

# A NEW SPECIES OF *Rhacodiaptomus* Kiefer, 1936, FROM THE BRAZILIAN AMAZON (CRUSTACEA: COPEPODA: CALANOIDA).

Edinaldo Nelson dos SANTOS-SILVA<sup>1</sup>, Barbara ROBERTSON<sup>1</sup>

**ABSTRACT** — A new species of Calanoid copepod, *Rhacodiaptomus besti*, is described from material collected in the Igarapé São Pedro, Rio Jamari, State of Rondônia, and Lago Amanã, Rio Japurá, State of Amazonas, in Western Amazonia. A detailed morphological analysis of the species was undertaken in order to provide a basis for future studies on inter and intrageneric relationships.

**Key words:** Calanoid copepod, *Rhacodiaptomus*, Amazon Basin, Brazil.

Uma nova espécie de *Rhacodiaptomus* KIEFER, 1936, da Amazônia brasileira (CRUSTACEA: COPEPODA: CALANOIDA)

**RESUMO** — Uma nova espécie de Copepoda Calanoida, *Rhacodiaptomus besti*, é descrita de material coletado no Igarapé São Pedro, Rio Jamari, Rondônia, e no Lago Amanã, rio Japurá, Tefé, Amazonas, na Amazônia Ocidental. Foi feita uma análise morfológica detalhada desta espécie para embasar futuros estudos de associações inter e intragenéricas.

**Palavras chave:** Copepoda Calanoida, *Rhacodiaptomus*, Bacia Amazônica, Brasil.

## INTRODUCTION

As has been pointed out several times (REID, 1985; 1987; SANTOS SILVA *et al.*, 1989), the incomplete descriptions of many South American diaptomid species have hindered the diagnoses of genera and made difficult, if not impossible, the understanding of interspecific and intergeneric relationships. Compared to many, however, the genus *Rhacodiaptomus* is relatively well defined. It was erected by KIEFER (1936) to accommodate three Amazonian species of calanoids originally described by WRIGHT (1927): *Diaptomus insolitus*, *D. calamensis*,

and *D. flexipes*, and three diagnostic features were given. Later, BRANDORFF (1972; 1973) described two more species, *Rhacodiaptomus calatus* and *R. retroflexus*, revised the genus, and proposed eight additional diagnostic features.

Currently, eleven diagnostic characteristics define the genus *Rhacodiaptomus*. However, although the genus is relatively well defined, the original descriptions of the species do not provide information on mouth parts, swimming legs, and antennae, other than the right antenna of the male. As stated by WILSON (1951), this information is essential for a sound

<sup>1</sup> Instituto Nacional de Pesquisas da Amazônia, Coordenação de Pesquisas em Biologia Aquática, Caixa Postal 478, 69011-970 - Manaus, Amazonas, Brasil.

basis of comparison and diagnoses of genera and species.

In this paper we describe a new species of *Rhacodiaptomus*, *R. besti*, and include descriptions of all appendages. With this more detailed morphological analysis of a *Rhacodiaptomus* species we expect to improve the basis for future inter and intrageneric comparative studies.

*Rhacodiaptomus besti*, new species (Figs. 1 - 29).

## MATERIAL EXAMINED

Holotype, female (Coleção Sistemática de Invertebrados do Instituto Nacional de Pesquisas da Amazônia, Seção Crustacea) (INPA - CR 637) and a male allotype (INPA - CR 638), whole mounts on slides in Canada Balsam. Paratypes: dissected specimens used for drawing, on slides, in Canada Balsam, 20 females (INPA - CR 639) and 20 males (INPA - CR 640); 60 females and 60 males (INPA - CR 641); 60 females and 60 males (Museu de Zoologia da Universidade de São Paulo) (MZUSP - 11213); 60 females and 60 males (U S National Museum of Natural History, Smithsonian Institution) (USNM - cat. 259478); and 60 females and 60 males in the first author's collection, all from type locality, Igarapé São Pedro, State of Rondônia, Brazil (9°36'S, 63°37'W), collected by J. L. de Oliveira, April 30, 1987. Eight females and nine males (INPA - CR 642), collected by the late Robin Best, November 7, 1979 from Lago Amanã. All undissected

paratype specimens were initially preserved in 6% formalin, with a drop of glycerine. Now, about half are also in 70% ethanol.

## Description

Female (mean lengths and ranges, excluding caudal setae) Igarapé São Pedro: 1.08 mm  $\pm$  0.0315 (1.00 - 1.16 mm), n = 20. Lago Amanã: 1.38 mm  $\pm$  0.0921 (1.19 - 1.5 mm), n = 20.

In dorsal view, body widest at first pediger (Fig. 1). Suture between fourth and fifth pedigers incomplete dorsally (Figs. 1, 2) Fifth pediger produced on each side asymmetrically. (Figs. 1, 4, 5, 6). Left side much produced posteriorly, reaching then middle of the genital segment, left protrusion bluntly conical with two strong blunt apical spines, one directed posteriorly and the other ventrally. (Figs. 1, 3, 4, 6). Right side slightly produced laterally, rounded, bearing a small blunt apical spine directed posteriorly and a small acute spine directed dorsally at dorsal midlength (Figs. 1, 3, 4, 5).

Urosome of three segments, not including caudal rami (Figs. 1, 3, 5, 6). Large genital segment 1/2 length of urosome. Anterior portion of genital segment asymmetrically expanded laterally. Right side expanded laterally in a large, flat, leaf-shaped lobe, with distal posteriorly directed cone tipped with large spine, reaching posterior end of third urosome segment (Figs. 1, 3, 4, 5). Widest part of this lobe about 1.5 width of midsection of genital segment. Left side of genital segment expanded laterally in posteriorly directed cone

with large apical spine, expansion reaching beyond midlength of genital segment (Figs. 1, 3, 4, 6). Genital field as in Fig. 4.

Medial and lateral margins of caudal rami haired (Figs. 1, 3).

Rostral points acute below frontal organ (Figs. 7, 8).

Antennules reaching past caudal setae (Fig. 1): armature as in Fig. 9. Penultimate segment with suture-like longitudinal fold dividing segment in middle. (Fig. 10).

Antenna as in Figure 11, typical for the family.

Gnathal lobe of mandible simple, with acute apical and subapical teeth (Fig. 12). Other mouthparts (Figs. 13, 14, 15), typical for family.

Legs 1 - 4 typically diaptomid, with Schmeil's organ present on posterior surface of segment two of endopod of leg 2 (Figs. 16, 17, 18, 19). Leg 3 not figured, identical to leg 4, but slightly smaller.

Leg 5 slender, first basal segment with relatively long slender conical process directed posteroventrally (Fig. 20). Medial margin of second basal segment convex about 3 times as long as lateral margin which bears a setae. Exopod 1 about two times longer than broad with slightly convex lateral margin. Exopod 2 lacking outer spine (Fig. 20). Exopod 3 not distinct segment, with two terminal spines, lateral about twice as long as medial, reaching only to proximal third of the terminal claw (Fig. 20). Terminal claw with medial and lateral row of fine hairs on distal 2/3 (Fig.

20). Endopod of one segment, slightly constricted near end, bearing 2 short spines on either side of a group of short hairs (Fig. 20),

Range of number of eggs carried by ovigerous females from Igarapé São Pedro: 22 - 37 eggs/female,  $n = 20$ . There were no ovigerous females in Lago Amanã samples.

Male (mean lengths and ranges, excluding caudal setae) Igarapé São Pedro:  $0.98 \text{ mm} \pm 0.0315$  (0.92 - 1.04 mm),  $n = 20$ . Lago Amanã:  $1.26 \text{ mm} \pm 0.0487$  (1.14 - 1.31 mm),  $n = 7$ .

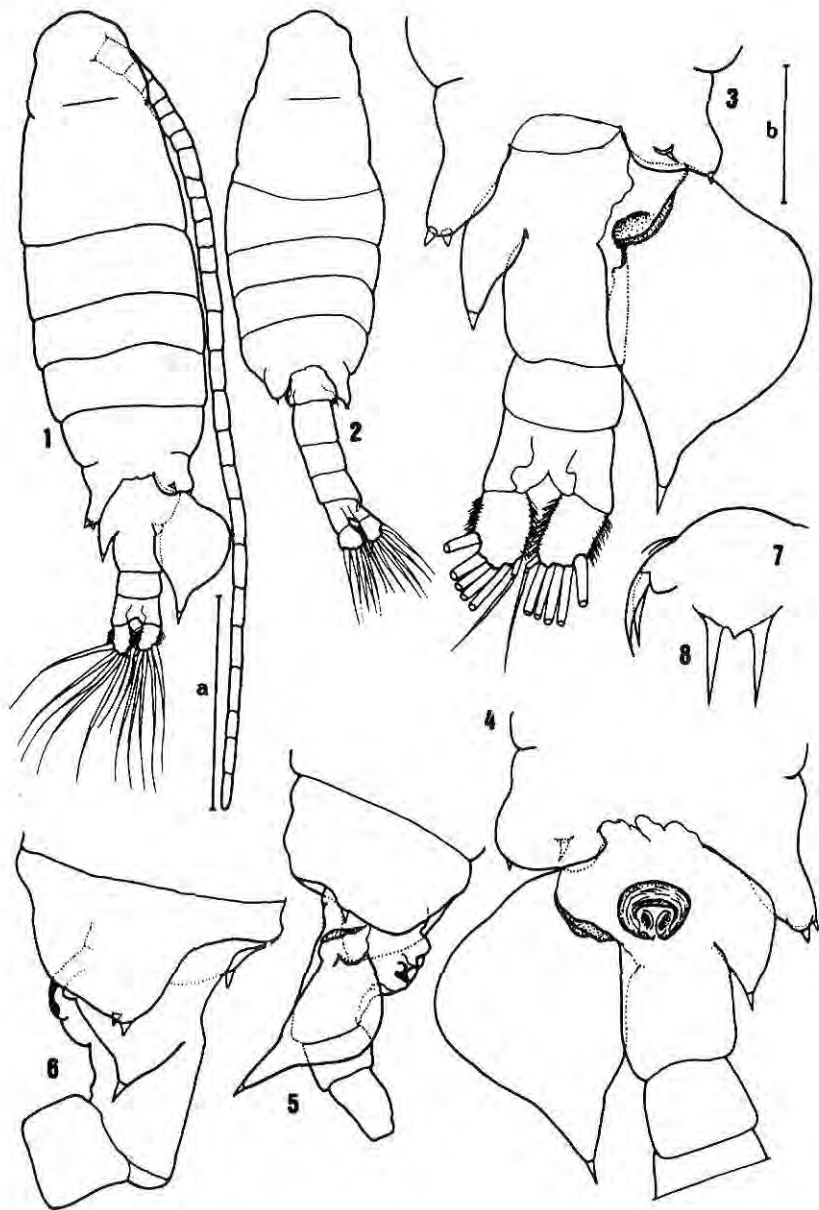
In dorsal view, body widest at first pediger. (Fig. 2). Suture between fourth and fifth pedigers incomplete dorsally. Fifth pediger asymmetric (Figs. 2, 21, 22). Left side expanded posteriorly, reaching past midlength of genital segment, rounded, with small slender spine directed posteriorly (Figs. 21, 22). Right side with long slender, conical expansion, reaching past genital segment, bearing small subterminal spine (Figs. 21, 22).

Genital segment slightly asymmetric (Figs. 21, 22). Right side expanded slightly posteriorly with very small spine on posterior corner.

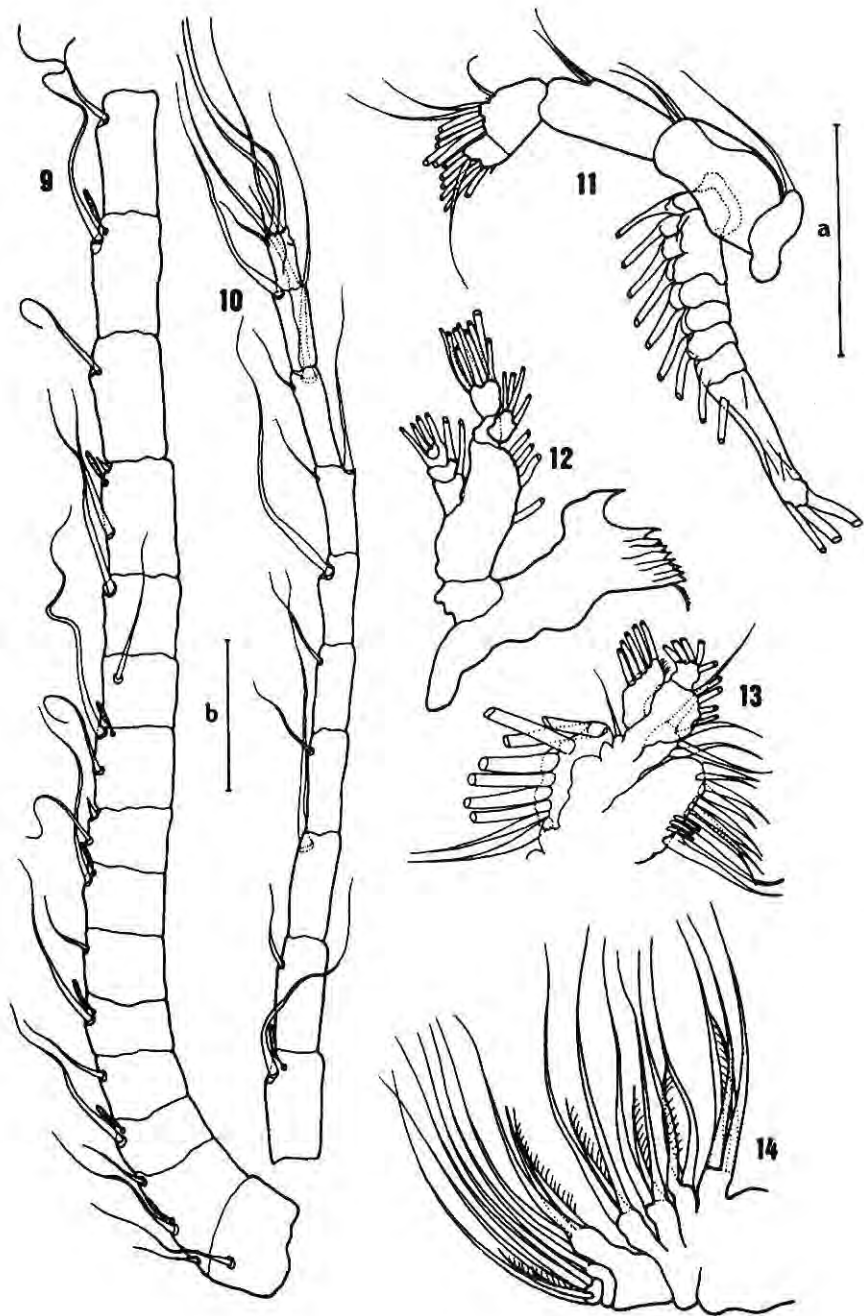
Fourth urosome segment asymmetric (Figs. 21, 22). Right side expanded posteriorly and ventrally, folding over right ventral portion of fifth urosome segment, so that left side of fifth urosome segment appears about double length of right side.

Medial margins of the caudal rami haired (Figs. 21, 22).

Rostral points acute as in female.



**Figuras 1-8.** *Rhacodiaptomus besti*; 1, female, habitus, dorsal; 2, male, habitus, dorsal; 3, female, pedigers 4 and 5 and urosome, dorsal; 4, female pedigers 4 and 5 and urosome, ventral; 5, female, pediger 5 and urosome, right lateral; 6, female, pediger 5 and urosome, left lateral; 7, female, rostral points and frontal organ; 8, female, rostral points. Scale a, figs 1, 2, 7, 8; scale b, figs 3,4,5,6; scale bars = 100  $\mu$ m.



**Figuras 9-14.** *Rhacodiaptomus besti*: female; 9,10, right antennule; 11 antenna; 12, mandible; 13, maxillula; 14, maxilla. Scale a, figs 11, 12, 13, 14; scale b, figs 9, 10; scale bars = 100  $\mu$ m.

Right antennule with socketed spines on segments 8 and 12 (Fig. 28). Spine on segment 10 about half the length of spine on segment 11. Both spines perpendicular to axis of antennule. Spine on segment 13 large, reaching midlength of segment 14, and lying parallel to axis of antennule. (Fig. 28). Process on antepenultimate segment long, surpassing penultimate segment, with slightly bent tip (Fig. 29). Penultimate and last segment as in female (Fig. 29).

Left antennule, antenna and mouth parts as in female.

Leg 5 Right leg (Fig. 23) slender. Basipod 1 with large posteriorly and ventrally directed process. This process varies between digitiform and bi-lobate in shape (Figs. 23, 24), projects over and reaches mid-length of basipod 2, and bears small spine on lateral margin (Figs. 23, 24). Basipod 2 with little crescentic hyaline lamella near anterior margin. Basipod 2 broadened posteriorly produced into large, asymmetrically bilobate claw-like process projecting posteriorly and ventrally, obscuring medial margin of exopod 1 (Fig. 23). Inner lobe of process shaped like blunt cone, reinforced with lamella: outer lobe spine-like and heavily striated. Lateral margin of basipod 2 with seta inserted in distal quarter. Exopod 1 irregularly shaped with disto-lateral corners produced and reinforced with lamella (Figs. 23, 26). Exopod 2 length more than double width; in dorsal view, medial margin slightly concave: lateral margin convex. "Lateral" spine slender, up-turned,

about one and a half times the width of exopod, inserted in middle of dorsal surface and at distal third of segment (Fig. 23). Terminal claw double length of exopod, curved and turned up at tip. Base of claw reinforced with lamella, appearing twisted. Claw with row of hairs on distal 1/2 of medial margins, not reaching tip of claw. Endopod of one article (Figs. 25, 26), longer than exopod 1, wider at base than at tip, with 2 spines on either side of group of short hairs on oblique tip.

Left leg (Fig. 23) slender. Basipod 1 with small spine inserted in lateral margin (Fig. 23), also with small crescentic lamella near inner, anterior margin. Basipod 2 about twice as long as wide, margins nearly straight, with a seta at distal quarter of lateral margin. Exopod long, of two articles. Article 1 with two separated proximal and distal inner hairy pads (Fig. 23). Article 2 distal process with row of hairs at tip and long slender smooth proximal process. Endopod of one segment about 2/3 as long as first segment of exopod, bearing two short spines on either side of group of short hairs (Fig 27).

### Distribution and occurrence

BRANDORFF (1973, 1976) observed that *Rhacodiaptomus* species occur only in the Brazilian Amazon region. This still seems to be the case except for *R. calatus* which more recently has been reported from Venezuela (DUSSART, 1984; TWOMBLY & LEWIS, 1987). *R. besti*, n. sp., has so far been found in two states in the

Amazon region, Rondônia and Amazonas, at sites very distant one from the other, which could suggest that the species is widely distributed. Also, the other calanoids occurring with *R. besti* (in Lago Amanã, *Notodiaptomus coniferoides*, *N. amazonicus*, and *Dactyloidiaptomus pearsi*: in Igarapé São Pedro, *N. coniferoides*) are widely distributed species in the Amazon basin (MATSAMURA-TUNDISI, 1986; SANTOS SILVA, 1989). However, there is no limnological information available from the sampling sites which makes it even more difficult to comment on the distribution of *R. besti*, particularly when there are cases of species (*Trichodiaptomus coronatus*, for example) which despite a broad distribution have narrow habitat requirements (REID, 1990).

### Variation

Males and females from Lago Amanã are larger than males and females from Igarapé São Pedro. The variation in the process of basipod 1 of the right P5 of the males was observed in specimens from both sampling sites, but the most frequent type was that illustrated in Figure 23.

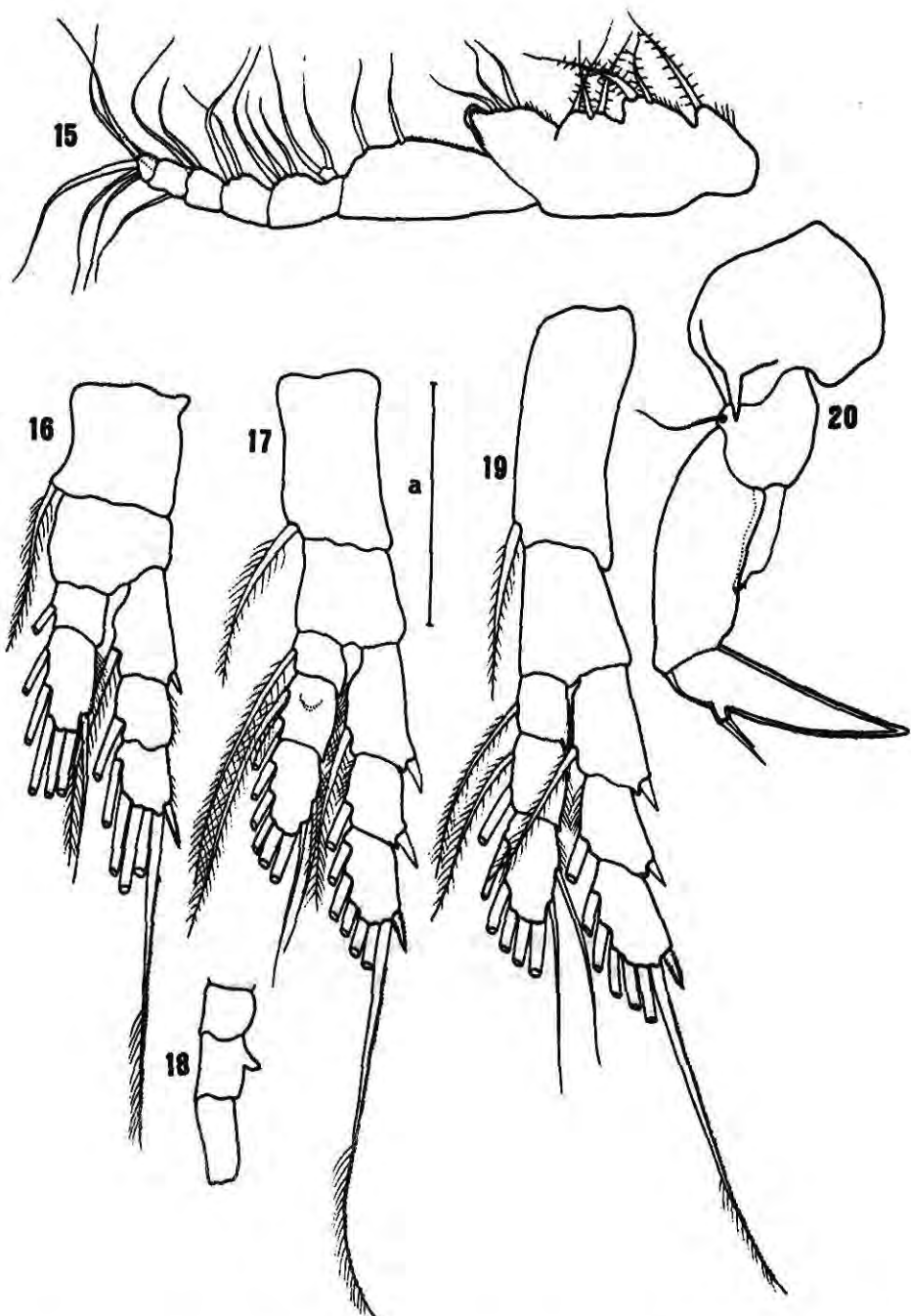
### Remarks

*R. besti*, n. sp. was included in the genus *Rhacodiaptomus* because it presents all the diagnostic characteristics of the genus. It differs from the other *Rhacodiaptomus* species in several features: female - the most evident feature is the size and shape of the

genital segment. No other *Rhacodiaptomus* species has such an extraordinarily expanded genital segment. On the basipod 1 of leg 5 there is a conical process and not a spine as figured in the other *Rhacodiaptomus* species (WRIGHT, 1927; BRANDORFF, 1973). The endopod of leg 5 is of one segment, short, about half the length of exopod 1. It is similar to that of *R. insolitus*, but different from all other species in which the endopod is either longer or two-segmented. Male - Leg 5 in the new species differs from all other *Rhacodiaptomus* species except for *R. retroflexus* with which it shares a few features; the origin and position, but not length, of the "lateral" spine, a large bilobate claw-like process (in *R. besti* it is on basipod 2 and in *R. retroflexus* it is on exopod 1). Left P5, in *R. besti* there are two hairy pads on article 1 and in *R. retroflexus* apparently only one.

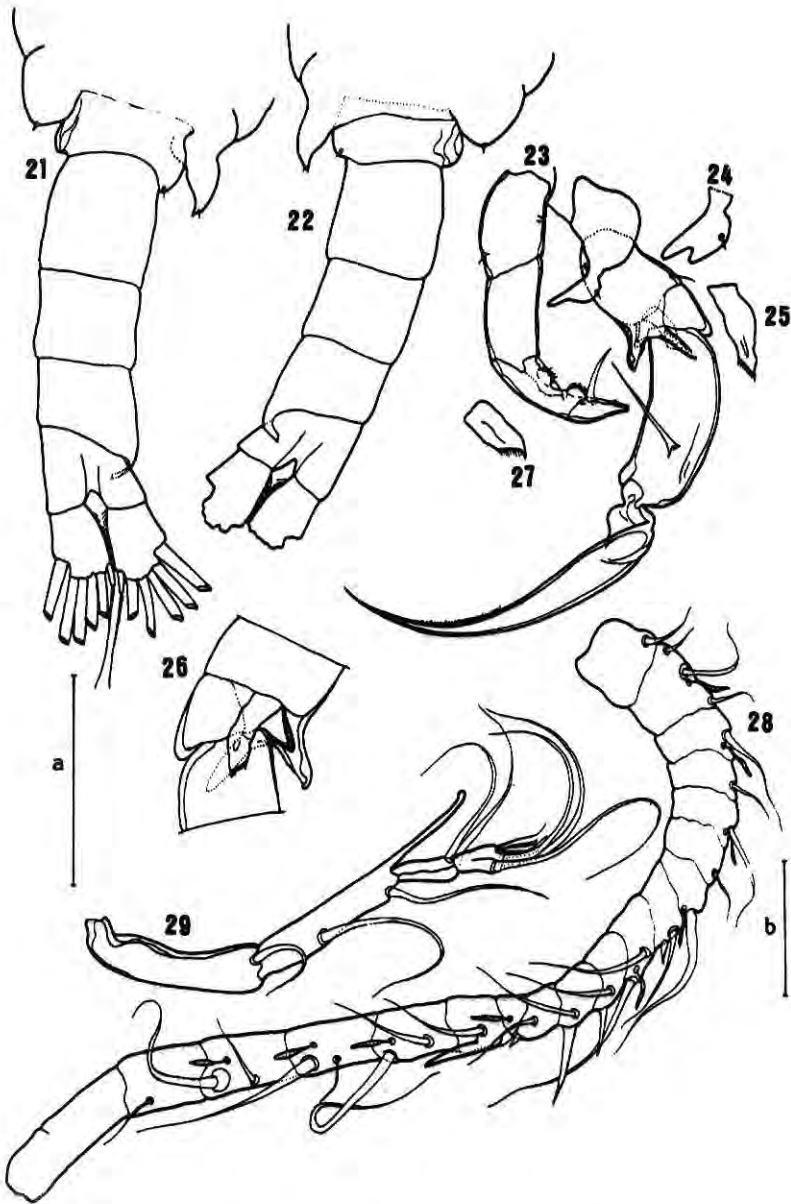
BRANDORFF (1973) commented that within the genus, *R. retroflexus* and *R. insolitus* are the most closely related species. While it is true that *R. besti* females, at most, share a few features in common with *R. insolitus* females and that *R. besti* males share a few features in common with *R. retroflexus* males, the differences between the species outweigh the similarities allowing us to suggest that *R. besti*, n. sp. has no particularly strong affinity to any other presently known *Rhacodiaptomus* species.

We continue to agree with BRANDORFF (1973) who said that "a relationship of the genus



Figuras 15-20. *Rhacodiaptomus bestii*; female; 15, maxilliped; 16, leg 1, anterior; 17, leg 2, anterior; 18, leg 2, Schmeil organ, lateral; 19, leg 4, anterior; 20, leg 5. Scale, figs 15-20: scale bar = 100 $\mu$ m.





**Figuras 21-29.** *Rhacodiaptomus besti*: male; 21, pedigers 4 and 5 and urosome, dorsal; 22, pedigers 4 and 5 and urosome, ventral; 23, leg 5, posterior; 24, variation of process on basipod 1 of right leg; 25, right leg 5, endopod, anterior; 26, basipod 2 and exopod 1 and endopod, right leg, medial; 27, left leg 5, endopod, anterior; 28 -29, right antennule. Scale a, figs 24,25,26,27; scale b, figs 21,22,23,28,29; scale bars = 100  $\mu$ m.

*Rhacodiaptomus* with other South American genera cannot be indicated", although mention should be made of what used to be *Diaptomus diabolicus* Brehm because the females also have expanded and asymmetric genital segments, to the point that at the time ZUNIGA (1975) commented "Las especiales características del segmento genital de la hembra (Fig. 1a), hacen fácilmente distinguible a *Diaptomus diabolicus* del resto de diaptomidos sud-americanas." BREHM (1965) actually included *D. diabolicus* in the genus *Rhacodiaptomus*, but it did not have all the diagnostic features proposed by KIEFER(1936) which invalidated its inclusion in the genus. More recently, DUSSART (1979) proposed to group *D. diabolicus*, *T. viviani* and, in his words, "probably" *Odontodiaptomus paulistanus* (Wright). under a new genus, *Tumeodiaptomus*. There is no diagnosis of the genus which serves as an example of the present difficulties in discussing intrageneric relationships among South American diaptomids. Apparently the only feature common to *R. besti* and the *Tumeodiaptomus* species is the expanded and asymmetrical genital segments of the females and even then they are not similar in terms of shape and size. There seem to be no other similarities between *R. besti* and the *Tumeodiaptomus* species.

### Etymology

This species is named in memory of our colleague, ROBIN BEST, who although specialized in research on

aquatic mammals, was interested in all animals, big and small.

### ACKNOWLEDGMENTS

At this opportunity we would like to thank Audrey Bergan for help in translation, Jacinta Laura de Oliveira for collecting the material, and Dr. J. Reid and Dr. V. Thatcher and two anonymous referees for valuable comments on the manuscript.

### Literature cited

- BRANDORFF, G-O. 1972. Ein Beitrag zur Calanoidenfauna (Crustacea, Copepoda) des Amazonasgebietes, mit eines Überblick über die Diaptomiden (Crustacea, Copepoda) Sudamerikas. - Dipomarbeit, Kiel, 108pp.
- BRANDORFF, G-O. 1973. Die Neotropische Gattung *Rhacodiaptomus* Kiefer (Crustacea, Copepoda) mit der Beschreibung von zwei neuen Arten. *Amazoniana*, 4(4):341-365.
- BRANDORFF, G-O. 1976. The geographic distribution of the Diaptomidae in South America. (Crustacea, Copepoda). *Rev. Bras. Biol.*, 36(3):613-627.
- BREHM, V. 1935. Mitteilungen von den Forschungsreisen Prof. Rahms. Mitteilung II. Gibt es in der Chilenischen Region Diaptomiden? *Diaptomus diabolicus* nov. spec. *Zool. Anz.*, 112:9-13.
- BREHM, V. 1965. Bericht über eine unvollendet gebliebene Untersuchung der Argentinischen Kopepodenfauna. *Sitz. Osterr. Akad. Wiss.*, I, 174(1-2):1-15.
- DUSSART, B. 1979. Algunos copepodes de America del Sur. *Publicacion ocasional, Museu Nacional de Historia Natural, Santiago, Chile*, nº 30:1-13.

- DUSSART, B. 1984. Some Crustacea Copepoda from Venezuela. *Hydrobiologia*, 113:25-67.
- KIEFER, F. 1936. Über die Systematik der sudamerikanischen Diptomiden (Crustacea, Copepoda). *Zool. Anz.*, 116:194-200.
- MATSAMURA-TUNDISI, T. 1986. Latitudinal distribution of Calanoid copepods in freshwater aquatic systems of Brazil. *Rev. Bras. Biol.* 46(3):527-553.
- REID, J. 1985. Calanoid copepods (Diptomidae) from coastal lakes, State of Rio de Janeiro, Brazil. *Proc. Biol. Wash.*, 98(3):574-590.
- REID, J. 1987. *Scolodiptomus* a new genus proposed for *Diptomus* (sensu lato) *corderoi* Wright, and description of *Notodiptomus brandorffi*, new species (Copepoda:Calanoida), from Brazil. *Journal of Crustacean Biology*, 72(2):364-379.
- REID, J. 1990. Redescription and new records of *Trichodiptomus coronatus* (G.O. Sars) (Copepoda;Calanoida;Diptomidae) from Brazil. *Proc. Biol. Soc. Wash.* 103(1):140-150.
- SANTOS SILVA, E. N.; ROBERTSON, B. A.; REID, J. L. W.; HARDY, E. R. 1989. Atlas de copepodos planctônicos, Calanoida e Cyclopoida (Crustacea) da Amazonia Brasileira. I. Represa de Curuá-Una, Pará. *Rev. Bras. Zool.*, 6(4):725-758.
- TWOMBLY, A.; LEWIS, W. 1987. Zooplankton abundance and species composition in Laguna Orsinera, a Venezuelan floodplain lake. *Arch. Hydrobiol. Suppl.* 79. 1:87-107.
- WILSON, M. S. 1951. A new subgenus of *Diptomus* (Copepoda; Calanoida) including an Asiatic species and a new species from Alaska. *Journal of Washington Academy of Sciences*, 41:168-179.
- WRIGHT, S (1927) A revision of the South American species of *Diptomus*. *Trans. Am. Microsc. Soc.*, 46:73-121.
- ZUNIGA, L. R. 1975. Sobre *Diptomus diabolicus* Brehm (Crustacea, Copepoda, Calanoida). *Noticiário Mensal, Museu Nacional de História Natural*, 19(228):3-9.

Aceito em 24/03/93