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The cyclopoid copepods of a wet campo marsh in central Brazil

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Abstract

Eight species of cyclopoid copepods were recorded from 1979–1983 in the complex microhabitats of a wet campo (campo úmido) marsh in central Brazil. *Ectocyclops herbsti* and *Paracyclops fimbriatus* occurred most often in areas with water covering the soil; *Muscocyclops therasiae* n. sp. occurred mainly in soils with no surface water; while *Metacyclops campestris* n. sp. showed no distinct microhabitat preference. Occurrence of the remaining four species was too sporadic to determine microhabitat preference. *Paracyclops carectum* n. sp., *Metacyclops campestris* n. sp., *Muscocyclops therasiae* n. sp., *Muscocyclops bidentatus* n. sp. and *Ponticyclops boscoi* n. g. n. sp. are described. A key to the New World species of *Metacyclops* s. str. is provided.

Introduction

Wet campo marshes (Portugese "campo úmido de costeira") commonly occur on poorly drained valley slopes in the cerrado (savanna) region of central Brazil. These marshes support a fully developed freshwater meiofaunal community, with nematodes numerically dominant and harpacticoid and cyclopoid copepods also numerous (Reid, 1984). The copepod community may be extremely diverse; 29 species of harpacticoid copepods and four species of cyclopoids were recorded from a wet campo described by Reid (1984). This article integrates the results of all transect and non-transect samples taken within that wet campo from Feb 1979 – Dec 1983 to provide an expanded list of species of cyclopoid copepods and a more detailed assessment of microhabitat preferences of the four most numerous species.

Since most of the cyclopoid copepods are previously unknown, a taxonomic section includes descriptions of all new species, including a new genus, as well as a key to the New World species of *Metacyclops* s. str.

Methods

The wet campo marsh studied is located in the Federal District (altitude 1165 m, Lat. 15°56′40″S, Long. 47°54′20″W), within the ecological reserve of the Fazenda Água Limpa, the research farm of the University of Brasília. It lies along the headwater slopes of the perennial stream Córrego da Onça in the Rio Prata/Paraná drainage basin. It includes a spring (Olho da Água da Onça); varied relief including murundú hummocks; a variety of vegetation such as grasses and sedges, shrubs and burití palms; moist to saturated organic soils, and areas of still or slowly flowing open water which develop complex mats of filamentous algae and decaying vegetation.

These microhabitats are divisible into three main zones (Reid, 1984).

1. Uphill near the cerrado border the organic soil layer is thin and the vegetation is short, sparse and tussocky so that most of the soil surface is insolated. Surface water is usually not present but sometimes occurs in mid- to late rainy season when the water table is highest.
2. Tall grasses and sedges in areas of slightly higher relief in the center of the marsh shade most of the soil surface and cover a thicker organic soil layer, rarely with surface water.
3. Areas of lower relief or near the spring with perennial open water have vegetation of short, widely spaced tussocks, more than 50% areal insolation, and deep organic soil covered by mats of filamentous algae and decaying vegetation.

As surface water may be present in some uphill areas during the rainy season and absent during the dry season, microhabitats may also be divided without regard to location into those with and without surface water. Since other factors such as areal insolation and depth of the soil organic layer are confounded with the presence of surface water, it becomes impractical to attempt to isolate their significance for the organisms.

A total of 94 samples over five years was taken by quantitative corers along a transect (Reid, 1984), as well as by non-quantitative sampling with nets and corers from all areas of the marsh. Sampling dates included Feb, Mar, Aug and Dec 1979; Jan and Aug 1981; Feb, Apr and Jun 1982; and Dec 1983, both in rainy seasons (Oct–May) and dry (Jun–Sep). Earlier samples and about half the later samples were taken from the spring and other areas with water on the surface; therefore areas without surface water are underrepresented in the totals.

Results and Discussion

44 of the 94 samples contained cyclopoid copepods belonging to eight species (Tables 1A, 1B). *Ectocyclops herbsti* nom. nov. Dussart, 1984 (reported as *Ectocyclops* a by Reid, 1984) appeared in 28 samples, frequently in abundance. Also frequent and relatively abundant were *Paracyclops fimbriatus* typ. (Fischer, 1853) and *Muscocyclops therasiae* (reported as *Muscocyclops* a by Reid, 1984), followed by *Metacyclops campestris*. Much rarer were *Eucyclops* sp. (total 3 males and 1 copepodite, not identifiable to species), *Muscocyclops bidentatus* (1 female), *Paracyclops carectum* (1 male) and *Ponticyclops boscoi* (1 female).

The four most common species displayed some differences in preference for the three main habitat zones (Tables 1A and 1B). *P. fimbriatus* is a cosmopolitan and eurytopic species, recorded mainly from the littoral zone of lakes as well as from marshes and subterranean habitats, though Chappuis (1927: 42) cited records from damp moss as well. In the wet campo it occurred mainly in microhabitat type 3 and in other areas only when there was some surface water, i.e. during the rainy season. Apparently its recorded ability to live sometimes in a thin film of water (Gurney, 1933: 127) does not translate into a capacity to invade the moist loams of the wet campo.

E. herbsti has been collected from widely scattered but apparently somewhat analogous habitats in South America. The earliest record is from a *Sphagnum* bog on Ilha Comprida, coast of São Paulo in southeastern Brazil (Herbst, 1959). In Venezuela, Dussart (1984) has reported this species from two ponds as well as a black water peat bog in a "morichal environment". In morichals, a common feature of the plains of the Orinoco Basin, palms of the species *Mauritia minor* grow densely in seepage zones around the headwaters of streams (Hueck, 1972, and G. Pereira, pers. comm.). Most recently, Dussart & Frutos (1985/1986) have reported it from among macrophytes in a shallow pond on an island of the Paraná River in Argentina (pH = 6.9; conductivity = 120 μS · cm^{-1}). In the wet campo *E. herbsti*, like *P. fimbriatus*, occurred significantly more often in wet areas. Two of three samples where it occurred in moist soil were taken in the rainy season, and one in Aug 79 was from the downhill limit of the water-free zone. *E. herbsti* can be characterized, then, as an inhabitant of shallow, neutral to acid waters and very moist organic bog sediments.

In contrast to these more robust (about

Table 1A. Occurrence of eight species of cyclopoid copepods in the wet campo, expressed as number and percent of samples within each of three microhabitat types: 1) short grass/ insolated/ shallow organic soil, sometimes with surface water; 2) long grass/ shaded/ deep organic soil, rarely with surface water; 3) tussocks/ insolated/ deep organic soil with surface water. χ^2 test of variation of occurrence among microhabitats: ** indicates p = < 0.01; * indicates p = < 0.05; NS indicates p = > 0.05.

Species	Microhabitats						
	1. No. Samples (%)		2. No. Samples (%)		3. No. Samples (%)		χ^2, 2 df
Ectocyclops herbsti	1	(16%)	2	(28)	25	(81)	13.31**
Paracyclops fimbriatus	2	(33)	0	(0)	12	(39)	3.95 NS
Muscocyclops therasiae	4	(67)	5	(71)	5	(16)	11.92**
Metacyclops campestris	1	(17)	1	(14)	7	(23)	0.29 NS
Eucyclops sp.	0	(0)	1	(14)	1	(3)	1.94 NS
Muscocyclops bidentatus	0	(0)	0	(0)	1	(3)	0.42 NS
Paracyclops carectum	0	(0)	0	(0)	1	(3)	0.42 NS
Ponticyclops boscoi	0	(0)	0	(0)	1	(3)	0.42 NS
Total no. samples examined	6		7		31		

Table 1B. Occurrence of eight species of cyclopoid copepods in the wet campo, in samples with and without surface water. Adjusted χ^2 test of variation of occurrence between microhabitats: ** indicates p = < 0.01; * indicates p = < 0.05; NS indicates p = > 0.05.

	No surface water No. Samples (%)		Surface water No. Samples (%)		Adjusted χ^2, 1 df
Ectocyclops herbsti	3	(33)	25	(71)	6.28*
Paracyclops fimbriatus	0	(0)	14	(40)	7.28**
Muscocyclops therasiae	6	(66)	8	(22)	4.47*
Metacyclops campestris	1	(11)	8	(22)	1.54 NS
Eucyclops sp.	1	(11)	1	(3)	0.02 NS
Muscocyclops bidentatus	0	(0)	1	(3)	4.06*
Paracyclops carectum	0	(0)	1	(3)	4.06*
Ponticyclops boscoi	0	(0)	1	(3)	4.06*
Total no. samples examined	9		35		

0.8–1.0 mm) forms, the tiny (about 0.3 mm) *Muscocyclops therasiae* signficantly preferred moist campo soils with no surface water. The only previously known congener, *M. operculatus* is known from damp moss in Surinam (Chappuis, 1917) and from bromeliads in Pernambuco, northeastern Brazil (Kiefer, 1935b). However, the single finding of the third congener, *M. bidentatus* in the campo was from an area with water over the surface.

The optimum habitats of species of *Muscocyclops* and of the closely related genus *Bryocyclops* might be moist organic soils and leaf mold, as first suggested by Bjornberg (1985). She described *B. caroli*, the only member of its genus known from South America, from humid leaf mold in São Paulo, where it occurred in great abundance. She pointed out that almost all other species of *Bryocyclops* have been collected in much fewer numbers from possibly marginal muscicolous, bromelicolous, interstitial and cavernicolous habitats. Certainly very few specimens of *M. operculatus* have been collected from mosses and bromeliads (Kiefer, 1935b), so collecting efforts in moist organic soils and leaf mold might be productive of these as well as other semiterrestrial cyclopoid and harpacticoid copepods, which are frequently numerous in such habitats (Reid, 1986).

In the wet campo *Metacyclops campestris* oc-

curred slightly (but not significantly) more often in wetter areas. It is morphologically very similar to *M. paludicola* (Herbst, 1959), known from a *Sphagnum* bog on Ilha Comprida, São Paulo, Brazil.

A single individual of *Paracyclops carectum* was collected from among filamentous algae in running water downhill from the spring. Several individuals were also collected from moist soil and among decaying vegetation at the margin of a small pond in a "vereda" (perennially inundated flatland) marsh in the Federal District (see below). This is a very rare species in the Federal District, where *P. fimbriatus* is commonly encountered in all types of aquatic habitats (unpublished data). The single individual of *Ponticyclops boscoi* was also collected from algal mats in running water below the spring.

The wet campo seems to provide a multiplicity of microhabitats, from perennial rivulets to moist soils, which favor the survival of several cyclopoid copepod species even in the absence of areas of open water deeper than 2–3 cm. The four species which occurred in several microhabitats during both rainy and dry seasons can be considered typical inhabitants of the campo, though of these only *M. therasiae* appeared to succeed in uphill moist loams lacking surface water. The remaining four species should be considered accidentals, and their preferred habitats sought elsewhere.

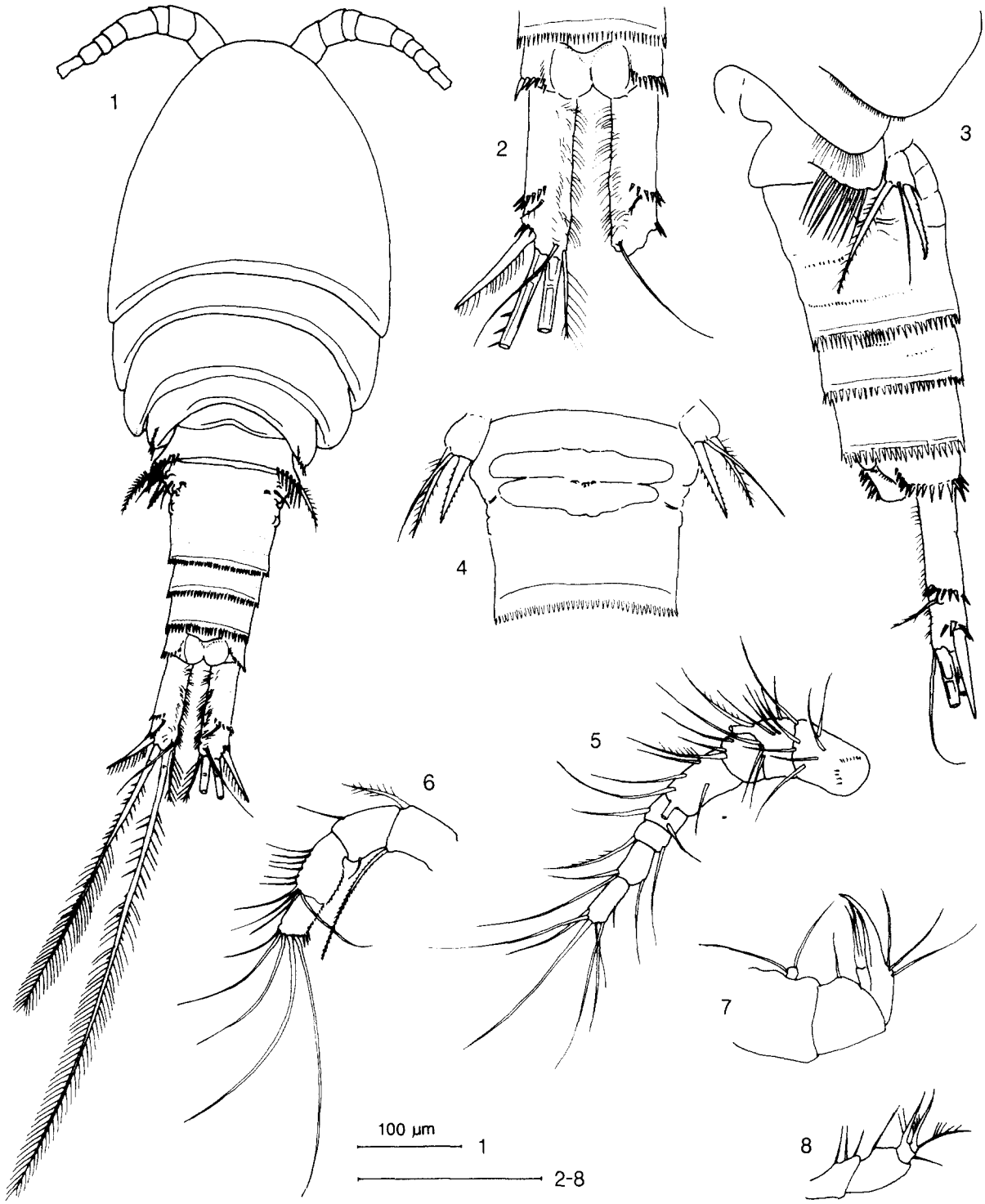
The previously unknown species are described below. All specimens were collected by the author unless otherwise noted.

Paracyclops carectum, *new species*

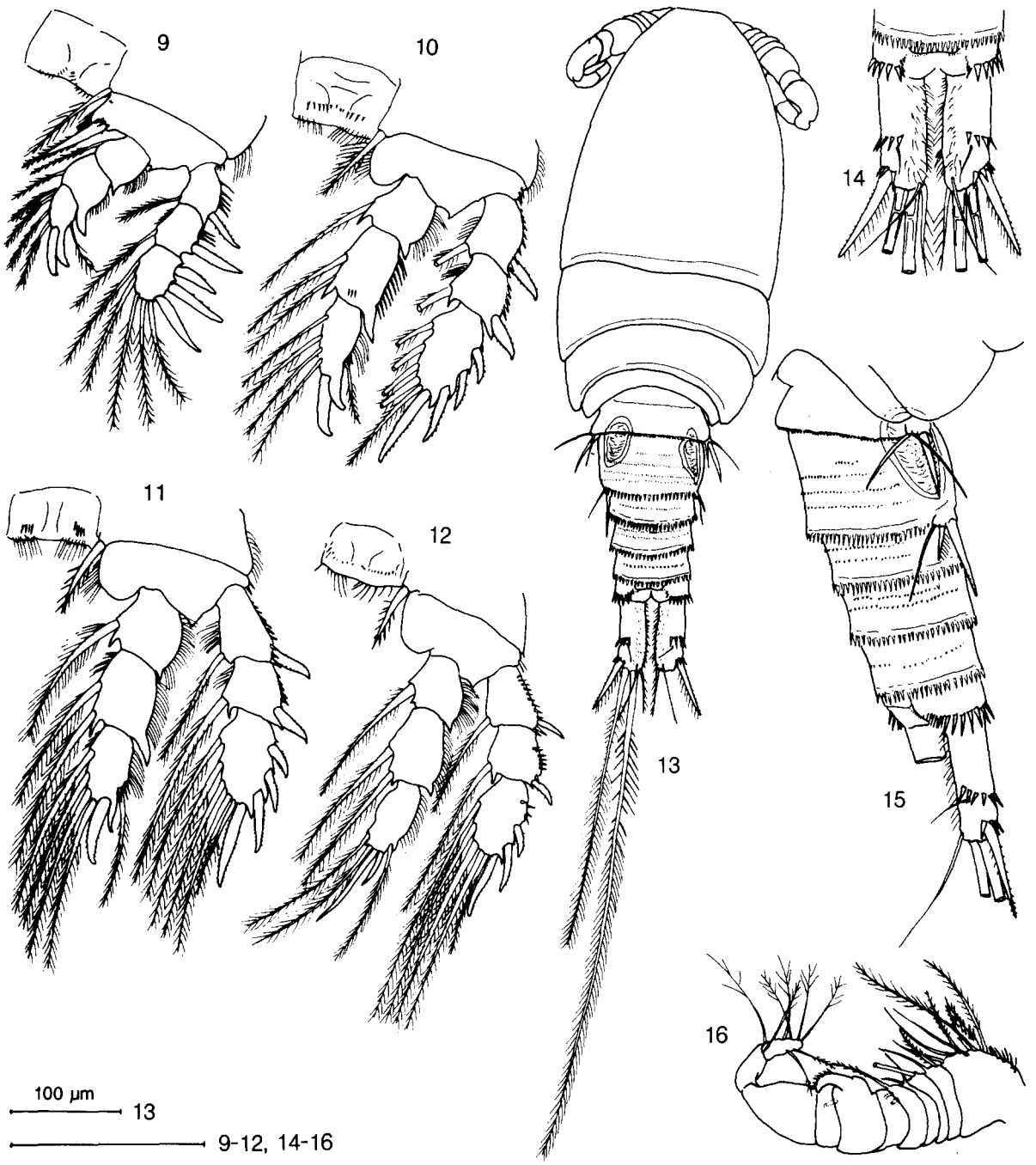
Material examined. Holotype: 1 ♀, dissected on 1 slide, Museum of Zoology of the University of São Paulo – MZUSP 8138, collected 1 May 1982 from moist ground near Vereda Grande Pond, Águas Emendadas Biological Reserve, Federal District, Brazil, 15°32′30″S, 47°34′57″W; sample no. 201. Allotype: 1 ♂, dissected on 1 slide, MZUSP 8139, collected 1 May 1982 from same locality. Paratypes: 5 ♀ and 1 ♂, MZUSP 8140, collected 1 May 1982 from algae and decaying vegetation near shore of Vereda Grande Pond. 4 ♀, National Museum of Natural History – USNM 232176, collected 1 May 1982 from shore of Vereda Grande Pond. 1 ♂, USNM 232175, collected 19 Apr 1982 from algal mats in rivulet downhill from spring Olho da Água da Onça in wet campo marsh, Fazenda Água Limpa, Federal District, Brazil. All undissected specimens are alcohol-preserved.

Female. Length of holotype excluding caudal setae 750 μm; lengths of 9 paratypes 600–800 μm (median length 650 μm). Prosome (Fig. 1) dorsoventrally depressed, posterior margins of all prosomites with smooth hyaline membranes; posterolateral margins of last 3 prosomites with hairs or long spinules (Fig. 3). Posterior margins of urosomites with toothed hyaline membranes, otherwise ornamented with few rows of fine spinules; posterior margin of anal somite with strong spinules (Figs. 1–3). Genital segment (Fig. 4) slightly expanded anteriorly, broader than long, with lateral tubercles at midlength; shape of seminal receptacle normal for genus. Caudal rami (Figs. 2, 3) 85 × 27 μm, thus 3.1 × longer than broad, parallel, separated at base by slightly less than breadth of ramus; with groups of coarse hairs along entire inner surfaces and extending somewhat dorsally; and dorsoventral row of strong spinules anterior to lateral seta. Lateral seta inserted almost at dorsal midline of ramus; length of seta 30 μm, thus 1.2 × longer than width of ramus. Dorsal seta smooth, length 70 μm. Lengths of inner to outer apical setae 48, 430, 280 and 55 μm respectively. Median apical setae heteronomous, coarsely plumed proximally and finely plumed distally, with short spinules interspersed with longer setules along middle third (Fig. 1).

Antennule (Fig. 5) of 8 articles. Antenna (Fig. 6) of 4 articles, basipods 1 and 2 each with 2 setae. Maxilla and maxilliped as in Figs. 7 and 8; mandible and maxillula not examined. Swimming legs 1–4 (Figs. 9–12) with rami of 3 articles and spine formula 3, 4, 4, 3. Terminal article of endopod of leg 4, 35 μm long by 21 μm broad, thus 1.8 × longer than broad; inner apical spine 47 μm, thus 2.3 × longer than outer spine (21 μm). Armament of basal lamellae complex: leg 1, each side with crescentic row of fine hairs; leg 2, anterior surface



Figs. 1–8. Paracyclops carectum, new species, female: 1, habitus,; 2, caudal rami, dorsal; 3, urosome, lateral; 4, genital segment, ventral; 5, antennule; 6, antenna; 7, maxilla; 8, maxilliped.



Figs. 9–12. Paracyclops carectum, new species, female: 9, leg 1; 10, leg 2; 11, leg 3; 12, leg 4. Figs. 13–16, *P. carectum*, male: 13, habitus; 14, caudal rami, dorsal; 15, urosome, lateral; 16, antennule.

with transverse row of spinules, each side of distal margin with row of fine hairs and 1 or 2 tiny spinules; leg 3, anterior surface with 2 transverse rows of spinules, distal margin with row of fine hairs and 3–4 tiny spinules on each side; leg 4 with row of spinules on each side and coarse hairs on distal margin.

Medial spine of leg 5 (Figs. 3, 4) reaching mid-length of genital segment. Lengths of medial to lateral spines and seta of leg 5, 39, 50 and 72 µm respectively. Leg 6 (Fig. 1) reduced to 1 seta.

Male. Length of allotype excluding caudal setae 580 μm; lengths of paratypes 550 and 600 μm. Prosome dorsoventrally depressed, slightly longer than urosome (Figs. 13–15); somites ornamented as in female except posterolateral margins of last 3 prosomites smooth, and urosomites with more rows of fine spinules. Caudal rami 2.3 × longer than broad, less well separated at base but armed much as in female. Antennules (Fig. 16) geniculate. Mouthparts and swimming legs similar to female. Leg 5 (Fig. 15) with relative lengths of spine and setae as in female; lengths of ventral to dorsal spine and setae of leg 6, 40, 16 and 38 μm respectively. Middle seta of leg 6 spiniform, unusually short and stout.

Etymology. Named for the habitat, "carectum", L., "a place where sedges grow". Proposed as a noun in apposition.

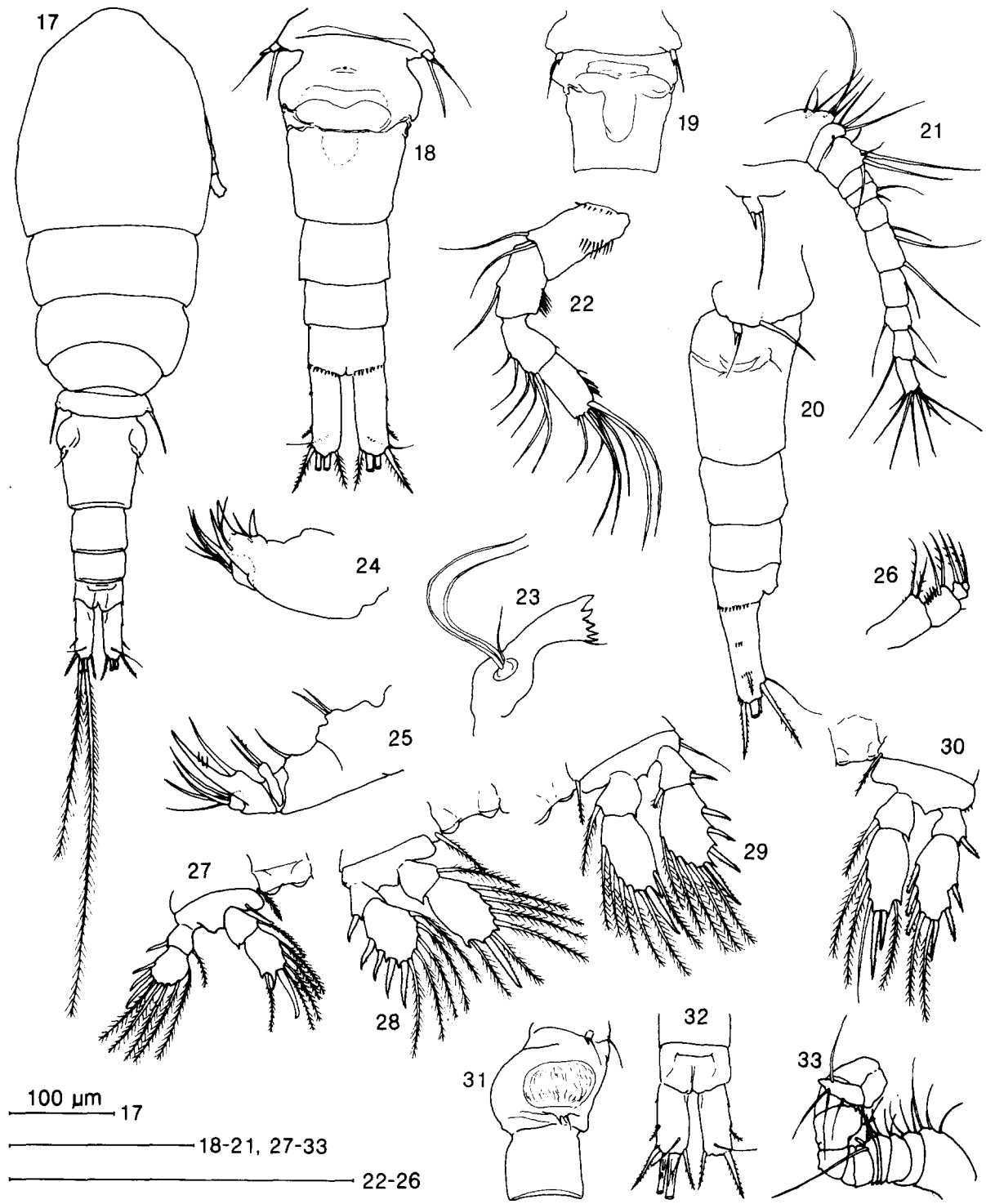
Remarks. Paracyclops carectum is at once distinguished from congeners by the thickly haired caudal rami. Among South American species it is intermediate in the proportions and distance between bases of the caudal rami between *P. andinus* Kiefer (1957) and *P. pilosus* Dussart (1984), which have short (2.4 and 2.9 × longer than broad) and closely set rami, and the several subspecies of *P. fimbriatus* (*P. fimbriatus* s. str., *P. fimbriatus poppei* (Rehberg, 1880), *P. fimbriatus andinus* Lindberg (1957) and *P. fimbriatus chiltoni* (Thomson, 1882)), all of which have caudal rami both longer (3–4.6 ×) than broad and more or less widely separated from each other at the base (Lindberg, 1958; Reid, 1985). Details of the armament of the basal lamellae of the swimming legs and of leg 6 of the male also distinguish *P. carectum* from its South American relatives, as far as their morphologyi s known.

Metacyclops campestris, *new species*

Material examined. Holotype: 1 ♀, MZUSP 8141, collected 9 Mar 1979, sample 63, from wet campo marsh on Fazenda Água Limpa, Federal District, Brazil. Allotype: 1 ♂, MZUSP 8142, collected 9 Mar 1979, sample 63. Paratypes from same locality: 2 copepodites, MZUSP 8143, collected 21 Feb 1979, sample 50. 1 copepodite, MZUSP 8144, collected 9 Mar 1979, sample 63. 2 copepodites, MZUSP 8145, collected 23 Aug 1979, sample series 75. 4 ♀ and 1 ♂, MZUSP 8146, collected 15 May 1982 by Mário Diniz de Araújo Neto, sample 225. 1 copepodite, USNM 232169, collected 19 Dec 1979, sample 81. 1 ♀, dissected on 1 slide, USNM 232170, collected 19 Apr 1982, sample 189. 1 ♀ and 1 copepodite, USNM 232171, collected 19 Apr 1982, sample 190. 1 ♀ and 5 copepodites, USNM 232172; 2 ♂ on slides, 1 dissected and 1 mounted whole, USNM 232173, all collected 3 Feb 1982, sample 215. 3 copepodites, USNM 232174, collected 5 Dec 1983, sample 219. All undissected specimens are alcohol-preserved.

Female. Length of holotype excluding caudal setae 400 μm; lengths of 5 paratypes 330–600 μm (median length 570 μm). Description is a composite from several specimens. Genital segment about as broad as long, broadest at anterior third and tapering posteriorly except for slight broadening or tubercle at posterior third (Figs. 17–19). Shape of seminal receptacle variable, length of posterior expansion about equal to or twice width of anterior expansion (Figs. 18, 19). Anal operculum weakly concave; caudal rami 2.75–2.95 × longer than broad, with lateral group of 3 spinules at anterior third and lateral seta inserted at posterior third (Figs. 17, 18, 20). Dorsal seta 3.5–5 × length of lateral seta; ratios of lengths of inner to outer apical setae 1 : 11 : 6.1 : 1.1.

Antennule (Fig. 21) of 11 articles, shorter than cephalosome, no hyaline lamella distinguishable on terminal articles. Antenna (Fig. 22) with 1 seta and 1 row of spinules on each side of basipod 1; basipod 2 with 1 seta and 1 row of spinules. Mandible, maxillula, maxilla and maxilliped as in Figs. 23–26. Swimming legs (Figs. 27–30) with rami of 2 articles; spine formula 3, 4, 4, 3. Terminal article of endopod of leg 4 1.5 × longer than broad; inner apical spine 1.7 × longer than outer apical spine. Basal lamellae of swimming legs with rounded margins, lacking ornamentation. Apical spine of



Figs. 17–30. Metacyclops campestris, new species, female: 17, habitus; 18, urosome, ventral; 19, genital segment of a second female; 20, urosome of a third female, lateral; 21, antennule; 22, antenna; 23, mandible; 24, maxillula; 25, maxilla; 26, maxilliped; 27, leg 1; 28, leg 2; 29, leg 3; 30, leg 4. Figs. 31–33, *M. campestris*, male: 31, genital and succeeding somite, lateral; 32, caudal rami, dorsal; 33, antennule.

leg 5 (Fig. 20) slightly longer than free article; apical seta smooth, about 5 × length of spine. Stout, smooth seta inserted dorsal to free article of leg 5. Leg 6 reduced to fine seta.

Male. Length of allotype 450 μm; lengths of 3 paratypes 320, 380 and 420 μm. Leg 5 (Fig. 31) as in female; leg 6 with ventral spine stout and dorsalmost seta about twice length of median seta. Caudal rami (Fig. 32) slightly stouter than those of female, about 2.75 × longer than broad.
Antennules (Fig. 33) geniculate, apparently of 14 articles.

Etymology. From "campestris", L. "of fields", after the Brazilian designation of the habitat.

Remarks. Microcyclops paludicola Herbst (1959), correctly assigned to *Metacyclops* by Pleşa (1981: 28), resembles *M. campestris* very closely. The seminal receptacle of *M. campestris* is less broadened and divided anteriorly, and the expansion or tubercle at the posterior third of the genital segment of the female less pronounced. Other differences are shown in Table 2. *M. paludicola dentatus* Pleşa (1981) lacks lateral tubercles on the genital segment of the female, and possesses 2 large teeth on the basal lamellae of the swimming legs in both sexes. I consider that these characters justify elevation of *M. dentatus* to species rank.

Pleşa (1981) united *Apocyclops* Lindberg, 1961, *Psammophilocyclops* Fryer, 1956 and *Metacyclops* Kiefer, 1929a, b as subgenera under the genus *Metacyclops* s. l.; this grouping was followed by Pesce (1985). While acknowledging that these genera are superficially similar, I see no advantage in such a reorganization since it obscures the nature of the morphological differences among them, as well as the existence of two probable evolutionary lines. *Psammophilocyclops* differs from *Metacyclops* sensu Lindberg (1942, 1961) primarily in reduction in the number of articles and changes in the armament of the swimming legs, these changes being associated with the benthic or interstitial habit. *Hesperocyclops* Herbst, 1984, a related genus, displays similar modifications (*Metacyclops stocki* Pesce, 1985 is a member of *Hesperocyclops*). On the other hand, species of *Apocyclops* are primarily planktonic and show no similar modifications in the structure of the swimming legs. Also, Lindberg's redefinition of *Metacyclops* (1942, 1961) correctly emphasized the distinct structure of leg 5 in *Apocyclops*, that is the broadening of the article and the consequent separation of the inner spine and outer seta. Members of *Apocyclops* also tend to be more slender than many members of *Metacyclops* and related genera, as well as differing in more subtle characters. Regrouping these genera without detailed consideration of comparative morphology and ecology can only lead to unproductive confusion.

In redefining the genus *Metacyclops*, Lindberg (1961) also supplied a key to females. Since then several species have been described, particularly in the neotropics, and the generic attributions of some others changed. It seems appropriate to present a key to those species currently known to inhabit the New World.

Table 2. Comparison of some characters of females of *Metacyclops paludicola* (Herbst) and *M. campestris*, n. sp.

Character	*M. paludicola*	*M. campestris*
Operculum	weakly convex	weakly concave
Length of inner apical: outer apical setae of caudal ramus	1.25	0.90
Median apical setae of caudal ramus	'heteronom befiedert'	homogeneously plumose
Number of spinules at anterior third of outer surface of caudal ramus	1	3
Apical spine of leg 5	shorter than free article	longer than free article

Key to the New World species of *Metacyclops* Kiefer, 1927b sensu Lindberg, 1961:

1. Antennule with 11 or 12 articles 2
1. Antennule with 13 articles ... *M. tredecimus* (Lowndes, 1934). Argentina, Paraguay, Venezuela.
1. Antennule with 17 articles. *M. grandis* (Kiefer, 1935a). Uruguay.

2. Terminal article of endopod of leg 4 with 1 apical spine 3
2. Terminal article of endopod of leg 4 with 2 apical spines or 1 spine and 1 seta 4
3. Inner apical seta of caudal ramus about 1.3 × longer than outer apical seta; posterior borders of urosomites with smooth hyaline membranes .... *M. curtispinosus* Dussart, 1984. Venezuela.
3. Inner apical seta of caudal ramus shorter than outer apical seta; posterior borders of urosomites with strong denticles . *M. denticulatus* Dussart & Frutos (1985/1986). Argentina.
4. Inner apical spine of terminal article of endopod of leg 4 distinctly (about 1.5–2 ×) longer than outer spine or seta 5
4. Apical spines of terminal article of endopod of leg 4 of approximately equal lengths .... *M. subaequalis* Dussart, 1984. Venezuela.
5. Caudal rami about 4–5 × (usually 5 ×) longer than broad 6
5. Caudal rami about 1.5–3 × longer than broad 7
6. Free article of leg 5 about as broad as long; inner apical seta of caudal ramus shorter (ratio 0.7 : 1) than outer apical seta; inner median apical seta of caudal ramus twice or less than twice length of ramus. *M. mendocinus* (Wierzejski, 1892). Argentina, Azores, Bolivia, Brazil, Chile, Colombia, Cuba, Equador, Haiti, Nicaragua, Paraguay, Peru, Uruguay, Venezuela.
6. Free article of leg 5 about 1.5 × longer than broad; inner and outer apical setae of caudal ramus about equal in length; inner median apical seta of caudal ramus 2.6–3.3 × longer than ramus. *M. leptopus* (Kiefer, 1927a) and subspecies *M. l. mucubajiensis* Kiefer, 1956 and *M. l. venezolanus* Kiefer, 1956. Bolivia, Peru, Venezuela.
7. Antennule extending past posterior margin of 2nd prosomite 8
7. Antennule reaching posterior margin of cephalosome, or shorter 9
8. Caudal rami 1.5 × longer than broad; terminal article of endopod of leg 4 bearing 1 stout inner apical spine and 1 very slender, short outer apical seta; antennule of 12 articles. *M. hartmanni* Herbst, 1960. Nicaragua.
8. Caudal rami 2.6 × longer than broad; terminal article of endopod of leg 4 bearing 2 stout spines; antennule of 11 articles. *M. rudis* Pleşa, 1981. Cuba.
9. Distal margin of lamella of leg 4 with triangular projections or spines which extend past margin of lamella 10
9. Distal margin of lamella of leg 4 straight or with rounded but unornamented projections (surface of lamella may be smooth or ornamented with hairs or spinules) 11
10. Distal margin of lamella of leg 4 with 2 large triangular projections, lamella otherwise smooth ... *M. dentatus* (Pleşa, 1981). Cuba.
10. Distal margin of lamella of leg 4 with 4 spines on each side, and 2 rows of spinules on surface of lamella ... *M. botosaneanui* Pesce, 1985. Bonaire.
11. Terminal article of endopod of leg 4 2.4–2.8 × longer than broad 12
11. Terminal article of endopod of leg 4 1.5 × longer than broad 14
12. Inner apical seta of caudal ramus 1.5–2 × longer than outer apical seta; basal lamella of leg 1 without ornamentation 13
12. Inner apical seta of caudal ramus shorter (0.7 : 1) than outer apical seta; basal lamella of leg 1 with 2 spinules on each side. *M. laticornis* (Lowndes, 1934). Paraguay; Brazil (Reid, unpublished data); probably Argentina (Dussart & Frutos, 1985/1986).
13. Basal lamella of leg 4 straight, with row of spinules which do not extend past margin of lamella; seta of terminal article of leg 5 reaching posterior third of genital segment. *M. brauni* Herbst, 1962. Brazil.
13. Basal lamella of leg 4 with rounded protrusions on each side, anterior surface smooth; seta of terminal article of leg 2 shorter than anterior quarter of genital segment. *M. dianae* Pesce, 1985. Haiti.
14. Inner apical seta of caudal ramus 1.25 × longer than outer apical seta; 1 spinule at anterior third of outer surface of caudal ramus. *M. paludicola* (Herbst, 1959). Brazil.

14. Inner apical seta of caudal ramus shorter (0.9:1) than outer apical seta; 3 spinules at anterior third of outer surface of caudal ramus. *M. campestris*, n. sp. Brazil.

Muscocyclops therasiae, *new species*

Material examined. Holotype: 1 ♀, MZUSP 8147, mounted whole, collected 3 Feb 1982, sample 215-E-3. Allotype: 1 ♂, dissected on 2 slides, MZUSP 8148, collected 3 Feb 1982, sample series 215. Paratypes: 1 ♀, dissected on 1 slide, MZUSP 8149, collected 3 Feb 1982, sample 215-E-2. 5 ♀, 2 ♂ and 1 copepodite, MZUSP 8150, collected 3 Feb 1982, sample series 215. 2 ♀ and 1 ♂, MZUSP 8151, collected 14 Jan 1981, sample series 131. 1 ♂, USNM 232177, collected 23 Aug 1979, sample series 75. 2 ♀ and 1 ♂, USNM 232178, collected 14 Jan 1981, sample series 131. 5 ♀ and 2 ♂, USNM 232179, collected 3 Feb 1982, sample series 215. 1 ♀, USNM 232180, collected 19 Apr 1982, sample 190. All from wet campo marsh on Fazenda Água Limpa, Federal District, Brazil. All undissected specimens alcohol-preserved.

Female. Length of holotype 330 μm; lengths of 13 paratypes 250–410 μm, median length 320 μm. Description is a composite from several specimens. Prosome (Fig. 34) not markedly depressed, slightly broader than urosome; posterior margins of all somites smooth, except anal somite which is bordered posteriorly by spinules. Genital segment broad, rounded, with seminal receptacle as in Fig. 36. Anal operculum (Figs. 34, 35) quadrate, posterior margin with 11 or 12 hyaline teeth. Caudal rami about 1.1 × longer than broad, with 3 or 4 spinules anterior to lateral seta; diagonal row of 6–7 spinules anterior to dorsal seta; and spinules on posteroventral border. Lateral seta slightly shorter than breadth of ramus; length of dorsal seta variable, 1.1–2 × length of ramus. Lengths of inner to outer apical setae of dissected paratype 13, 150, 103 and 26 μm respectively. Median apical setae with homogeneous short setules.

Antennule (Fig. 37) of 11 articles, shorter than cephalosome. Antenna, mandible, maxillula, maxilla and maxilliped as in Figs. 38–42. Swimming legs 1–4 (Figs. 43–46) with rami of 2 articles; spine formula 2, 3, 3, 2. Inner expansion of basipod 2 of leg 1 without seta. Terminal article of endopod of leg 4 almost as broad as long; apical seta about twice length of apical spine. Basal lamellae smooth, with rounded distal margins. Leg 5 (Fig. 36) with free article slightly broader than long, bearing 2 stout apical setae of which lateral is twice length of medial. Seta of fused article stout, smooth. No remnant of leg 6 visible.

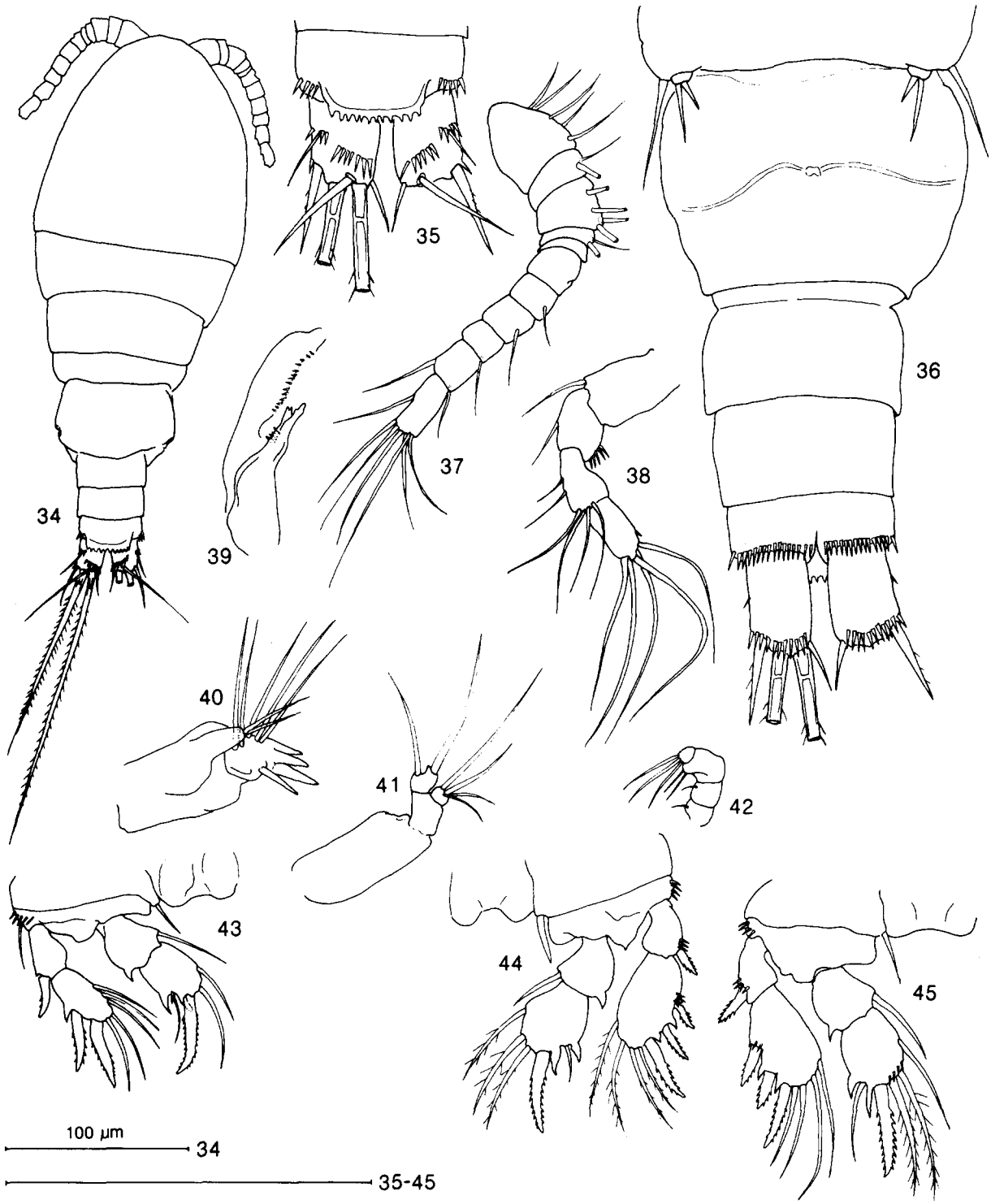
Male. Length of allotype 310 μm; lengths of 7 paratypes 270–350 μm, median length 320 μm. Habitus and armament of swimming legs as in female. Antennules (Fig. 47) geniculate, apparently of 14 articles. Leg 6 consisting of 2 short, stout setae inserted on posterior margin of genital somite (Fig. 48).

Etymology. This diminutive species is named for Dr. Therezinha Isaia Paviani, Department of Plant Biology, University of Brasília; in recognition of her encouragement and substantive assistance.

Muscocyclops bidentatus, *new species*

Material examined. Type: 1 ♀, alcohol-preserved, MZUSP 8152, collected 21 Feb 1979, sample 55 from wet campo marsh, Fazenda Água Limpa, Federal District, Brazil.

Female. Length 330 μm. Prosome (Fig. 49) not much depressed, about 1.5 × longer than urosome. Posterior margins of prosomites smooth, those of urosomites finely toothed, except posteroventral margin of anal somite with spinules. Genital segment 1.5 × broader than long, anterior half expanded laterally, tapering posteriorly; seminal receptacle visible as narrow horizontal scar (Fig. 50). Anal operculum (Fig. 51) with prominent tooth at each posterolateral corner. Caudal rami 23 × 14 μm (1.6 × longer than broad), with horizontal row of spinules anterior to dorsal seta. Dorsal seta sparsely plumose on distal half, length 65 μm; length of lateral seta 13 μm. Lengths of in-



Figs. 34–45. Muscocyclops therasiae, new species, female: 34, habitus; 35, caudal rami, dorsal; 36, urosome, ventral; 37, antennule; 38, antenna; 39, mandible and labral spinules, ventral; 40, maxillula; 41, maxilla (broken); 42, maxilliped, ventral; 43, leg 1; 44, leg 2; 45, leg 3.

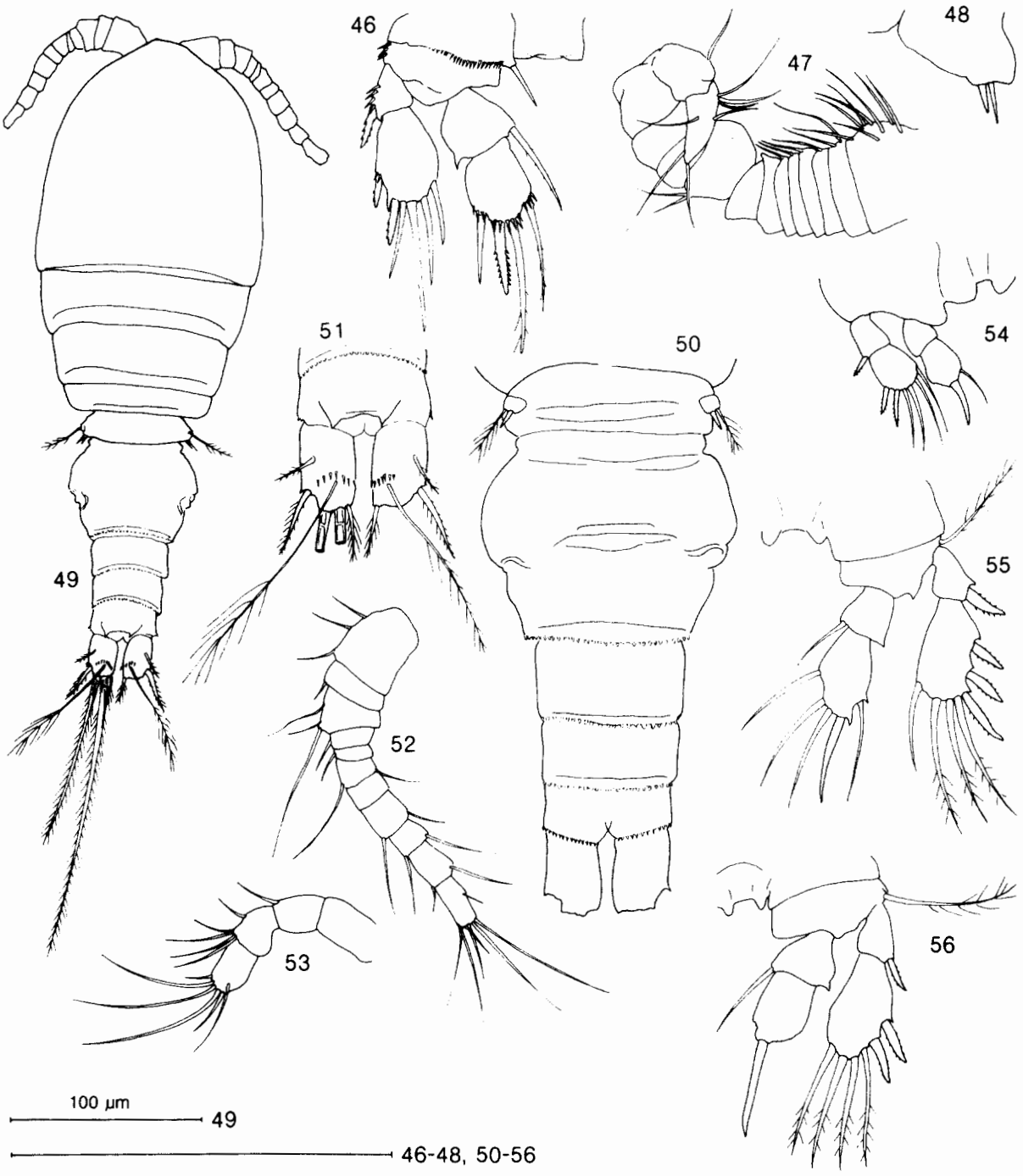


Fig. 46. Muscocyclops therasiae, new species, female, leg 4. Figs. 47, 48, *M. therasiae*, male: 47, antennule; 48, leg 6. Figs. 49–56, *M. bidentatus*, new species, female: 49, habitus; 50, urusome, ventral; 51. caudal rami, dorsal; 52, antennule; 53, antenna; 54, leg 1; 55, leg 3; 56, leg 4. Complete setation of antenna and swimming legs of *M. bidentatus* not visible.

ner to outer apical setae 12, 146, 89 and 19 μm respectively.

Antennule (Fig. 52) of 11 articles, shorter than cephalosome. Antenna (Fig. 53) of 4 articles; basipods 1 and 2 incompletely visible. Remaining mouthparts not examined. Each swimming leg (Figs. 54–56) with rami of 2 articles; spine formula 2, 3, 3, 2. Structure and setation of endopods of legs 1–4 and exopod of leg 1 were incompletely seen; however, these appear similar to *M. therasiae*, except basal lamellae with rounded projections on each side, apparently most produced in leg 4. Free article of leg 5 (Fig. 50) about as broad as long, with medial apical spine slightly longer than article and plumose lateral apical seta about 3 × length of spine. Seta of fused article slender, plumose. No remnant of leg 6 visible.

Male unknown.

Etymology. From L. "two-toothed", to describe the structure of the operculum.

Remarks. From the features of *M. therasiae* and *M. bidentatus* the diagnosis of *Muscocyclops* (Kiefer, 1937; modified by Lindberg, 1954) can be extended as follows:
Small (less than 0.5 mm) species inhabiting phytotelmata, mosses, moist soils and restricted bodies of water.

Female. Genital segment laterally expanded. Seminal receptacle transversely elongate, ribbon-shaped, without anterior enlargement; sometimes with small rounded posterior enlargement. Anal operculum large, ornamented with 2 to many hyaline teeth. Caudal rami short, about 1.5 × longer than broad, with horizontal row of 6–8 spinules anterior to dorsal seta. Antennule of 11 articles, or 10 if article 6 is not divided.
Swimming legs with rami of 2 articles, spine formula 2, 3, 3, 2, terminal articles of endopods each with strong apical spine. Medial corner of basipod 2 of leg 1 lacking seta. Probable armament of swimming legs (cf. Morton, 1985):

P1	0.52	1.211
P2	0.43	1.311
P3	0.43	1.311
P4	0.42	1.211

Basal lamellae of swimming legs unornamented, more or less produced each side into rounded projections. Free article of leg 5 small, distinct from somite, about as broad as long, with 2 setiform or spiniform appendages; basal article completely fused with somite, remaining single seta inserted dorsal to free article. Leg 6 absent.

Male. Antennules geniculate. Leg 6 consisting of 2 short setae inserted on posterior margin of genital somite. Little or no sexual dimorphism in structure of caudal rami or swimming legs.

Type species: M. operculatus *(Chappuis, 1917).*

The species can be distinguished most easily by the shape of the anal operculum and the number of hyaline teeth on its free border. The operculum of *M. operculatus* is rounded and fringed with a finely toothed hyaline membrane. The 2 apical setae of leg 5 of *M. operculatus* are plumose and of equal length.

Ponticyclops, *new genus*

Female. Caudal rami longer than broad, without conspicuous ornamentation except for normal complement of setae. Antennule of 17 articles, without hyaline membrane on terminal articles. Swimming legs with rami each of 3 articles. Leg 1 with seta on medial corner of basipod 2. Medial corners of second basipods of leg 2–4 smooth, without spurs. Terminal article of endopod of leg 4 with 2 apical spines. Spine formula 2, 3, 3, 3; armament of swimming legs as follows:

P1	1.1.42	1.2.411
P2	1.1.43	1.2.411
P3	1.1.43	1.2.411
P4	1.1.43	1.2.221

Leg 5 consisting of 1 free article and 1 article fused

to lateral expansion of somite, indicated by seta lateral to free article. Free article of leg 5 longer than broad, armed with 1 long apical seta and 1 spinule on medial surface. Leg 6 consisting of 1 seta.

Type species: Ponticyclops boscoi, *new species.*

Etymology. From "pons", L. "bridge", indicating the intermediate position among several genera; species name after St. João Bosco ("Dom Bosco"), a visionary nineteenth-century Italian monk and patron saint of the city of Brasília.

Remarks. The genus is distinguished from the related genera *Acanthocyclops* Kiefer, *Australocyclops* Morton and *Microcyclops* Claus by the combination of the antennule of 17 articles, rami of all swimming legs of 3 articles, and leg 5 of 1 free article with 1 apical seta and 1 spinule on medial surface (Table 3). *Ponticyclops* seems to be in some respects intermediate between *Acanthocyclops* and *Australocyclops*, since it displays a reduction of leg 5 while retaining the more primitive number of articles of the antennule and of the rami of the swimming legs. Species of *Microcyclops* show reduction in all three features.

Ponticyclops boscoi, *new species*

Material examined. Type: 1 ♀, alcohol-preserved, MZUSP 8153, collected 9 Mar 1979 from running water below spring "Olho da Água da Onça", sample 59 from wet campo marsh, Fazenda Água Limpa, Federal District, Brazil.

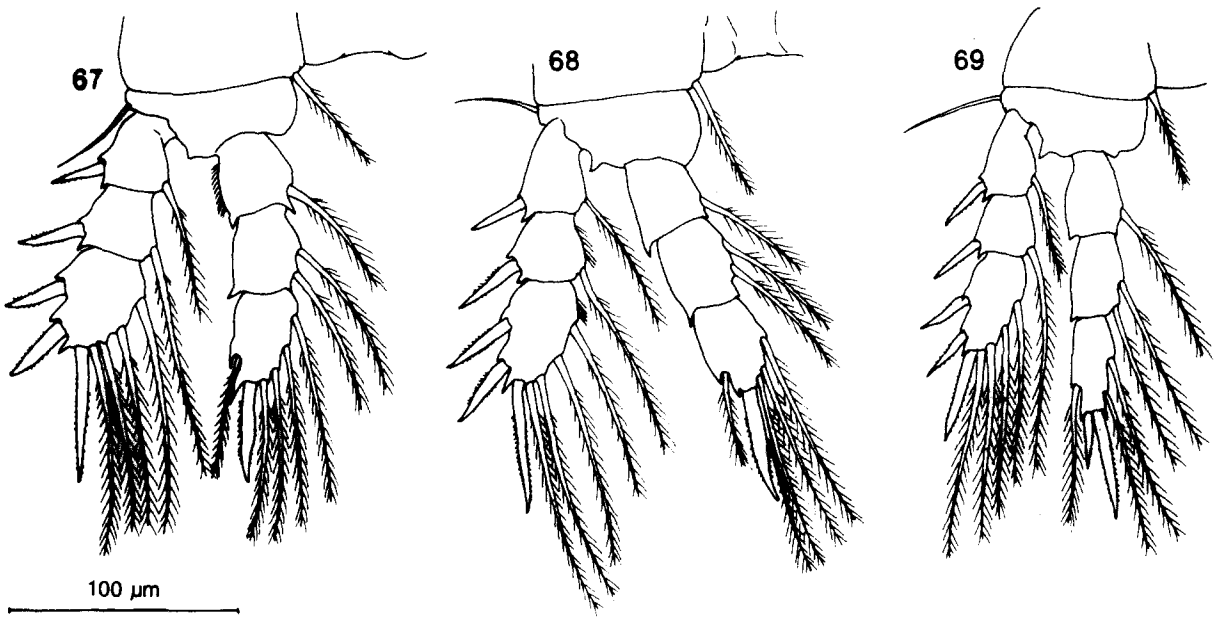
Female. Length 880 μm. Prosome (Fig. 57) nearly twice length of urosome; posterior margins of all somites smooth, except anal somite with spinules ventrally, Genital segment (Figs. 58, 59) about as broad as long, anterior half expanded laterally, posterior half tapering. Seminal receptacle faintly visible as horizontal scar. Anal operculum slightly convex. Caudal rami (Figs. 58, 60) 95 × 24 μm, thus 4 × longer than broad; without ornamentation. Length of lateral seta 26 μm; length of dorsal seta 70 μm. Length of inner apical seta 135 μm; length of outer apical seta 65 μm. Both median apical setae broken; remaining setae finely plumose.

Antennule (Fig. 61) of 17 articles, terminal articles lacking hyaline membrane. Antenna (Fig. 62) of 4 articles, basipods 1 and 2 indistinctly seen; basipod 1 with 3 setae. Maxillula, maxilla and maxilliped as in Figs. 63–65; mandible not examined. Swimming legs 1–4 (Figs. 66–69) with armament as described for genus. Terminal article of endopod of leg 4 about twice as broad as long (length

Table 3. Some diagnostic characters of the genera *Acanthocyclops* s. 1. Kiefer (after Morton, 1985), *Australocyclops* Morton, *Microcyclops* Claus, and *Ponticyclops*, new genus.

Character	*Acanthocyclops*	*Ponticyclops*	*Australocyclops*	*Microcyclops*
Leg 5, number of free articles	2	1	1	1
Antennule, number of articles	11–17	17	12	10–12
Spine formula	variable, 3,4,4,4 or 2,3,3,3	2,3,3,3	3,3,3,3	3,4,4,3
Leg 1, number of articles in rami	3	3	2	2
Legs 2–4, number of articles in rami	3	3	3	2
Leg 4, inner margin of proximal article of exopod, number of setae	1	1	0	0
Legs 1–4, next distalmost article, number of setae	2	2	1	1
Medial corners of basipods 2	with spurs	without spurs	with spurs	without spurs

Figs. 57–66. Ponticyclops boscoi, new genus, new species, female: 57, habitus; 58, urosome, ventral; 59, genital segment, dorsal; 60, caudal rami, dorsal; 61, antennule; 62, antenna; 63, maxillula; 64, maxilla; 65, maxilliped; 66, leg 1.



Figs. 67–69. Ponticyclops boscoi, new genus, new species, female: 67, leg 2; 68, leg 3; 69, leg 4.

40 µm, breadth 19 µm); inner apical spine (46 µm) about twice as long as outer (24 µm).

Leg 5 (Figs. 58, 59) of 1 fused article, indicated by seta inserted on lateral expansion of somite; and 1 free article, about 3 × longer than broad, with 1 long, sparsely plumose apical seta and 1 tiny spinule at distal third of inner margin. Lateral expansion of somite with horizontal row of hairs anterior to lateral seta. Leg 6 reduced to 1 naked seta.

Male unknown

Remarks. The assumption that this single specimen is not abnormal is reinforced by the fact that both sides are symmetrical and show no evidence of breakage or repair of appendages.

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