PROC. BIOL. SOC. WASH.
98(3), 1985, pp. 574–590

CALANOID COPEPODS (DIAPTOMIDAE) FROM COASTAL LAKES, STATE OF RIO DE JANEIRO, BRAZIL

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Abstract.—Three species of diaptomid copepods (Calanoida) were collected from the plankton of four coastal lakes, State of Rio de Janeiro, Brazil. *Notodiaptomus iheringi* (Wright) is redescribed based on topotype specimens in the collection of the National Museum of Natural History and on specimens from two of the Rio lakes. The female and male of "*Diaptomus*" *azureus,* new species, and the male of "*D.*" *fluminensis,* new species, are described.

In the course of a survey of physical, chemical, and faunistic characteristics of lakes and lagoons along the coast of the State of Rio de Janeiro, Brazil (Esteves et al. 1983), samples of zooplankton from 14 lakes were taken by F. A. Esteves in January and September, 1983, and confided to me for determination of species present. Adult diaptomid copepods occurred in samples from 4 lakes. *Notodiaptomus iheringi* (Wright) occurred in Lagoa do Campelo and Lagoa da Saudade; "*Diaptomus*" *azureus,* new species, in Lagoa Comprida; and "*D.*" *fluminensis,* new species, in Lagoa Iodada (Coca-Cola). Wright (1935) supplied only a partial description of *N. iheringi.* The incompleteness of extant descriptions of many species of South American diaptomids is seriously impeding the understanding of interspecific and intergeneric relationships (Brehm 1958; Brandorff 1976). A redescription of this species from specimens collected by Wright from the type-locality and deposited in the collections of the National Museum of Natural History, as well as from the Rio specimens is presented. The female and male of "*D.*" *azureus* and the male of "*D.*" *fluminensis* are described also. Some physical and chemical characteristics of the Rio lakes appear in Table 1 (data supplied by F. A. Esteves).

Notodiaptomus iheringi (Wright)
Figs. 1–28

Diaptomus iheringi Wright, 1935:223–226, pl. 1, fig. 4, pl. 2, figs. 3, 5–11.—Wright, 1936:80–81.—Wright, 1938:562.

Notodiaptomus iheringi.—Kiefer, 1936:197–198, figs. 3–4.—Cipólli and Carvalho, 1973:97, 98, 101, tab. 2.—Brandorff, 1976:616–617, fig. 2.—Sendacz and Kubo, 1982:69–71, 85–86, figs. 25–29.

Material examined.—1 ♀ (National Museum of Natural History—USNM 79542) topotype (after Wright's label, "from the type-locality, Açude Puxinamã, near Campino Grande, State of Parahyba, Brazil"), S. Wright coll.; 3 ♀ and 3 ♂ (USNM 216065), 3 ♀ (Museu de Zoologia da Universidade de São Paulo—MZUSP 6191), 4 ♂ (MZUSP 6192), 4 copepodites (MZUSP 6193), all alcohol-preserved, and 1 ♀, dissected (author's collection), from Lagoa da Saudade, State of Rio de Janeiro,

Table 1.—Physical and chemical characteristics of four lakes inhabited by diaptomid copepods, State of Rio de Janeiro, Brazil (data supplied by F. A. Esteves).

	Lake					
	L. do Campelo		L. da Saudade	L. Comprida	L. Todada (Coca-Cola)	
Sampling dates	01/83	09/83	01/83	01/83	01/83	09/83
Area (km^2)	9.85		0.79	0.11	0.12	
Max. depth (m)	1.5		2.5	3.0	1.5	
Water color	Clear		Black	Black	Black	
Secchi depth (m)	1.50	—	2.0	0.75	0.40	0.50
pH	7.45	9.0	6.6	4.4	5.3	5.6
% sat. O_2	86	110	93	79	70	79
Conductivity ($\mu S\ cm^{-1}$)	440	645	410	530	4700	4520
Chlorophyll ($\mu g\ l^{-1}$)	10.42	4.10	1.20	0.67	—	8.47
Ca^{2+} ($mg\ l^{-1}$)	11.07	—	4.68	6.30	19.43	—
Na^{+} ($mg\ l^{-1}$)	53.8	—	57.0	85.9	561.9	—
Cl^{-} ($mg\ l^{-1}$)	78.0	—	94.4	123.3	997.5	—
CO_3^{2-} ($mg\ l^{-1}$)	0.012	0.101	7.0×10^{-4}	—	1.2×10^{-5}	6.1×10^{-4}
NO_3^{-} ($\mu g\ l^{-1}$)	10.7	6.5	7.6	7.3	10.2	25.0
PO_4^{-} ($\mu g\ l^{-1}$)	0.8	5.9	0.6	0.5	1.25	—

Brazil, 21°42′S, 41°20′W; 10 ♀ and 10 ♂ (USNM 216066), 10 ♀ (MZUSP 6194), 10 ♂ (MZUSP 6195) and 56 copepodites (MZUSP 6196), 22 ♀ and 14 ♂ (collection of F. A. Esteves), all alcohol-preserved, and 1 ♀ and 1 ♂, dissected (author's collection), from Lagoa do Campelo, State of Rio de Janeiro, 21°40′S, 41°11′W, all collected 28 Jan 1983.

Description.—Female: Length (including caudal rami) of Açude Puxinamã specimen 1.11 mm; mean length of 10 Lagoa da Saudade specimens 1.34 mm (range 1.24–1.40 mm); mean length of 10 Lagoa do Campelo specimens 1.23 mm (range 1.16–1.30 mm). Body widest at 1st pediger in dorsal view. Suture between 4th and 5th pedigers complete but faint dorsally. 3rd and 4th pedigers in Rio de Janeiro specimens each with 1 to 3 rows of spinules near posterior border, single row on 4th pediger continuing laterally (Figs. 1–4). 5th pediger produced on each side in small wing, ending in single spine; left wing directed laterally (Fig. 3), right wing dorsally (Fig. 4); inner corner of left wing slightly expanded (Fig. 2).

Urosome of 3 segments, most of 2nd segment covered by genital segment and hardly visible. Genital segment about 1.5× as long as rest of urosome (including caudal rami), slightly expanded anterolaterally, right expansion slightly larger than and anterior to left expansion, each expansion with laterally directed spine. Right posterolateral margin of genital segment slightly produced. Genital segment saddle-shaped in lateral view. Genital opening with conical process on either side (Fig. 5). Inner margins of caudal rami haired (Fig. 2).

Rostral points acute (Fig. 6). 1st antenna reaching well past caudal rami; segments 11 and 13–21 each with 1 seta; complete armature as in Fig. 7.

2nd antenna with normal setation; bases of terminal setae on exopod distinctly separated from segment 7 (Fig. 8). Mandible also with normal setation (Fig. 9); dentition of gnathal lobe in ventral to dorsal order as follows (nomenclature after

Fleminger 1967): apical and subapical teeth pointed. Medial teeth 4 in number, ventralmost a rounded lobe with tiny acute cusp, dorsal 3 medial teeth bicuspidate. Basal teeth 3 in number, ventralmost tooth tricuspidate, 2 dorsalmost teeth slender, bicuspidate (Figs. 13, 14).

Maxillula, maxilla and maxilliped as in Figs. 10–12 respectively; distal lobe at 1st basipod of maxilliped with only 3 setae.

Swimming legs with normal complement of spines and setae; setation of leg 4 identical to leg 3 (Figs. 15–17). Leg 2 with Schmeil's organ on posterior surface of 2nd endopod segment (Figs. 16, 18).

Leg 5 (Figs. 19–22) stout, 1st basal segment with prominent posteroventrally directed process tipped with stout spine. Posterodistal angle of 2nd basal segment produced in rounded process; lateral seta reaches to distal third of 1st exopod segment. 1st exopod segment unarmed, about 2× longer than broad. 2nd exopod segment with short spine lateral to base of 3rd exopod segment, about as long as 3rd segment (Fig. 21); claw stout, curved slightly inwards, middle part of each margin spinulose. 3rd exopod segment distinct from 2nd exopod segment, slightly longer than wide, bearing 2 terminal spines, inner spine about 2.3× longer than outer. Endopod of 1 segment, slightly constricted near base, reaching past mid-length of 1st exopod segment, bearing 2 long spines on either side of group of hairs on oblique inner distal margin (Fig. 22).

Male: Mean length (including caudal rami) of 7 Lagoa da Saudade specimens 1.16 mm (range 1.14–1.18 mm); mean length of 10 Lagoa do Campelo specimens 1.06 mm (range 1.02–1.12 mm). Body widest at 2nd pediger in dorsal view. Suture between 4th and 5th pedigers complete but faint; posterior border of 4th pediger with row of spinules on each side. Each side of 5th pediger produced into posteriorly directed wings, each tipped with spine; left spine directed posteriorly, right spine directed obliquely outward. Urosome of 5 segments, curved slightly to right in most preserved specimens. Genital segment asymmetrical, right side expanded posteriorly over next urosomal segment. Inner margins of caudal rami haired (Fig. 23).

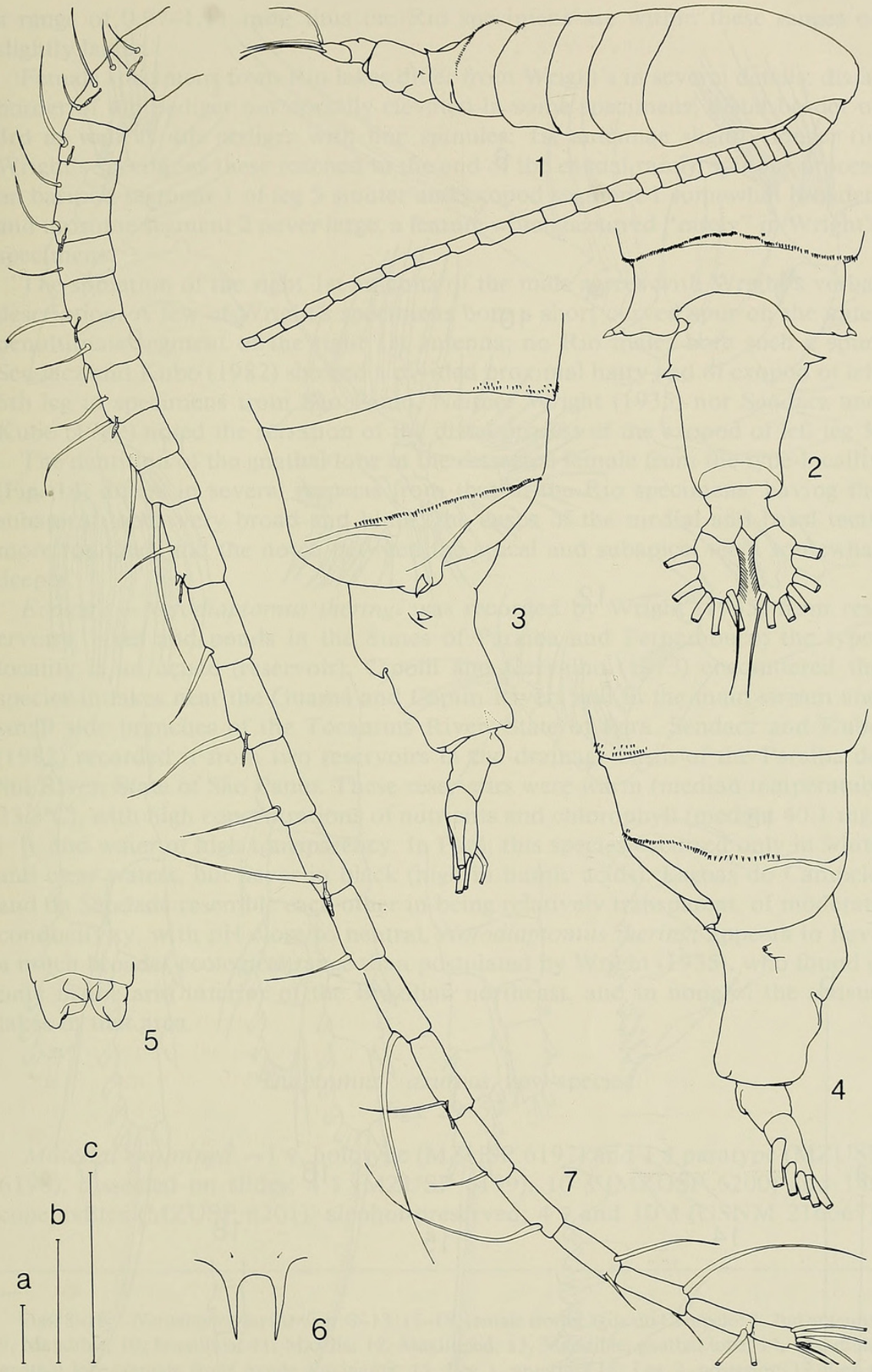
Right 1st antenna with socketed spines on segments 8 and 12; spines on segments 10, 11, 13, 15, and 16 without basal articulation (Fig. 24). Spines on segments 10 and 11 of equal length, parallel to axis of antenna; spine on segment 10 overlapping base of spine on segment 11. Spine on segment 13 large, with notched tip. Spine on segment 16 very small. Antepenultimate segment with narrow hyaline membrane (Fig. 25). Armature of left 1st antenna identical to that of female.

Structure and armature of 2nd antenna, maxillula, maxilla and maxilliped as in female. Dentition of gnathal lobe of mandible similar to female except dorsal 3 medial teeth and middle basal tooth each with additional tiny cusp on ventral surface (Fig. 26).

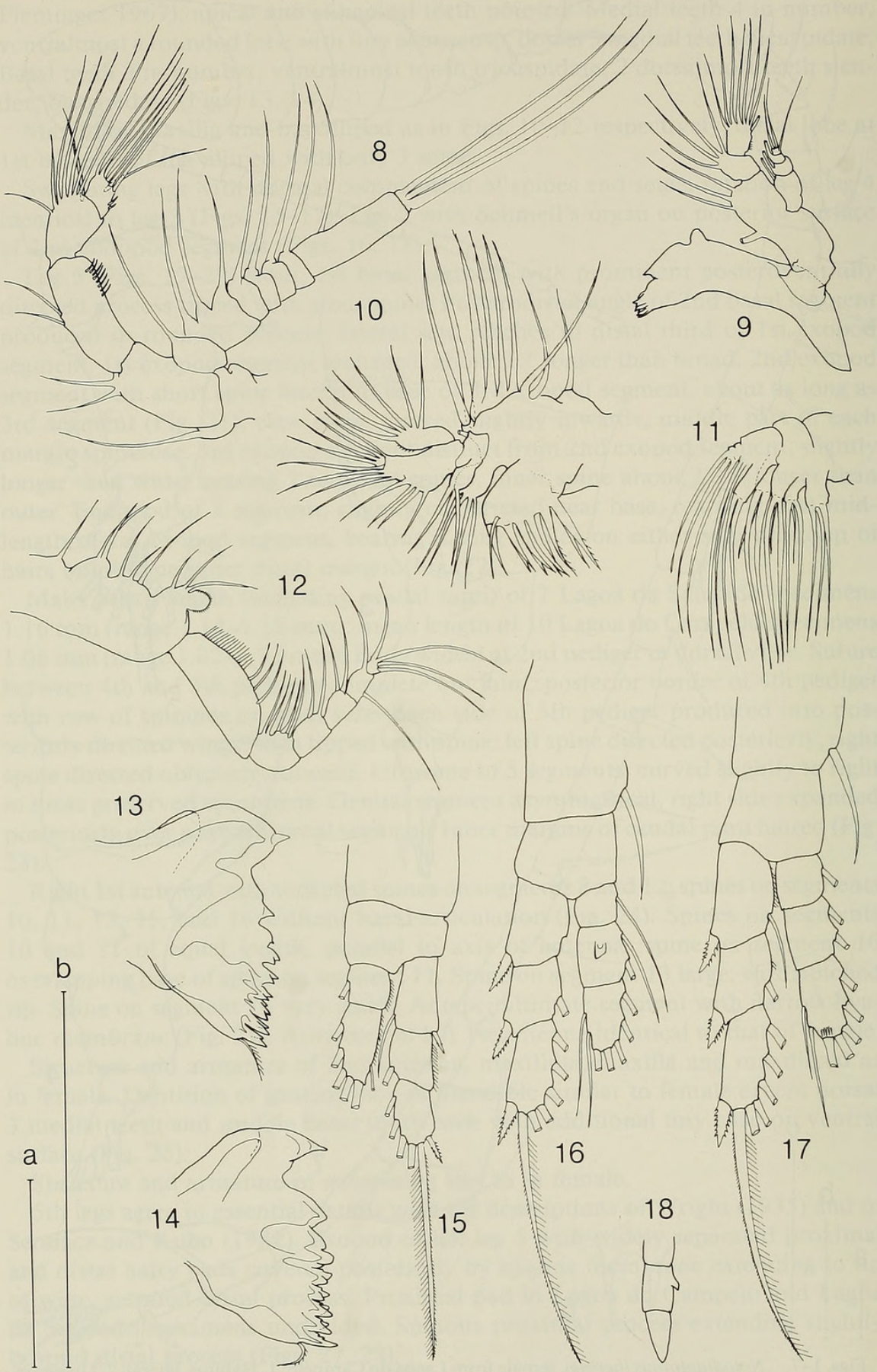
Structure and armature of swimming legs as in female.

5th legs agree in essential details with the descriptions of Wright (1935) and of Sendacz and Kubo (1982). Exopod of left leg 5 with widely separated proximal and distal hairy pads covered posteriorly by hyaline membrane extending to tip of wide, serrated distal process. Proximal pad in Lagoa do Campelo and Lagoa da Saudade specimens undivided. Spinous proximal process extending slightly beyond distal process (Figs. 27, 28).

Remarks.—Wright reported the mean length of 20 females to be 1.18 mm, with a range of 1.11–1.27 mm, and the mean length of 20 males to be 1.03 mm, with



Figs. 1–7. *Notodiaptomus iheringi,* female from Lagoa do Campelo: 1, Habitus, lateral; 2, Urosome, dorsal; 3, Urosome, left lateral; 4, Urosome, right lateral; 5, Genital area, ventral; 6, Rostrum, ventral; 7, 1st antenna. Scale a, Fig. 1; Scale b, Figs. 2–4, 7; Scale c, Figs. 5, 6; each scale = 100 μm.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a range of 0.97–1.11 mm; thus the Rio specimens are within these ranges or slightly larger.

Female specimens from Rio lakes differ from Wright's in several details: distal border of 4th pediger not dorsally elevated in some specimens; distal border of 3rd as well as 4th pediger with fine spinules; 1st antennae slightly longer (in Wright's specimens these reached to the end of the caudal rami); spinous process on basipod segment 1 of leg 5 stouter and exopod segment 1 somewhat broader; and urosome segment 2 never large, a feature which occurred "rarely" in Wright's specimens.

The spination of the right 1st antenna of the male agrees with Wright's verbal description. A few of Wright's specimens bore a short curved spur on the antepenultimate segment of the right 1st antenna; no Rio males bore such a spur. Sendacz and Kubo (1982) showed a divided proximal hairy pad of exopod of left 5th leg in specimens from São Paulo. Neither Wright (1935) nor Sendacz and Kubo (1982) noted the serration of the distal process of the exopod of left leg 5.

The dentition of the gnathal lobe in the dissected female from the type-locality (Fig. 14) differs in several respects from that of the Rio specimens, having the subapical tooth very broad and blunt, the cusps of the medial and basal teeth more rounded, and the notch between the apical and subapical teeth somewhat deeper.

Ecology.—*Notodiaptomus iheringi* was recorded by Wright (1935) from reservoirs, lakes and ponds in the States of Paraíba and Pernambuco; the type-locality is an açude (reservoir). Cipólli and Carvalho (1973) encountered the species in lakes near the Guamá and Capim Rivers and in the main stream and small side branches of the Tocantins River, State of Pará. Sendacz and Kubo (1982) recorded it from two reservoirs in the drainage basin of the Paraíba do Sul River, State of São Paulo. These reservoirs were warm (median temperature 23.3°C), with high concentrations of nutrients and chlorophyll (median 40.1 mg·l^{-1}), and water of high transparency. In Pará, this species occurred only in white and clear waters, but never in black (high in humic acids). Lagoas do Campelo and da Saudade resemble each other in being relatively transparent, of moderate conductivity, with pH close to neutral. *Notodiaptomus iheringi* appears to have a much broader ecological range than postulated by Wright (1935), who found it only in the arid interior of the Brazilian northeast, and in none of the coastal lakes in that area.

"*Diaptomus*" *azureus,* new species
Figs. 29–59

Material examined.—1 ♀, holotype (MZUSP 6197) and 1 ♂ paratype (MZUSP 6198), dissected on slides; 4 ♀ (MZUSP 6199), 10 ♂ (MZUSP 6200) and 140 copepodites (MZUSP 6201), alcohol-preserved; 4 ♀ and 10 ♂ (USNM 216067),

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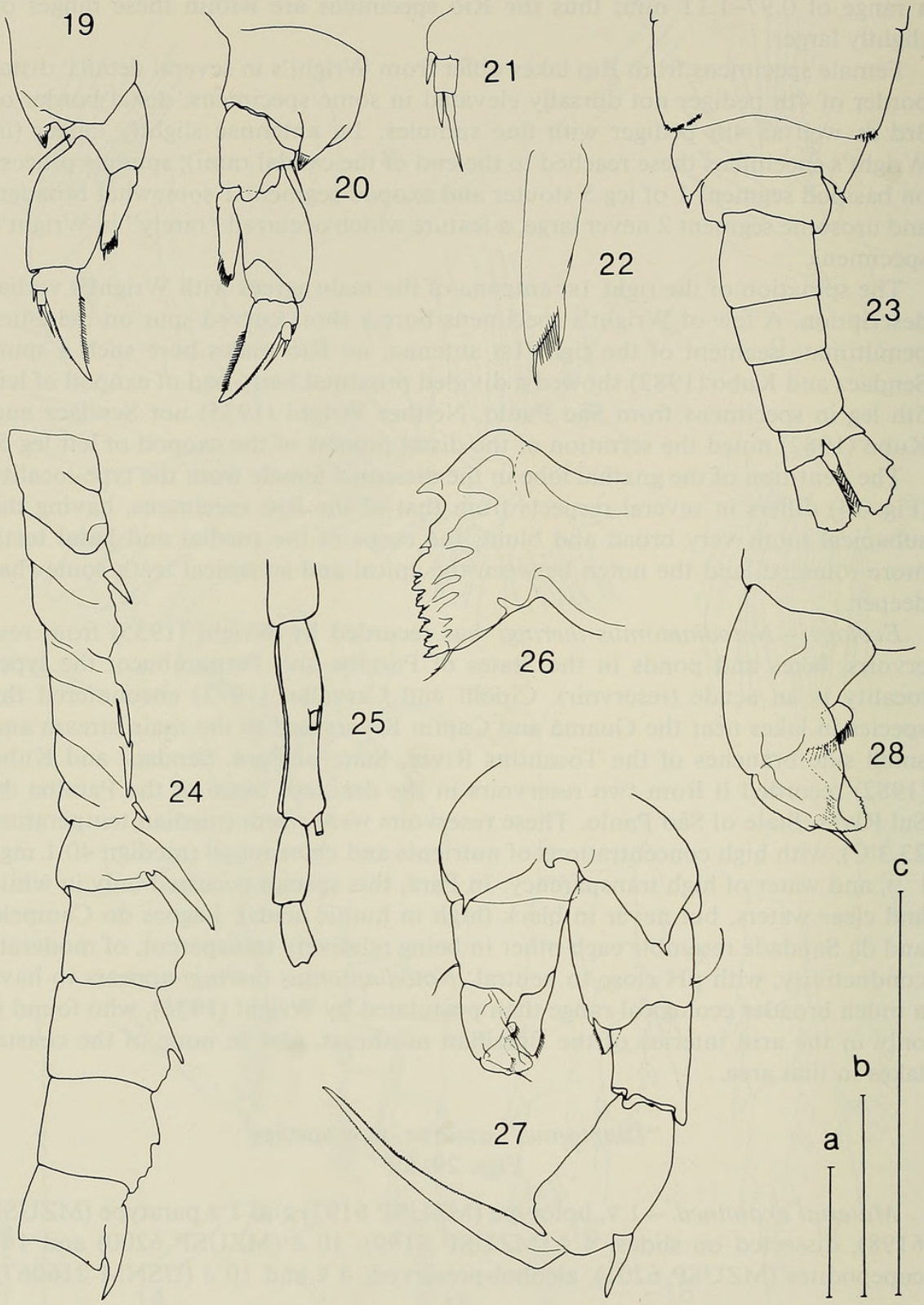
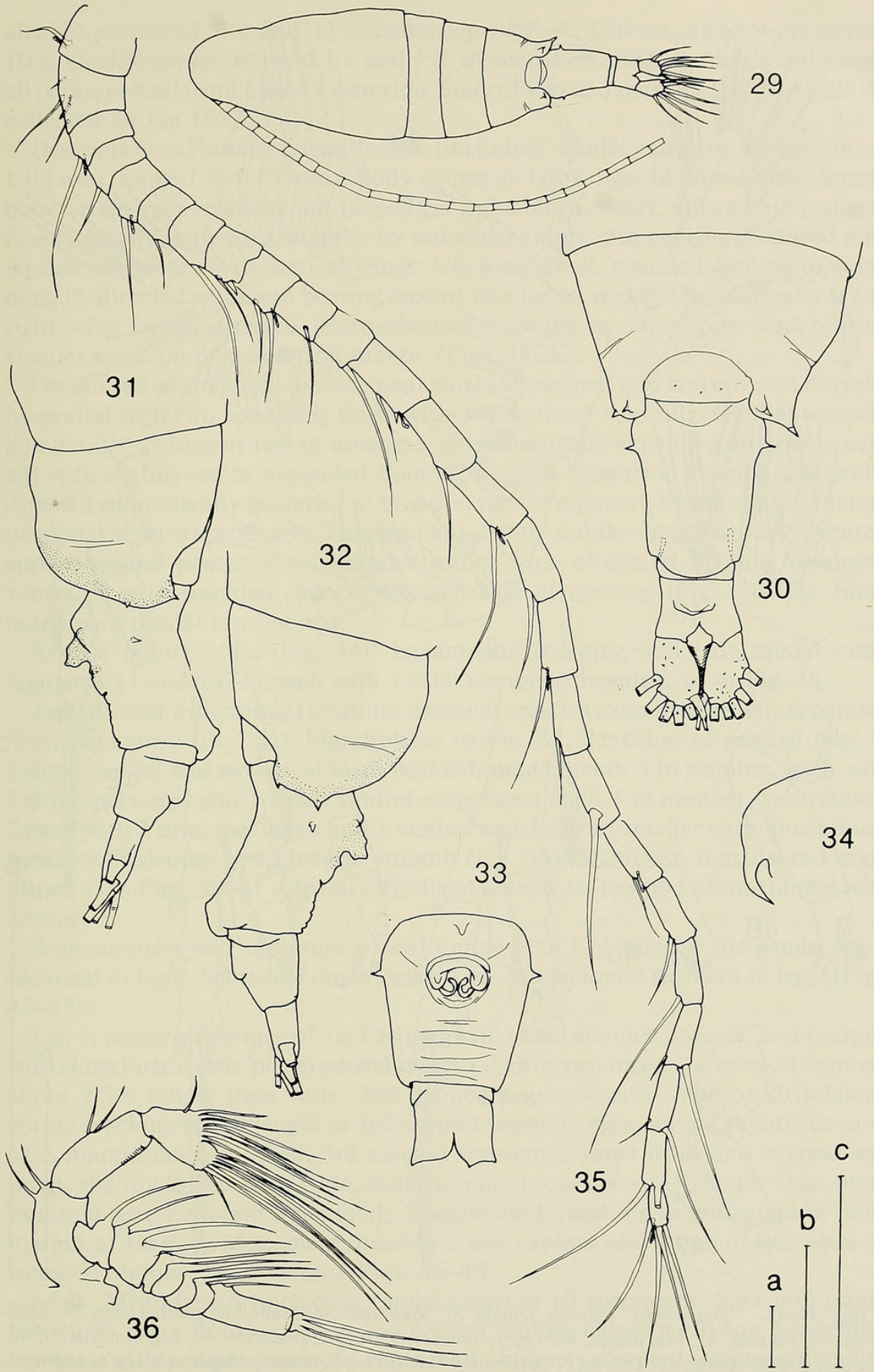
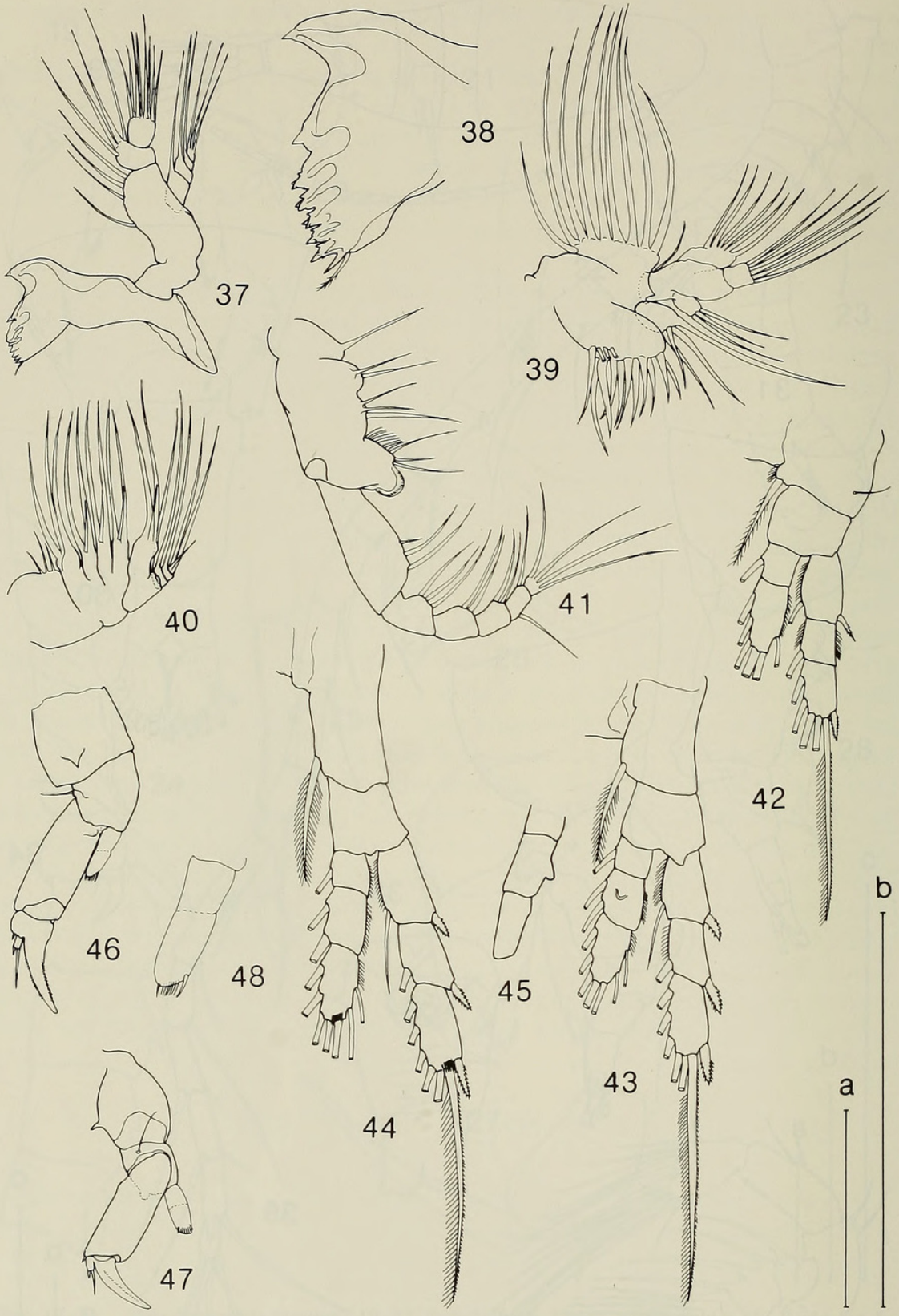
Figs. 8–18. *Notodiaptomus iheringi*: 8–13, 15–18, female from Lagoa do Campelo: 8, 2nd antenna; 9, Mandible; 10, Maxillula; 11, Maxilla; 12, Maxilliped; 13, Mandible, gnathal lobe; 14, Mandible, gnathal lobe, female from Açude Puxinamã; 15, Leg 1, anterior; 16, Leg 2, posterior; 17, Leg 4, posterior; 18, Leg 2 endopod, lateral. Scale a, Figs. 8–12, 15–18; Scale b, Figs. 13, 14; each scale = 100 μm.



Figs. 19–28. *Notodiaptomus iheringi*: 19–22, female from Lagoa do Campelo: 19, Right leg 5, anterior; 20, Right leg 5, posterior; 21, Leg 5, exopod segment 3; 22, Leg 5, endopod. 23–28, Male from Lagoa do Campelo: 23, Urosome, dorsal; 24, Right 1st antenna, segments 7–17; 25, Right 1st antenna, segments 23–25; 26, Mandible, gnathal lobe; 27, Legs 5, posterior; 28, Left leg 5 exopod, posterior. Scale a, Fig. 23; Scale b, Figs. 19, 20, 24, 25, 27; Scale c, Figs. 21, 22, 26, 28; each scale = 100 μm.



Figs. 29–36. "*Diaptomus*" *azureus*, female: 29, Habitus, dorsal; 30, Urosome, dorsal; 31, Urosome, left lateral; 32, Urosome, right lateral; 33, Urosome, ventral; 34, Rostrum, lateral; 35, 1st antenna; 36, 2nd antenna. Scale a, Fig. 29; Scale b, Figs. 30–33, 35; Scale c, Figs. 34, 36; each scale = 100 μm.



Figs. 37–48. "*Diaptomus*" *azureus,* female: 37, Mandible; 38, Mandible, gnathal lobe; 39, Maxillula; 40, Maxilla; 41, Maxilliped; 42, Leg 1, anterior; 43, Leg 2, posterior; 44, Leg 3, posterior; 45, Leg 2 endopod, lateral; 46, Left leg 5, posterior; 47, Right leg 5, lateral-oblique; 48, Leg 5, endopod. Scale a, Figs. 37, 39–47; Scale b, Figs. 38, 48; each scale = 100 μm.

alcohol-preserved; 3 ♀ and 11 ♂, collection of F. A. Esteves, alcohol-preserved; 10 ♂, alcohol-preserved, and 1 ♀ and 1 ♂, dissected on slides, author's collection; all paratypes; all from Lagoa Comprida, State of Rio de Janeiro, 21°17′S, 41°39′W, collected 26 Jan 1983.

Description.—Female: Mean length (including caudal rami) of 10 specimens 1.06 mm (range 1.0–1.15 mm). Body widest at 1st pediger in dorsal view. Suture between cephalic segment and 1st pediger indistinct dorsally; 4th and 5th pedigers fused dorsally, separated laterally by indistinct suture. 5th pediger produced posterolaterally into asymmetrical wings: left wing small, rounded, ending in small dorsally directed spine and bearing second smaller spine on posterolateral margin; right wing larger, directed latero-obliquely, ending in stout spine and bearing smaller spine on posterodorsal margin (Figs. 29–32).

Urosome 3-segmented, 2nd segment partly telescoped into and covered dorsally by genital segment, appearing fused with 3rd segment ventrally. Genital segment about 1.2× as long as rest of urosome, asymmetrically expanded anteriorly with left side slightly more expanded than right, each expansion bearing a laterally directed spine slightly posterior to broadest part of segment. Posterodorsal margin of genital segment produced. This segment slightly saddle-shaped dorsally, ventral surface rugose posterior to genital opening; area of genital opening produced ventrally, with rounded process on each side of opening (Figs. 30–33). Inner margins of caudal rami haired.

Rostral points acute (Fig. 34). 1st antenna reaching well past caudal rami; segments 11 and 13–21 each with 1 seta; complete armature as in Fig. 35.

2nd antenna with normal setation, terminal setae on exopod distinctly separated from segment 7 (Fig. 36). Mandible as in Fig. 37; dentition of gnathal lobe as follows: apical and subapical teeth pointed; medial teeth 3 in number, each with 2 principal cusps and 1 small ventral cusp; basal teeth 3 in number, ventralmost 2 each with 2 principal cusps and 1 ventral and 1 dorsal smaller cusp; dorsalmost basal tooth slender, with margin smooth (Fig. 38). Maxillula, maxilla and maxilliped as in Figs. 39–41 respectively; distal lobe of 1st basipod of maxilliped with 3 setae.

Segmentation and armature of swimming legs 1–4 normal for genus, leg 4 identical to leg 3; Schmeil's organ present on 2nd endopod segment of leg 2 (Figs. 42–45).

Leg 5, posterior surface of 1st basipod with small spinous process. 2nd basipod with short lateral seta; posterodistal margin slightly produced. 1st exopod segment about 2.5× longer than wide. 2nd exopod segment with spine on distolateral corner reaching to midlength of 3rd exopod segment; claw curved slightly inward, each margin finely toothed. 3rd exopod segment distinct from 2nd exopod segment, slightly longer than wide, inner terminal seta about 5× longer than outer terminal seta. Endopod indistinctly 2-segmented, reaching to midlength of inner margin of 1st exopod segment, bearing 2 short spines and group of fine hairs on rounded oblique distal margin (Figs. 46–48).

Male: Mean length (including caudal rami) of 10 specimens, 0.93 mm (range 0.90–0.96 mm). Body widest at 2nd pediger. Suture between 4th and 5th pediger complete. 5th pediger produced into small obliquely directed wings each ending in small spine; right wing slightly larger. Genital segment asymmetrical, right side slightly extended posteriorly. Inner margins of caudal rami haired (Figs. 49–51).

Rostral points acute (Fig. 52). Right 1st antenna with socketed spines on segments 8 and 12; spine on segment 10 about two-thirds length of spine on segment 11, these spines parallel to each other and directed obliquely outwards from axis of antenna. Spine on segment 13 large, acute, reaching midlength of segment 14. Spine on segment 15 slightly longer than spine on segment 16. Antepenultimate segment with smooth hyaline membrane (Figs. 53, 54).

2nd antenna and mouthparts similar to those of female. Medial and basal teeth of mandibular gnathal lobe slightly blunter than in female, with at most 1 secondary small cusp; dorsalmost basal tooth serrate (Fig. 55). Segmentation and armature of swimming legs as in female.

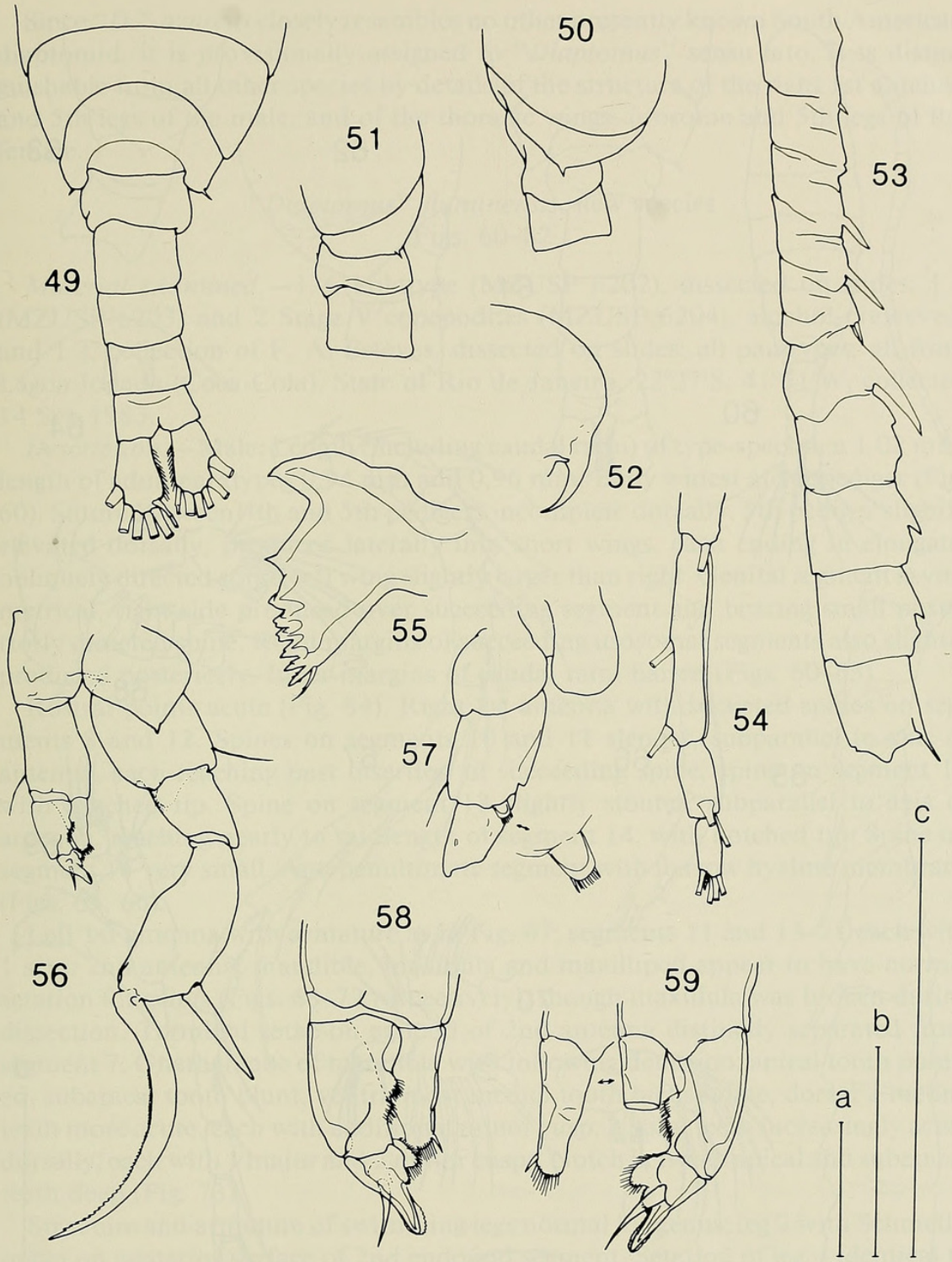
Right leg 5, 1st basal segment with posterior expansion ending in short spine. 2nd basal segment almost as broad as long; outer margin with seta at distal quarter; inner margin convex, smooth. Exopod, excluding claw, nearly twice as long as basipod; 1st segment about 1.3× longer than broad, distolateral corner produced. 2nd exopod segment broadest at midlength, 2.5× longer than 1st segment; strong, smooth lateral spine at distal quarter of outer margin, extending almost at right angle to axis of segment and about 1.3× longer than greatest width of segment. Terminal claw slightly longer than exopod, evenly curved, teeth of inner margin increasing in size distally. Endopod short, located on inner posterodistal margin of and distinct from 2nd basal segment; slightly longer than broad and bearing fine hairs on distal margin (Figs. 56, 57).

Left leg 5 (Figs. 56, 58, 59) reaching proximal third of 2nd exopod of right leg. 1st basal segment slightly longer than wide, with small conical process on posterior surface. 2nd basal segment about 1.5× longer than broad, broadest just beyond midpoint, with seta at distal quarter of outer margin. Proximal and distal hairy pads of exopod separate, proximal pad incompletely divided with proximal part slightly more expanded. Proximal expansion of distal pad with numerous fine hairs, separated by sinus from distal part which bears short spinules. Distal process about as long as 2nd exopod segment, with serrate hyaline flange on each side. Proximal process slender, acute, distinct from 2nd exopod segment, slightly longer than distal process. Endopod of 1 segment, conical, reaching midlength of 2nd exopod segment, with fine hairs and 1 spine on rounded distal margin.

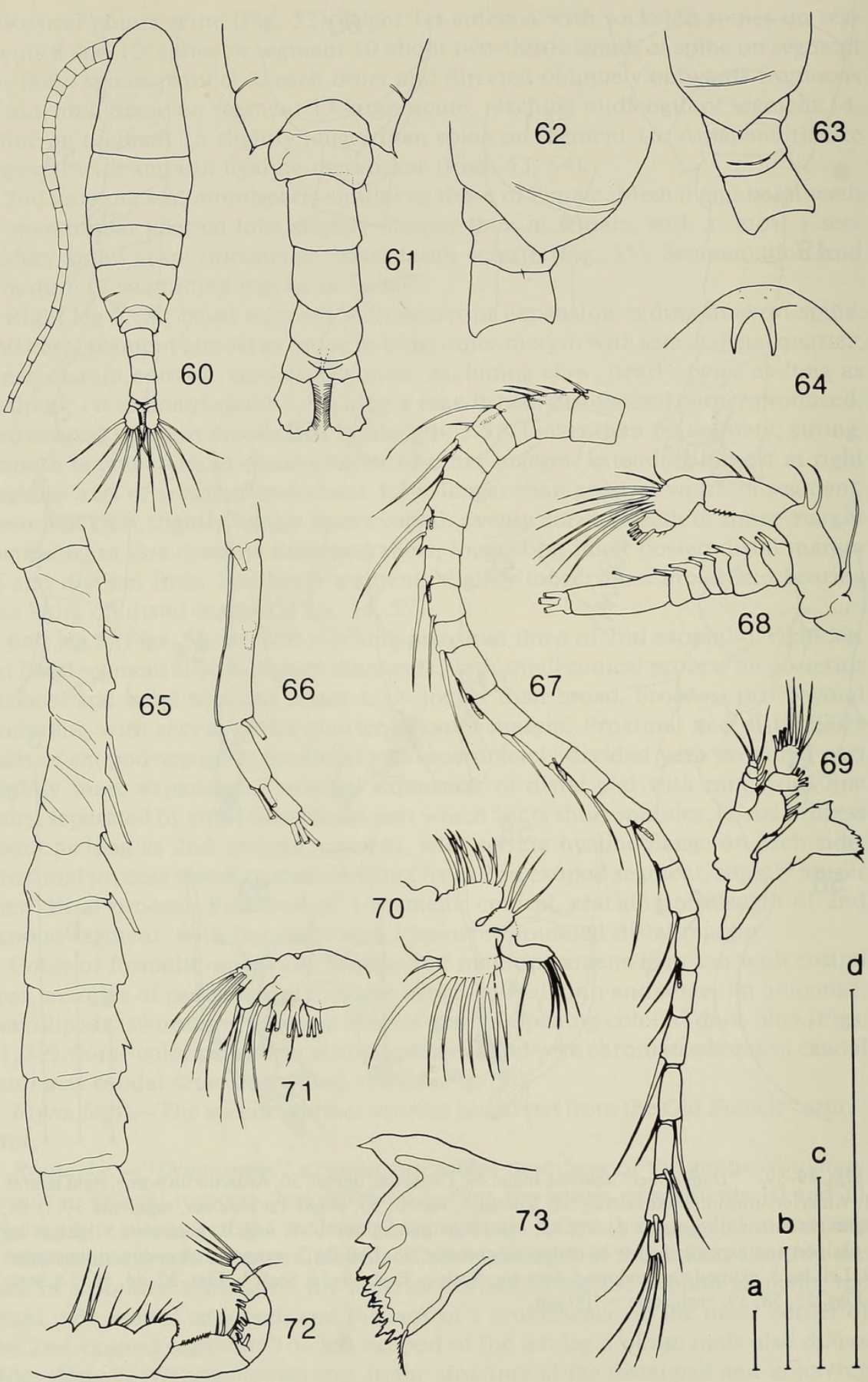
Color of formalin-preserved female and male specimens light tan with rostral area, margins of pedigers and thoracic wings, caudal rami and setae, 1st antennae, maxillipeds, swimming legs and area of genital opening colored dark blue (Figs. 31, 32). Some color persists in alcohol preservation with chromatophores in caudal rami and caudal setae remaining visible (Fig. 30).

Etymology.—The specific epithet *azureus* is derived from the Old French "azur," blue.

Remarks.—"*Diaptomus*" *azureus* resembles members of the genus *Notodiaptomus* in several respects, but differs in having the spines of segments 10 and 11 of the right antenna of the male angled outwards rather than parallel to the axis of the antenna; and in several details of the right leg 5 of the male, primarily the lack of a pointed process on the anterior surface of the 2st exopod segment; the blunt, not conical endopod; and the lack of a prominence on the inner border of the 2nd exopod segment. The left exopod of the left leg 5 of the male also differs from those of *Notodiaptomus* spp. in the structure of the distal pad and in having the proximal process extending past the distal process.



Figs. 49–59. "*Diaptomus*" *azureus,* male: 49, Urosome, dorsal; 50, Anterior urosome, right lateral; 51, Anterior urosome, left lateral; 52, Rostrum, lateral; 53, Right 1st antenna, segments 8–17; 54, Right 1st antenna, segments 23–25; 55, Mandible, gnathal lobe; 56, Legs 5, posterior; 57, Right leg 5, basipod and expanded view of endopod, anterior; 58, Left leg 5, exopod and endopod, posterior; 59, Left leg 5, exopod and endopod, anterior. Scale a, Figs. 49–51; Scale b, Figs. 52–54, 56, 57; Scale c, Figs. 55, 58, 59; each scale = 100 μm.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Since "*D.*" *azureus* closely resembles no other presently known South American diaptomid, it is provisionally assigned to "*Diaptomus*" sensu lato. It is distinguishable from all other species by details of the structure of the right 1st antenna and 5th legs of the male, and of the thoracic wings, urosome and 5th legs of the female.

"*Diaptomus*" *fluminensis,* new species
Figs. 60–82

Material examined.—1 ♂, holotype (MZUSP 6202), dissected on slides; 1 ♂ (MZUSP 6203) and 2 Stage V copepodites (MZUSP 6204), alcohol-preserved; and 1 ♂, collection of F. A. Esteves, dissected on slides; all paratypes; all from Lagoa Iodada (Coca-Cola), State of Rio de Janeiro, 22°27′S, 41°51′W, collected 14 Sep 1983.

Description.—Male: Length (including caudal rami) of type-specimen 1.02 mm; length of adult paratypes 0.94 mm and 0.96 mm. Body widest at 1st pediger (Fig. 60). Suture between 4th and 5th pedigers incomplete dorsally. 5th pediger slightly elevated dorsally, produced laterally into short wings, each ending in elongate, obliquely directed spine, left wing slightly larger than right. Genital segment asymmetrical, right side produced over succeeding segment and bearing small posteriorly directed spine. Right margins of succeeding urosomal segments also slightly produced posteriorly. Inner margins of caudal rami haired (Figs. 60–63).

Rostral points acute (Fig. 64). Right 1st antenna with socketed spines on segments 8 and 12. Spines on segments 10 and 11 slender, subparallel to axis of antenna, each reaching past insertion of succeeding spine; spine on segment 11 with notched tip. Spine on segment 13 slightly stouter, subparallel to axis of antenna, reaching nearly to midlength of segment 14, with notched tip. Spine on segment 16 very small. Antepenultimate segment with narrow hyaline membrane (Figs. 65, 66).

Left 1st antenna with armature as in Fig. 67; segments 11 and 13–21 each with 1 seta. 2nd antenna, mandible, maxillula and maxilliped appear to have normal setation for genus (Figs. 68–72 respectively), though maxillula was broken during dissection. Terminal setae on exopod of 2nd antenna distinctly separated from segment 7. Gnathal lobe of mandible with following dentition: apical tooth pointed, subapical tooth blunt; ventralmost medial tooth bicuspidate, dorsal 2 medial teeth more acute, each with additional minor cusp; 3 basal teeth increasingly acute dorsally, each with 1 major and 2 minor cusps. Notch between apical and subapical teeth deep (Fig. 73).

Structure and armature of swimming legs normal for genus; leg 2 with Schmeil's organ on posterior surface of 2nd endopod segment. Setation of leg 4 identical to that of leg 3 (Figs. 74–77).

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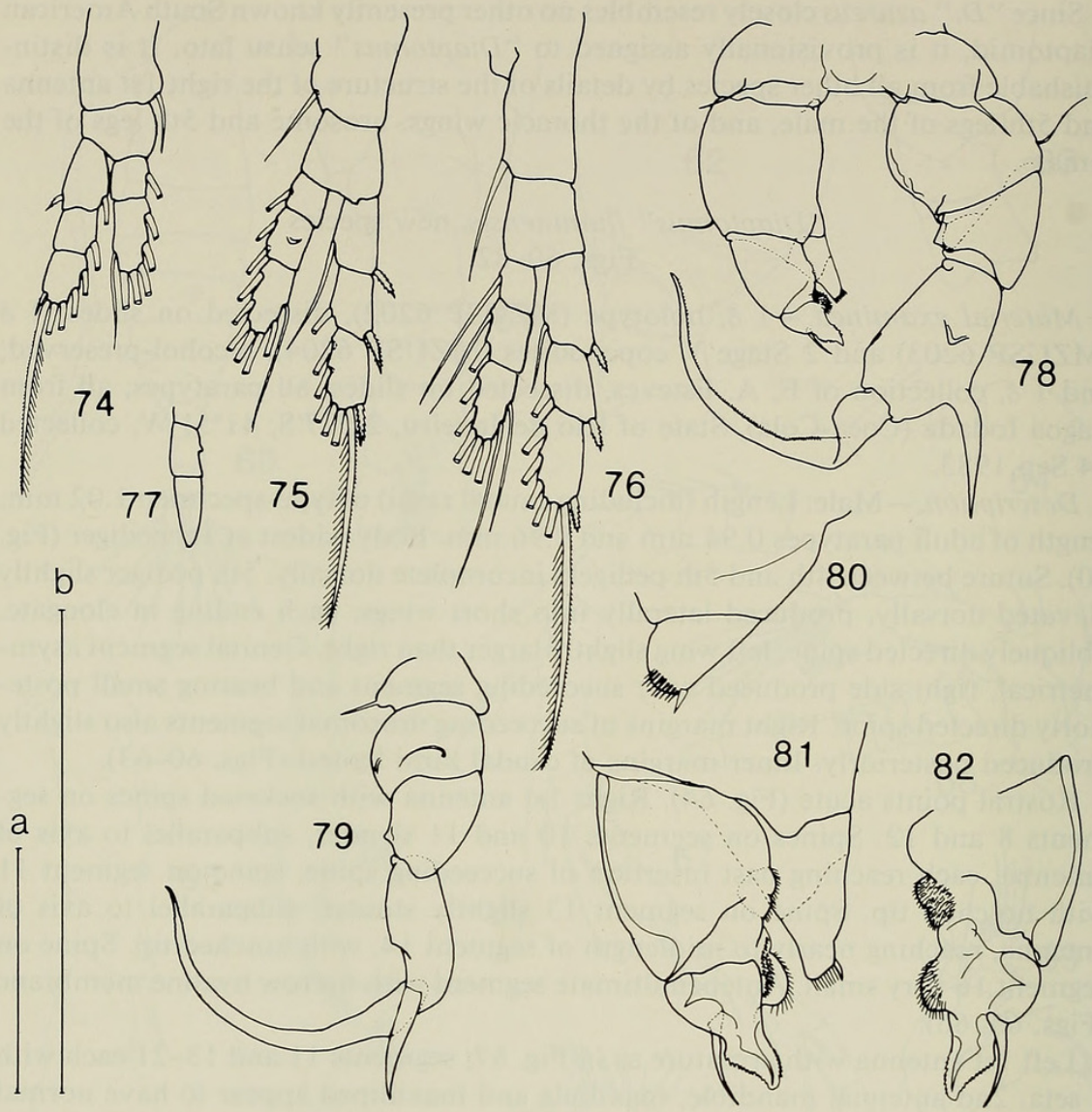
Figs. 60–73. "*Diaptomus*" *fluminensis,* male: 60, Habitus, dorsal; 61, Urosome, dorsal; 62, Anterior urosome, right lateral; 63, Anterior urosome, left lateral; 64, Rostrum, ventral; 65, Right 1st antenna, segments 7–16; 66, Right 1st antenna, segments 23–25; 67, Left 1st antenna; 68, 2nd antenna; 69, Mandible; 70, Maxillula (broken); 71, Maxilla; 72, Maxilliped; 73, Mandible, gnathal lobe. Scale a, Fig. 60; Scale b, Figs. 61–63, 67; Scale c, Figs. 64–66, 68–72; Scale d, Fig. 73; each scale = 100 μm.



Figs. 74–82. "*Diaptomus*" *fluminensis*, male: 74, Leg 1, anterior; 75, Leg 2, posterior; 76, Leg 3, anterior; 77, Leg 2 endopod, lateral; 78, Legs 5, posterior; 79, Right leg 5, lateral; 80, Right leg 5, endopod; 81, Left leg 5, exopod and endopod, posterior; 82, Left leg 5, exopod, anterior. Scale a, Figs. 74–79; Scale b, Figs. 80–82; each scale = 100 μm.

5th legs (Figs. 78–82) stout, 1st basipods broader than long, each with posterior conical projection ending in posterolaterally directed spine, right projection and spine larger than left. Right 2nd basipod also stout, broader than long, inner margin convex with several posteromedial cuticular thickenings, outer margin with short seta at distal third, anterodistal margin produced. Right exopod about 1.5× length of basipod, 1st exopod segment slightly longer than broad, outer margin about twice as long as inner margin, outer and inner distal corners produced. 2nd exopod segment broadest at distal quarter, slightly less than twice as long as broad, with cuticular thickenings on inner proximal corner, distal quarter of inner margin, and posterior surface. Smooth lateral spine at distal third of outer margin, bent slightly at proximal quarter. Terminal claw slightly longer than exopod, directed posterodorsally, recurved at tip, inner margin finely serrate. Endopod broadly triangular, of 1 segment, inserted on produced anterodistal

margin of 2nd basal segment, reaching almost to mediodistal corner of 1st exopod segment, bearing subterminal row of fine hairs and 1 stout claw on outer margin.

Left 2nd basipod segment slightly longer than broad, both margins slightly convex, inner proximal corner produced into rounded knob, short seta proximal to outer distal corner. Left endopod broadly triangular, weakly 2-segmented with suture most apparent on anterior surface, reaching midlength of distal pad of left exopod; blunt tip with terminal group of fine hairs and 1 spine on mediodistal corner. Both segments of left exopod distinctly separated, pad on posterodistal corner of 1st exopod segment partly divided, haired on anterior surface. 2nd exopod segment, inner margin with crescentic pad set with spinules and anterodistal rounded pad with many long hairs on anterior surface. Distal process continuous with 2nd exopod segment, broadly triangular with tip recurved outwards, margins serrate. Slender proximal process about as long as and inserted slightly anterior to distal process.

Color of formalin-preserved specimens light tan.

Etymology.—The specific epithet is derived from the Brazilian term "fluminense," a native of the State of Rio de Janeiro.

Remarks.—Though many characters of "*D.*" *fluminensis* agree with those of the rather loosely defined genus *Notodiaptomus,* several details of the 5th legs such as the shape of the right 1st exopod, the 2-segmented left endopod and the placement of the proximal process of the left exopod preclude its inclusion in this genus. Principal differences from other species include the details of the spination of the right 1st antenna and the form of the distal process of the exopod of the left 5th leg. It is provisionally assigned to "*Diaptomus*" sensu lato.

Discussion

As M. S. Wilson (1951) pointed out, knowledge of the structure and armature of mouthparts, particularly the maxilliped, the 1st and 2nd swimming legs, the armature of the 1st antennae of the female and of the left 1st antenna of the male is necessary for satisfactory comparison of species or genera of diaptomid copepods. Unfortunately these features have been described for only a few South American diaptomids. Lack of comprehensive knowledge of the morphology of most species has contributed to the present confusion in which about 20 species have not been assigned to genera (or subgenera), remaining in "*Diaptomus*" sensu lato (Brandorff 1976). Nor has it been possible to construct a complete key to the identification of all species (Brehm 1958).

Therefore I have included descriptions of mouthparts and other characters of uncertain taxonomic utility. For instance, the extent to which details of the dentition of the mandibular gnathal lobe may vary with sex, age or genetic differences has not been investigated. The dentition of the lobe in *N. iheringi* differs from *N. cearensis* as redescribed by Bowman (1973) in having the cusp of the ventralmost medial tooth produced in a separate acute tooth; the margin ventral to the subapical tooth produced into a distinct lobe; and most teeth tricuspidate rather than bicuspidate as in *N. cearensis.* The setation of the 1st basipod of the maxilliped is similar in both species.

Wilson (1951) noted that Schmeil's organ (Schmeil 1896) is lacking in both sexes of *Nordodiaptomus alaskaensis* and in females of *Nordodiaptomus siberiensis,* but is present in males of the latter species. This organ, of unknown function,

occurs in both sexes of *Notodiaptomus venezolanus deeveyorum* Bowman (1973), *N. cearensis* as redescribed by Bowman (1973), and *Pectenodiaptomus caperatus* (Bowman, 1979), as well as in the three species described here.

Acknowledgments

I thank Dr. Francisco de A. Esteves for providing the samples of zooplankton and the data in Table 1, as well as for his kind hospitality during a working visit to the laboratório de Limnologia, Departamento de Ciências Biológicas, Universidade de São Carlos, São Paulo. Drs. Thomas E. Bowman and Carlos Eduardo F. da Rocha and an anonymous reviewer made helpful comments on the manuscript.

The Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq) and the Fundação de Amparo para Pesquisa do Estado de São Paulo (FAPESP) provided support for the collections and water analyses. The U.S.–Latin American Cooperative Science Program, Division of International Programs, National Science Foundation, provided a travel grant to the author.

Literature Cited

Bowman, T. E. 1973. Two freshwater copepods from Barrancas, Venezuela: *Notodiaptomus cearensis* (Wright) and *N. venezolanus deeveyorum,* new subspecies (Calanoida: Diaptomidae).—Proceedings of the Biological Society of Washington 86:193–202.

———. 1979. Amsterdam Expeditions to the West Indian Islands, Report 5. *Notodiaptomus caperatus,* a new calanoid copepod from phreatic groundwater in Barbuda (Crustacea: Diaptomidae).—Bijdragen tot de Dierkunde 49:219–226.

Brandorff, G.-O. 1976. The geographic distribution of the Diaptomidae in South America (Crustacea, Copepoda).—Revista Brasileira de Biologia 36:613–627.

Brehm, V. 1958. Bemerkungen zu einigen Kopepoden Südamerikas.—Sitzungsberichte der Österreichischen Akademie der Wissenschaften, Abteilung 1, 167:139–171.

Cipólli, M. N., and M. A. J. Carvalho. 1973. Levantamento de Calanoida e Cyclopoida (Copepoda, Crustacea) das águas da região do Guamá, Capim e Tocantins, com nota sobre a fauna acompanhante.—Papéis Avulsos de Zoologia 27:95–110.

Esteves, F. A., R. Barbieri, I. H. Ishii, and A. F. M. Camargo. 1983. Estudos limnológicos em algumas lagoas costeiras do Estado do Rio de Janeiro.—Anais do III Seminário Regional de Ecologia (Universidade Federal de São Carlos, Brazil):25–38.

Fleminger, A. 1967. Taxonomy, distribution and polymorphism in the *Labidocera jollae* group, with remarks on evolution within the group (Copepoda: Calanoida).—Proceedings of the United States National Museum 120:1–61.

Kiefer, F. 1936. Über die Systematik der Südamerikanischen Diaptomiden (Crust. Copep.).—Zoologischer Anzeiger 116:194–200.

Schmeil, O. 1896. Deutschlands freilebende Süsswasser-Copepoden. III Teil: Centropagidae. Erwin Nägele Verlag, Stuttgart. Pp. 1–143.

Sendacz, S., and E. Kubo. 1982. Copepoda (Calanoida e Cyclopoida) de reservatórios do Estado de São Paulo.—Boletim do Instituto de Pesca 9:51–89.

Wilson, M. S. 1951. A new subgenus of *Diaptomus* (Copepoda: Calanoida), including an Asiatic species and a new species from Alaska.—Journal of the Washington Academy of Sciences 41: 168–179.

Wright, S. 1935. Three new species of *Diaptomus* from northeast Brazil.—Annais da Academia Brasileira de Sciências 7:213–233.

———. 1936. Preliminary report on six new species of *Diaptomus* from Brazil.—Annais da Academia Brasileira de Sciências 8:79–85.

———. 1938. Distribuição geográphica das espécies de *Diaptomus* na América do Sul.—Livro Jubilar do Prof. Travassos 3:561–566.

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