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Argyrodiaptomus nhumirim, a new species, and *Austrinodiaptomus kleerekoperi*, a new genus and species, with redescription of *Argyrodiaptomus macrochaetus* Brehm, new rank, from Brazil (Crustacea: Copepoda: Diaptomidae)

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Abstract.—Two species of diaptomid calanoid copepods are described, and one species is redescribed from Brazilian specimens. *Argyrodiaptomus nhumirim*, new species, inhabits small fishless freshwater ponds in the Pantanal, State of Mato Grosso do Sul. *Argyrodiaptomus furcatus* var. *macrochaetus* Brehm is redescribed from the State of Rio Grande do Sul and raised to species rank. A new genus and species *Austrinodiaptomus kleerekoperi* is described, also from Rio Grande do Sul. *Diaptomus* s.l. *inexspectatus* Brehm is transferred to *Austrinodiaptomus*. The first record from the State of Sergipe is given for *Argyrodiaptomus azevedoi* (Wright).

Samples from small ponds in the Pantanal, State of Mato Grosso do Sul, Brazil, contained a hitherto unknown species of the diaptomid calanoid copepod genus *Argyrodiaptomus*. The new species is described and compared with *A. azevedoi* (Wright 1935). The first record from the State of Sergipe, Brazil, is given for the latter.

Samples from temporary ponds in the State of Rio Grande do Sul, Brazil, collected in 1941 by H. Kleerekoper and now in the R. W. Kiser Collection in the National Museum of Natural History, Smithsonian Institution, proved to contain two interesting species of calanoids. *Argyrodiaptomus furcatus* var. *macrochaetus* Brehm, 1937, is redescribed and raised to species rank. A new genus and species of the subfamily Diaptominae is described, and the similar *Diaptomus* s.l. *inexspectatus* Brehm, 1958 is transferred to the new genus.

Drawings were made using a Wild M30 microscope fitted with a drawing tube, from specimens in lactic acid or, after dissection, in commercial polyvinyl lactophenol or CMC-10 with a little Chlorazol Black E added to the medium. Most drawings were made from supported mounts except those of antennules and of the male of *A. nhumirim*, which were made after dissection and permanent mounting. The specimens were deposited in the Museu de Zoologia da Universidade de São Paulo (MZUSP) and the United States National Museum of Natural History, Smithsonian Institution (USNM).

Order Calanoida G. O. Sars, 1903
Family Diaptomidae Baird, 1850
Subfamily Diaptominae Kiefer, 1932
Genus *Argyrodiaptomus* Brehm, 1933
Argyrodiaptomus nhumirim, new species
Figs. 1–16

Argyrodiaptomus sp.—Reid & Moreno 1990:725–728, tab. 2.

Material examined.—Holotype ♂, fully dissected and mounted on slide in polyvinyl lactophenol (MZUSP 12286); allotype ♀, fully dissected and mounted on slide in CMC-10 (MZUSP 12287); and undissected paratype ♀ in 70% ethanol (USNM 284931); all from among aquatic macro-

phytes in Baía da Carandazal (Baía 29), Fazenda Nhumirim, State of Mato Grosso do Sul, Brazil, 4 Apr 1987, leg. J. W. Reid. Accompanying copepod species: *Notodiaptomus coniferoides* (Wright; USNM 284939, 284940), *Notodiaptomus* sp. (USNM 284949), *Mesocyclops longisetus* (Thiébaud) s.s. (USNM 284965), *Mesocyclops meridianus* (Kiefer; USNM 284972, 284973), *Microcyclops anceps* (Richard) s.s. (USNM 284981), *Neutrocyclops brevifurca* (Lowndes; USNM 284990), and *Ectocyclops* cf. *phaleratus* (Koch; USNM 284963). Additional paratype: 1 undissected copepodid in 70% ethanol (USNM 284932), from among *Nymphaea* spp., Baía 57, Fazenda Nhumirim, 5 Apr 1987, leg. J. W. Reid. Accompanying copepods: *Notodiaptomus* sp. (USNM 284950), *M. longisetus* (USNM 284964), *Microcyclops ceibaensis* (Marsh; USNM 284988). These records were previously reported by Reid & Moreno (1990). Geographical coordinates of Fazenda Nhumirim: 18°59′S, 56°39′W.

The only male specimen was dissected and mounted before it was recognized as a new species. No habitus drawing of the unmounted male was made.

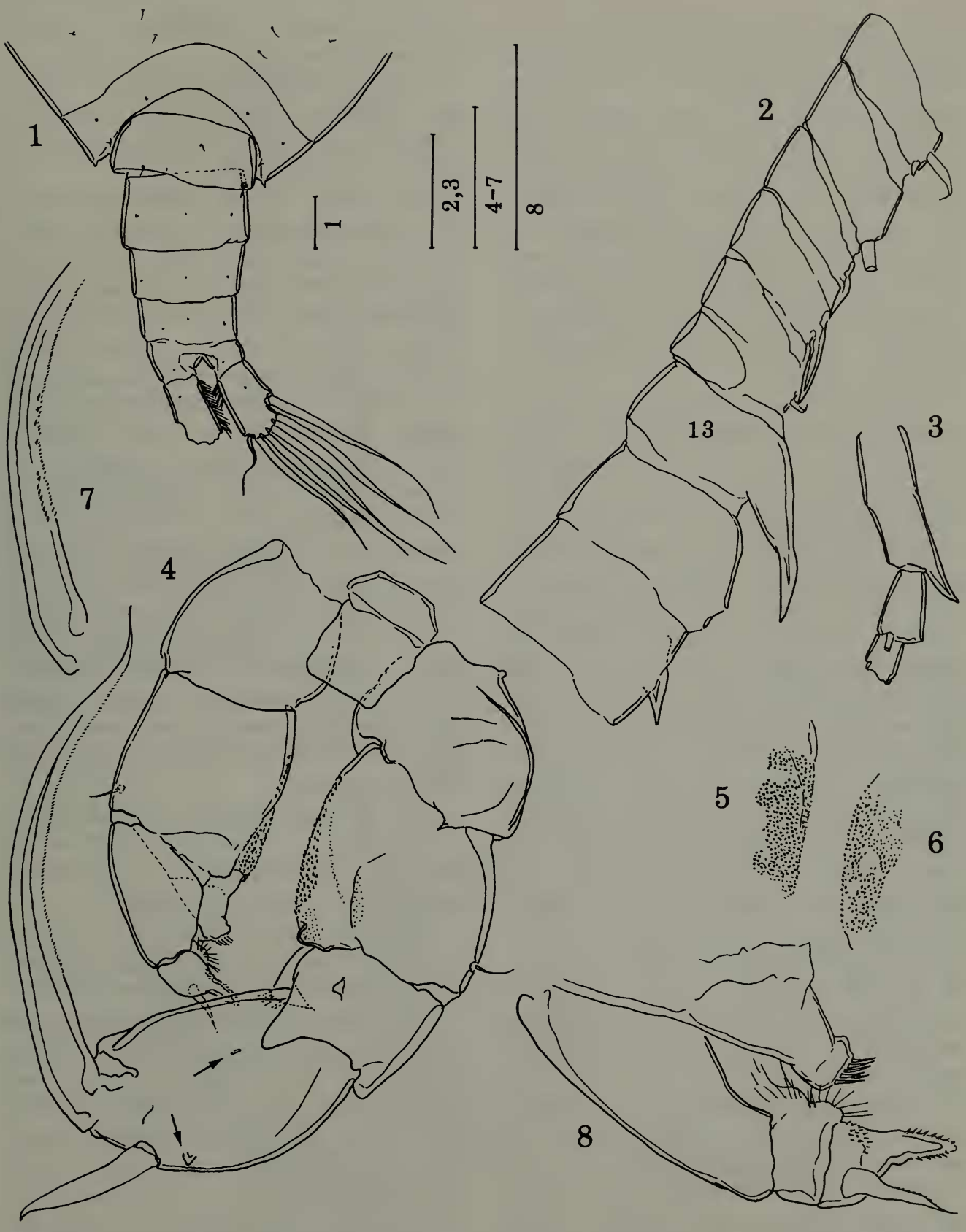
Male.—Length of holotype 2.0 mm. Pedigers 4 and 5 (Fig. 1) distinct. Lateral wings of pediger 5 nearly symmetrical, right wing slightly longer, each with dorsal hairlike sensillum and ventral spiniform sensillum on margin. Urosomite 1 slightly inflated, with short sensillum on right distolateral corner and short hair near left distolateral corner. Urosomites and caudal rami each with few dorsal pores. Caudal rami about 1.7 times longer than broad, haired on medial margins only. Terminal caudal setae uniformly and finely plumose; medialmost (dorsal) caudal seta slender, also uniformly plumose; setae of left and right rami identical.

Right antennule (Figs. 2, 3) with 22 segments, geniculate between segments 18 and 19. Segment 12 partly divided. Segments 8 and compound segment 12 each with small socketed spine; spiniform processes of segments 10 and 11 parallel to longitudinal axis of antennule, reaching base of process or spine of next distal segment; spiniform process of segment 13 large; segments 14 and 16 without, segment 15 with spiniform process. Antepenultimate segment with stout curved process extending to midlength of penultimate segment.

Left antennule with 25 segments. Number of setae (s), spines (sp), and aesthetascs (a) of each segment as follows: (1) s + a, (2) 3s + a, (3) s + a, (4) s, (5) s + a, (6) s, (7) s + a, (8) s + sp, (9) 2s + a, (10) s, (11) s, (12) s + sp + a, (13) s, (14) s + a, (15) s, (16) s + a, (17) s, (18) s, (19) s + a, (20) s, (21) s, (22) 2s, (23) 2s, (24) 2s, (25) 5s + a. Of terminal setae, 3 setae longer than segment 25, remaining 2 setae short. No seta longer than succeeding 2 segments.

Antenna, mouthparts, and legs 1–4 like corresponding structures of *Austrinodiaptomus kleerekoperi*, new genus, new species (see following section). Schmeil's organ as in female (compare Fig. 13).

Leg 5 (Figs. 4–8): each coxopodite with small spiniform sensillum on small, distally directed process. Right basipodite (Fig. 4) not lobate except for small lobe covered with fine granules at distomedial corner; medial surface (Figs. 4, 6) with coarse denticles, caudal surface with 3 areas of fine granules. Right exopodite 1 broader than long, with small blunt process on caudal surface, and stout, distally directed process near distomedial corner. Right exopodite 2 broad, smoothly ovate, with small blunt process and short ridge on caudal surface (indicated by arrows in Fig. 4); lateral spine subterminal, stout, smooth, with slightly recurved tip; terminal claw nearly as long as entire right leg, gently and regularly curved, with slender recurved tip, and several accessory spinules on frontal surface in addition to spinules along most of medial margin (Fig. 7). Right endopodite short, broadly triangular, with apical row of hairs. Left basipodite without notable structure except irregular field of coarse denticles on



Figs. 1–8. *Argyrodiaptomus nhumirim*, new species, holotype ♂ (MZUSP 12286): 1, Pedigers 4 and 5 and urosome, dorsal (in flattened mount); 2, Right antennule segments 8–15 (most setae omitted); 3, Right antennule terminal segments (most setae omitted); 4, Leg 5, caudal; 5, Pattern of tiny spinules on left leg 5 basipodite, frontal (drawn reversed); 6, Pattern of tiny spinules on right leg 5 basipodite, frontal (reversed); 7, Proximal section of terminal claw of right leg 5, frontal (reversed); 8, Left leg 5 exopodite and endopodite, frontal (reversed). Scales = 100 μm.

medial and frontal surfaces (Fig. 5). Left exopodite 1 with proximal haired pad little developed. Left exopodite 2 (Fig. 8) appearing divided on frontal surface, with haired pad on proximal part of medial margin, and ending in narrow, coarsely serrate digitiform process; frontal side with field of tiny denticles proximal to digitiform process; proximal spine minutely serrate, with hairlike tip, extending only slightly past tip of digitiform process. Left endopodite indistinctly 2-segmented, with terminal row of 6 stout spinules.

Female.—Length of allotype 1.8 mm, of paratype 2.0 mm. Body (Figs. 9–11) stout. Prosome without ornamentation except few pairs of pores, some with hairs. Rostral points (not illustrated) acute. Pedigers 4 and 5 fused, faint fusion line visible laterally only. Posterodorsal margins of pedigers 4 and 5 not elevated. Lateral wings of pediger 5 small, posteriorly directed, right wing slightly larger than left wing, each wing with small dorsal sensillum tipped with fine hair and larger ventral spiniform sensillum, wing widest posteriorly at level of ventral spiniform sensillum. Urosome of 3 segments plus caudal rami. Genital compound segment nearly symmetrical, except right margin slightly produced posteriorly, and right spiniform sensillum placed slightly more anteriorly than left spiniform sensillum; left sensillum (Fig. 10) with acute bifid tip, right sensillum (Fig. 11) with blunt tip. Urosomite 2 slightly broader than long, proximal half telescoped into genital compound segment. Genital operculum (Fig. 12) with narrow crescentic proximal plate and broad distal plate with prominent lateral arms set wide apart (terminology after Cicchino 1994). Urosomites and caudal rami with several pairs of pores. Caudal rami about 1.7 times longer than broad, haired on medial margins only. Lateral and lateralmost terminal caudal setae stouter than more medial setae; dorsal seta slender; all setae finely and uniformly plumed.

Antennules reaching just past anterior margin of genital compound segment. Number of segments and armature as in left antennule of male.

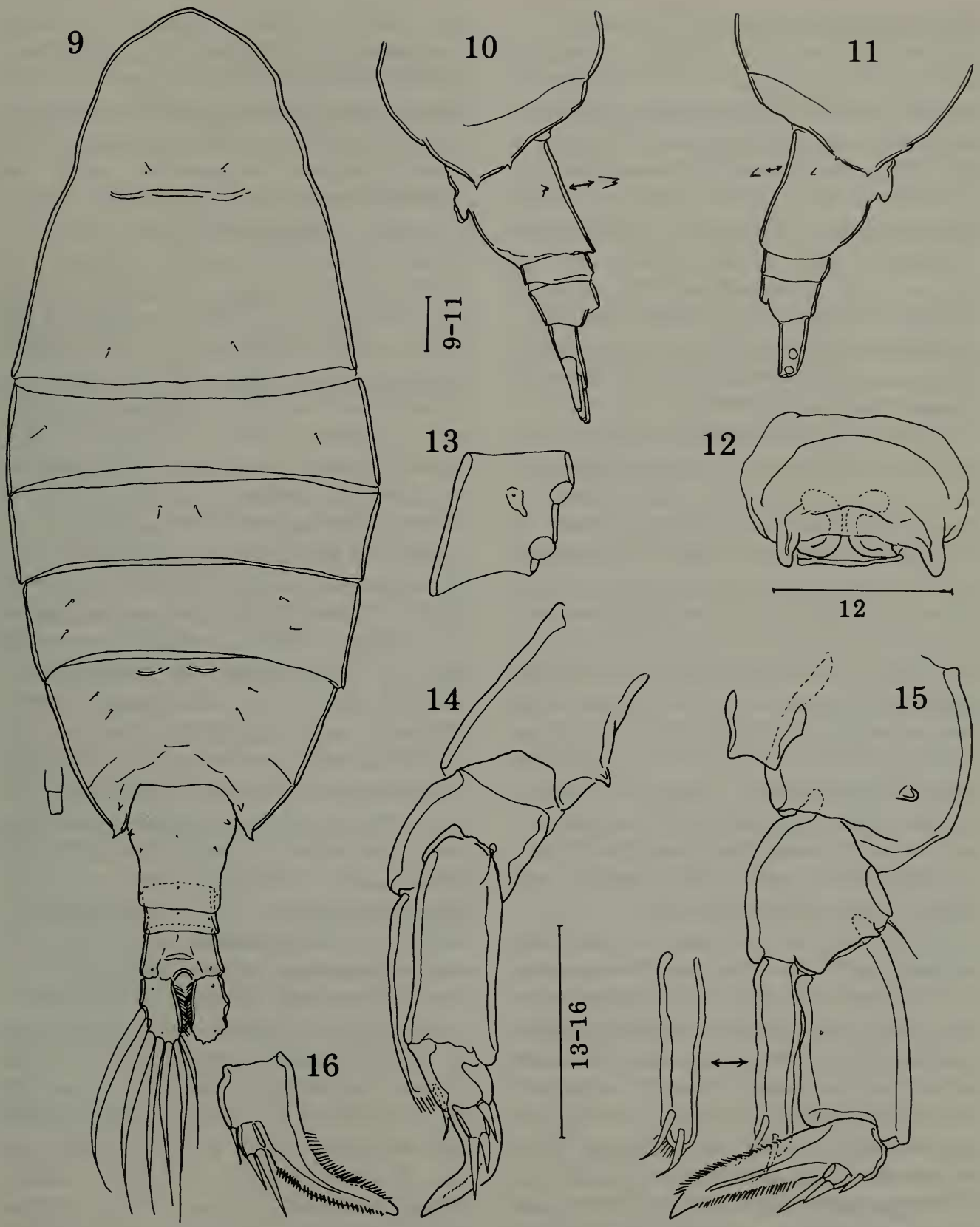
Antenna, mouthparts, and legs 1–4 as in male. Schmeil's organ (Fig. 13) mammiform, borne on caudal surface of leg 2 endopodite 2 (compare Fig. 55).

Leg 5 (Figs. 14–16): coxopodite stout, with blunt prominence on caudal surface. Basipodite with long convex medial margin, short lateral margin, and short seta at distolateral corner. Exopodite 1 about twice as long as broad, lateral margin slightly convex, medial margin uneven; with pore on caudal surface near midlength of medial margin. Exopodite 2 with small spine at base of exopodite 3, spine as long as exopodite 3; claw coarsely serrate along most of both margins; claw of each foot curved anteriorly and slightly distally, left claw more strongly curved than right claw (Fig. 14). Exopodite 3 distinct from exopodite 2, with 2 terminal spines of which lateral spine is slightly more than half length of medial spine. Endopodite slightly longer than exopodite 1, unsegmented, bearing terminal row of hairs and 2 long, curved subterminal spines.

Color of living specimens.—Light blue.

Etymology.—Named for the Fazenda Nhumirim where the species was collected; proposed as a noun in apposition.

Discussion and comparisons.—*Argyrodiaptomus nhumirim* falls morphologically and geographically among three congeners: *A. denticulatus* (Pesta, 1927), known from Argentina and Bolivia; *A. azevedoi* (Wright, 1935), from the Brazilian Northeast and Amazon Basin; and *A. robertsonae* Dussart, 1985a, from the Brazilian Amazon Basin. The male of *A. nhumirim* is easily distinguished from that of *A. denticulatus* by several characters of the 5th leg, the latter species having prominent lobes on the right basipodite medial margin, a long lateral spine on the right exopodite 2, and a long spiniform proximal process on the left exopodite 2. The spiniform process on the antennular antepenultimate segment is long in *A. denticulatus*, reaching the end of the pen-



Figs. 9–16. *Argyrodiaptomus nhumirim*, new species, allotype ♀ (MZUSP 12287): 9, Habitus, dorsal; 10, Pedigers 4 and 5 and urosome, left lateral, with enlarged illustration of bifid spiniform sensillum; 11, Pedigers 4 and 5 and urosome, right lateral, with enlarged illustration of acute spiniform sensillum; 12, Genital operculum; 13, Leg 2 endopodite 2, caudal, showing Schmeil's organ; 14, Left leg 5, lateral; 15, Right leg 5, caudal, with detail of endopodite; 16, Left leg 5 exopodites 2 and 3, caudal. Scales = 100 μm.

ultimate segment. Females of *A. denticulatus* usually have a row of spines along the lateral part of the line of fusion between pedigers 4 and 5, although these spines are lacking in some populations (J. C. Paggi, in litt. 1997). Females of *A. denticulatus* consistently have the dorsal sensillum of each wing set on an expansion; a longer, more slender genital compound segment with the left and right spiniform sensilla set at the same level; and the leg 5 with a short, two-segmented endopodite, and no spine lateral to the base of exopodite 3 (after the redescription by Dussart 1985a).

The male of *A. robertsonae* differs from that of *A. nhumirim* in having pedigers 4 and 5 fused, urosomite 1 (the genital somite) not inflated, the spiniform process on the right antennule segment 11 reaching the distal end of segment 12, and especially in having the right leg 5 basipodite with a large lobe on its caudal surface, and the distal process of the right exopodite 1 directed laterally. The female of *A. robertsonae* differs in having the lateral wings of pediger 5 most produced at the level of each dorsal spiniform sensillum, urosomite 2 much broader than long, and leg 5 exopodite 3 with a tiny laterolterminal spine, less than $\frac{1}{5}$ the length of the medioterminal spine (from Dussart 1985a:Pl. 2 Fig. 10).

Argyrodiaptomus azevedoi is morphologically closest to *A. nhumirim*, but the male of the former differs in a few characters of the right leg 5: there is a large lobe on the caudal surface of the basipodite, the caudal surface of exopodites 1 and 2 lacks processes, and the terminal claw is doubly angled with the middle part straight. These features are consistent in the representations of Wright (1935, 1938), Kiefer (1936), and Brandorff (1972), and were confirmed by inspection of a male from Betume (near Neópolis), State of Sergipe, Brazil, 13 March 1983, leg. E. R. dos Santos, identified by C. E. F. da Rocha (USNM 227122). Wright (1935) stated that the left leg 5 endopodite of the male is one-segmented, but it is indistinctly divided in the specimen from Sergipe. In the female of *A. azevedoi* (confirmed by inspection of a female from USNM 227122), there is a lateral groove but not a suture line between the fused pedigers 4 and 5, both spiniform sensilla of the genital compound segment are acute, the antennules extend to the posterior end of the genital compound segment, and the laterolterminal spine of leg 5 exopodite 3 is less than ⅓ the length of the medioterminal spine. The armature of the antennules of the female and the left antennule of the male is identical in both species. *Argyrodiaptomus azevedoi* has been reported from the northeastern Brazilian States of Bahia, Ceará, and Paraíba, and the Brazilian Amazon Basin (States of Amazonas and Pará). This is the first published record from Sergipe.

Males of the remaining congeners, *Argyrodiaptomus bergi* (Richard 1897), *A. falcifer* (Daday 1905) (=*Diaptomus argentinus* Wright, 1938), *A. furcatus* (G. O. Sars 1901) (=*D. aculeatus* Van Douwe 1911, 1912), *A. furcatus* f. *exilis* Dussart, 1985b, *A. granulosus* Brehm, 1933, *A. macrochaetus* Brehm, 1937, and *A. neglectus* (Wright 1938) all lack denticles on the medial surface of the right leg 5 basipodite (although some have areas of minute granules on the caudal surface of this segment). In the females of all these, the leg 5 endopodite is distinctly two-segmented, and except in *A. macrochaetus* and some populations of *A. furcatus*, it is much shorter than exopodite 1.

All known species of *Argyrodiaptomus* are South American (Brandorff 1976). The Chinese *Argyrodiaptomus ferus* Shen & Tai, 1964 and *A. cavernicolax* Shen & Tai, 1965 were improperly assigned to this genus (Dussart & Defaye 1983, Dussart 1985a). Both are in need of redescription and re-evaluation as to their generic affiliation, which is beyond the scope of the present article.

The Fazenda Nhumirim is maintained for agricultural and ecological research by the Empresa Brasileira de Pesquisa Agropecuária (EMBRAPA). It contains numerous permanent and ephemeral freshwater and

saline ponds, locally termed "baías" and "salinas" respectively. Of 19 localities in the southern Pantanal investigated by Reid & Moreno (1990), *A. nhumirim* appeared in only two small, shallow, fishless baías.

Argyrodiaptomus macrochaetus Brehm, 1937, new rank
Figs. 17–31

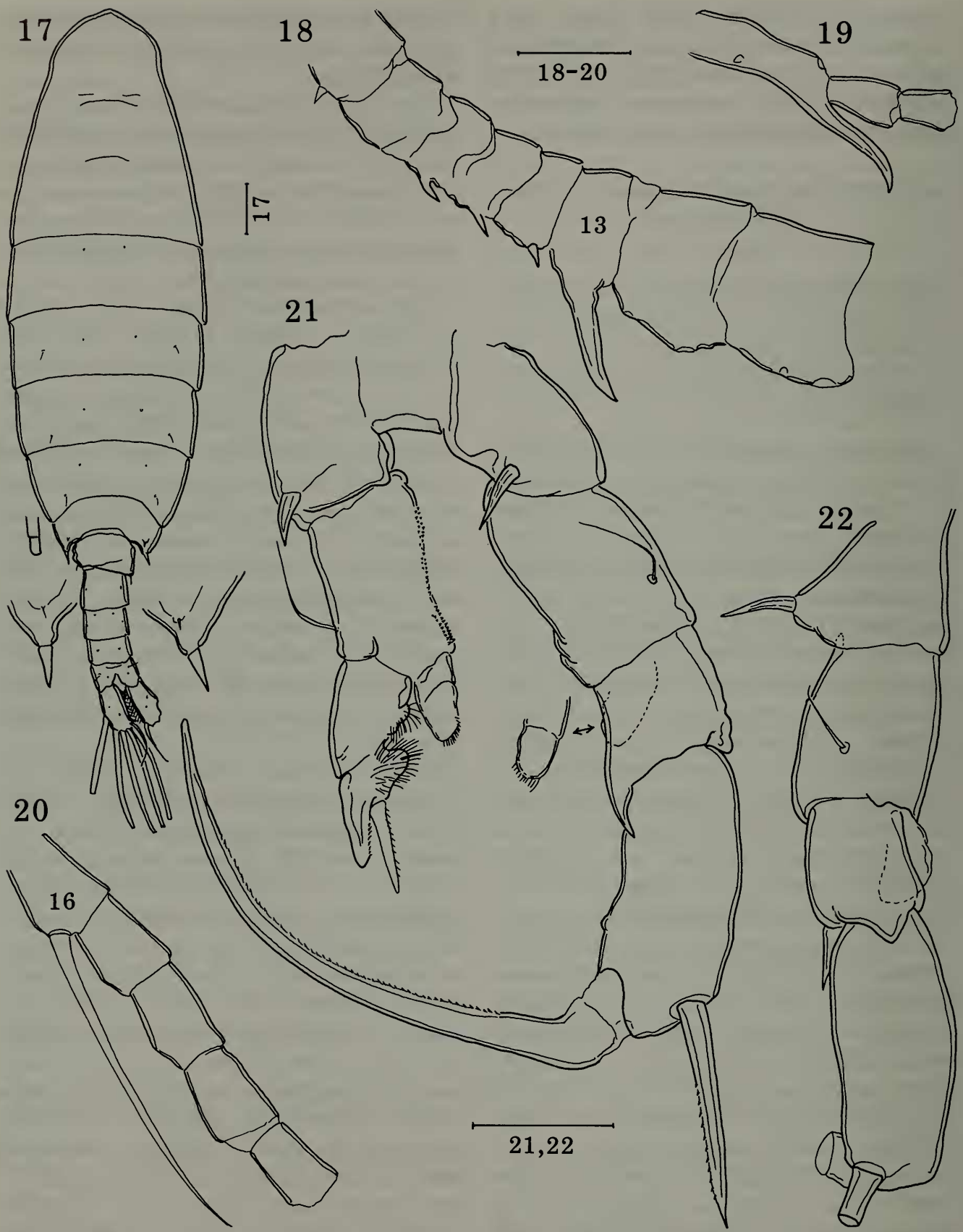
Argyrodiaptomus furcatus var. *macrochaetus* Brehm, 1937:122–125, figs. 3, 4.—Dussart & Defaye 1983:131.
Argyrodiaptomus furcatus macrochaetus.—Dussart 1984:63.

Material examined.—♂ (fully dissected on slide), ♀ (fully dissected on slide), and 2 ♀♀ and 2 copepodids, preserved whole in ethanol, from R. W. Kiser Collection, Sample 460SM/164/520 (USNM 283139). Accompanying copepod species: *Attheyella fuhrmanni* (Thiébaud; USNM 283146), *Ectocyclops rubescens* Brady (USNM 283140), *Eucyclops ensifer* Kiefer (USNM 283141), *Mesocyclops longisetus* s.s. (USNM 283142), *Microcyclops alius* (Kiefer; USNM 283143), *Neutrocyclops brevifurca* (USNM 283145), *Paracyclops chiltoni* (Thomson; USNM 283114), and *Tropocyclops prasinus* (Fischer) s.s. (USNM 283144). ♂ and 2 ♀♀, ethanol-preserved, Kiser Collection Sample 465B/198 (USNM 283123). Accompanying copepods: *A. fuhrmanni* (USNM 283126), *Austrinodiaptomus kleerekoperi*, new species (see following section), *E. rubescens* (USNM 283125), *E. ensifer* (USNM 283119), *Macrocyclops albidus* (Jurine) s.s. (USNM 283130), *M. alius* (USNM 283121), *Microcyclops anceps* (USNM 283122), *Microcyclops* cf. *ceibaensis* (USNM 283127), *Microcyclops varicans* (G. O. Sars) s.s. (USNM 283116), *Microcyclops* sp. (USNM 283118), *P. chiltoni* (USNM 283113), and *Tropocyclops prasinus meridionalis* (Kiefer; USNM 283117). Both samples from temporary pools near Porto Alegre, Rio Grande do Sul, Brazil, Sep 1941, leg. H. Kleerekoper. (Note: the Kiser Collection material arrived at the National Museum of Natural History in xylene, and was transferred to ethanol about 1986.)

The following description refers mainly to the specimens in hand, except where information is added from the incomplete description of Brehm (1937). Because of the age and dark color of the specimens, the prosomite pores could not be reliably observed in most individuals.

Male.—Lengths in mm: 1.09 (USNM 283139), 1.2 (USNM 283123). Body (Fig. 17) slender in dorsal view. Pedigers 4 and 5 distinct. Lateral wings of pediger 5 nearly symmetrical, each with hairlike dorsal sensillum and long spiniform ventral sensillum on margin, right wing slightly longer and its ventral sensillum directed slightly more laterally. Right side of urosomite 1 slightly inflated and produced posteriorly; short hair-sensillum present on each posterior corner of urosomite 1. Metasomites, urosomites, and caudal rami with paired pores (pore pattern may be incomplete as illustrated). Caudal rami haired on medial margins only.

Antennules short, reaching posterior end of prosome. Right antennule (Figs. 18, 19) with 22 segments, geniculate between segments 18 and 19. Segment 8 and (simple) segment 12 each with small socketed spine; spiniform processes of segments 10 and 11 nearly parallel to long axis of antennule, each reaching only to proximal end of succeeding segment; spiniform process of segment 13 large; segments 14–16 without processes; antepenultimate segment with stout curved process reaching nearly midlength of segment 22 (Fig. 19). Left antennule (Fig. 20) with 25 segments; number of setae (s), spines (sp), and aesthetascs (a) of each segment as follows: (1) s + a, (2) 3s + a, (3) s + a, (4) s, (5) s + a, (6) s, (7) s + a, (8) s + sp, (9) 2s + a, (10) s, (11) s, (12) s + sp + a, (13) s, (14) s + a, (15) s, (16) s, (17) s, (18) s, (19) s + a, (20) s, (21) s, (22) 2s, (23) 2s, (24) 2s, (25) 5s + a. Seta of segment 16 reaching past midlength of segment 20, no aesthetasc at base



Figs. 17–22. *Argyrodiaptomus macrochaetus* Brehm, 1937, ♂ (17, USNM 283123; 18–22, USNM 283139): 17, Habitus, dorsal, with detail of left and right wings of pediger 5; 18, Right antennule segments 8–15 (setae omitted); 19, Right antennule terminal segments; 20, Left antennule segments 16–20 (most setae omitted); 21, Leg 5, caudal, showing Schmeil's organ; 22, Right leg 5, lateral. Scales = 100 μm.

of seta. Lengths of remaining setae similar to corresponding setae of female (Figs. 27, 28).

Antenna, mouthparts, and legs 1–4 like corresponding structures of *Austrinodiaptomus kleerekoperi*, new genus, new species (see following section). Schmeil's organ as in female (compare Fig. 29).

Leg 5 (Figs. 21, 22): each coxopodite with large spiniform sensillum on small, caudally directed lobe. Right basipodite with distal part of medial margin slightly lobate, and ornamented only with long lateral seta. Right exopodite 1 slightly longer than broad, with small blunt conical lobe on distolateral corner and long acute curved process on distomedial corner. Right exopodite 2 with small rounded process at distal ⅔ of medial margin; lateral spine subterminal, about ¾ length of segment, with serrate medial margin; terminal claw about as long as right basipodite and exopodite combined, gently curved with major curvature at distal ⅔, and serrate along medial margin (tip of claw worn, thus claw may actually be somewhat longer and possibly recurved). Right endopodite short, cylindrical, indistinctly 2-segmented, with apical row of fine hairs. Left basipodite with proximomedial corner slightly dilated, and 3 small groups of denticles on medial surface (denticles not continuing onto caudal or frontal surface). Left exopodite 1 with small haired pad on medial surface; exopodite 2 with larger haired pad on medial surface, and ending in coarsely serrate digitiform process; proximal spine longer than digitiform process, straight, with blunt tip and fine hairs along medial margin. Left endopodite indistinctly 2-segmented, with terminal row of many fine hairs.

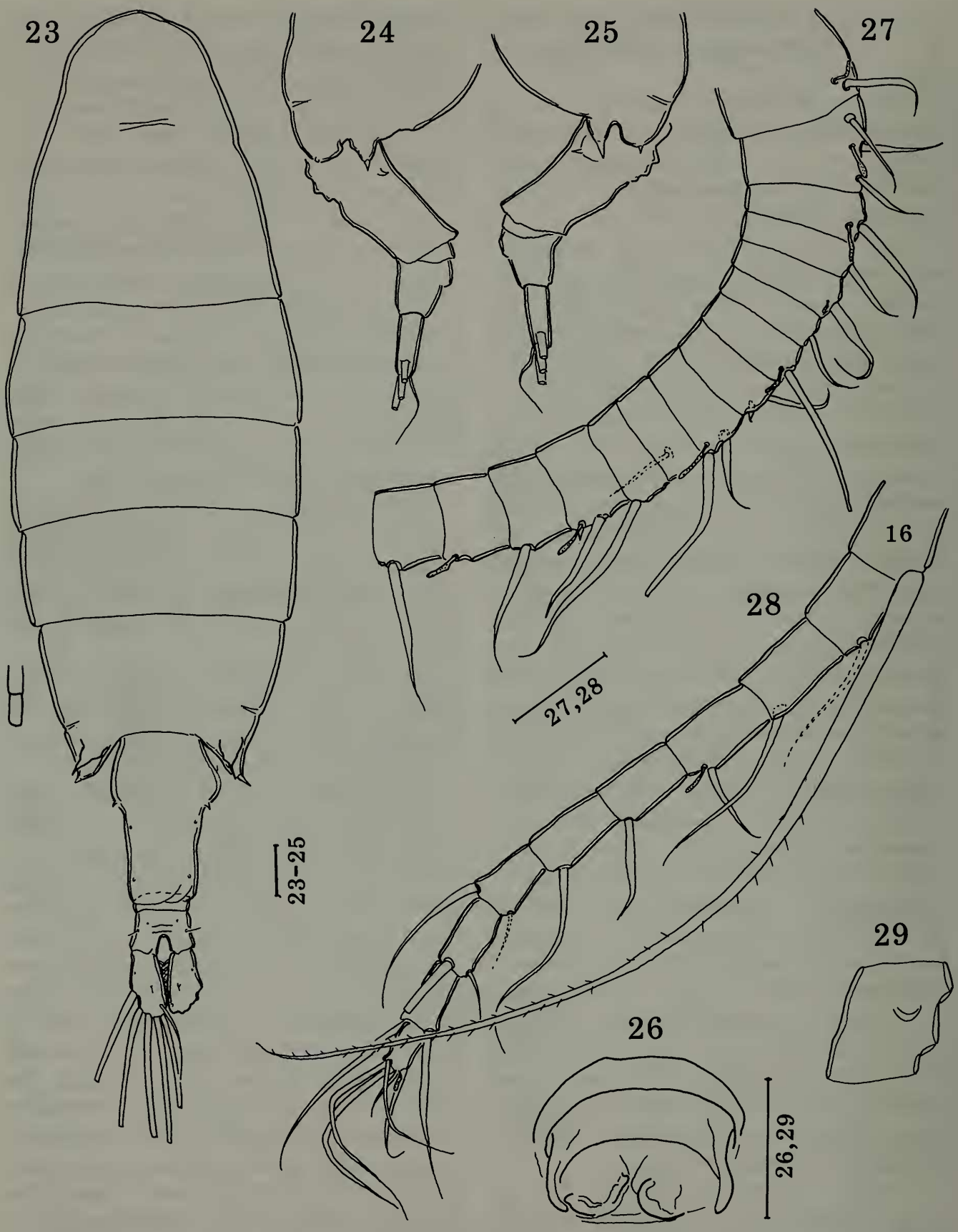
Female.—Lengths in mm: 1.6, 1.8, 2.0 (USNM 283139); 1.5, 1.7 (USNM 283123). Body (Figs. 23–25) moderately stout. Rostral points (not illustrated) acute. Pedigers 4 and 5 completely fused, line of fusion visible as lateral sulcus. Dorsal margins of pedigers 4 and 5 not elevated. Lateral wings of pediger 5 small, double, each with large dorsal and smaller ventral spiniform sensillum on margin; right wing slightly longer than left wing, with larger sensilla. Urosome of 3 segments plus caudal rami. Genital compound segment long, nearly symmetrical, except right anterior side slightly more produced than left side, and right sensillum located very slightly more posteriorly than left sensillum. Both sensilla acute (Figs. 24, 25). Genital operculum (Fig. 26) with lateral arms slightly longer than in *A. nhumirim*, otherwise similar. Urosomite 2 broader than long, telescoped into and completely covered ventrally by genital compound segment. Urosomites and caudal rami with several pairs of pores. Caudal rami haired on medial margins only.

Antennule (Figs. 27, 28) reaching only posterior end of pediger 4. Number of segments and armature as in left antennule of male, including segment 16 without aesthetasc. Seta of segment 16 extending past end of antennule.

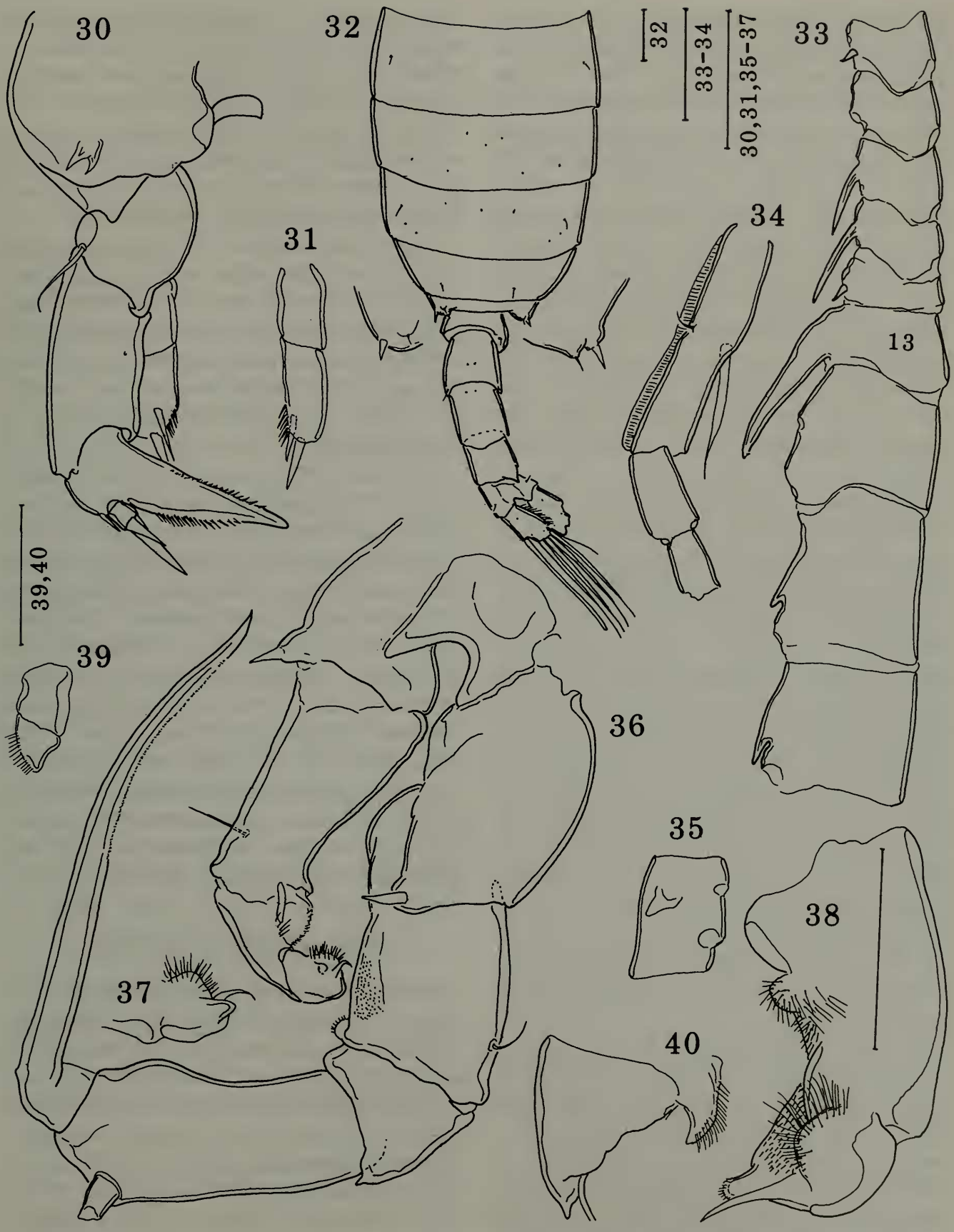
Antenna, mouthparts, and legs 1–4 like those of male. Schmeil's organ (Fig. 29) bluntly rounded, borne on caudal surface of leg 2 endopodite 2 (compare Fig. 55).

Leg 5 (Figs. 30, 31): coxopodite stout, with acutely bifid prominence on caudal surface. Basipodite with long convex medial margin, short lateral margin, and long lateral seta. Exopodite 1 slightly more than twice longer than broad, with pore on caudal surface near midlength of medial margin. Claw of exopodite 2 (of both 5th legs) broad and coarsely serrate along most of both straight margins; exopodite 2 also with slender spine at base of exopodite 3, this spine as long as and closely appressed to exopodite 3. Exopodite 3 distinct, with 2 stout terminal spines of which lateral spine is about half length of medial spine. Endopodite reaching end of medial margin of exopodite 1, distinctly 2-segmented, bearing subterminal medial row of hairs and 2 long, straight subterminal spines, distal spine especially stout.

Color of living specimens.—Notes by R. Thomsen, as reported by Brehm (1937:123,



Figs. 23–29. *Argyrodiaptomus macrochaetus* Brehm, 1937, ♀ (USNM 283139): 23, Habitus, dorsal; 24, Pedigers 4 and 5 and urosome, left lateral; 25, Pedigers 4 and 5 and urosome, right lateral; 26, Genital operculum; 27, Antennule segments 1–15; 28, Antennule segments 16–25; 29, Leg 2 endopodite 2, caudal, showing Schmeil's organ. Scales = 100 μm.



Figs. 30–40. *Argyrodiaptomus macrochaetus* Brehm, 1937, ♀ (USNM 283139): 30, Leg 5, caudal; 31, Leg 5 endopodite, frontal. Figs. 32–40. *Austrinodiaptomus kleerekoperi*, new genus, new species, holotype ♂ (MZUSP 12288): 32, Habitus, dorsal, with enlarged detail of lateral wings of pediger 5 (cephalosome broken); 33, Right antennule segments 8–16; 34, Right antennule terminal segments; 35, Leg 2 endopodite 2, caudal, showing Schmeil's organ; 36, Right Leg 5, oblique caudal; 37, Leg 5, left exopodite 2, oblique caudal; 38, Leg 5, left exopodite, caudal; 39, Leg 5, left endopodite, frontal; 40, Right leg 5, endopodite and exopodite 1, frontal. Scales = 100 μm.

translated): "The antennas of all animals are marked with 2 or 3 colored bands, each band includes 2–3 segments. Thus in some males, which I have directly under the microscope, on the antenna counting from the end, segments 6, 7, 8, 13 and 14 have a deep red coloration, which can be nearly black, while the other segments remain clear. Also the body shows these remarkable bands: segment 6 and 5 dark, 4 and 3 light, 2 again dark. A female is, in contrast, grass-green." Brehm (1937) confirmed this banding in his preserved specimens, but their color had changed to brownish red. The present, long-preserved specimens are light to dark brown with no trace of color banding.

Discussion and comparisons.—Brehm (1937) gave a cursory description of *A. furcatus* var. *macrochaetus*, with only two partial figures of the antennule and fifth leg of the female. Nevertheless, most characters mentioned by Brehm, including (in the male) the lack of spiniform processes on the right antennule segments 14 and 15, and the lateral spine of the right fifth leg exopodite 2 being much shorter than the segment, and (in the female) the long, strong subterminal spine of the leg 5 endopodite, and especially the strikingly long seta of antennule segment 16 agree exactly with the present specimens. Brehm (1937) stated that leg 5 endopodite of the female had three spines, but he probably mistook the rather stout proximalmost hairs of the subterminal hair row for a spine.

In other respects, as observed by Brehm, *A. macrochaetus* does indeed resemble *A. furcatus* and *A. furcatus* f. *exilis*. Important differentiating characters of *A. macrochaetus* include the long setae (especially on segment 16) of the antennule of both sexes; in males, the antennule lacking spiniform processes on segments 14 and 15 and with a long process on the antepenultimate segment, and, in the fifth leg, the large spiniform sensilla on the coxopodites, the small proximomedial lobe of the left basipodite, the long acute distomedial process of the right exopodite 1, and the relatively short lateral spine of the right exopodite 2; in females, the double lateral wings of pediger 5, and in the fifth leg, the bifid prominence of the coxopodite and the relatively long, two-segmented endopodite with two strong spines. These distinctive attributes fully justify raising the taxon to species rank.

Argyrodiaptomus macrochaetus has been reported only from the original collection, near the mouth of the La Plata River, Uruguay. The find near Porto Alegre extends its range northeastwards. Brehm (1937) did not specify the habitat, except that it was in fresh water. Apparently this is a species of temporary pools.

Cicchino (1994) pointed out the potential utility of the genital operculum in the taxonomy of diaptomids. She described the genital operculum structure in 10 South American species belonging to 6 genera, not including *Argyrodiaptomus*. The opercula of *A. nhumirim* and *A. macrochaetus* differ from all these in having a narrow proximal plate and broad distal plate with prominent lateral arms. The shape of the distal plate and its lateral arms resembles most that of species of *Notodiaptomus* Kiefer, 1936, but in *Notodiaptomus* the proximal plate is about as broad as the distal plate, and subrectangular (Cicchino 1994).

Austrinodiaptomus, new genus

Diagnosis.—Diaptomidae, Diaptominae. Species of temporary ponds. Left antennule of male and both antennules of female with 2 setae on segment 11 and 1 seta on each of segments 13–19; no setae with hooked ends, but several setae of terminal segments stout, with blunt tips. Legs 1–4 with lateral spine on each exopodite segment, except leg 1 exopodite 2 lacking spine. Schmeil's organ present on leg 2 endopodite 2. Male: urosomite 1 (genital somite) with small hair-sensillum on right distal margin. Right antennule with socketed spine on each of segments 8 and 12, and spiniform process on each of segments 10, 11, 13, 15, and 16;

antepenultimate segment with hyaline membrane along nearly entire length, but without process. Right leg 5, coxopodite not markedly expanded medially, caudal surface with large, distally directed protrusion bearing spiniform sensillum; basipodite produced posteriorly, ornamented only with tiny granules; endopodite of 1 short segment; exopodite 1 short and broad, exopodite 2 slightly expanded distally, bearing subterminal lateral spine and long slender terminal claw. Left leg 5, coxopodite with small protrusion bearing spiniform sensillum; basipodite slender, lacking surface ornament except lateral seta; endopodite of 2 short segments; exopodite 1 more than twice as long as exopodite 2, bearing medial haired pad; exopodite 2 narrow, with medial haired pad and ending in short stubby digitiform process and slightly longer proximal spine. Female: Pedigers 4 and 5 distinct, without dorsal process; lateral wings double, nearly symmetrical, each with 2 large spiniform sensilla. Urosome of 3 segments plus caudal rami, urosomite 2 short. Leg 5, coxopodite with large spiniform sensillum borne on conical protrusion on caudal surface, and with or without accessory spiniform process on anterolateral surface; basipodite with lateral seta inserted directly on segment, not on protrusion; exopodite 1 usually without ornament except for medial pore (1 specimen of *A. kleerekoperi* with lateral spiniform process on 1 leg), exopodite 2 with lateral spine, and exopodite 3 distinct, with 2 terminal spines; endopodite shorter than or equal to exopodite 1, with 2 or 3 short subterminal spines and subterminal oblique row of hairlike spinules.

Etymology.—From the Latin *austrinus*, south, prefixed to *Diaptomus*; gender masculine.

Type species.—*Austrinodiaptomus kleerekoperi*, new species.

Additional species.—*Austrinodiaptomus inexspectatus* (Brehm 1958), new combination.

Discussion and comparisons.—A combination of several characters makes it impossible to assign the new species to any existing genus of the family, particularly the several genera that include medium to large diaptomids of temporary ponds. These characters are, in both sexes, the two setae on antennule segment 11 and one seta on segments 13–19, the lack of hooked setae and the presence of stout blunt setae on some segments of the antennule, and the presence of Schmeil's organ on leg 2 endopodite 2. Characters of the male include the right antennule without a spiniform process on segment 14 or a process on the antepenultimate segment, and in leg 5, the short endopodites, the narrow left exopodite, and the right coxopodite without a large medial expansion. Characters of the female include the lack of a dorsal projection on pedigers 4 or 5, and in leg 5, the short stout spines on the endopodite, the presence of a lateral spine on exopodite 2, and the distinct exopodite 3.

Of the South American diaptomid genera, several (*Argyrodiaptomus*, *Colombodiaptomus* Gaviria 1989, *Dasydiaptomus* Defaye & Dussart, 1993, *Notodiaptomus* Kiefer 1936, *Prionodiaptomus* Light 1939, *Rhacodiaptomus*, and *Scolodiaptomus* Reid 1987) possess only 1 seta on antennule segment 11, among other differences. Other genera for which the antennular setation is undescribed (*Calodiaptomus* Kiefer 1936, *Dactylodiaptomus* Kiefer 1936) differ in having the male with spiniform processes on segment 14 and the antepenultimate segment of the right antennule, and the female with leg 5 exopodite 3 fused to exopodite 2, among other features. In *Aspinus* Brandorff, 1973b, exopodite 1 of legs 1–4 lacks a lateral spine. Females of *Idiodiaptomus* Kiefer, 1936 have one subterminal spine on the leg 5 endopodite; males possess a spiniform process on right antennule segment 14. Females of *Odontodiaptomus* Kiefer, 1936 have single pediger 5 wings and the leg 5 endopodite with only one subterminal spine; males have the right leg 5 endopodite long, and complex lobing on the basipodite

and exopodite. In females of *Tumeodiaptomus* Dussart, 1979 the urosomite 2 is longer than broad and expanded, and in males there is a pectinate process on the antepenultimate segment of the antennule and the lateral spine of the right leg 5 exopodite 2 is inserted in the proximal half of the segment. Therefore, the new genus *Austrinodiaptomus* is proposed to accommodate the new species and the similar *D. inexspectatus*.

Austrinodiaptomus kleerekoperi,
new species
Figs. 32–59

Diaptomus s.l. *inexspectatus* Brehm, 1958.—Brandorff 1972:50 (partim).—Brandorff 1973a:342 (partim).

Diaptomus s.l. *inexpectatus*.—Brandorff 1976:618 (partim).—Dussart & Defaye 1983:64 (partim).—Dussart 1984:64 (partim).—Battistoni 1995:958 (partim).

Rhacodiaptomus inexspectatus.—Brehm 1965:3, 11–14, fig. 1 (partim).

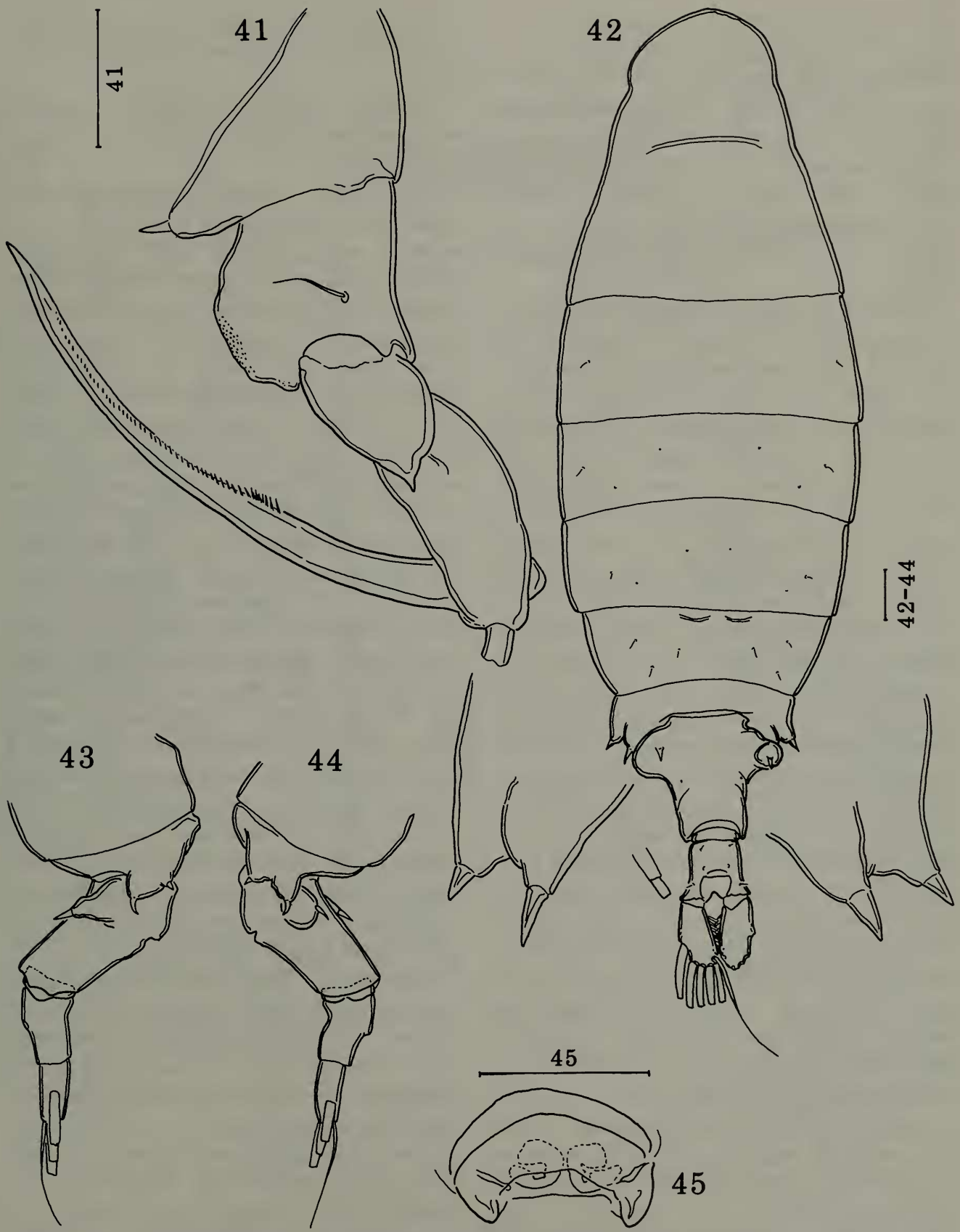
Material examined.—♂ holotype (MZUSP 12288) and ♀ allotype (MZUSP 12289), each fully dissected on slide. Paratypes: 2 ♀♀, ethanol-preserved (MZUSP 12290); ♀, dissected on slide, and 2 ♀♀ (1 broken) and 1 copepodid, ethanol-preserved (USNM 283124). All from R. W. Kiser Collection, Sample 465B/198, temporary pool near Porto Alegre, Rio Grande do Sul, Brazil, Sep 1941, leg. H. Kleerekoper. Accompanying fauna: see description of *A. macrochaetus*.

Male.—Length 1.2 mm. Body (Fig. 32) slender. Rostral points (not illustrated) acute. Pedigers 4 and 5 distinct. Lateral wings of pediger 5 small, nearly symmetrical, each with dorsal hair-sensillum and ventral spiniform sensillum, sensilla of right wing slightly larger. Right side of urosomite 1 slightly inflated and posteriorly produced, with short sensillum on distal corner. Right posterior corner of urosomite 4 produced in triangular process. Cephalosome broken; metasomites, most urosomites, and caudal rami with paired pores. Caudal rami haired on medial margins only.

Antennules reaching posterior end of anal somite. Right antennule (Figs. 33, 34) with 22 segments, geniculate between segments 18 and 19. Segments 8 and 12 each with small socketed spine; slender spiniform processes of segments 10 and 11 extending slightly outward from long axis of antennule and the latter well past base of next process; process of segment 13 large, with tiny subterminal hook; segment 14 without process, but segments 15 and 16 each with small spiniform process, process of segment 16 about twice as long as that of segment 15; antepenultimate segment lacking distal process, but with broad hyaline membrane extending along nearly entire length of segment (Fig. 34). Left antennule as in female. Seta on segment 16 broken, but reaching at least end of segment 19.

Schmeil's organ (Fig. 35) mammiform, located on caudal surface of leg 2 endopodite 2 (compare Fig. 55).

Leg 5 (Figs. 36–41): each coxopodite with large sensillum on lobe on caudal surface, left lobe small, right lobe large and produced distally (Fig. 41). Right coxopodite with distomedial margin not much expanded. Right basipodite with proximal part of medial margin slightly expanded, and distal part of caudal surface expanded, with field of tiny granules; lateral seta inserted at distal ⅔. Right exopodite 1 slightly broader than long, lateral margin about twice as long as medial margin, and distolateral corner produced in small, distally directed mammiform swelling. Right exopodite 2 lacking notable surface ornamentation, with distal half of medial margin expanded, broken lateral spine inserted subterminally, and partly serrate terminal claw, gently curved with recurved tip. Right endopodite represented by short conical protrusion with row of hairs along medial surface. Left basipodite long, proximomedial corner slightly expanded, surface smooth except for lateral seta inserted at distal ¾. Left exopodite



Figs. 41–45. *Austrinodiaptomus kleerekoperi*, new genus, new species; 41, holotype ♂ (MZUSP 12288): 41, Right leg 5, lateral; 42–45, allotype ♀ (MZUSP 12289): 42, Habitus, dorsal, showing tip of antennule and enlarged details of wings of pediger 5; 43, Posterior pedigers and urosome, right lateral; 44, Posterior pedigers and urosome, left lateral; 45, Genital operculum. Scales = 100 μm.

(Fig. 38) of 2 segments, exopodite 1 about twice as long as segment 2 and bearing medial haired pad; exopodite 2 bluntly quadrate, with field of tiny hairs on medial surface, medial pad with long hairs, slender, curved, naked proximal spine, and short, stubby, finely haired digitiform process. Left endopodite (Fig. 39) of 2 segments, endopodite 2 with row of hairs along medial surface.

Female.—Lengths of allotype 1.75 mm, of paratypes 1.72, 1.72, and 1.80 mm. Body (Figs. 42–44) stout; metasomites and urosome with several pairs of dorsal pores. Rostral points (not illustrated) acute. Pedigers 4 and 5 distinct. Pedigers 4 with pair of thick transverse bars near anterodorsal margin (Fig. 42) and slightly elevated posterodorsal margin (Figs. 43, 44). Lateral wings of pediger 5 large, approximately symmetrical, double, each wing with 2 large spiniform sensilla, dorsal sensillum ventrally curved (Figs. 43, 44). Urosome of 3 segments plus caudal rami. Anterior half of genital compound segment much expanded, conical right expansion directed dorsally and posteriorly, left expansion spherical, each with large acute spiniform sensillum; right posterior margin of segment extended in shallow trapezoidal process (Fig. 43). Genital operculum (Fig. 43). Genital operculum (Fig. 45) with narrow crescentic proximal plate, broad distal plate, and broad, prominent lateral arms set wide apart. Urosomite 2 broader than long, but narrower than other urosomites. Anal somite broadened posteriorly. Caudal rami haired on medial margins only.

Antennule (Figs. 46–48) reaching caudal rami, with 25 segments. Number of setae (s), spines (sp), and aesthetascs (a) of each segment as follows: (1) s + a, (2) 3s + a, (3) s + a, (4) s, (5) s + a, (6) s, (7) s + a, (8) s + sp, (9) 2s + a, (10) s, (11) 2s, (12) s + sp + a, (13) s, (14) s + a, (15) s, (16) s + a, (17) s, (18) s, (19) s + a, (20) s, (21) s, (22) 2s, (23) 2s, (24) 2s, (25) 5s + a. Seta of segment 16 reaching end of antennule. Larger setae of segments 18, 21, and 23–25 stout, with blunt tips; smaller setae of segments 22, 23, and 25 short and slender.

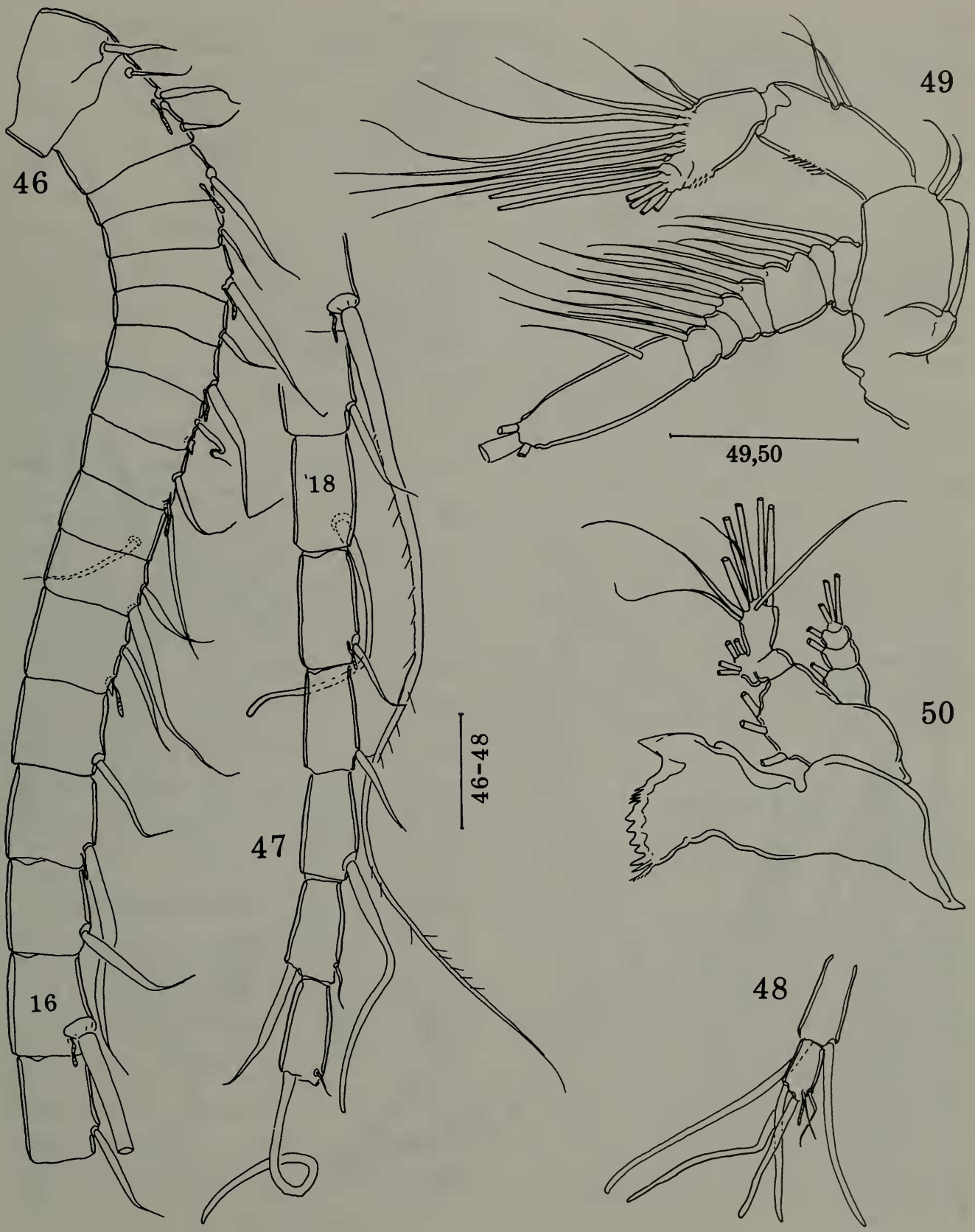
Antenna, mandible, maxillule, maxilla, and maxilliped (Figs. 49–53) of usual structure in family.

Leg 1 (Fig. 54) with 3-segmented exopodite and 2-segmented endopodite, exopodite 2 lacking lateral spine. Leg 2 (Fig. 55) with both rami 3-segmented and bluntly rounded Schmeil's organ (Fig. 56) borne on caudal surface of endopodite 2. Legs 3 and 4 (not illustrated) similar to leg 2 except slightly larger and lacking Schmeil's organ.

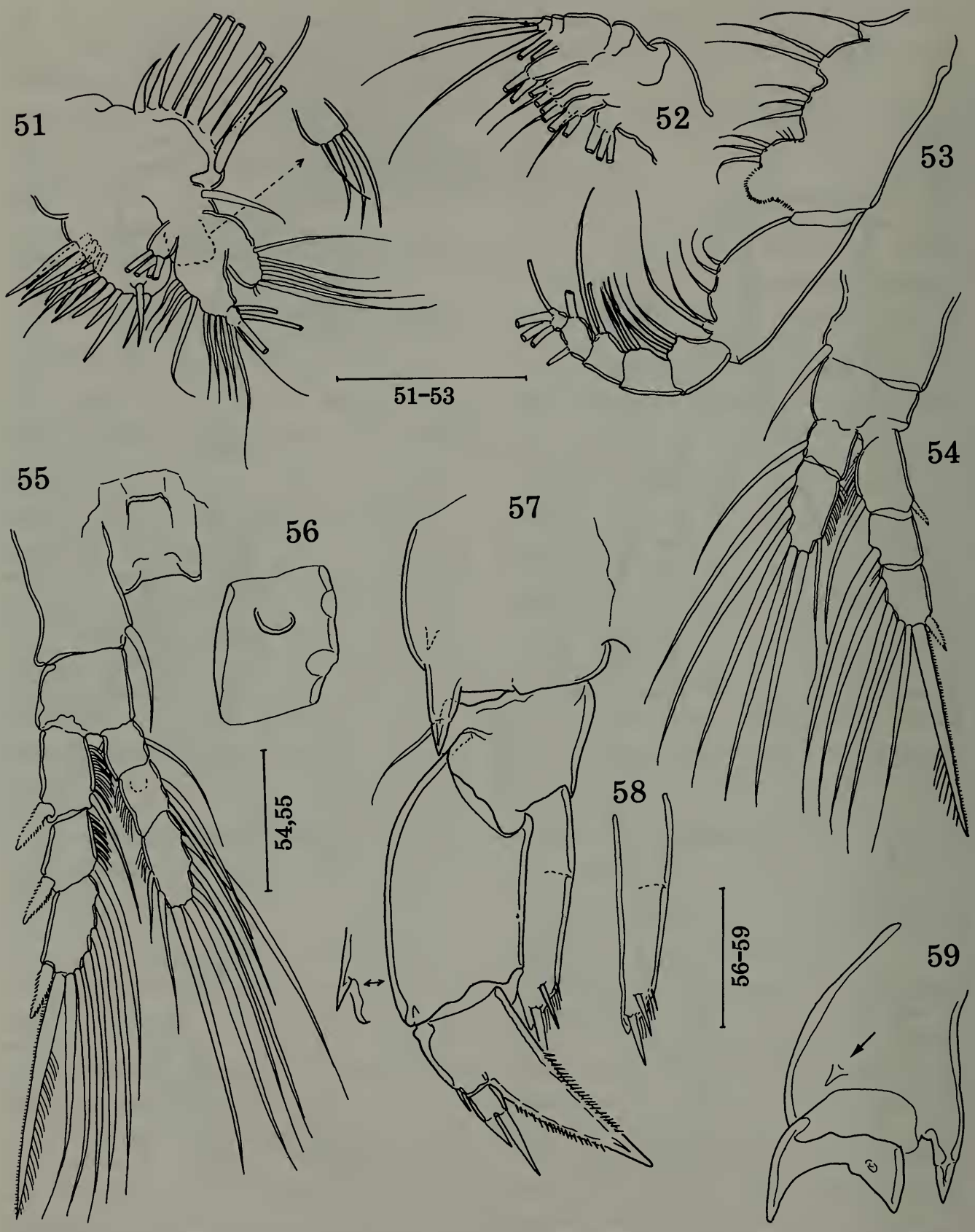
Leg 5 (Figs. 57–59): coxopodite stout, with large spiniform sensillum borne on coniform expansion on caudal surface, and spiniform process on anterolateral surface (indicated by arrow in Fig. 59). Basipodite with lateral seta inserted directly on segment, not on expansion. Exopodite 1 in most specimens without ornament except medial pore; allotype female with lateral spiniform process on 1 leg, as in detail of Fig. 57. Exopodite 2 with narrow lateral spine reaching midlength of exopodite 3, and stout claw serrate along most of each margin. Exopodite 3 distinct, with 2 stout terminal spines, lateral spine half length of medial spine. Endopodite as long as exopodite 1, indistinctly divided at proximal ⅓, with 2 short subterminal spines and oblique subterminal row of fine hairs.

Etymology.—This species is dedicated to Herman Kleerekoper, whose early investigations of southern Brazilian continental waters formed much of the basis for the subsequent development of the science of limnology in that country.

Discussion and comparisons.—*Diaptomus* s.l. *inexspectatus* was incompletely described from Argentinian material by Brehm (1958, repeated 1960). Later, Brehm (1965) made additional comments on supposed *D. inexspectatus* from old manuscript notes on female specimens collected from Las Garcias, Corrientes, Argentina, and (by H. Kleerekoper) near Porto Alegre, Brazil, and gave a sketch of a female from Porto



Figs. 46–50. *Austrinodiaptomus kleerekoperi*, new genus, new species; 46–48, allotype ♀ (MZUSP 12289); 49, 50, paratype ♀ (USNM 283124): 46, Antennule segments 1–17; 47, Antennule segments 16–23; 48, Antennule segments 24–25; 49, Antenna; 50, Mandible. Scales = 100 μm.



Figs. 51–59. *Austrinodiaptomus kleerekoperi*, new genus, new species; 51–55, paratype ♀ (USNM 283124); 56–59, holotype ♀ (MZUSP 12289): 51, Maxillule; 52, Maxilla; 53, Maxilliped; 54, Leg 1, frontal; 55, Leg 2, frontal; 56, Leg 2 endopodite 2, caudal, showing Schmeil's organ; 57, Leg 5, caudal, with detail of aberrant spiniform process on exopodite 2, found on one specimen; 58, Leg 5 endopodite, caudal; 59, Leg 5 coxa-basipodite, left lateral. Scales = 100 μm.

Alegre. Brehm (1965) claimed that his specimens from Brazil corresponded exactly with the Argentinian species. Certainly, Brehm's descriptions of the female of *D. inexspectatus* agree with the Brazilian specimens in hand regarding the distinctive double wings of pediger 5, the lobate genital compound segment, and certainly the leg 5 exopodite structure and ornament. However, there are several discrepancies. According to Brehm's (1958, 1960) descriptions, in females of the Argentinian population, the antennules reach the end of the caudal setae, the leg 5 endopodite is about ⅔ the length of exopodite 1 and bears three spines, the lateroterminal spine of exopodite 3 is about ⅙ as long as the medioterminal spine, and Brehm saw no spiniform sensillum on the left expansion of the female genital compound segment. Brehm's (1958, 1960) representations of the right leg 5 of the Argentinian male correspond with some features of the Brazilian specimen, such as the general proportions of the segments and terminal claw, the large coxopodite lobe, and the placement of the lateral exopodite spine. However, other features such as the right basipodite and exopodite 1 processes, and especially the left fifth leg exopodite do not correspond at all. Similarly, Brehm described the male right antennule as having a long segment 15 spiniform process (¾ the length of the process of segment 13). Even though Brehm had difficulty in describing the single, poorly preserved male, these discrepancies are difficult to explain as lapses of observation, and appear significant at the species level. Therefore it seems justifiable to propose a new taxon for the Brazilian population, pending redescription of the Argentine species and improvements in knowledge of variation.

Brehm (1965) transferred *D. inexspectatus* to the genus *Rhacodiaptomus* Kiefer, 1936, on the basis of the lobate genital compound segment of the female, while admitting that the structure of the male leg 5 did not agree with the diagnosis of *Rhacodiaptomus*. Subsequent authors (Brandorff 1972, 1973a, 1976; Dussart & Defaye 1983; Dussart 1984; Battistoni 1995) preferred to retain the species in *Diaptomus* Westwood, 1836 s.l.

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Literature Cited

Baird, W. 1850. The natural history of the British Entomostraca. The Ray Society, London, 364 pp. + pls. 1–36.

Battistoni, P. A. 1995. Crustacea Copepoda. Pp. 953–971 *in* E. C. Lopretto & G. Tell, eds., Ecosistemas de Aguas Continentales: Metodologías para su Estudio. Vol. 3, Ediciones Sur, La Plata.

Brandorff, G.-O. 1972. Ein Beitrag zur Calanidenfauna (Crustacea Copepoda) des Amazonasgebietes, mit einem Überblick über die Diaptomidae (Crustacea Copepoda) Sulamerikas. Unpublished Diplomarbeit, Max-Planck-Institut für Limnologie, Plön, 57 pp.

———. 1973a. Die neotropischer Gattung *Rhacodiaptomus* Kiefer (Crustacea, Copepoda), mit der Beschreibung von zwei neuen Arten.—Amazoniana 4:341–365.

———. 1973b. Neue freilebenden calanoide Copepoden (Crustacea) aus dem Amazonasgebiet.—Amazoniana 4:205–218.

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

Brehm, V. 1933. *Argyrodiaptomus granulosus* nov.

spec., ein neuer Diaptomus aus Uruguay.—Zoologischer Anzeiger 104:283–287.

———. 1937. Weitere Mitteilungen über die Süsswasserfauna Uruguays. I. Teil.—Zoologischer Anzeiger 120:120–125.

———. 1958. Bemerkungen zu einigen Kopepoden Südamerikas.—Sitzungsberichten der Österreichischen Akademie der Wissenschaften, Mathematische-naturwissenschaftliche Klasse, I, 167:139–171.

———. 1960. Sobre los copepodos hallados por el Profesor Biraben en la Argentina. 6ª. Comunicación.—Neotrópica 6(20):49–54.

———. 1965. Bericht über eine unvollendet gebliebene Untersuchung der Argentinischen Kopepodenfauna.—Sitzungsberichten der Österreichischen Akademie der Wissenschaften, Mathematische-naturwissenschaftliche Klasse, I, 174:1–15.

Cicchino, G. 1994. Importance of the genital operculum in the taxonomy of South American Diaptomidae (Copepoda, Calanoida).—Hydrobiologia 292/293:143–147.

Daday, E. von. 1905. Untersuchungen über die Süsswasser-Mikrofauna Paraguays.—Zoologica 18(44):1–374 + pls. 1–23.

Defaye, D., & B. H. Dussart. 1993. *Dasydiaptomus* nom. nov. for *Trichodiaptomus* (Copepoda, Calanoida, Diaptomidae).—Hydrobiologia 257: 127.

Dussart, B. H. 1979. Algunos copépodos de América del Sur.—Publicación Ocasional del Museu Nacional de Historia Natural, Santiago de Chile 30:3–13.

———. 1984. Some Crustacea Copepoda from Venezuela.—Hydrobiologia 113:25–67.

———. 1985a. Another new diaptomid (Crustacea, Copepoda) from the Brazilian Amazon.—Amazoniana 9:275–280.

———. 1985b. Sur quelques copépodes d'Amérique du Sud. V. Diaptomidae.—Archiv für Hydrobiologie 103:201–215.

———, & D. Defaye. 1983. Répertoire mondial des crustacés copépodes des eaux intérieures. I.—Calanoïdes. Éditions du Centre National de la Recherche Scientifique, Paris, 224 pp.

Gaviria, S. 1989. The calanoid fauna (Crustacea, Copepoda) of the Cordillera Oriental of the Colombian Andes.—Hydrobiologia 178:113–134.

Kiefer, F. 1932. Versuch eines Systems der Diaptomiden (Copepoda, Calanoida).—Zoologisches Jahrbuch für Systematik 63:451–520.

———. 1936. Über die Systematik der südamerikanischen Diaptomiden (Crustacea, Copepoda).—Zoologischer Anzeiger 116:194–200.

Light, S. F. 1939. New American subgenera of *Diaptomus* Westwood.—Transactions of the American Microscopical Society 58:473–484.

Pesta, O. 1927. Ein Beitrag zur Kenntnis der Copepodenfauna von Argentinien.—Zoologischer Anzeiger 73:67–80.

Reid, J. W. 1987. *Scolodiaptomus*, a new genus proposed for *Diaptomus* (*sensu lato*) *corderoi* Wright, and description of *Notodiaptomus brandorffi*, new species (Copepoda, Calanoida), from Brazil.—Journal of Crustacean Biology 7: 364–379.

———, & I. H. Moreno. 1990. The Copepoda (Crustacea) of the southern Pantanal, Brazil.—Acta Limnologica Brasiliensia 3:721–739.

Richard, J. 1897. Sur quelques entomostracés d'eau douce des environs de Buenos Aires.—Anales del Museo Nacional de Buenos Aires 5:321–332.

Sars, G. O. 1901. Contributions to the knowledge of the fresh-water Entomostraca of South America as shown by artificial hatching from dried material. II. Copepoda—Ostracoda.—Archiv for Mathematik og Naturvidenskab 24:3–52 + pls. 1–8.

———. 1903. An account of the Crustacea of Norway. 4. Copepoda Calanoida. Bergen Museum, Bergen, 171 pp. + pls. 1–102, suppl. pls. 1–6.

Shen, C. J., & A. Y. Tai. 1964. Descriptions of eight new species of freshwater Copepoda (Calanoida) from the Delta of the Pearl River, South China.—Acta Zoologica Sinica 16:225–246. (in Chinese; English summary.)

———. 1965. Descriptions of six new species of freshwater copepods chiefly from the Pearl River Delta, South China.—Acta Zootaxonomica Sinica 2:126–140. (in Chinese; English summary.)

Van Douwe, C. 1911. Neue Süsswasser-Copepoden aus Brasilien.—Zoologischer Anzeiger 37:161–163.

———. 1912. Zur Kenntnis der Süsswassercopepoden von Brasilien.—Archiv für Hydrobiologie 7:309–321.

Westwood, J. O. 1836. *Cyclops* (Muller).—British Cyclopaedia of Natural History 2:227–228.

Wright, S. 1935. Three new species of *Diaptomus* from Northeast Brazil.—Annaes da Academia Brasileira de Sciencias 7:213–233 + pls. 1–4.

———. 1938. A review of the *Diaptomus bergi* group, with descriptions of two new species.—Transactions of the American Microscopical Society 57:297–315.