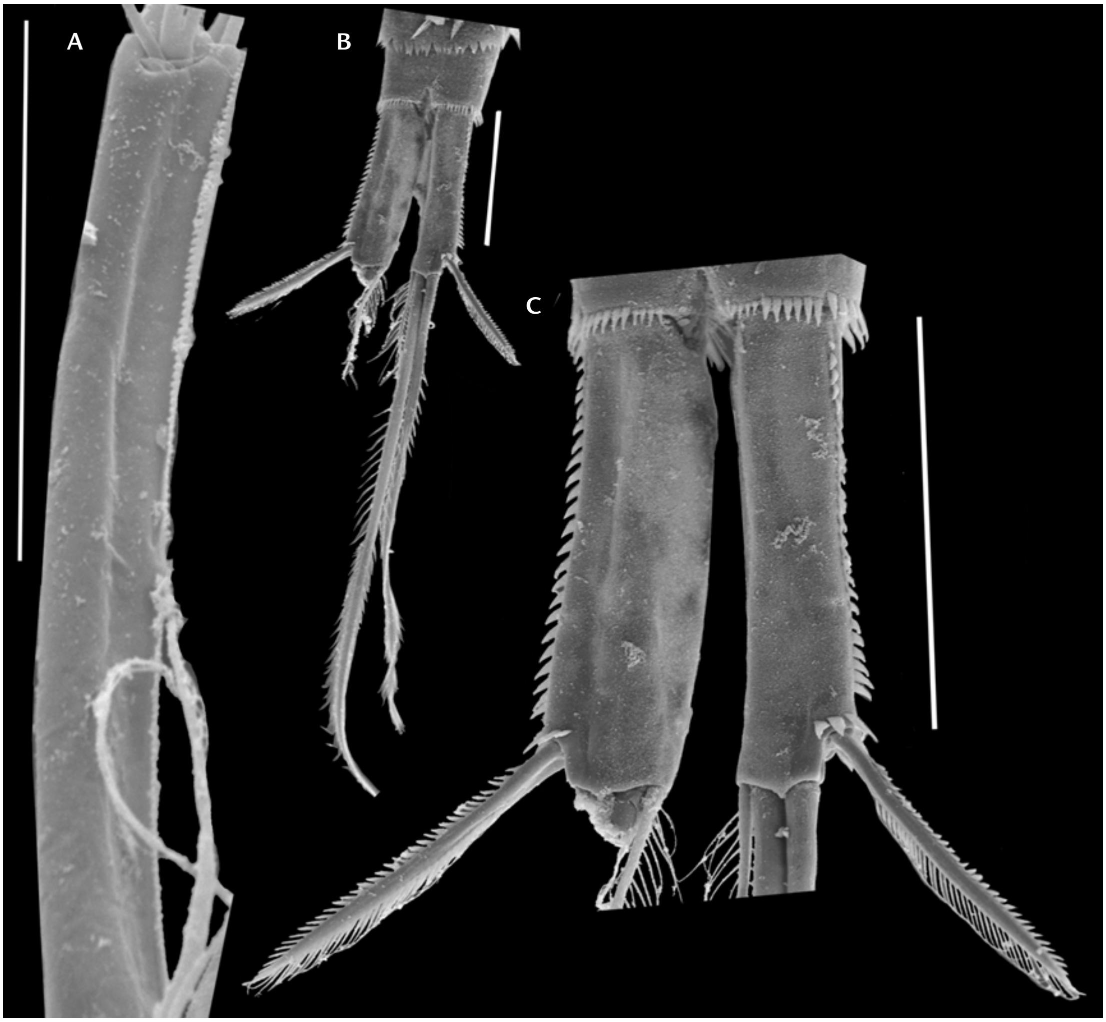


Figure 13. *Eucyclops prionophorus*, female: (A) last segment of antennule; (B) caudal rami; (C) caudal rami. Scale bars: A, B = 300 µm; C = 100 µm.

but common in lotic stretches and floodplains. As it is the only species of the genus, it is easily identifiable by the P5.

Mesocyclops aspericornis (Daday, 1906)
Fig. 20

Diagnosis. Adult female, 1,300 µm in length excluding caudal setae (Fig. 20A). Caudal rami about 3 times longer than wide, setules along the entire inner margin; telson has a continuous row of spinules near each caudal rami insertion (Fig. 20B). Genital double-somite 1.1–1.3 times longer than wide, without setules (Fig. 20C). Seminal receptacle tapering distally in the lateral projections; proximal margin usually sinuous in the middle (Fig. 20C, arrow). Transverse seminal ducts forming a fused V shape in the copulatory pore; copulatory duct usually strongly curved (Fig. 20C). Irregular intervals of 4–10 spinules rows on the distal margin of P4 coxa; 4–11 spinules usually arranged in a single row at the latero-distal angle; proximal row of 4–12 large spinules, and dense outer setulae patch (Fig. 20D). Inner apical spine of terminal P4-endopod segment 1.1 times longer than the outer one (Fig. 20F). Basis of antenna spinule ornamentation patterns similar to the *M. leuckarti*-type, a wide field of spinules on posterior margin at the level of the insertion of the median seta, a group of very small longitudinal spinules along the outer margin, and an inner row of longitudinal spinules at irregular intervals, near the concave margin (Fig. 20G, H). Anterior face of the antenna basis composed of 17–35 spinules arranged in a longitudinal row along the

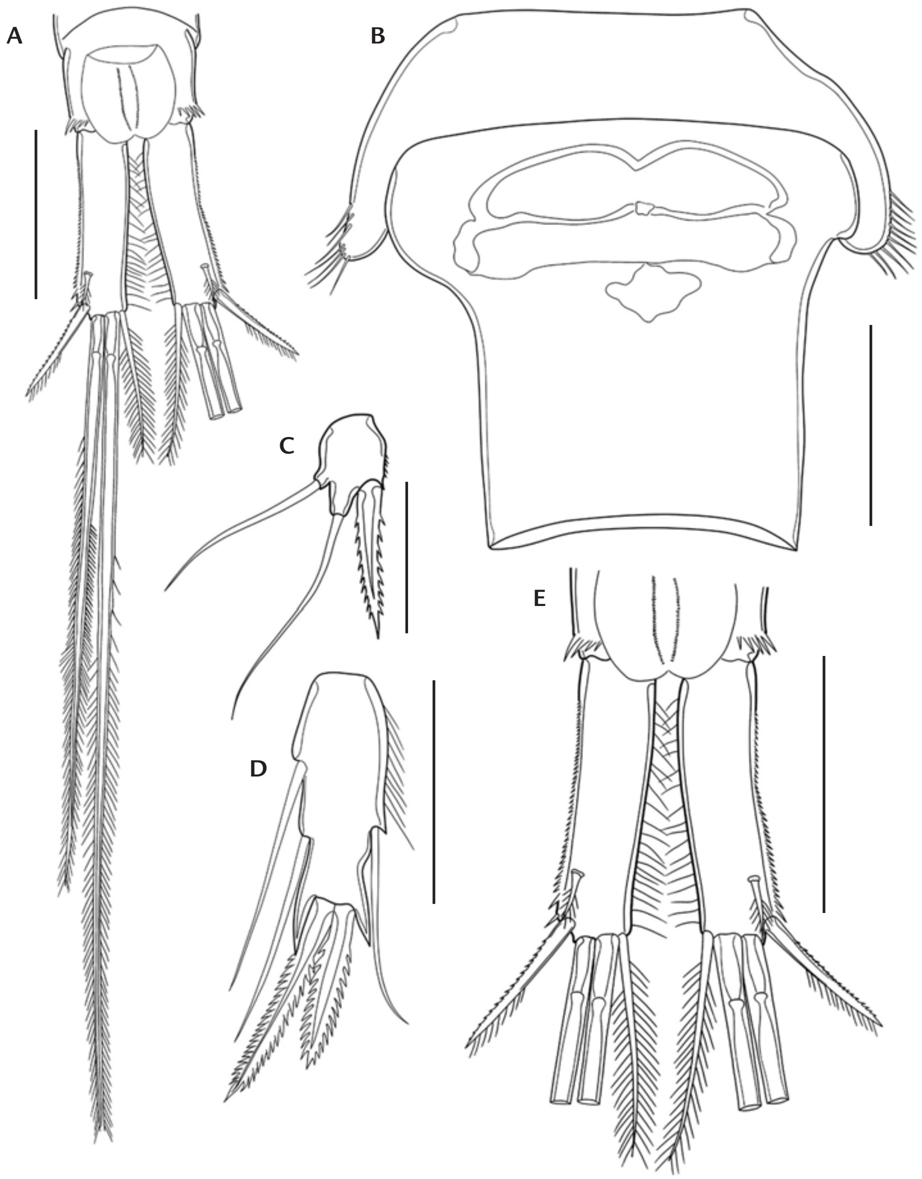


Figure 14. *Eucyclops serrulatus serrulatus*, female: (A) caudal ramus and caudal setae; (B) genital double-somite, seminal receptacle in the middle; (C) P5; (D) P4 terminal endopod; (E) caudal ramus. Scale bars: A, B, E = 100 µm; C = 100 µm.

inner concave margin, transverse row of small spinules on the distal margin, and a transverse row of spinules medially, on the outer margin (Fig. 20G, H). Strongly serrulate hyaline membrane on the last segment of antennule, large indentation in its medial portion (Fig. 20E).

Remarks. Collected in the middle stretch of the Paraguay River, which has slow flow and many drifting macrophyte banks. Perbiche-Neves et al. (2014) found this species in the Barra Bonita reservoir, which is the first record of this species for São Paulo state. The species was previously recorded by Reid et al. (1988) in Minas Gerais and Reid (1994) in the Federal District. Reid (1985) stated that this species has been recorded from Colombia, Venezuela, Antilles, Africa, Asia and islands of the Pacific Ocean. It is one of *Mesocyclops* species considered as a pantropical species (Holyńska 2000), and present in Australia. Holyńska et al. (2003) mentioned this species from the islands of Sumatra, Singapore, and Hawaii.

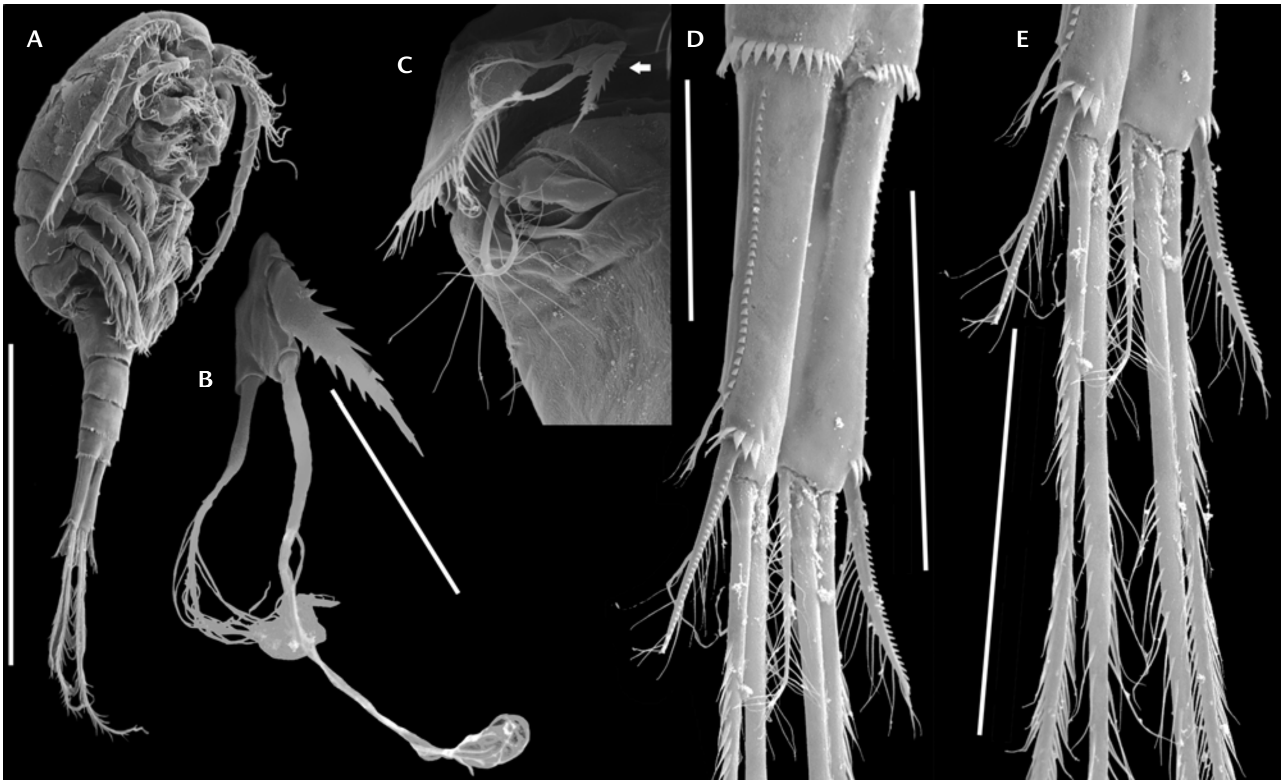


Figure 15. *Eucyclops serrulatus serrulatus*, female: (A) habitus, ventrolateral view; (B) P5; (C) prosomite 5 and genital double-somite in lateral view, showing P5 (indicated by arrow); (D–E) caudal rami. Scale bars: A = 500 µm; B = 20 µm; C = 50 µm; D, E = 100 µm.

Mesocyclops ellipticus Kiefer, 1936
Fig. 21

Diagnosis. Adult female, 960 µm in length excluding caudal setae (Fig. 21A). Setules on inner margin of caudal rami (Fig. 21B). Genital double-somite 1.0–1.2 times longer than wide, seminal receptacle with very narrow elliptical ducts expanding horizontally (Fig. 21C). Ornamentation of P4-coxa in posterior view composed of 5 or 6 groups of spinules; with one proximal row in the middle, one inner row (close to the intercoxal sclerite) medially on the segment, two spinules rows on the distal outer margin and one row on the distal inner margin; occasionally, individual spinules also occur in the middle portion (Fig. 21D). P5 terminal seta slightly longer than the inner spine and the outer seta of the anterior segment (Fig. 21E). P4 endopod outer terminal spine 1.1 times longer than the inner one (Fig. 21G). Terminal segment of the antennule with a finely serrulate hyaline membrane (Fig. 21F). Antenna basis with row of spinules on the inner concave margin in anterior and posterior views in a similar trend, slightly smaller spines in the proximal and distal regions and larger spinules in the middle, giving a semi elliptical shape to this ornamentation (Fig. 21H, I).

Remarks. In this study, this species was found only in the upper stretch of the Paraguay River, which has a slow flow and many drifting aquatic macrophyte banks, especially *Eichhornia* sp. Holyńska et al. (2003) mentioned that this species occurred in small puddles (type locality is Bom Conselho, Pernambuco, Brazil) and in large lakes such as Lake Maracaibo in Venezuela, and these authors mentioned a variation for the P4 terminal endopod inner spine between 0.9–1.2 times than the outer one. In Brazil, Perbiche-Neves et al. (2014) found this species in the eutrophic Barra Bonita Reservoir, contrasting with the suggestions by Dussart (1984) and Rocha and Botelho (1998) that this species prefers oligotrophic waters. Probably the association with macrophytes is valid. This species is easily recognizable by the elliptical seminal receptacle, the basis of the antenna, and the P4 coxa. It can be confused with *Mesocyclops reidae*, but this latter species has been recorded only in Central America and southern North America.

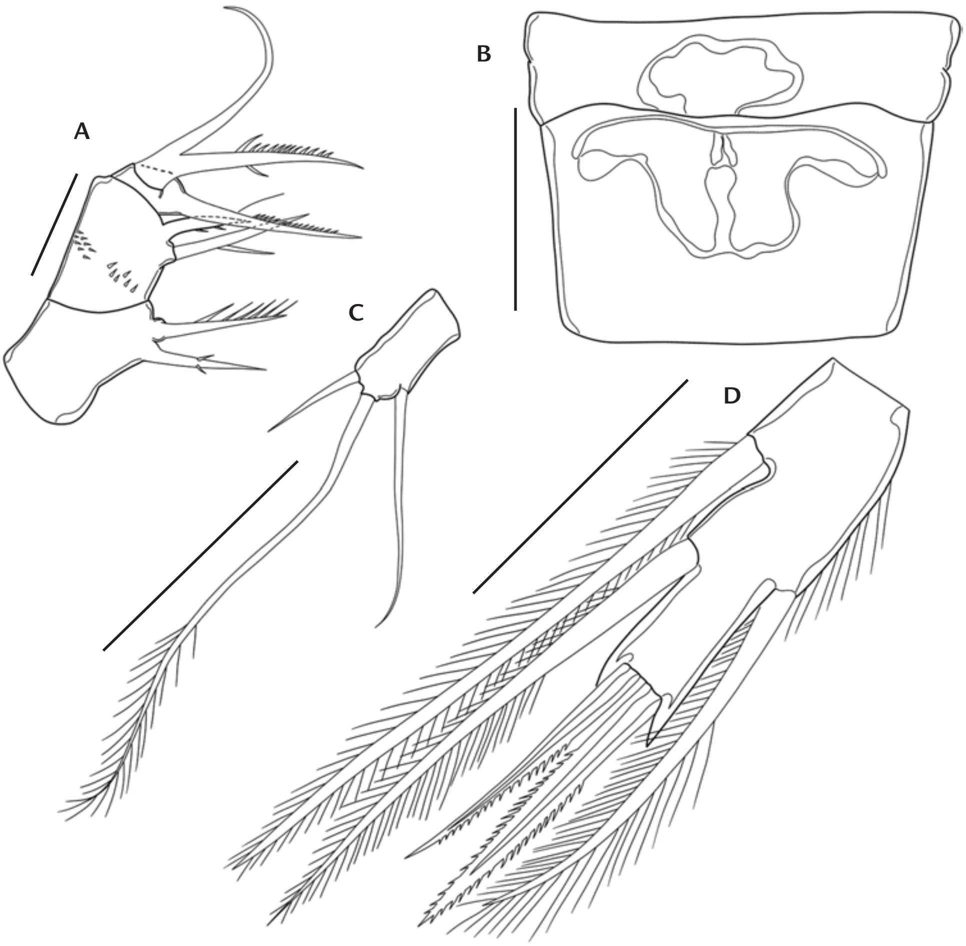


Figure 16. *Homocyclops ater*, female: (A) maxilliped; (B) genital double-somite; (C) P5; (D) P4-endopod terminal segment. Scale bars: 50 µm.

Mesocyclops longisetus longisetus (Thiébaud, 1912)
Fig. 22

Diagnosis. Adult female, 1,510 µm in length excluding caudal setae. Four groups of spinule rows on the anterior side of the P4 basis (Fig. 22A). Ducts of seminal receptacle curved posteriorly (Fig. 22B). Caudal ramus is 3.2 times longer than wide and with setules on inner margin (Fig. 22C). One row and two patches of spinules at maxilliped exopod (Fig. 22D). Hyaline membrane of last segment of antennule is strongly serrulate, strongly indentation medially developed (Fig. 22E). Antenna basis with three small rows of spinules in anterior view (Fig. 22F) and two larger rows of spinules in posterior view, without small spinules (Fig. 22G). P5 apical seta 2 times longer than the median spine. P4-endopod terminal segment 2.5 times longer than wide.

Remarks. The specimen examined was found in the Iguaçu River, in the Foz do Areia Reservoir. It is widely distributed in the upper Paraná River Basin, as shown by several reports (Perbiche-Neves et al. 2014). This species has a wide geographic distribution in South America, and is usually found in low numbers, possibly because it is large and predatory. It is eurythermal and produces egg-sacs with many eggs (>100). In Brazil, the subspecies *M. longisetus curvatus* has been widely reported, but the validity of this subspecies has been doubted, as the details used to identify it are rarely observed. We decided in this study to be conservative, however a revision of these subspecies especially in the Neotropics is necessary to validate the difference. Considering the results of Wyngaard et al. (2010), these authors do not find significant difference between populations of *M. longisetus* from USA and *M. longisetus curvatus* from Brazil.

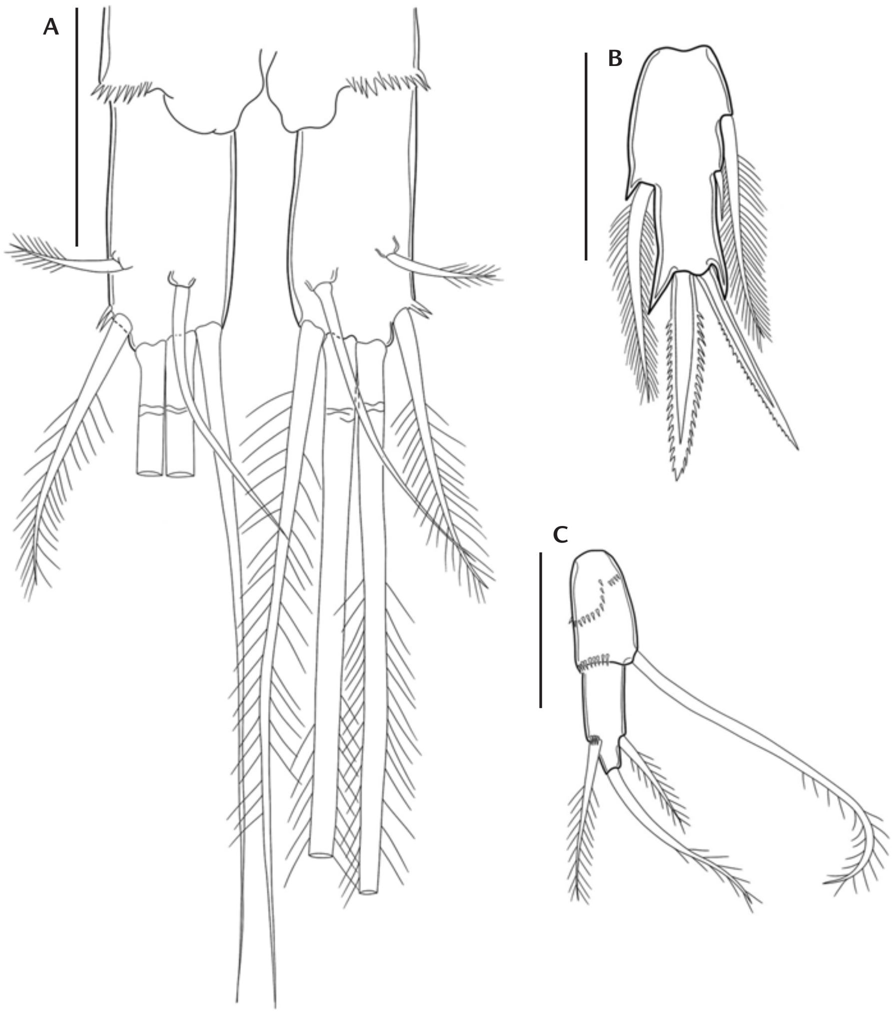


Figure 17. *Macrocyclops albidus albidus*, female: (A) caudal rami; (B) terminal P4-endopod; (C) P5. Scale bars: A, B = 50 µm; C = 25 µm.

This species can occur in various environments, such as the pelagic zone, littoral of rivers and lakes, among aquatic macrophytes, river channel, puddles, etc.

Mesocyclops meridianus (Kiefer, 1926)

Figs 23, 24

Diagnosis. Adult female, 1,100 µm in length excluding caudal setae. Genital double-somite is 1.3 times longer than wide. Seminal receptacle has narrow, almost filiform and horizontal lateral expansions (Fig. 23A). P4 endopod outer terminal spine is approximately in the same length as its segment (Figs 23B, 24E). Hyaline membrane on the last segment of antennule with small indentations in the proximal 2/3 and heavily indented, more than three large invaginations in the distal 1/3 (Figs 23C, 24C). Distal margin of P4 intercoxal sclerite smooth (Fig. 23D); P4 basis with six groups of spinules in posterior view: three short rows of small spinules proximally, one row in the medial region, one group transversely on the lateral outer margin, and a row on the inner distal margin (Fig. 23D). Spinule pattern of antenna basis anterior surface: two converging rows proximally, near the concave margin; two rows of different lengths near the insertion of the outer seta, and a short row, medially, on the inner margin (Fig. 23E). Mandible endopod segment with proximal, middle, and distal rows of spinules in anterior view (Fig. 24A). Caudal ramus 2.6 times longer than broad, smooth, or finely hirsute on the inner margin (Fig. 24B).

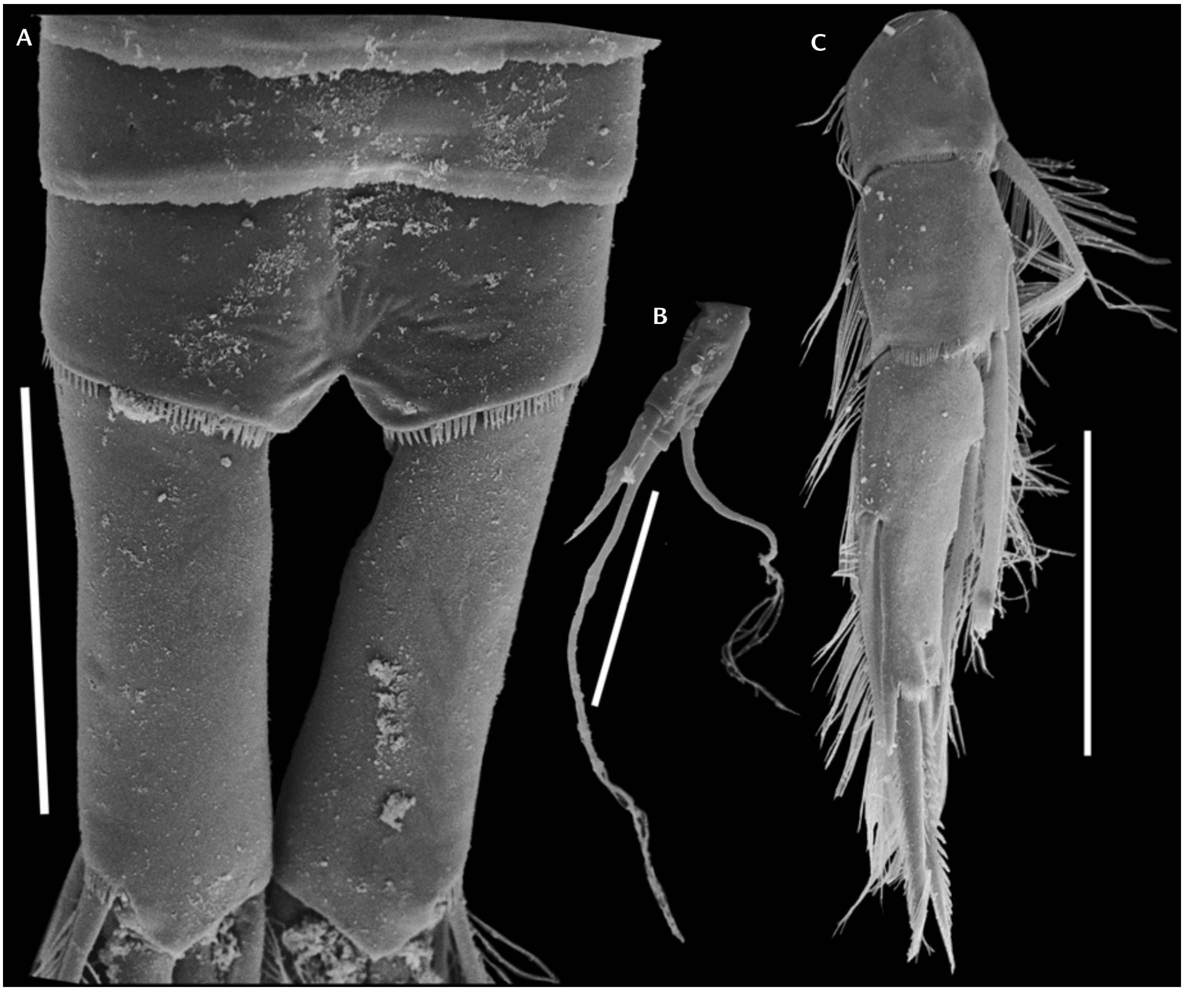


Figure 18. *Macrocyclops albidus*, female: (A) last segment of urosome and caudal rami; (B) P5; (C) P4 endopod. Scale bars: A = 100 µm; B = 50 µm; C = 200 µm.

Remarks. Specimen collected in the Middle Paraguay River. This species is widely distributed in the La Plata Basin. It was described by Kiefer (1926) from samples from the Paraguay River. It was, and still is, confused with *Mesocyclops brasilianus*, described from the Amazon region by Kiefer (1933). Dussart (1984) suggested a possible synonymy of *M. meridianus* with *M. brasilianus*. Gutiérrez-Aguirre and Suárez-Morales (2001) confirmed some morphological differences between these two species, and identified some specimens from São Paulo state as *M. meridianus*. Later, supporting the previous hypothesis, Gutiérrez-Aguirre et al. (2006) reviewed the Neotropical *Mesocyclops* and observed that *M. brasilianus* occurs in the Amazon region and *M. meridianus* more southward on the continent. Possibly, records in northern Brazil are of *M. brasilianus*, but they need to be verified. The original description of *M. meridianus* was based on specimens from Paraguay, and several studies indicate that *M. meridianus* occurs in almost the entire La Plata Basin. However, further studies are needed, as it is possibly a complex of species that cannot be reliably identified based on morphological characters only, since specimens with intermediate characteristics between these two species are often found. In this study, all specimens of this species were checked in detail and confirmed as *M. meridianus*. However, molecular analyses are needed, comparing organisms from different regions across South America and looking for variations within populations. When comparing this species with others presented by Holyńska et al. (2003), it can be confused with *Mesocyclops meridionalis*, *Mesocyclops pseudomeridianus* and *Mesocyclops paranaensis*.

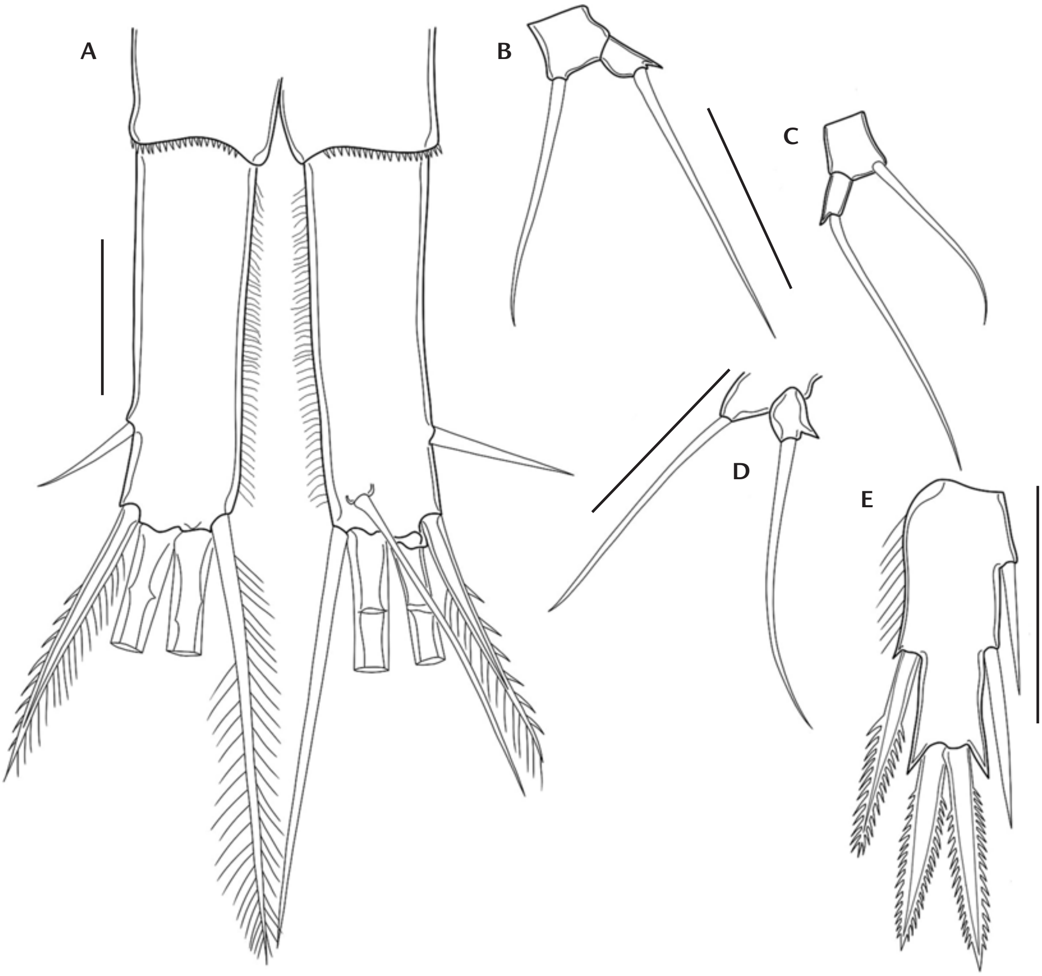


Figure 19. *Megacyclops viridis viridis*, female: (A) caudal rami; (B–D) P5 in different positions; (E) terminal segment of P4-endopod. Scale bars: 50 µm.

Mesocyclops ogunnus Onabamiro, 1957
Fig. 25

Diagnosis. Adult female, 1,180 µm in length excluding caudal setae. Genital double-somite 1.2 times longer than wide, seminal receptacle with lateral and posterior expansions (Fig. 25A). The last P4 endopod segment 1.1 times longer than the inner terminal spine of this segment; this inner terminal spine not exceeds the outer apical spine length (Fig. 25B). Last segment of antennule is ornamented with a narrow, finely serrulate hyaline membrane almost entirely, except to a large subterminal invagination (Fig. 25C). Row of spinules in the anterior region of the maxillule palp (Fig. 25D). Antenna basis is of the "leuckarti" type with proximal, medial, and distal rows of spinules; in anterior view a row of spinules on the lateral outer margin and two rows of spinules in the middle of the segment, three rows in the inner margin, and a row of larger spinules on the distal margin, close to the insertion of the terminal setae (Fig. 25E). P4 basis with three rows of large spinules in anterior view, two on distal margin and one transverse row close to the outer margin, almost in the middle of the segment (Fig. 25F). P4 intercoxal sclerite has small projections on the distal margin. Caudal ramus 2.7 times longer than wide, without setules on the inner margin.

Remarks. Specimen collected in the Rio Grande River, Água Vermelha Reservoir. This species is native from Africa and is now widely distributed in southeastern Brazil. Until now, the records indicate that this invasion began in the upper Paraná River Basin. It may have been introduced with tilapia culture (Coelho and Henry 2017, Macêdo et

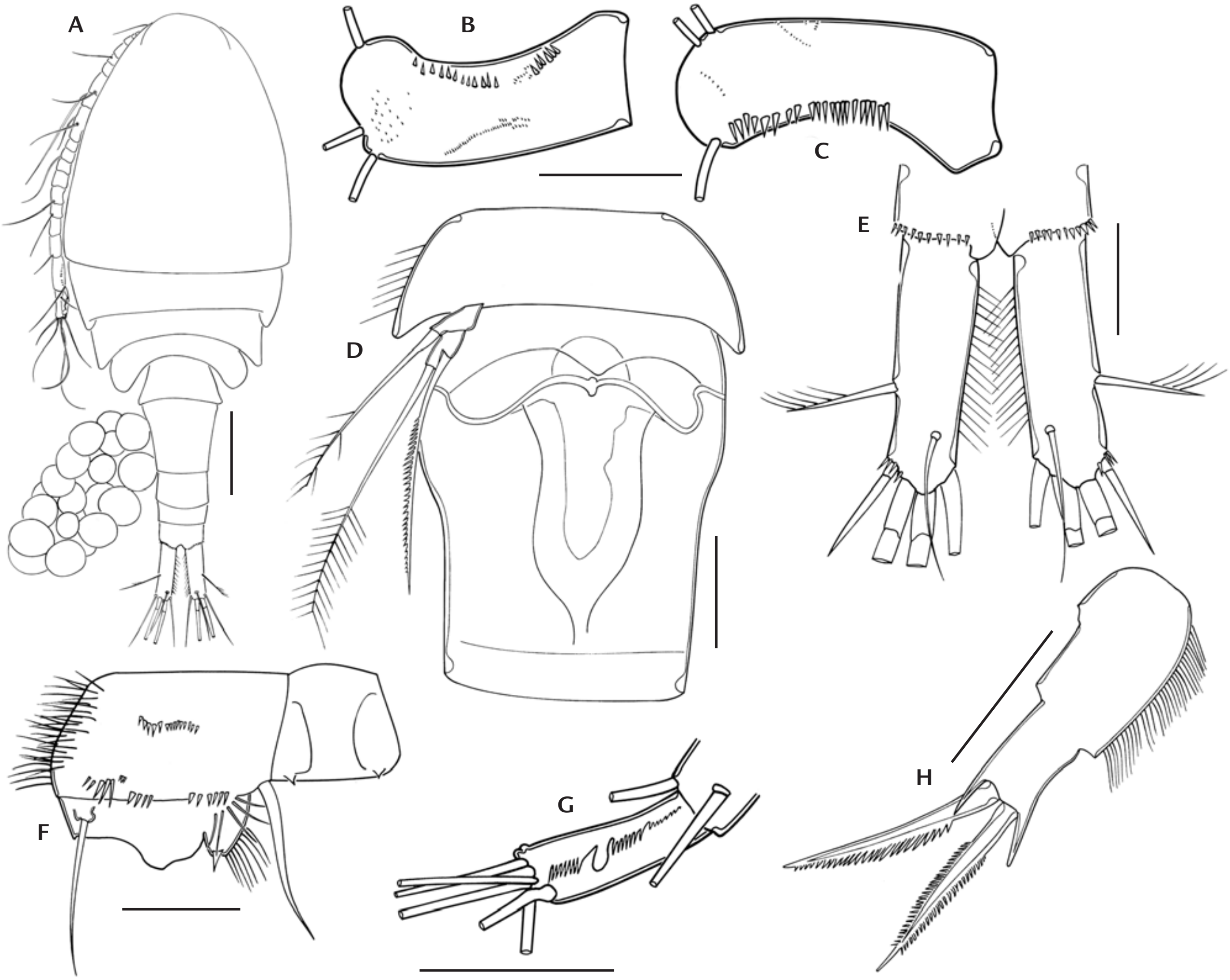


Figure 20. *Mesocyclops aspericornis*, female: (A) dorsal view of female; (B) dorsal view of caudal ramus; (C) ventral view of genital double-somite, arrow indicates the genital receptacle; (D) P4-intercoxal sclerite, coxa-basis, arrow indicates row of spinules; (E) last segment of antennule, arrow indicates serrated hyaline membrane ornamentation; (F) terminal segment of P4-endopod; (G) basis of antenna, posterior view, arrow indicates a row of spinules; (H) basis of antenna, anterior view, arrow indicates a row of spinules. Scale bars: A–D, F–H = 50 µm, E = 100 µm.

al. 2022). More studies are needed to determine its true distribution, whether it is restricted to specific regions, or whether it is limited to the tropics, as it has been found only in southeastern Brazil, not occurring farther south in the La Plata Basin (Perbiche-Neves et al. 2014). Based on data from Castilho-Noll et al. (2023), this species was found in 43 studies in Brazil, the first dated from 1994 in Furnas Reservoir (Reid and Pinto-Coelho 1994), followed by 2001 and 2002 in the Upper Paraná River floodplain (Velho et al. 2001, Lansac-Tôha et al. 2002), and several records were published after 2002 in São Paulo State, especially in reservoirs (e.g., Matsumura-Tundisi and Silva 2002). Custodio et al. (2024) listed 63 records of *M. ogunnus* in Brazil distributed in 70 articles, and these authors provided models for the distribution of *M. ogunnus* in the main river basins in Brazil, with potential colonization across the Paraná River Basin, the main watercourses of the Amazon River Basin, and the San Francisco River. The first record in Northeast Brazil was published in 2013 (Cardôso et al. 2013) and in the Amazon in 2017 (Silva and Roche 2017). Probably previous records of *Mesocyclops kieferi* in São Paulo State refer to *M. ogunnus*, as Matsumura-Tundisi et al. (1990) corrected by Matsumu-

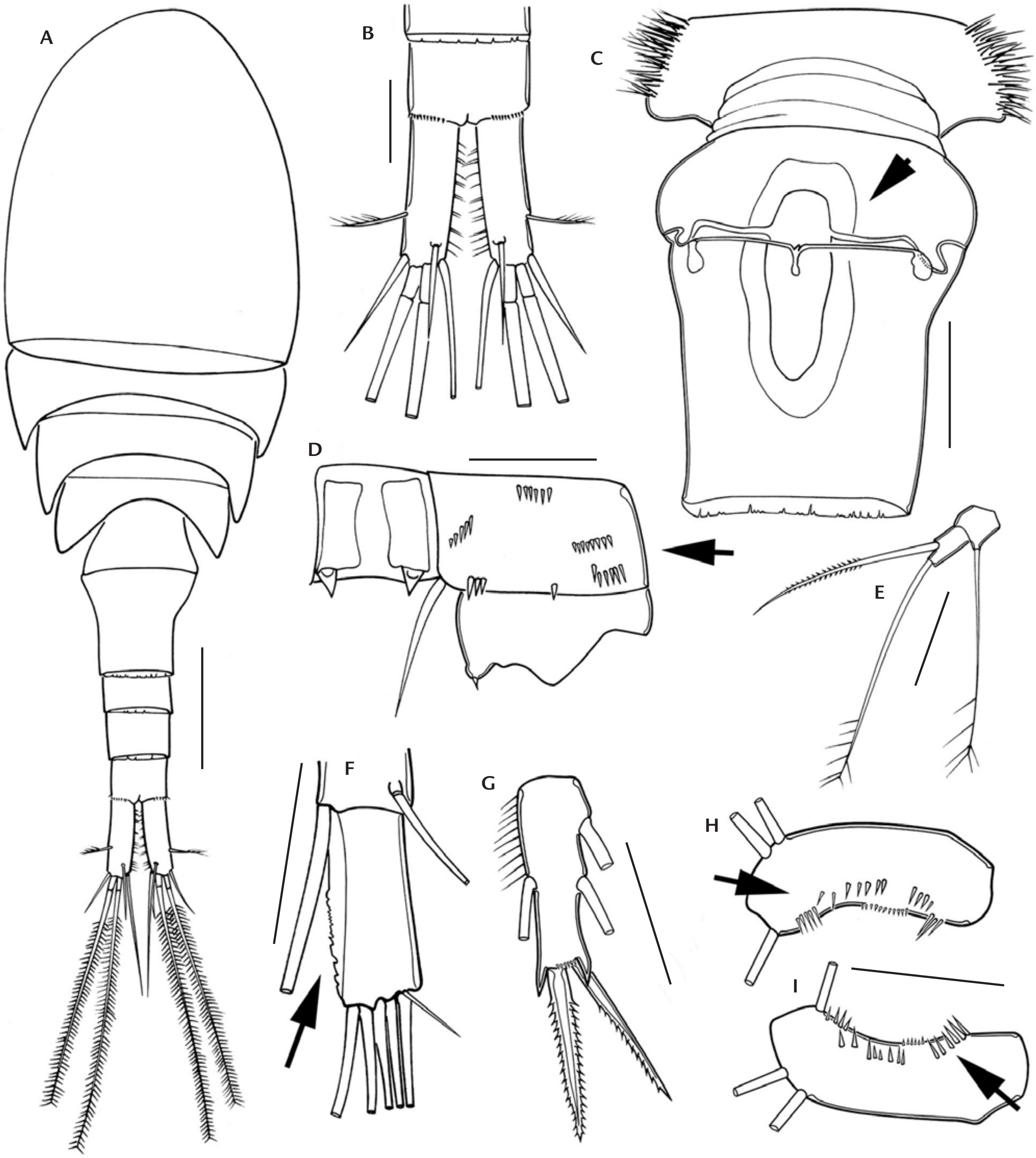


Figure 21. *Mesocyclops ellipticus*, female: (A) dorsal view of adult female; (B) dorsal view of caudal ramus; (C) genital double-somite, ventral view, arrow indicates seminal receptacle; (D) P4- Intercoxal sclerite, coxa and basis, arrow indicates spinules rows; (E) P5; (F) last segment of antennule, arrow indicates ornamentation in the hyaline membrane; (G) terminal segment of P4 endopod; (H) antenna basis, anterior view, row indicates spinule rows; (I) antenna basis, posterior view, arrow indicates spinule rows. Scale bars: A = 100 µm, B–I = 50 µm.

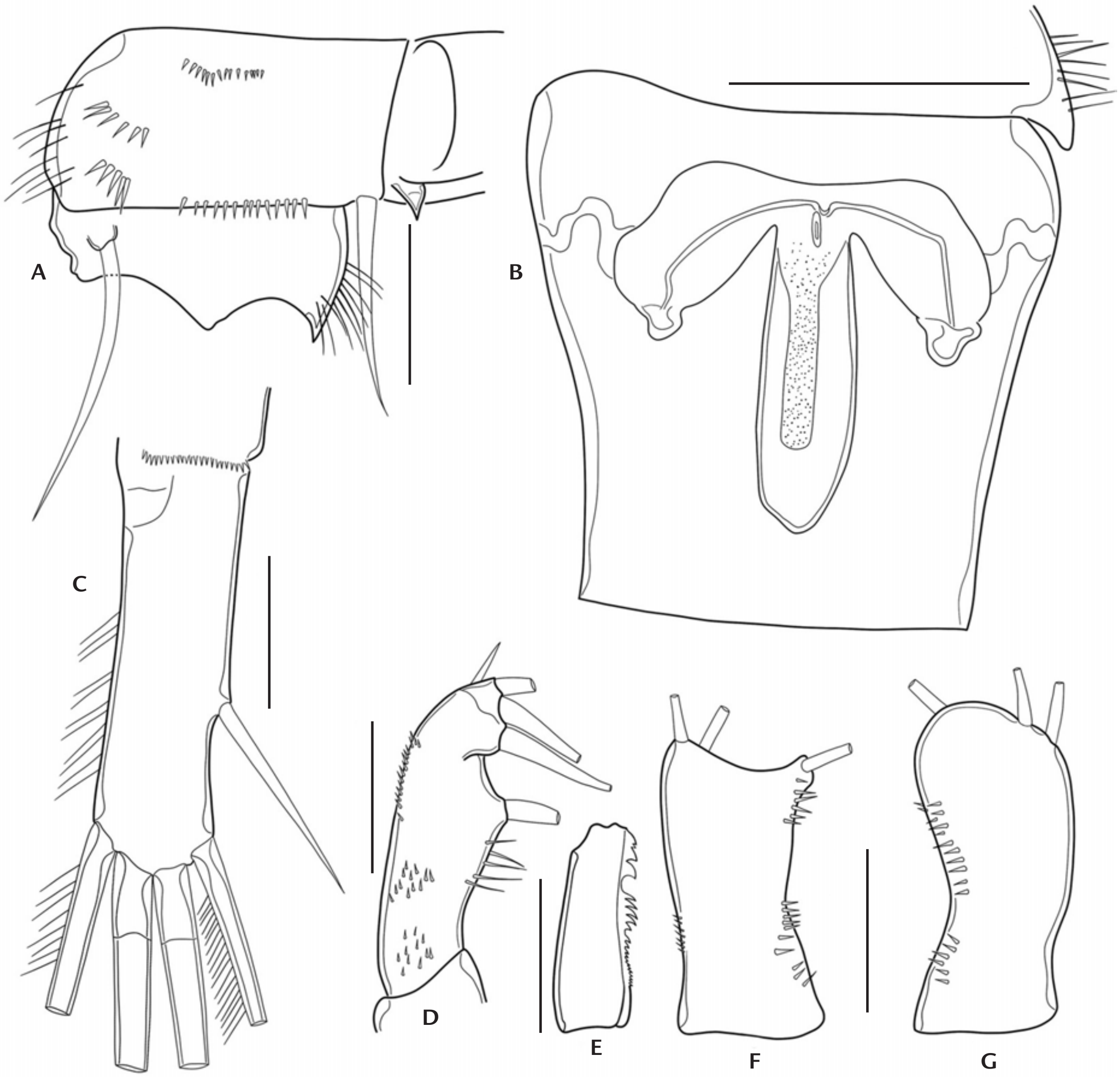


Figure 22. *Mesocyclops longisetus longisetus*, female: (A) basis, coxa and intercoxal sclerite of P4; (B) genital double-somite; (C) ventral view of right caudal ramus; (D) maxilliped exopod; (E) last segment of antennule, showing shape of hyaline membrane; (F) basis of antenna, anterior; (G) basis of antenna, posterior. Scale bars: A, C–G = 50 µm, B = 100 µm.

ra-Tundisi and Silva (2002), Nogueira (2001), Rocha et al. (2002), Santos-Wisniewski and Rocha (2007), and Sartori et al. (2009), according to Castilho-Noll et al. (2023).

Metacyclops laticornis (Lowndes, 1934)

Fig. 26

Diagnosis. Adult female, 770 µm in length excluding caudal setae. Short P5 apical setae; seminal receptacle with thin lateral projections and a long and wide posterior projection (Fig. 26A). A row of spinules on the distal margin of the last urosomal segment, near the basis of the caudal ramus; caudal rami 2.3 times longer than wide; inner terminal setae of the caudal ramus shorter than the outer terminal setae (0.7:1) (Fig. 26B). P4 endopod outer terminal spine is 1.1 times longer than inner terminal spine (Fig. 26C). Intercoxal sclerite of P4 is ornamented with small spinules (Fig. 26C). P1 intercoxal sclerite with 3 spinules on each rounded projection (Fig. 26D).

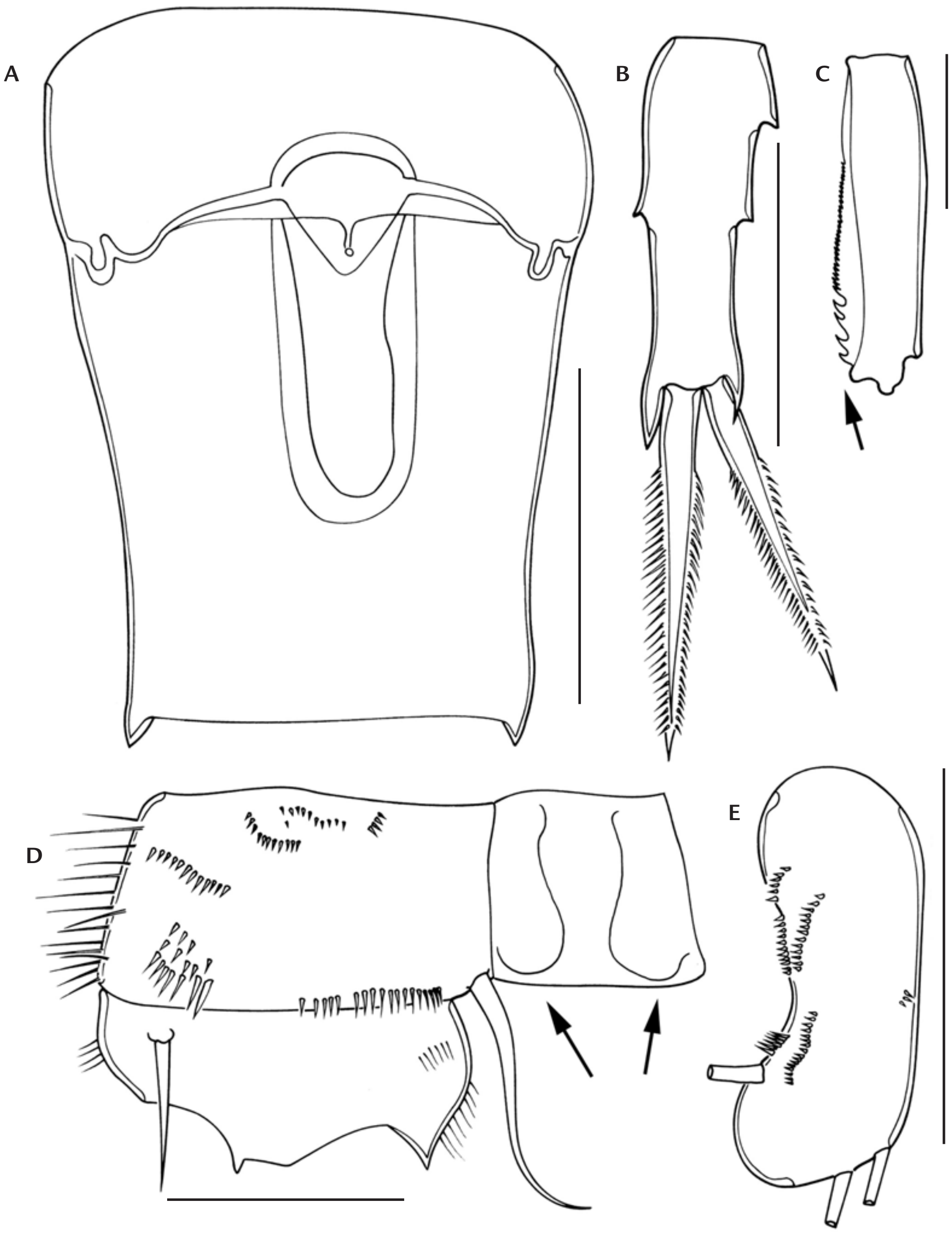


Figure 23. *Mesocyclops meridianus*, female: (A) genital double-somite; (B) terminal P4-endopod; (C) last segment of antennule, arrow indicate hyaline membrane ornamentation; (D) P4 coxa, basis and intercoxal sclerite, arrows indicate the absence of spines; (E) basis of antenna, anterior view. Scale bars: A, B, D, E = 100 µm, C = 50 µm.

Remarks. The specimen illustrated was collected in the middle stretch of the Paraguay River. Reid (1985) reported this species in Paraguay, in swamps, and Dussart and Frutos (1985) found this species in the middle Paraná River, but did not provide a description. In our study this species occurred only in low numbers. The genus *Metacyclops* is diverse and in studies of planktonic organisms, few species are found. Most species occur in swamps, puddles, and ephemeral environments.

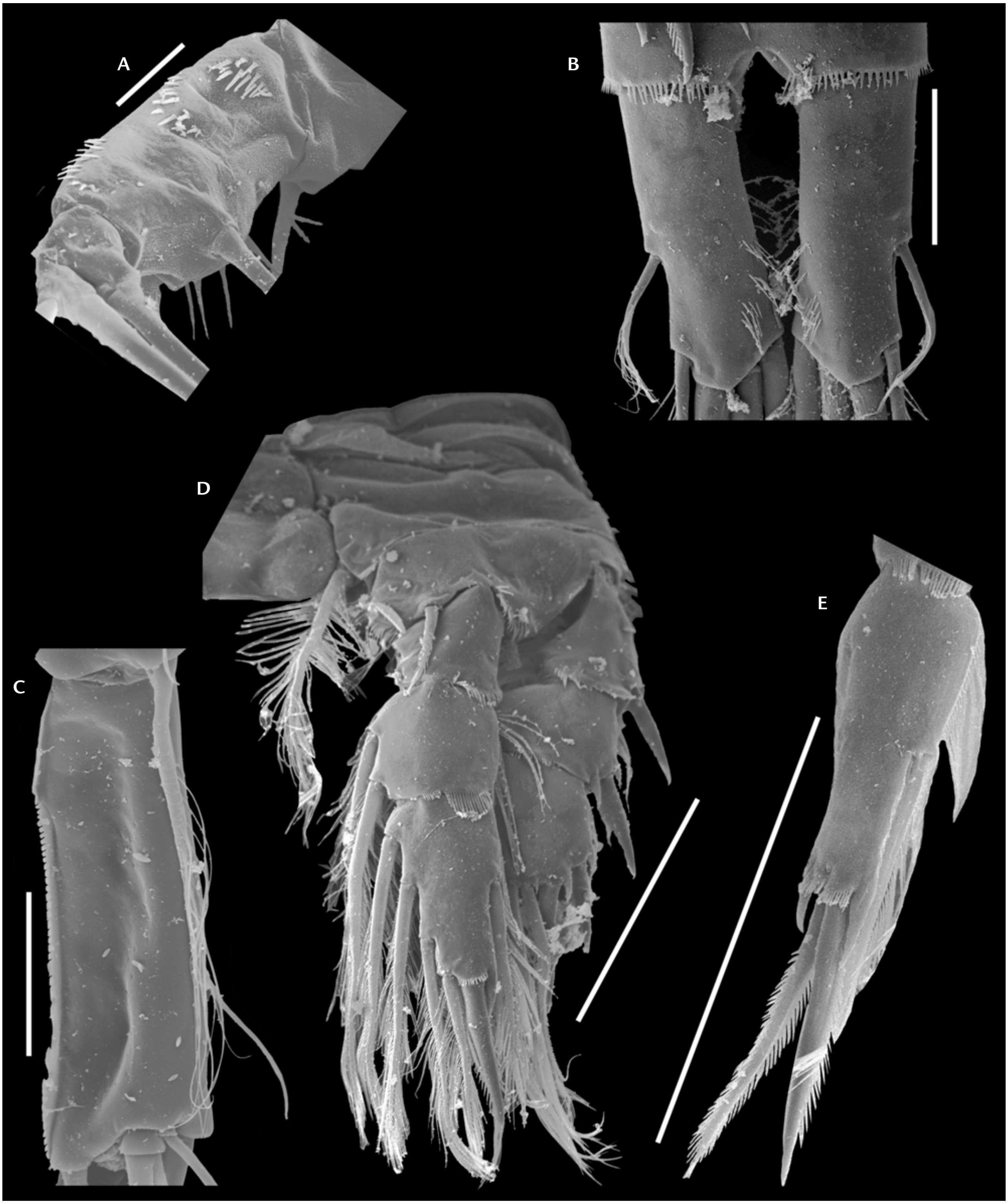


Figure 24. *Mesocyclops meridianus*, female: (A) maxillary basis endopod ornamentation; (B) caudal rami; (C) hyaline membrane on last segment of antennule; (D) P1; (E) last segment of P4 endopod. Scale bars: A, C = 20 µm, B = 50 µm, D, E = 100 µm.

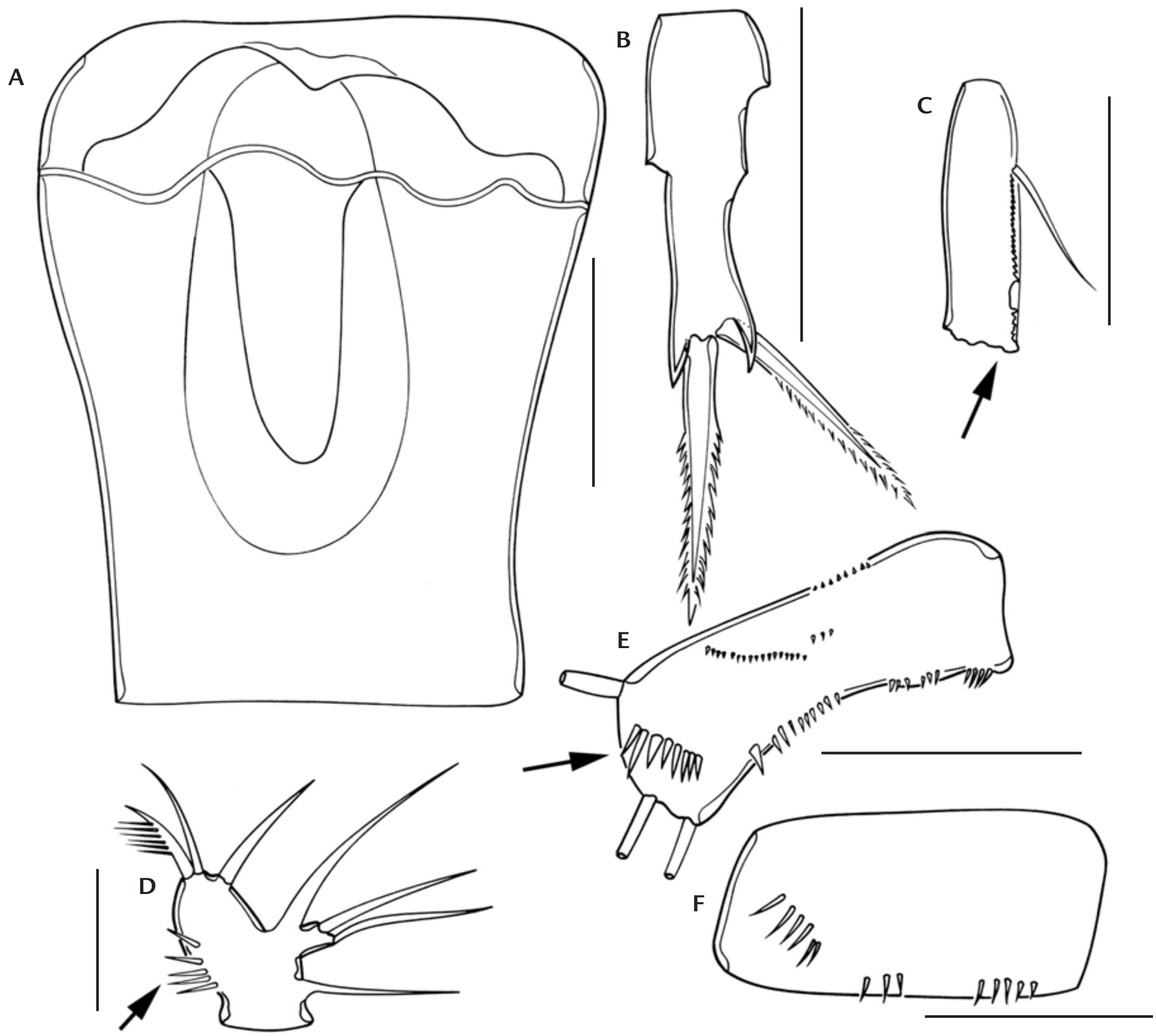


Figure 25. *Mesocyclops ogunnus*, female: (A) genital double-somite; (B) terminal segment P4-endopod; (C) last segment of antennule with finely serrate hyaline membrane and a large subterminal invagination (arrowed); (D) maxillule palp, arrow indicates spinule row; (E) Antenna basis spinule ornamentation (arrowed), anterior view; (F) P4 basis. Scale bars: A, C, D, F = 50 µm, B, E = 100 µm.

Metacyclops mendocinus mendocinus (Wierzejski, 1892)

Fig. 27

Diagnosis. Adult female, 1,150 µm in length excluding caudal setae. The P4 intercoxal sclerite bears a distal patch and irregular rows of spinules; coxa with two outer rows proximally (Fig. 27B); inner apical spine of P4-endopod is 2.3 times the length of the outer one (Fig. 27A). P5 inner terminal spine is 2.5 times shorter than outer terminal one (Fig. 27C). Inner and outer terminal seta of the caudal ramus about the same length; inner middle terminal seta of caudal ramus is less than 2 times the length of the ramus; caudal ramus 5.1 times longer than wide (Fig. 27D). Genital double somite as long as wide; seminal receptacle with short lateral projections, with a wide proximal and tapered distal part (Fig. 27E).

Remarks. The specimen illustrated was collected in the Iguaçu River, in the Foz do Areia reservoir, which receives effluents from a large city. Perbiche-Neves et al. (2014) noted that this species occurs in impacted reservoirs, which was confirmed in this study. This species is widely distributed in reservoirs in the southeast-south regions of Brazil. Reid

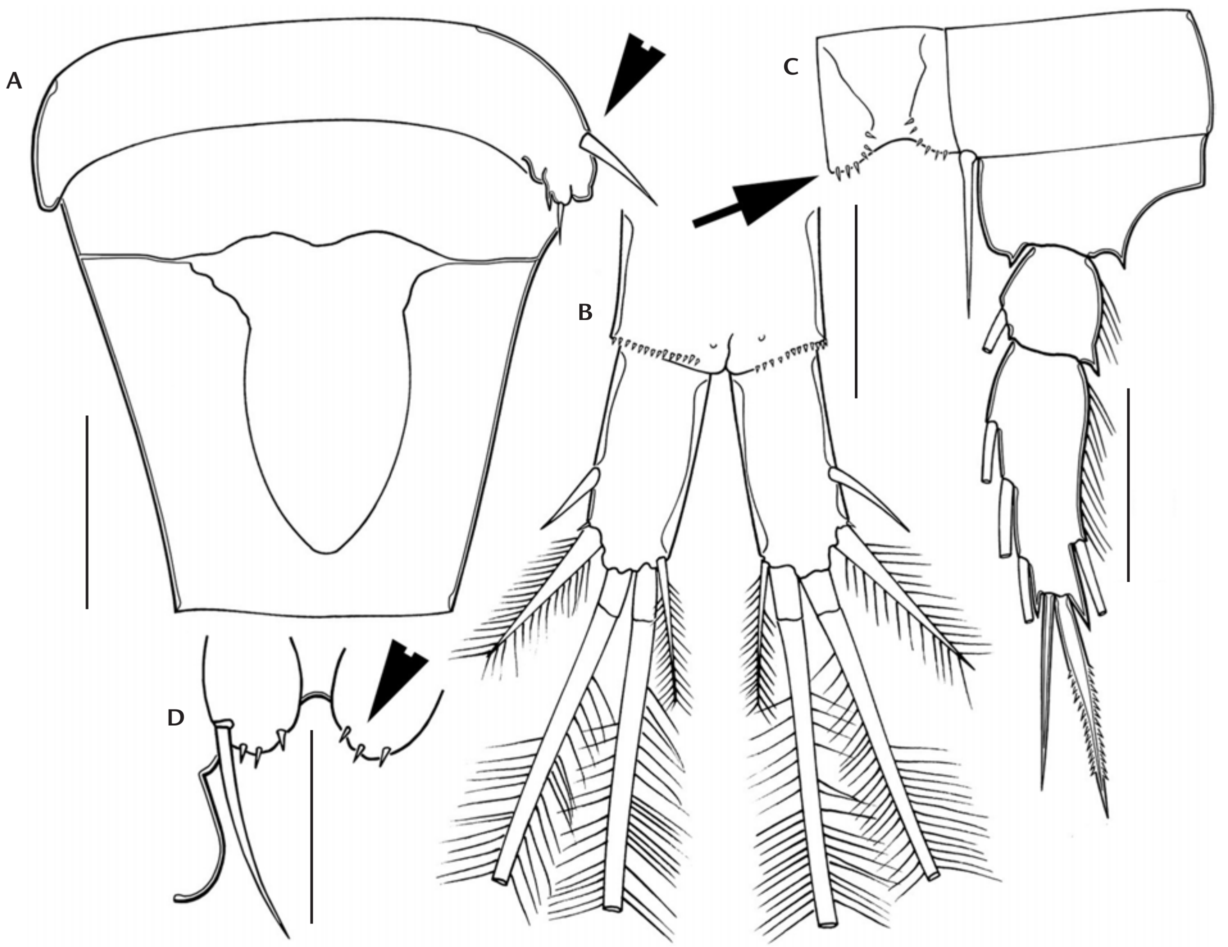


Figure 26. *Metacyclops laticornis*, female: (A) ventral view of prosomite 5 and genital double-somite, arrow indicates P5; (B) ventral view of caudal rami; (C) P4 intercoxal sclerite, coxa, basis and endopod, arrow indicates spinules in intercoxal sclerite; (D) P1 intercoxal sclerite and spinules (arrowed). Scale bars: 50 µm.

(1985) reported its occurrence in some South American countries. It can be easily identified by its 2-segmented P4 and relatively long caudal rami compared to *Metacyclops* and *Microcyclops*.

Microcyclops anceps anceps (Richard, 1897)

Figs 28, 29, 30

Diagnosis. Adult female, 720 µm in length excluding caudal setae (Fig. 28A). The distal margin of the second prosomite bears an ornate scalloped membrane, and the other segments have smooth membrane (Figs 28B, 29B, C). Caudal ramus 3.1 times longer than wide (Figs 28C, 29A). The P1 endopod terminal segment has a pore close to the outer margin in anterior view; P1 endopod terminal spine serrated shape slightly asymmetric compared to *Microcyclops finitimus* and *Microcyclops ceibaensis* (Figs 28D, 30A, B, C). The inner apical spine on the terminal P4 endopod segment 1.4 times longer than the outer spine (Fig. 30D). P5 last segment 2.4 times longer than wide; P5 terminal spine 1.6 times shorter than the width of its segment in the middle portion (Fig. 30E).

Remarks. The specimen was collected in the upper stretch of the Paraguay River. Rocha (1998) provided simple and practical characteristics for the identification of five species of *Microcyclops* that occur in Brazil. *Microcyclops anceps* is widely distributed in South America (Dussart and Frutos 1985, José de Paggi and Paggi 2008). Reid (1985) reported it from Brazil, Argentina, Bolivia, Chile, Ecuador, Paraguay, Peru, Uruguay, Venezuela, Central America, and Mexico and Gutiérrez-Aguirre and Cervantes-Martínez (2016) examined specimens also from Guyana and Guatemala.

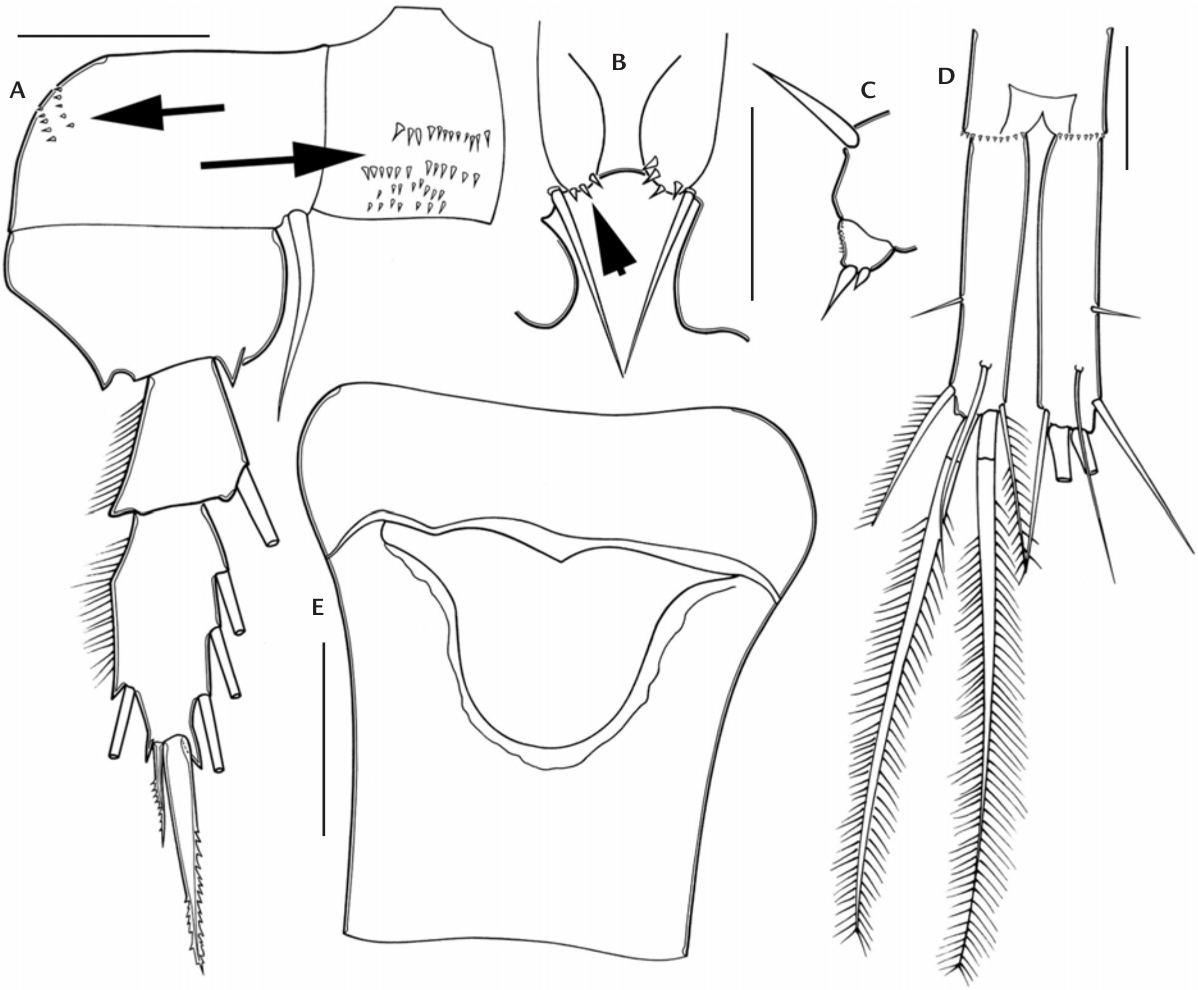


Figure 27. *Metacyclops mendocinus*, female: (A) intercoxal sclerite of P4, coxa, basis and endopod, arrows indicate spinules rows; (B) P1, intercoxal sclerite, arrow indicates spinule ornamentation; (C) P5; (D) dorsal view of caudal ramus; (E) ventral view of genital double-somite. Scale bars: 50 µm.

Microcyclops ceibaensis (Marsh, 1919)

Fig. 31

Diagnosis. Adult female, 870 µm in length excluding caudal setae. Caudal ramus 3.3 times longer than wide (but the literature indicates a variation between 2.8–5 times), 5–6 spinules inserted anteriorly to the distal outer seta (Fig. 31A). Genital double-somite 1.1 times longer than wide. P1-endopod last segment with two pores on the surface, close to the outer margin in anterior view; P1 endopod last segment with a row of long spinules gradually increasing in length in the distal margin, close to the terminal spine, and long spinules gradually increasing in length close to the insertion of the distalmost inner distal seta (Fig. 31B). Dorsal margin of prosomites 2 to 4 slightly serrated; urosomites with serrated hyaline fringes. P4 basis has two transverse series of spinules in anterior view.

Remarks. The specimen illustrated was collected in the lower stretch of the Paraná River. Reid (1985) reported this species in several countries in South America, in the coastal zone of lakes. Reid (1986) reported this species based on the observation of the type material deposited at the National Museum of Natural History, Smithsonian Institution (USA). Among the *Microcyclops* species found in the La Plata Basin, it is the only species with two pores in the last endopod segment of the P1. Gutiérrez-Aguirre and Cervantes-Martínez (2016) advanced *M. diversus* as a synonym of *M. ceibaensis*.

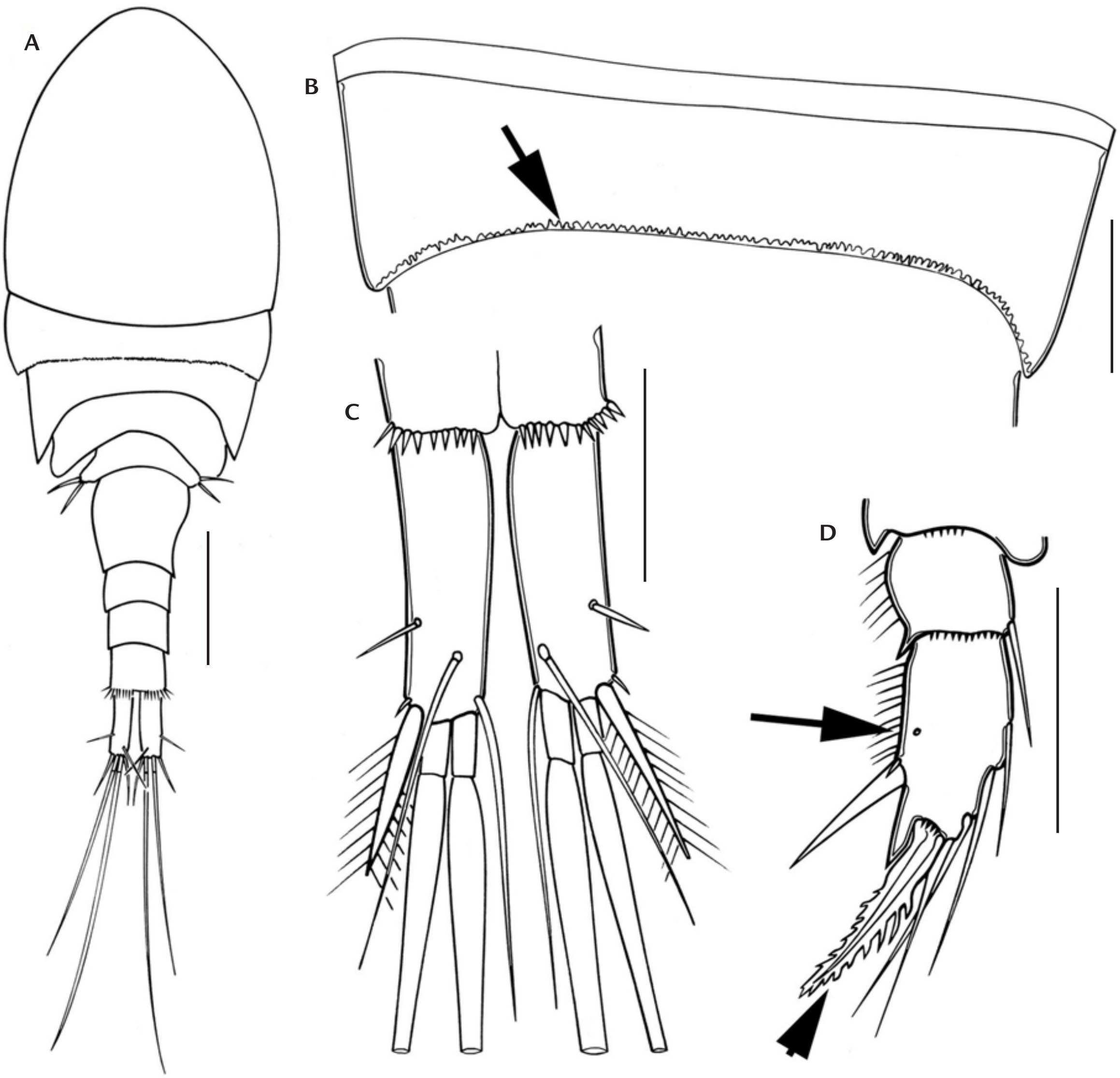


Figure 28. *Microcyclops anceps anceps*, female: (A) dorsal view; (B) detail (arrow) of scalloped ornamentation between second and third prosomites; (C) dorsal view of caudal ramus; (D) P1–endopod, pore on surface and terminal spine ornamentation (arrowed). Scale bars: A = 100 µm; B–D = 50 µm.

Microcyclops finitimus Dussart, 1984

Figs 32, 33

Diagnosis. Adult female, 580 µm in length excluding caudal setae (Figs 32A, 33A). Prosomites 4 and 5 with a finely serrulate membrane on the distal margin and at the corners (Fig. 33B, C), dorsal margin of first to third prosomites smooth. Last P1-endopod segment has a pore on the anterior surface, close to the outer margin, also a row of small spinules on the distal margin; terminal spine 1.2 times longer than the segment (Fig. 32B). Caudal ramus 4 times longer than wide (Fig. 33D).

Remarks. The illustrated specimen was collected in the Tietê River, in the Três Irmãos reservoir. It has a wide distribution in South America, from Venezuela to the upper Paraná River Basin. It is more common near macrophyte banks or in the littoral zone. In the sampling sites it was relatively frequent, along with *M. anceps*. A complementary description of this species was provided by Gutiérrez-Aguirre and Cervantes-Martínez (2016).

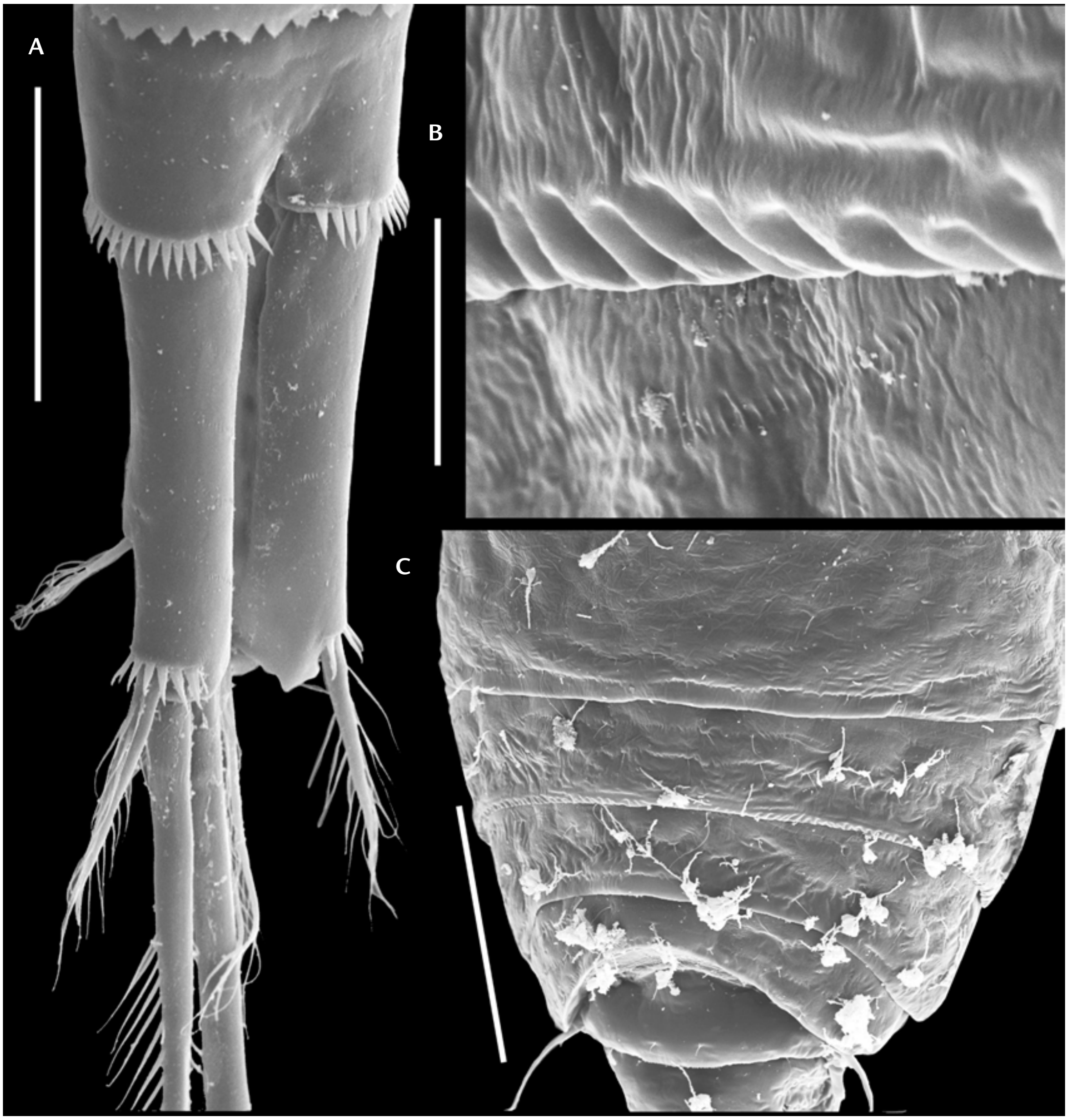


Figure 29. *Microcyclops anceps anceps*, female: (A) caudal rami, ventrolateral view; (B) detail of distal margin of the second prosomite, showing a scalloped membrane; (C) cephalothorax in dorsal view, with an ornate scalloped membrane on the distal margin of prosomite 2. Scale bars: A, C = 100 µm; B = 10 µm.

Microcyclops mediasetosus Dussart & Frutos, 1985

Fig. 34

Diagnosis. Adult female, 1,180 µm in length excluding caudal setae. Caudal ramus 2-2.5 times longer than wide; small spinules at the insertion of the lateral seta and at the insertion of the terminal outer spine (Fig. 34A, D). Last P1-endopod segment has three pores on the surface in anterior view, and large spinules gradually increasing in length close to the insertion of the apical spine (Fig. 34B, C). Prosomites 4 and 5 has very finely serrate membranes. Seminal receptacle divided into two sections, one above and one below the ovigerous ducts; it has lateral projections that slightly taper distally. P5 apical seta 3 times longer than the segment in which it is inserted.

Remarks. The illustrated specimen was found in the lower stretch of the Paraná River, where it is commonly found near the banks of macrophytes. It can be easily identified by the lack of ornamentations on the second prosomites

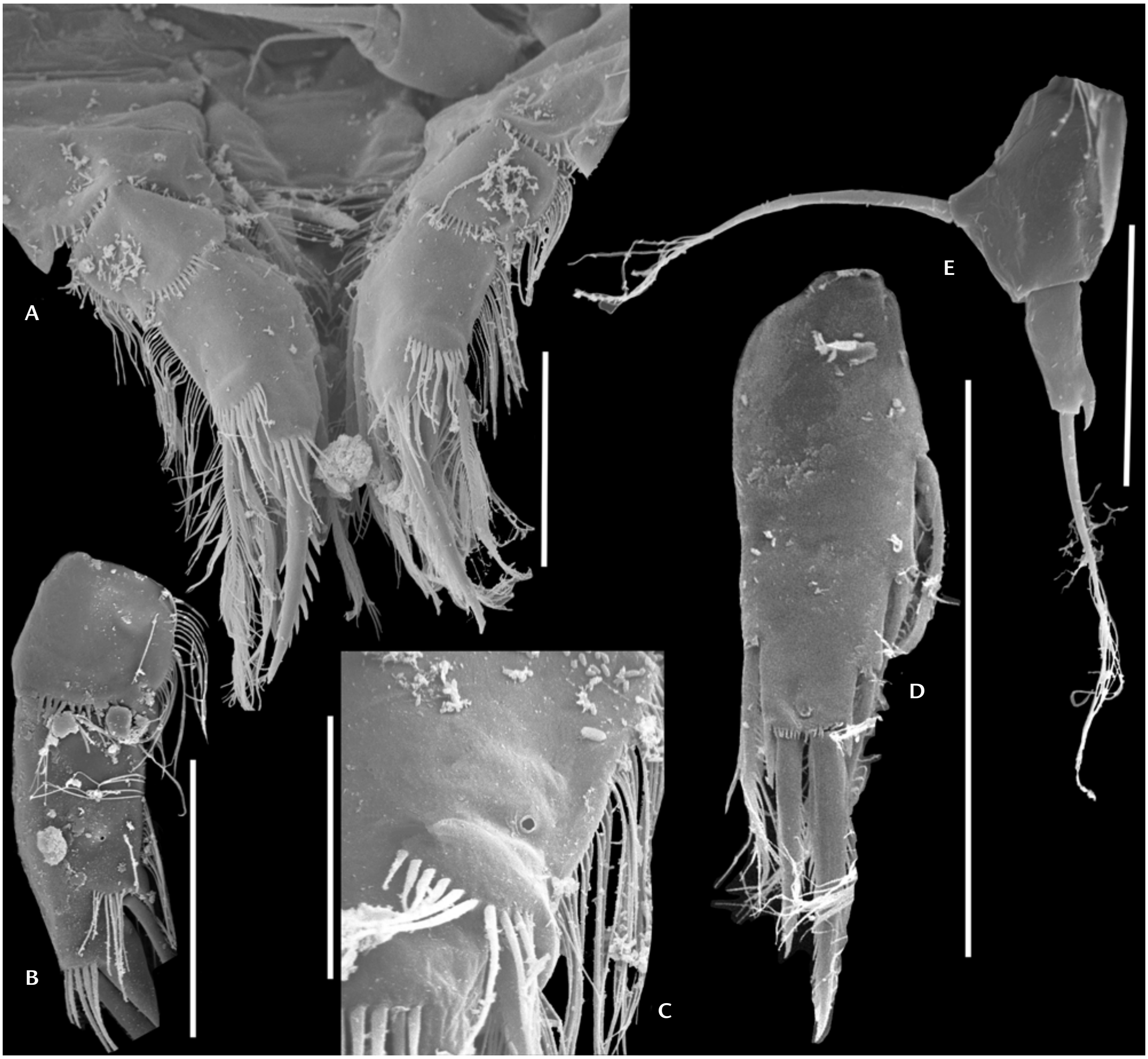


Figure 30. *Microcyclops anceps anceps*, female: (A) P1 endopod segment, anterior view; (B) left P1 endopod, frontolateral view; (C) detail of surface pore on P1 endopod terminal segment; (D) left P4 endopod last segment; (E) right P5, lateral view. Scale bars: A, B, D, E = 50 µm; C = 20 µm.

margins (excluding *M. anceps*) or fouth prosomite plus first urosomite (excluding *M. finitimus*) and the presence of three pores on the last segment of the P1-endopod.

Paracyclops chiltoni (G.M. Thomson, 1883)

Fig. 35

Diagnosis. Adult female, 1,340 µm in length excluding caudal setae. Inner terminal spine of the last P4-endopod segment 3 times longer than the outer terminal spine (Fig. 35A). Caudal rami 3 times longer than wide (Fig. 35B). P5-outer seta 1.3 times longer than the inner spine (Fig. 35C).

Remarks. This species has a wide geographic distribution in the Americas, and may belong to a complex of species. It is frequently found in rivers, littoral zones and among aquatic macrophytes. It can also occur in reservoirs, but seldom in the pelagic zone of storage reservoirs. The genus can

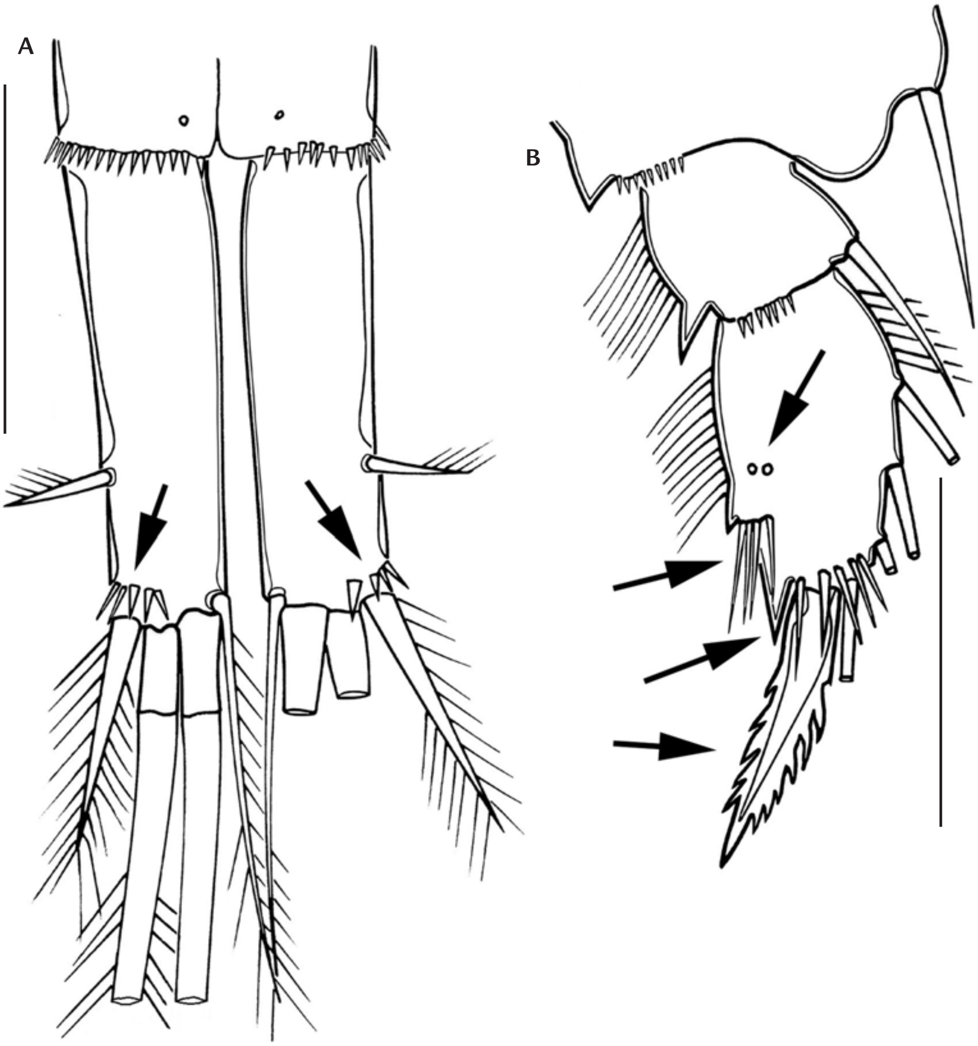


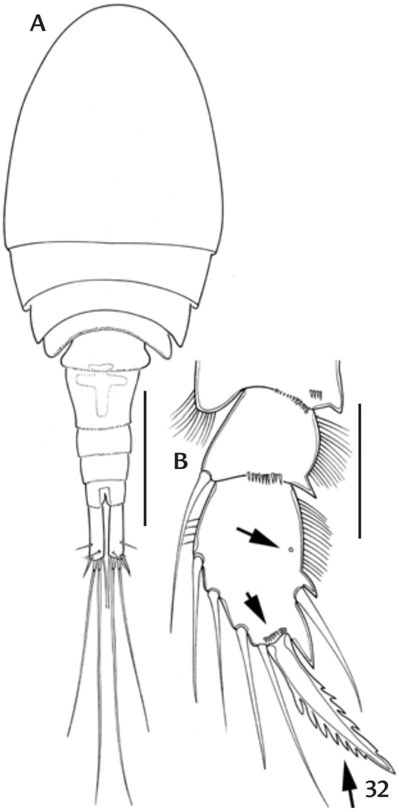
Figure 31. *Microcyclops ceibaensis*, female: (A) ventral view of caudal rami, arrows indicate the spinules close to the insertion of caudal setae; (B) left P1, arrow indicating the pores on the surface of last segment, plus spinules close the terminal spines. Scale bars: 50 µm.

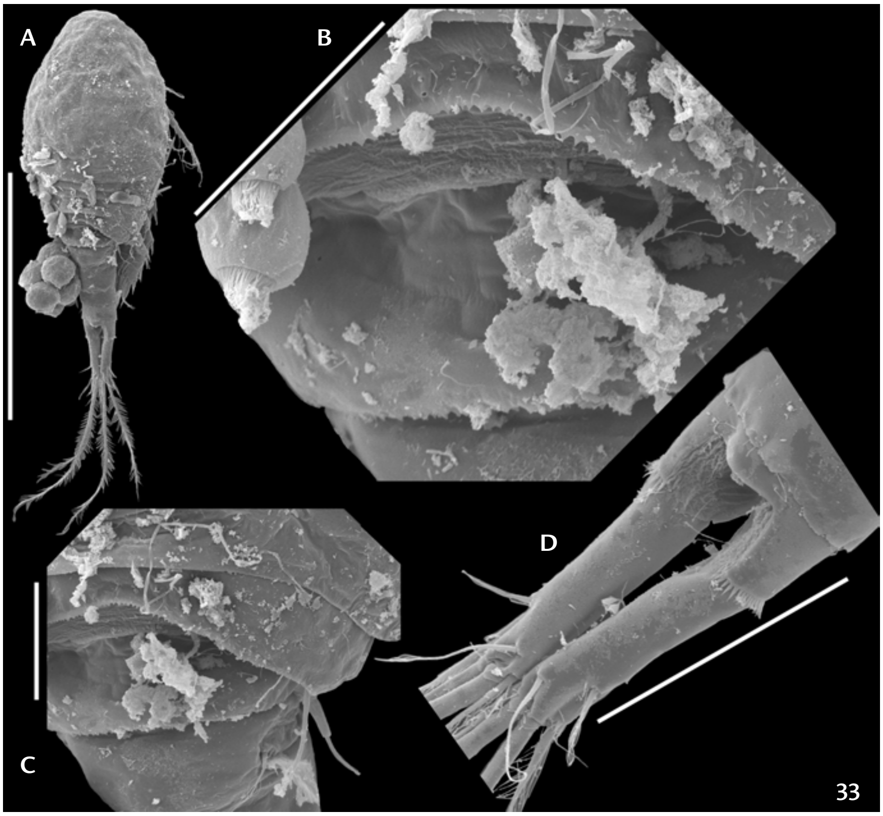
be easily recognized by the single row of transverse spinules proximal to the lateral seta of the caudal ramus, different from *Eucyclops* which generally has spinules along the outer margin, or from *Ectocyclops* which has several small rows transversely and horizontally. Karaytug (1999) published a world revision and key for *Paracyclops*.

Thermocyclops decipiens Kiefer, 1929
Figs 36, 37

Diagnosis. Adult female, 850 µm in length excluding caudal setae (Fig. 36A). Caudal ramus 2.5 times longer than broad; lateral seta inserted in the distal third of the ramus; inner terminal seta is 3 times longer than the outer terminal seta (Fig. 36A). Seminal receptacle with posteriorly curved aliform projections (Fig. 36B). P5 terminal spine is 1.1 times longer than the terminal seta (Figs 36C, 37D). Inner spine of terminal P4-endopod segment is 2.4 times longer than the outer one (Figs 36D, 37A, B). P4 intercoxal sclerite has ornamented spatula-shaped bilaterally symmetrical structures on the distal margin (Figs 36E, 37C). Mandible endopod has two patches of spinules in anterior view, one close to the distal outer margin, and another semicircular patch proximally (Fig. 37E, F).

Remarks. The specimen illustrated was found in the Uruguay River, in the Machadinho Reservoir. It is the most





Figures 32–33. *Microcyclops finitimus*, female. 32: (A) dorsal view of adult female, with detail of the serrated membrane of the distal margin of prosomites 4 and 5 (see also Figure 33B); (B) P1–endopod, pore and ornamentation of terminal spine, indicated by arrows. 33: (A) habitus, dorsal; (B); (C) distal margin of last prosomite and genital double-somite with finely serrulate membranes; (D) caudal rami, dorsal view. Scale bars: Fig. 32: A = 200 µm, B = 50 µm, Fig. 33: A = 500 µm, B, C = 50 µm; D = 100 µm.

widely distributed species of Cyclopoida in reservoirs of the La Plata Basin, occurring in Brazil, Argentina, Paraguay, Uruguay, and other countries of the continent. Several studies report its wide occurrence in Brazil (Silva and Matsumura-Tundisi 2005, Nogueira et al. 2008). It is also present in Asia, Africa, and North America (Reid 1989) and Australia (Mirabdullayev et al. 2003). It is well adapted and often dominant in reservoirs and lakes, associated with increased trophy in some reservoirs (Sendacz and Kubo 1982, Landa et al. 2007, Silva 2011, Perbiche-Neves et al. 2016, 2021). However, it is also present in more oligotrophic locations, in both storage and run-of-river reservoirs (Nogueira et al. 2008). In this study, this species was found in almost all sampled environments, occurring both in reservoirs with oligotrophic characteristics, such as Furnas Reservoir in the Rio Grande, and in eutrophic reservoirs, such as Barra Bonita in the Tietê River Basin and Foz do Areia in the Iguaçu River Basin, where it was the dominant species. These results suggest that the use of this species as a bioindicator must be viewed with caution. In addition, the widespread use of the ratio *Thermocyclops decipiens*/*Thermocyclops minutus* should be critically addressed (Perbiche-Neves et al. 2021). Long-term or laboratory studies could shed some light on this question, with experiments designed to test hypotheses about the ratio of *Thermocyclops decipiens*/*Thermocyclops minutus* in different degrees of trophy. Studies of this nature could also include the other co-occurring species of the genus, *T. inversus*. This species can be distinguished from *T. minutus* and *T. inversus* by the shape of the cephalothorax, which is more fusiform in *Thermocyclops decipiens*, and by the curved caudal setae.

Thermocyclops inversus Kiefer, 1936

Fig. 38

Diagnosis. Adult female, 530 µm in length excluding caudal setae. Lateral arms of genital receptacle are straight

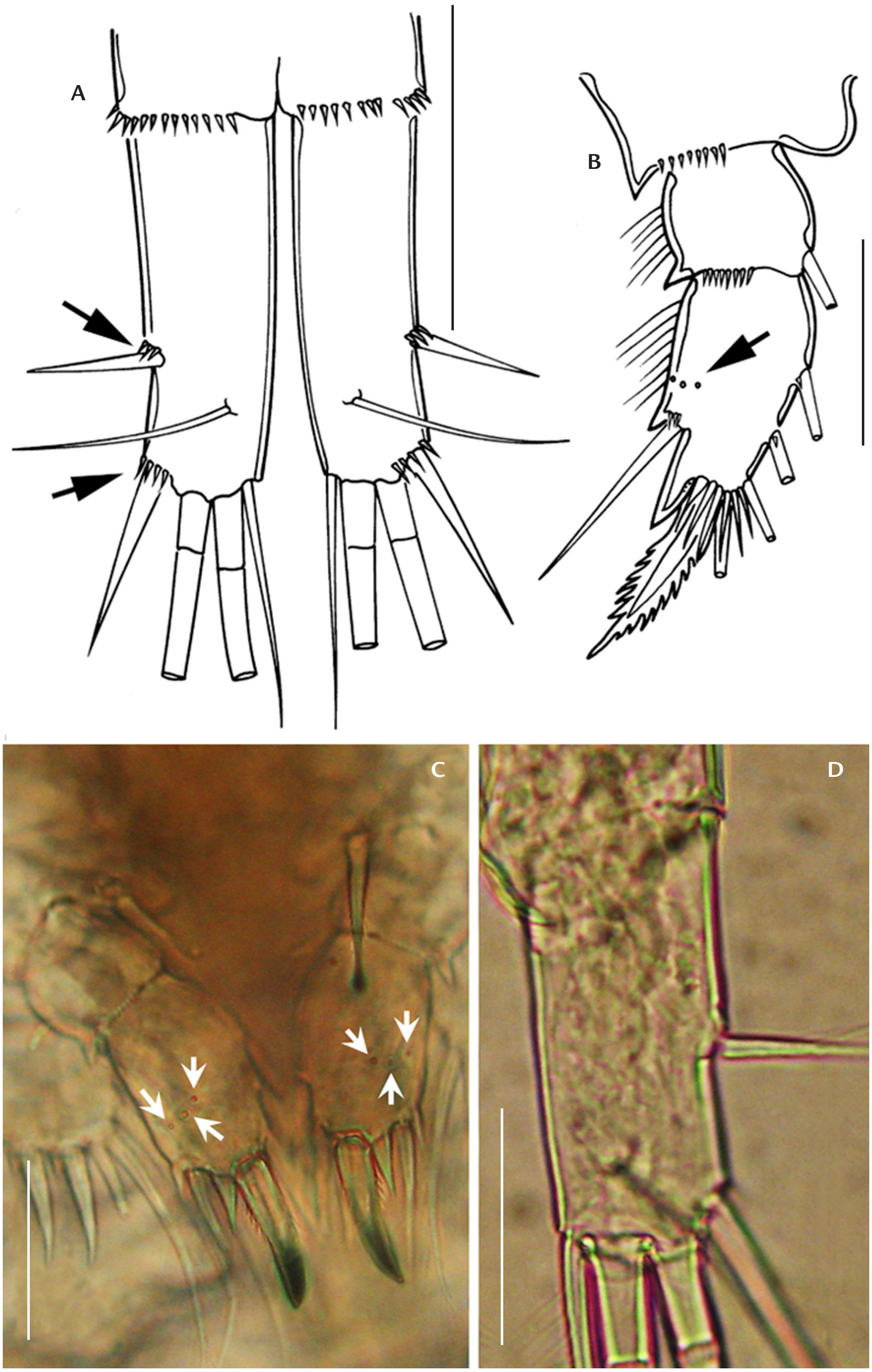


Figure 34. *Microcyclops mediasetosus*, female: (A) caudal rami, arrows indicate lateral seta and the spinules close the insertion of terminal seta; (B) P1-endopod terminal segment, arrow indicates a pore; (C) P1 endopod and three small pores on surface (arrowed) of last segment, anterior view; (D) left caudal ramus, ventral view. Scale bars: A = 50 µm, B–D = 40 µm.

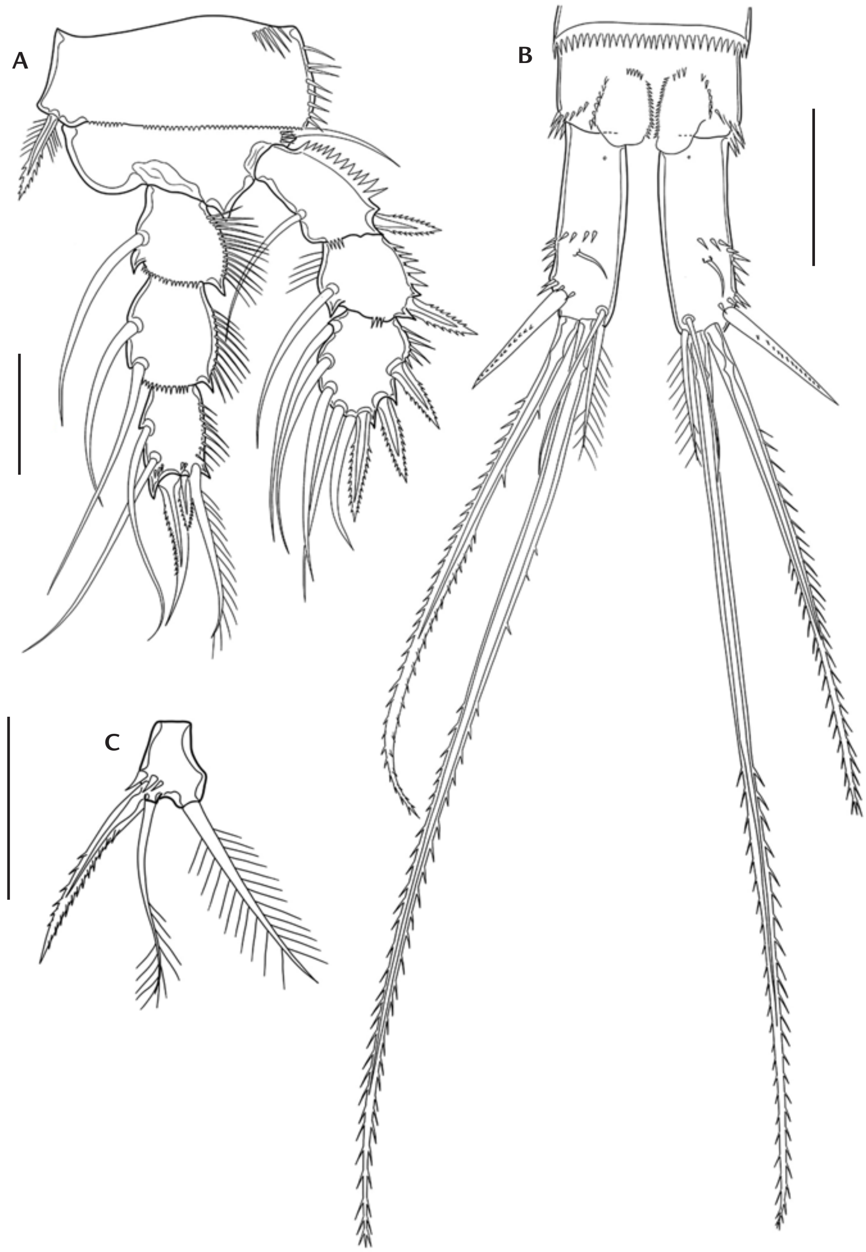


Figure 35. *Paracyclops chiltoni*, female: (A) P4 anterior view; (B) caudal rami and caudal setae; (C) P5. Scale bars: A, C = 50 µm, B = 200 µm.

(Fig. 38A). Seminal receptacle exceeds ¾ the length of the genital double-somite (Fig. 38A). Caudal rami 3 times longer than wide; the two median setae of the caudal ramus are thicker than in the other *Thermocyclops* species (Fig. 38A). P4-endopod last segment terminal spine as long as the segment, and slightly shorter or in the same length than the outer terminal spine (Fig. 38B).

The specimen was found in the upper Paranaíba River, Emborcação Reservoir. The body length of *T. inversus* from different locations shows wide seasonal and spatial variability. This species has been reported in Brazil, Paraguay, and Central America (Reid 1989, Perbiche-Neves et al. 2014) and is considered indicative of mesotrophic conditions by some authors (Silva 2011, Perbiche-Neves et al. 2016, 2021).

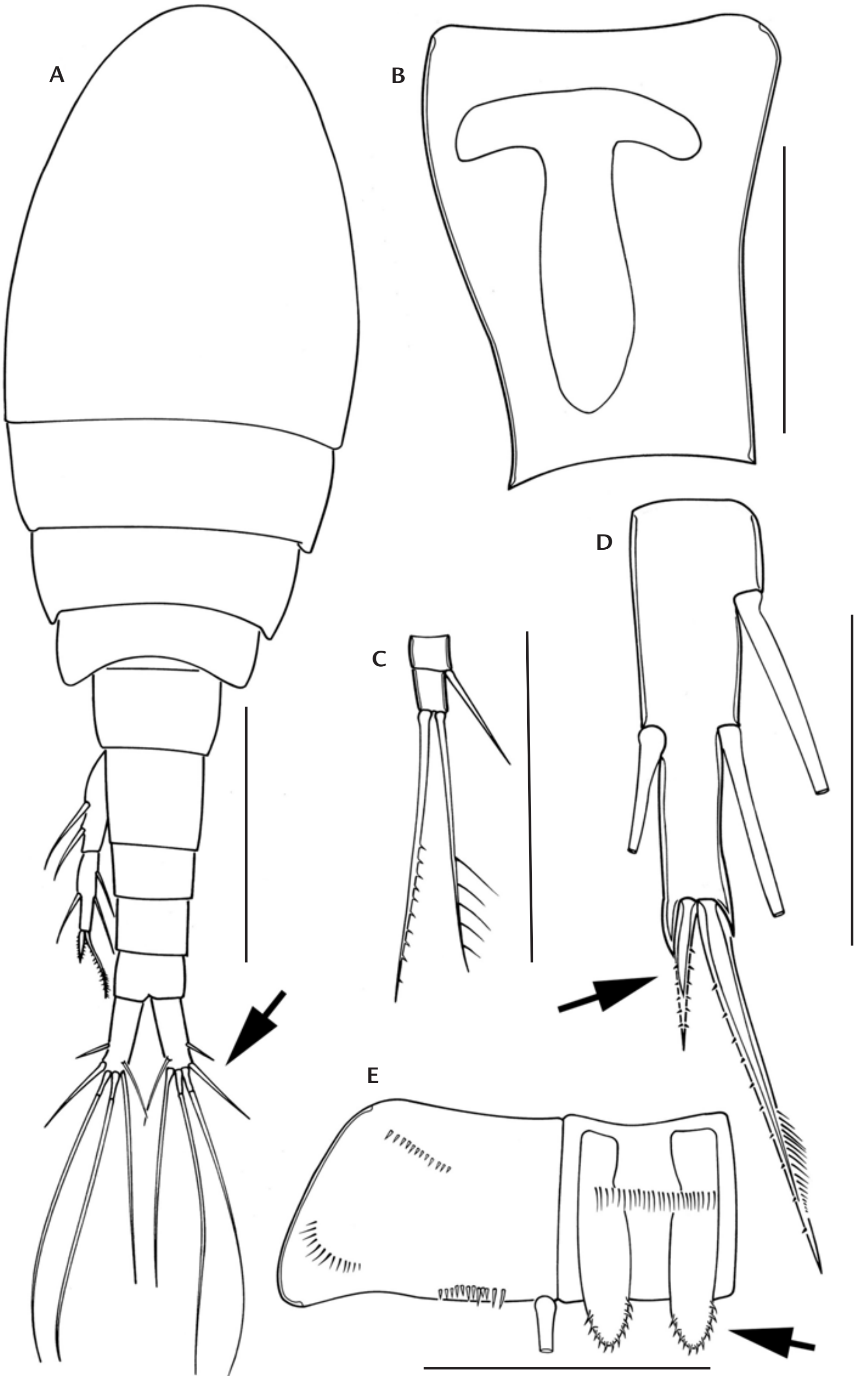


Figure 36. *Thermocyclops decipiens*, female: (A) adult female with detail of caudal rami, arrow indicates the position of caudal setae; (B) ventral view of genital double-somite; (C) P5, arrow indicates the inner terminal spine; (D) terminal segment of P4-endopod; (E) intercoxal sclerite and basis of P4, arrow indicates spinules in the intercoxal sclerite. Scale bars: A = 100 µm, B–D = 50 µm.

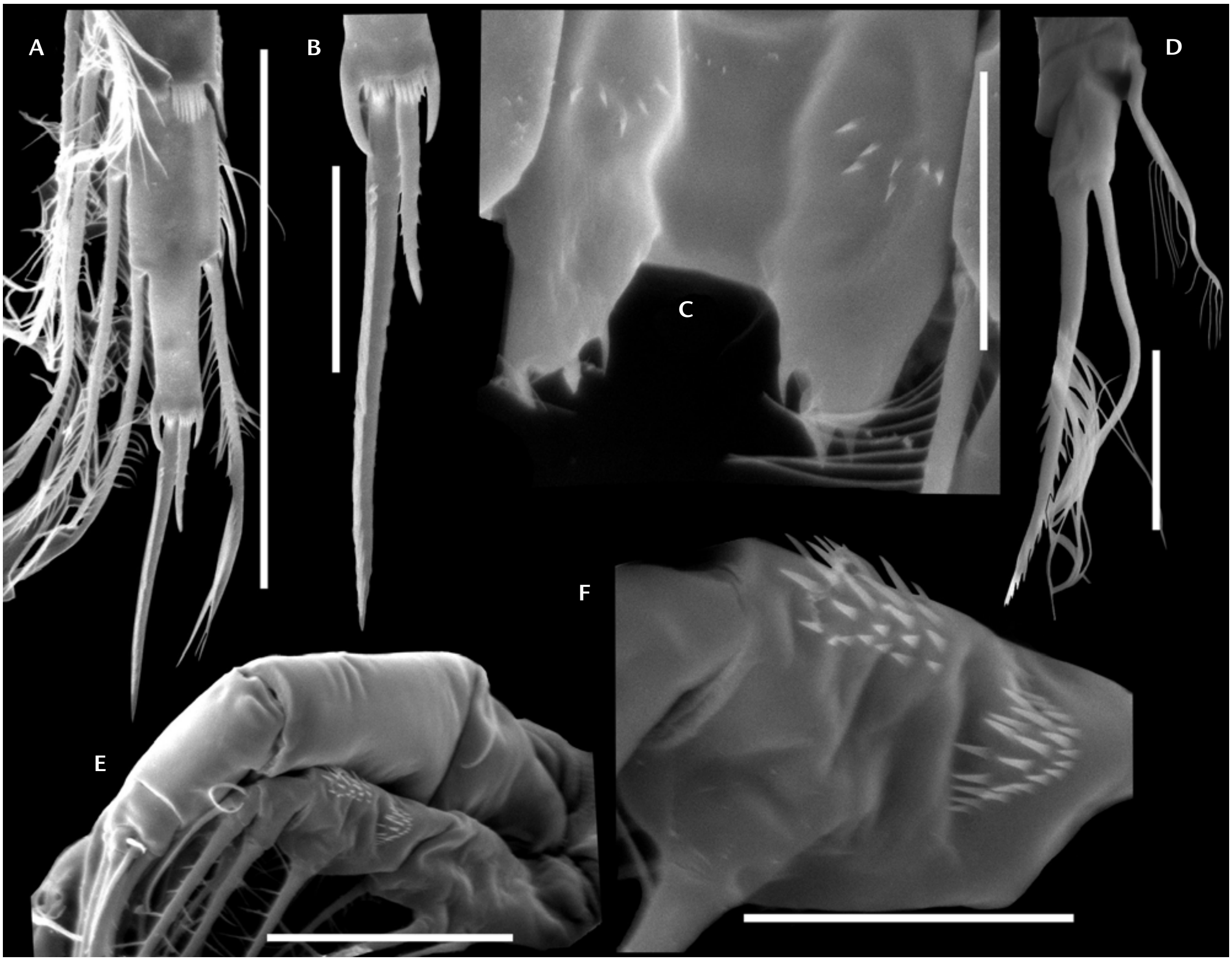


Figure 37. *Thermocyclops decipiens*, female: (A) last segment of P4-endopod; (B) detail of terminal spines of last segment of P4-endopod; (C) intercoxal sclerite, with detail of spinules; (D) P5; (E) right maxilla and the maxilliped; (F) maxilliped basis, showing spinule clusters. Scale bars: A = 100 µm; B, C, D, F = 20 µm; E = 50 µm.

Thermocyclops minutus (Lowndes, 1934)

Fig. 39

Diagnosis. Adult female, 500 µm in length excluding caudal setae (Fig. 39A). Seminal receptacle reaches ¾ of the the genital double—somite length (Fig. 39B). Seminal receptacle lateral arms relatively short, with curveted expansion (Fig. 39B). P5 terminal spine and seta approximately of the same length (Fig. 39C). P4-endopod last segment with sigmoid inner distal spine and longer than the segment, 5 times longer than the outer spine (Fig. 39D). Caudal rami 2.5–2.8 times longer than wide, with a small spine at the base of the lateral seta of the caudal ramus (Fig. 39E).

Remarks. This species is common in Brazilian reservoirs and has been recorded in many studies. It generally predominates in oligo/mesotrophic waters, a trend observed in recent studies (Landa et al. 2007, Silva 2011, Perbiche-Neves et al. 2016). The proportion of this species compared to *T. decipiens* may indicate the trophic status, with a potential high abundance of *T. decipiens* in more trophic waters. However, this must be carefully evaluated since *T. decipiens* can also dominate in oligo/mesotrophic waters. Nevertheless, *T. minutus* is rare in eutrophic waters. This species is small compared to other cyclopoids, and extra care must be taken to avoid confusing it with copepodites of larger species. The curved inner terminal spine and the short outer spine of the third endopodal segment of P4 are useful for the correct identification of this species.

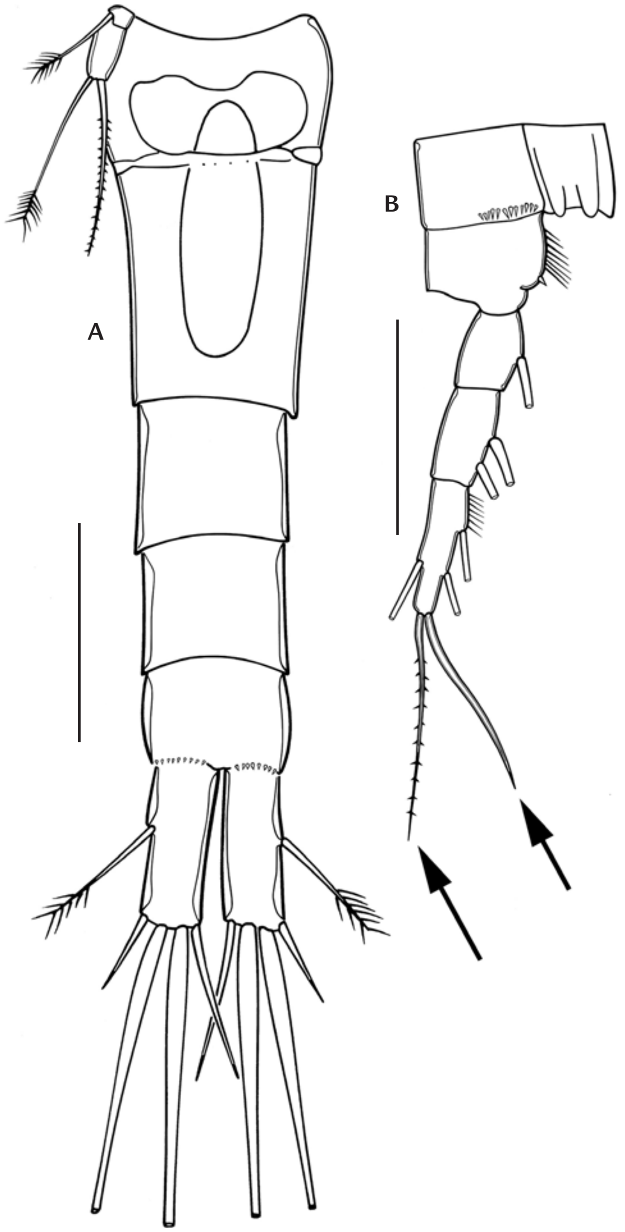


Figure 38. *Thermocyclops inversus*, female: (A) ventral view of urosome, showing P5 and genital double-somite; (B) P4 intercoxal sclerite, coxa, basis and endopod, arrows indicate terminal spines. Scale bars: 50 µm.

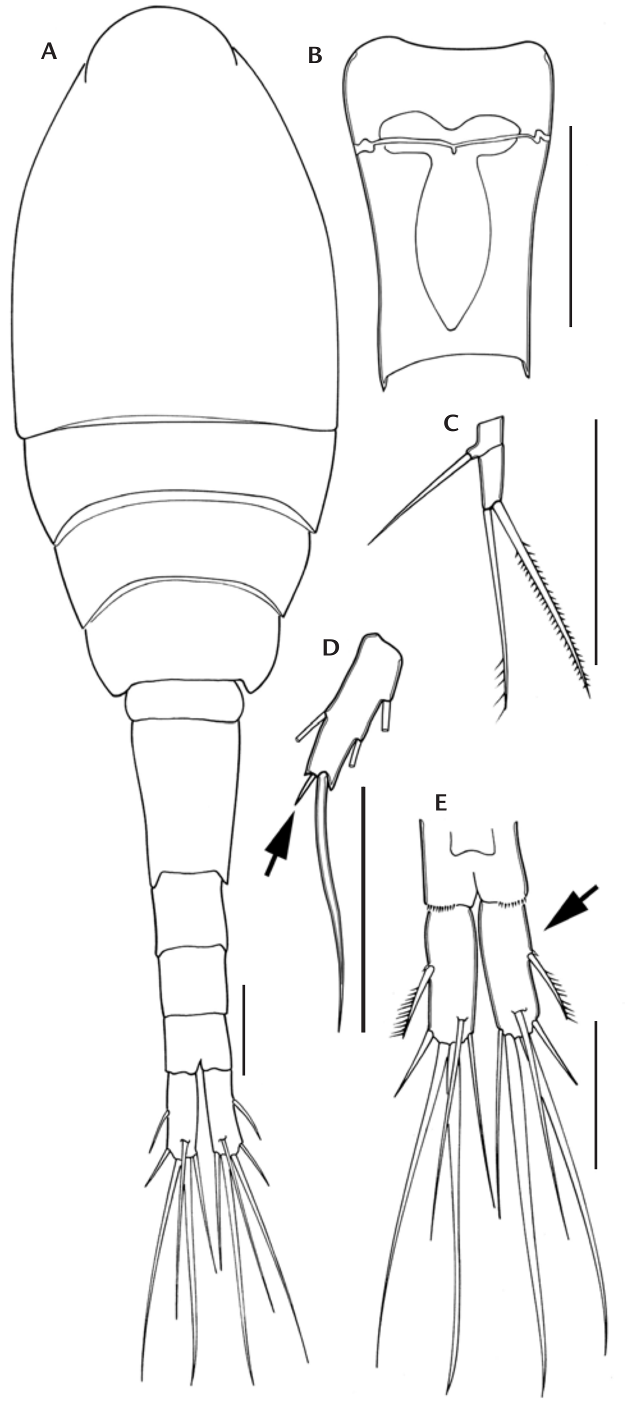


Figure 39. *Thermocyclops minutus*, female: (A) dorsal view; (B) ventral view of genital double somite; (C) P5; (D) terminal segment of the P4-endopod, arrow indicates inner terminal spine; (E) dorsal view of the caudal rami, arrow indicates the insertion position of lateral seta and a small spine at base. Scale bars: 50 µm.

Tropocyclops prasinus meridionalis (Kiefer, 1931)
Fig. 40

Diagnosis. Adult female, 500 µm in length excluding caudal setae (Fig. 40C). Genital double-somite 1.6 times longer than wide; seminal receptacle with two horizontal projections (Fig. 40A). Caudal ramus 1.7–2.1 times longer

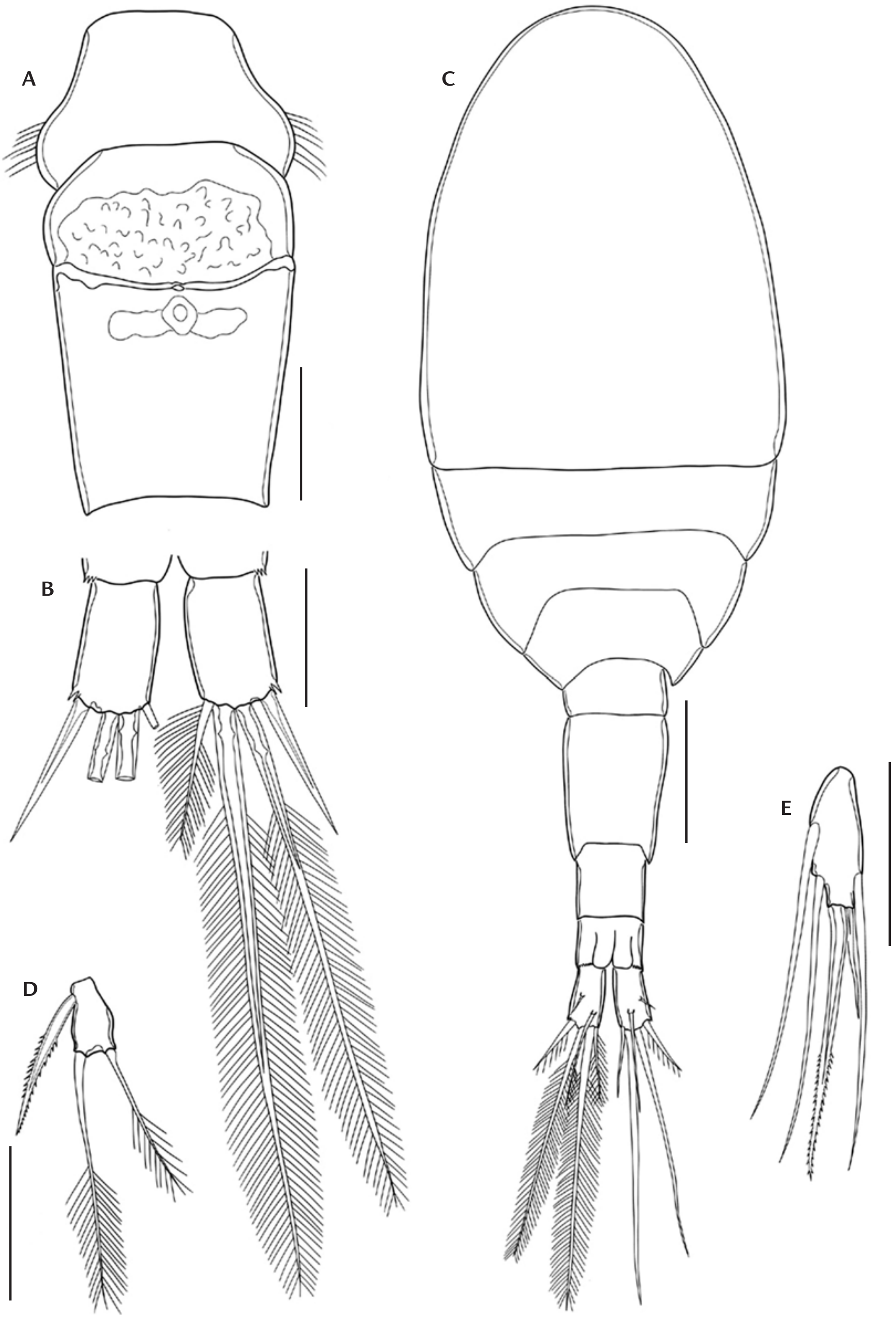


Figure 40. *Tropocyclops prasinus meridionalis*, female: (A) genital double-somite; (B) caudal ramus; (C) habitus, dorsal view; (D) P5; (E) terminal segment of P4 endopod. Scale bars: A, B, D, E = 50 µm, C = 100 µm.

than wide (Fig. 40B). The P5 inner seta and the outer spine has approximately the same length (Fig. 40D). The P4-endopod outer terminal spine is slightly less than half the length of the inner terminal spine (Fig. 40E).

Remarks. This species is common in reservoirs and other lentic environments (pools, ponds, lakes, burrows) of Brazil and Argentina, and occurs in ephemeral environments where few species can survive, such as very warm waters or areas susceptible to freezing, or in ponds rich in humic acids in Amazonia. This species occurs from latitude 3°N in Brazil (Perbiche-Neves unpublished data) to southern Argentina (Menu Marque 2001). It can be dominant in eutrophic reservoirs, if conditions are unfavorable for other species. Due to its small size, it may be mistaken for a copepodite. *Tropocyclops prasinus meridionalis* may co-occur with *T. prasinus prasinus*, but in the latter species, the caudal rami tend to be slightly longer than in *T. prasinus meridionalis*0In addition, there are differences in the terminal outer and inner spine length of the P4-endopod segment, according to Reid (1985). The *T. prasinus* complex requires an urgent worldwide revision.

DISCUSSION

This guide covers a part of all copepod species that exist in the La Plata Basin, but it is highly representative for the region and is a useful tool for the identification of planktonic and littoral cyclopoids. It provides new detailed images, highlighting the most important characters used to distinguish between species and subspecies. Detailed information can be found in some references cited above (Karaytug (1999) for *Paracyclops*, Einsle (1996) for *Eucyclops*, Rocha (1998) for *Microcyclops*, Holyńska et al. (2003) for *Mesocyclops* and Mirabdullayev et al. (2003) for *Thermocyclops*, among others). The studies published by B. Dussart are also important, including many species from several regions that he sampled in the La Plata Basin (e.g., Dussart 1984, Dussart and Frutos 1985, 1986).

Considering our samplings, with two periods in 70% of the basin area, the number of species we found (28 species) is approximately half of the planktonic and littoral species present in Reid's (1985) list for the South American cyclopoids. If we include all the inventoried species from very distinctive environments—estuaries, groundwater, phytotelmata, and bryophyte-associated species, the number of species we found is about 30%.

In similar environments (pelagic and littoral close to macrophytes), including long-term sampling series in particular environments of the La Plata Basin, other authors found between 12 cyclopoid species (all found in our study) in the Upper Paraná River floodplain (Lansac-Tôha et al. 2002) and 23 species in the Middle Paraná River (Paggi and José de Paggi 1990). Silva and Matsumura-Tundisi (2011), analyzing several rivers across the state of São Paulo, Brazil, found 24 cyclopoid species, six of them not found in our study. Reid and Moreno (1990) found 11 cyclopoid species in the Pantanal floodplain region in the Paraguay River Basin in a brief sampling, mostly in baías (ponds). In lakes of the Middle Doce River (Atlantic Southeast drainage), Maia-Barbosa et al. (2014) found 17 cyclopoid species, only one of which did not appear in our study.

The most important structures for morphological identification are the length of spines and ornamentation of the last segment of the endopod of the first and fourth natatory legs, the morphology and armature of the fifth leg, the presence of spinules on the basis of the antenna, the morphology of the hyaline membrane on the last antennule segment or the number of segments or setae on the antennule, the shape of the genital double-somite copulatory ducts, the length and ornamentation of the caudal rami and the positions of their setae, and the micro-ornamentation of spinules, which are distributed in rows or patches on several of these structures mentioned above (Reid 1985, Rocha 1998, Ueda and Reid 2003).

The use of new and complementary imaging technologies provides clear and high-quality illustrations. In addition to SEM, laser confocal microscopy (MCFL) can also offer high-quality images that can reveal important morphological structures that have not yet been studied or in insufficient detail (Mercado-Salas et al. 2018). Finally, besides the important recent references (e.g., Suárez-Morales and Gutiérrez-Aguirre 2020a, 2020b), an update of the key of Reid (1985) for all known South American cyclopoids is necessary. Several genera need deep revisions using integrative taxonomy, especially focusing on cryptic complexes.

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Competing Interests

The authors have declared that no competing interests exist.

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All data generated and/or analyzed are included in this article.

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