

Two new species of *Halicyclops* (Copepoda, Cyclopoida) from the Amazon Basin, Brazil

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Abstract

Two new species of *Halicyclops* are described from plankton samples taken in two localities in the Amazon River mouth area, State of Pará, Brazil. *Halicyclops lindbergi* sp.n. resembles *H. hurlberti* and *H. clarkei* from which it differs by a combination of characters in leg 5, the anal pseudoperculum and the caudal rami. The other new species, *H. dussarti*, is most morphologically similar to *H. pilosus*, but they are separated by differences in legs 1 and 5 as well as in the ornamentation of the middle caudal setae.

Introduction

Halicyclops is a cosmopolitan genus of cyclopid copepods of the subfamily Halicyclopinæ chiefly inhabiting coastal brackish water habitats. Species living in waters with low salinities can be also collected in sections of estuaries alternately carrying fresh and brackish water, as *H. oryzanus* in a pond near a ricefield irrigated by water coming from the River Mana, French Guiana (Defaye & Dussart, 1988) and *H. glaber* in several estuaries along the Brazilian coast (Rocha, unpublished data). *Halicyclops rotundipes* Kiefer, 1935, a species known from coastal areas of the Mediterranean and Black seas, was recorded as frequent in freshwater canals and in a reservoir of southern Ukraine by Bazilevich & Kaftannikova (1970).

However, very few species have been reported as exclusive freshwater forms, like those dealt with in this paper. Kiefer (1928) proposed the name *H. sinensis* for specimens tentatively identified as *H. aequoreus* by Burckhardt (1913) from the River Yangtse, China. Lindberg (1952) described *H. blachei* from River Mekong and Tonle Sap, Cambodia. In South America, *H. aberrans* was described by Rocha (1983a) from the Amazon Basin, about 120 km southeast of Belém. More recently the latter species was reported in the

rivers Mana and Kourou, French Guiana by Defaye & Dussart (1988).

Material and methods

The material analysed was collected in the lower River Guamá, about 60 km from Belém, and in the south part of Marajó Bay, near Abaetetuba. The localities sampled were in front of 'igarapés', the local name for narrow branches of the river. The water was freshwater, although the salinity has not been measured. The water movements are influenced by the tide.

Whole specimens were examined in temporary lactic acid mounts in different positions (see Rocha, 1991). After examination the specimens were returned and preserved in 70% ethanol.

The figures were made using an oil immersion lens and a camera lucida on a Leitz Laborlux D phase-contrast microscope.

The material is deposited in the Museu de Zoologia of the Universidade de São Paulo, São Paulo (MZUSP).

Taxonomy

Halicyclops lindbergi sp.n. (Figs 1–10)

Material examined. Female holotype (MZUSP 12133) from River Guamá at the mouth of Igarapé Bujaru (1°34'S, 47°56'W), State of Pará, Brazil, 18 April 1984, M. L. Carvalho col.

Female. Body length, excluding caudal setae, 480 µm. Prosome: urosome ratio 1.52:1. Cephalosome with rounded integumental window dorsally (Fig. 1). Posterior borders of all prosomites smooth (Fig. 1). Genital double somite (Fig. 2) 1.07 times longer than greatest width, slightly swollen proximally. Hyaline frills of pediger 5, genital double somite and subsequent somite (Fig. 2) similarly crenulate on both ventral and dorsal surfaces. Posterior margin of pre-anal somite expanded dorsally into coarsely serrate anal pseudopericulum. Posterior border of anal somite with ventral and lateral row of spinules; 4 medialmost ventral spinules longer than remaining spinules of row.

Caudal rami (Fig. 2) twice longer than wide. Lateral seta placed dorsally at end of first third of ramus. Outermost apical seta shorter than ramus and about 3 times longer than innermost apical seta. Dorsal seta twice length of outermost apical seta and inserted on protuberance. Inner middle apical seta 2.3 times longer than outer middle apical seta (Fig. 3). Proximal half of inner middle apical seta smooth; distal half spinulose proximally and plumose terminally. Outer middle apical seta armed with sparse spinules on outer, dorsal and ventral surfaces along most of its length and plumose distally.

Antennule of 6 segments, armed as follows (numbers refer to setae): 8 + row of spinules ventrally, 12, 5 + spine, 6 + aesthetasc, 2, 10 + aesthetasc. Segment 4 twice longer than wide.

Antenna consisting of 4 segments. Coxa reduced and unarmed. Basis with 2 setae at inner corner; seta representing exopod present. Terminal endopodal segment with 5 setae on inner margin and 7 setae around apex.

Mandible consisting of gnathobase and reduced palp with 2 setae. Gnathobase with curved row of 7 spinules anteriorly to insertion of palp (Fig. 4). Armament of distomedial margin of gnathobase not examined.

Maxillule praecoxa with 3 spines fused to segment and 1 articulated spine on apex; inner surface armament consisting of 7 setae. Palp 2-segmented and with 7 setae.

Maxilla (Fig. 5) differing from that of *H. dussarti* (Fig. 16) only by ornamentation of both terminal setae.

Maxilliped (Fig. 6) 2-segmented, armed with 2 setae on protopod and 5 setae on endopod. Proximal seta and inner apical seta of endopod each with very long stiff setule. Apical setae of endopod similar in length.

Swimming legs 1–4 armed as follows (Roman numerals indicating spines, Arabic numerals representing setae):

	Coxa	Basis	Exopod			Endopod		
			1	2	3	1	2	3
Leg 1	0-1	I-I	I-I;	I-I;	III,2,3	0-1;	0-1;	I,I+1,3
Leg 2	0-1	I-0	I-I;	I-I;	III,I+1,4	0-1;	0-2;	I,II,3
Leg 3	0-1	I-0	I-I;	I-I;	III,I+1,4	0-1;	0-2;	I,II,3
Leg 4	0-1	I-0	I-I;	I-I;	II,I+1,4	0-1;	0-2;	I,II,I+1

Spine inserted at inner corner of leg 1 basis (Fig. 7) reaching distal border of leg 1 endopod 2. Spines of leg 1 exopod similar in length to outer spines of exopods of other swimming legs. Endopod 3 of legs 2 (Fig. 8) and 3 with proximal seta spiniform, serrate distally and plumose basally; integumental pore located on anterior surface between both apical spines. Both setae of leg 4 endopod 2 plumose (Fig. 9); distal seta longer than proximal seta and almost reaching tip of inner apical spine of endopod. Leg 4 endopod 3 (Fig. 9) 1.7 times longer than wide; inner apical spine about 1.1 times longer than segment, and 1.7 times longer than outer apical spine; distal stout curved spine on inner margin 1.5 times longer than inner apical spine, bearing large denticles on concave edge and tiny denticles on convex edge; proximal inner seta spiniform, naked basally and serrate distally; only distal inner spine extending beyond tip of inner apical spine.

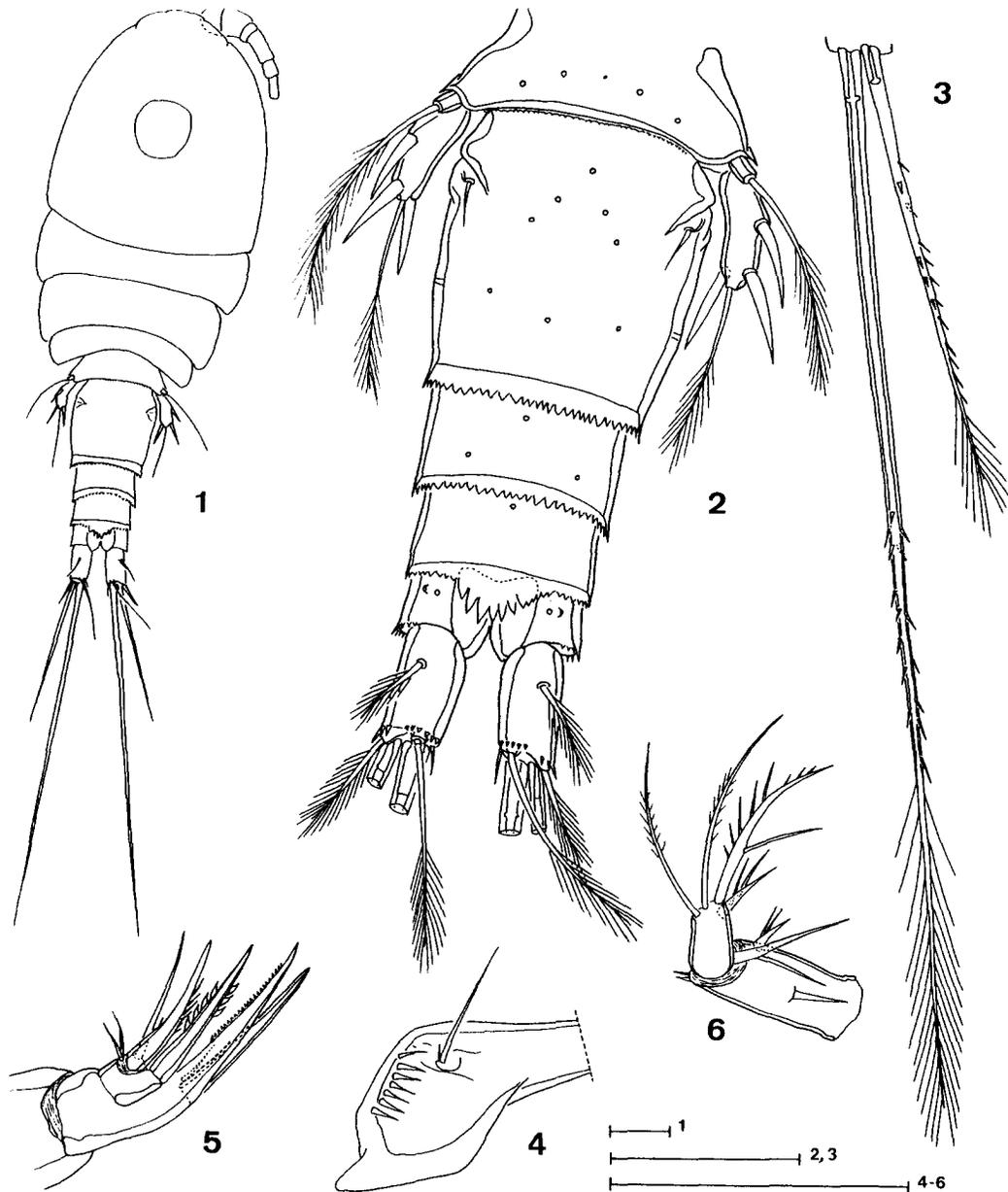
Intercoxal sclerites of legs 1 and 2 plumose near distal corners. Intercoxal sclerites of legs 3 and 4 smooth.

Leg 5 exopod (Fig. 10) 1.65 times longer than broad, bearing 3 spines and 1 seta. Outer proximal spine longer than exopod and other 2 spines. Seta 1.5 times longer than segment.

Male. Unknown.

Etymology. The species is named after Dr K. Lindberg, distinguished copepodologist who described the first *Halicyclops* species of South America.

Differential diagnosis. *Halicyclops lindbergi* sp.n. resembles *H. hurlberti* from California (Rocha, 1991) and *H. clarkei*, described by Herbst (1982) from

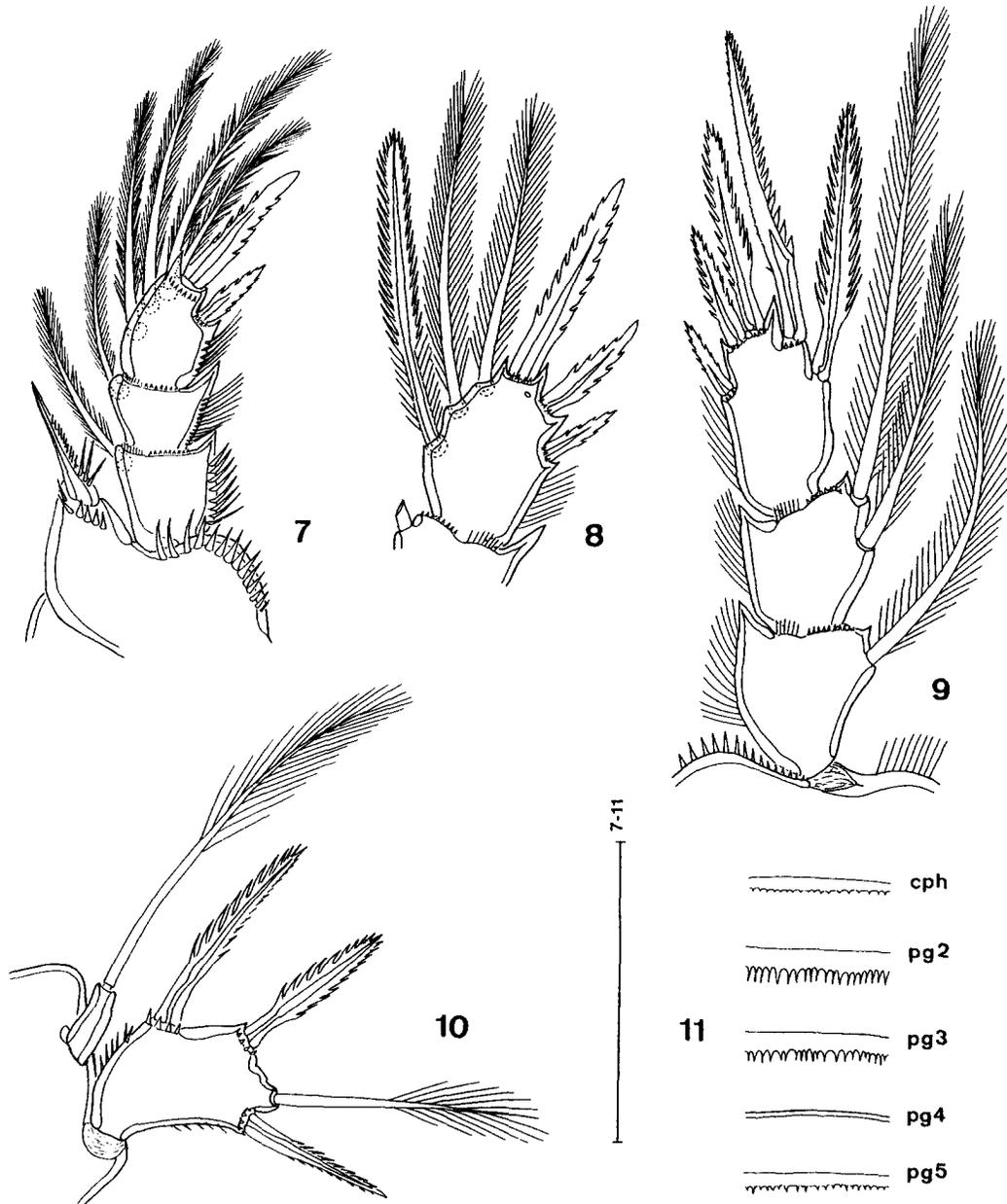


Figs 1–6. *Halicyclops lindbergi* sp.n. Female. 1. habitus, dorsal; 2. urosome, dorsal; 3. middle apical setae of caudal rami, dorsal; 4. proximal part of mandible, ventral; 5. terminal portion of maxilla, ventral; 6. maxilliped, medial. Scale bars = 50 μ m.

Louisiana and tentatively identified from the Pacific coast of Panama by Rocha (1991), in the shape of the genital double somite and general morphology of the leg 4 endopod. It is separated from these two species in having a well developed anal pseudopericulum, caudal rami twice as long as wide, ornamentation of the mid-

dle caudal setae, and the innermost spine of the leg 5 exopod shorter than the outermost spine.

Halicyclops lindbergi bears a rounded integumental window on the cephalosomic shield as figured by Ishida (1993) for *H. japonicus*. According to this same author, *H. sinensis* has an elongate, slightly constricted at halflength, integumental window which looks like



Figs 7–11. *Halicyclops lindbergi* sp.n. Female. 7. basis and endopod of leg 1, anterior; 8. terminal segment of endopod of leg 2, anterior; 9. endopod of leg 4, anterior; 10. leg 5, anterior. *Halicyclops dussarti* sp.n. Female. 11. posterior borders of cephalosome (cph) and pedigers 2 to 5 (pg2–pg5), dorsal. Scale bar = 50 μ m.

that observed in *H. bowmani* by Rocha & Iliffe (1993). Nowadays it is impossible to define the importance of this structure in the taxonomy of the genus, since its presence and shape is known for a very restricted number of species.

Halicyclops dussarti sp.n. (Figs 11–25)

Material examined. Brazil, State of Pará: female holotype (MZUSP 12134) from igarapé Jacarequara, near Abaetetuba (1 °44'S, 48 °53'W), 29 August 1970, M. A. J. de Carvalho col.; 2 male paratypes (MZUSP 12135) from River Guamá at the mouth of igarapé

Bujaru (1°34'S, 47°56'W), 11 April 1984, M. L. Carvalho col.

Female. Body length, excluding caudal setae, 640 µm.

Prosome:urosome ratio 1.66:1. Posterior edges of cephalosome and pedigers 2, 3 and 5 serrate (Fig. 11); posterior edge of pediger 4 smooth. Genital double somite (Fig. 12) 1.12 times broader than long, expanded into blunt lateral protrusions at proximal third and narrowing at posterior third. Hyaline frills of genital double somite and 2 subsequent somites (Figs 12, 13) serrate; ventral denticles of hyaline frill larger than dorsal ones and with striae converging toward their tips as shown by Fig. 14 for urosomite 4. Hyaline frill of pre-anal somite (Fig. 13) bearing little more developed denticles over anal area than on lateral parts. Anal somite (Fig. 14) having distally 3 medialmost spines much longer and stouter than remaining spines of row.

Caudal rami (Fig. 13) as long as wide. Both outermost apical setae broken off. Dorsal seta twice longer than innermost apical seta and placed on protuberance extending beyond border of ramus. Middle apical setae setulose only (Fig. 15). Proximal portion of inner middle apical seta of right ramus with few setules on both margins; equivalent seta of left ramus setulose only on inner margin. Inner middle apical seta broken near tip (Fig. 15), but at least 2.5 times longer than outer middle apical seta.

Antennule of 6 segments, armed as follows: 8 + row of spinules ventrally, 12, 5 + spine, 6 + aesthetasc, 2, 10 + aesthetasc. Fourth segment 1.8 times longer than wide.

Antenna 4-segmented. Coxa unarmed. Basis bearing seta representing exopod and 2 setae at inner distal corner. Endopod 1 with 1 inner seta. Distal segment 2.4 times longer than wide, bearing 5 setae on inner margin and 7 setae around apex.

Mandible and maxillule as in *H. lindbergi*.

Maxilla (Fig. 16) 4-segmented. Praecoxa fused to coxa on posterior surface and with 2 setae on endite. Coxa with 3 setae; seta fused to endite smooth. Basis expanded into spinulose claw and armed with 2 setae; strong seta as long as claw, both serrate on concave edge. Endopod carrying seta serrate on concave edge, another seta with a pair of spinules and 3 smooth setae.

Maxilliped (Fig. 17) 2-segmented, armed with 3 setae on protopod and 5 setae on endopod, all spinulose.

Swimming legs 1–4 armed as follows (Roman numerals indicating spines, Arabic numerals representing setae):

	Coxa	Basis	Exopod			Endopod		
			1	2	3	1	2	3
Leg 1	0-1	I-I	I-I;	I-I;	III,2,3	0-1;	0-1;	I,I+1,3
Leg 2	0-1	I-0	I-I;	I-I;	III,I+1,4	0-1;	0-2;	I,II,3
Leg 3	0-1	I-0	I-I;	I-I;	III,I+1,4	0-1;	0-2;	I,II,3
Leg 4	0-1	I-0	I-I;	I-I;	II,I+1,4	0-1;	0-2;	I,II,2

Spine inserted at inner corner of leg 1 basis (Fig. 18) reaching midlength of leg 1 endopod 3. Spines of leg 1 exopod longer than exopodal spines of other swimming legs. Endopod 3 of legs 2 and 3 (Fig. 19) with proximal-most seta spiniform, serrate distally and plumose basally. Both setae of leg 4 endopod 2 (Fig. 20) plumose and not overpassing tip of inner apical spine. Leg 4 endopod 3 (Fig. 20) 1.43 times longer than wide; inner apical spine about 1.45 times longer than segment and outer apical spine; both inner setae spiniform, similar in length each other, plumose basally and serrate distally, none of them reaching tip of inner apical spine.

Leg 5 exopod (Fig. 21) 1.2 times longer than broad, bearing 3 spines and seta; outer lateral spine as long as exopod; inner spine 1.6 times length of exopod and about twice longer than seta.

Male. Body length of 2 paratypes 400 and 430 µm. Urosome with 6 somites. Posterior borders of genital somite and 3 subsequent somites with denticles narrower and longer than in female; convergent striae of denticles absent.

Outermost apical seta of caudal ramus (Fig. 22) 1.4 times longer than innermost apical seta. Apical middle setae setulose. Proximal portion of both inner middle apical setae (Fig. 22) without setules on outer margin.

Antennule of 14 segments.

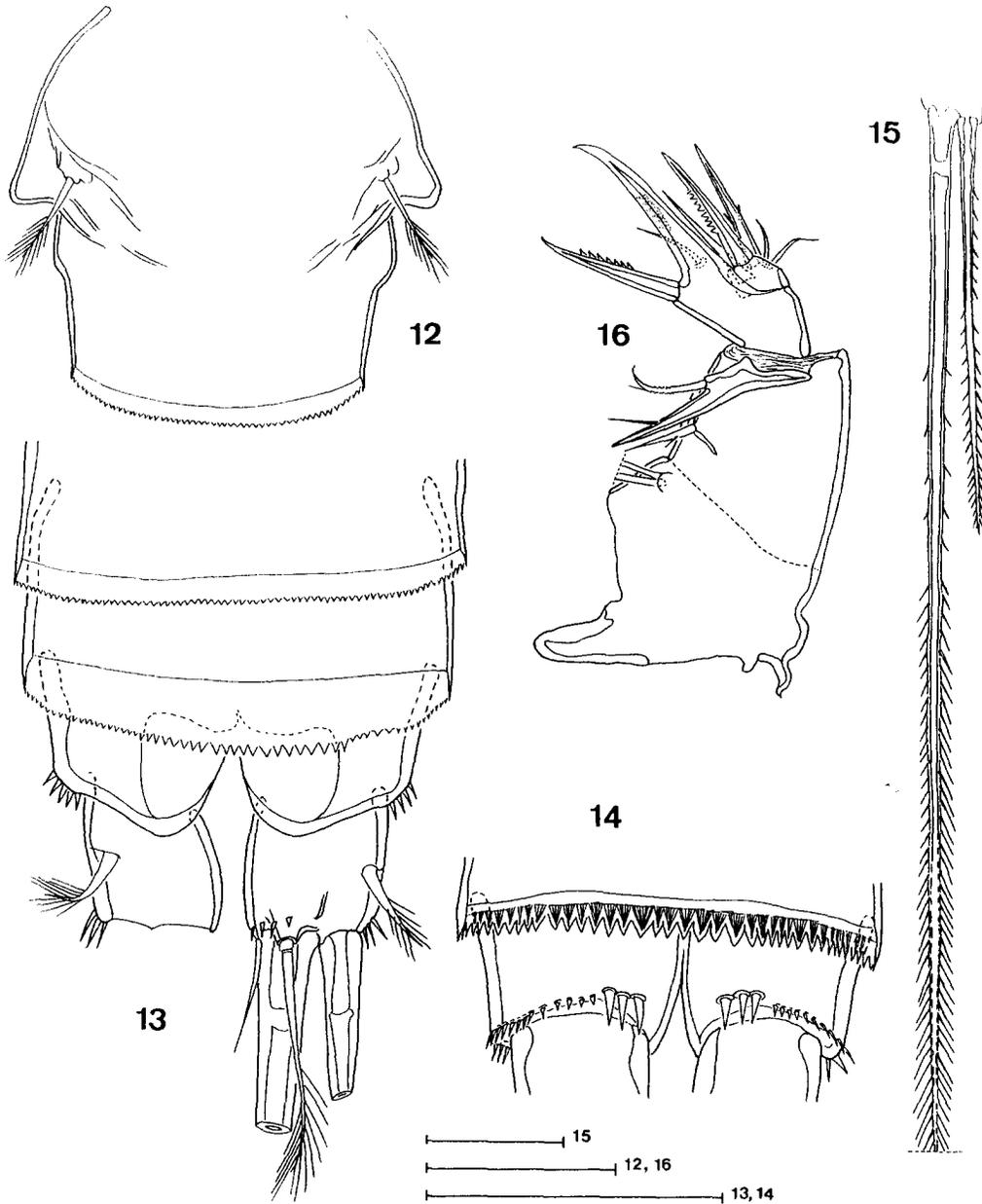
Leg 4 endopod 2 (Fig. 23) bearing proximal seta spiniform, plumose basally and serrate distally.

Leg 5 exopod (Figs 24, 25) as long as wide, with 3 spines and 2 setae. Inner spine longer than other 2 spines in one of paratypes (Fig. 24), but shorter than outer apical spine in other paratype (Fig. 25).

Leg 6 (Fig. 25) consisting of inner spine and 2 plumose setae; outer seta twice longer than median seta.

The male is identical to female in all other respects.

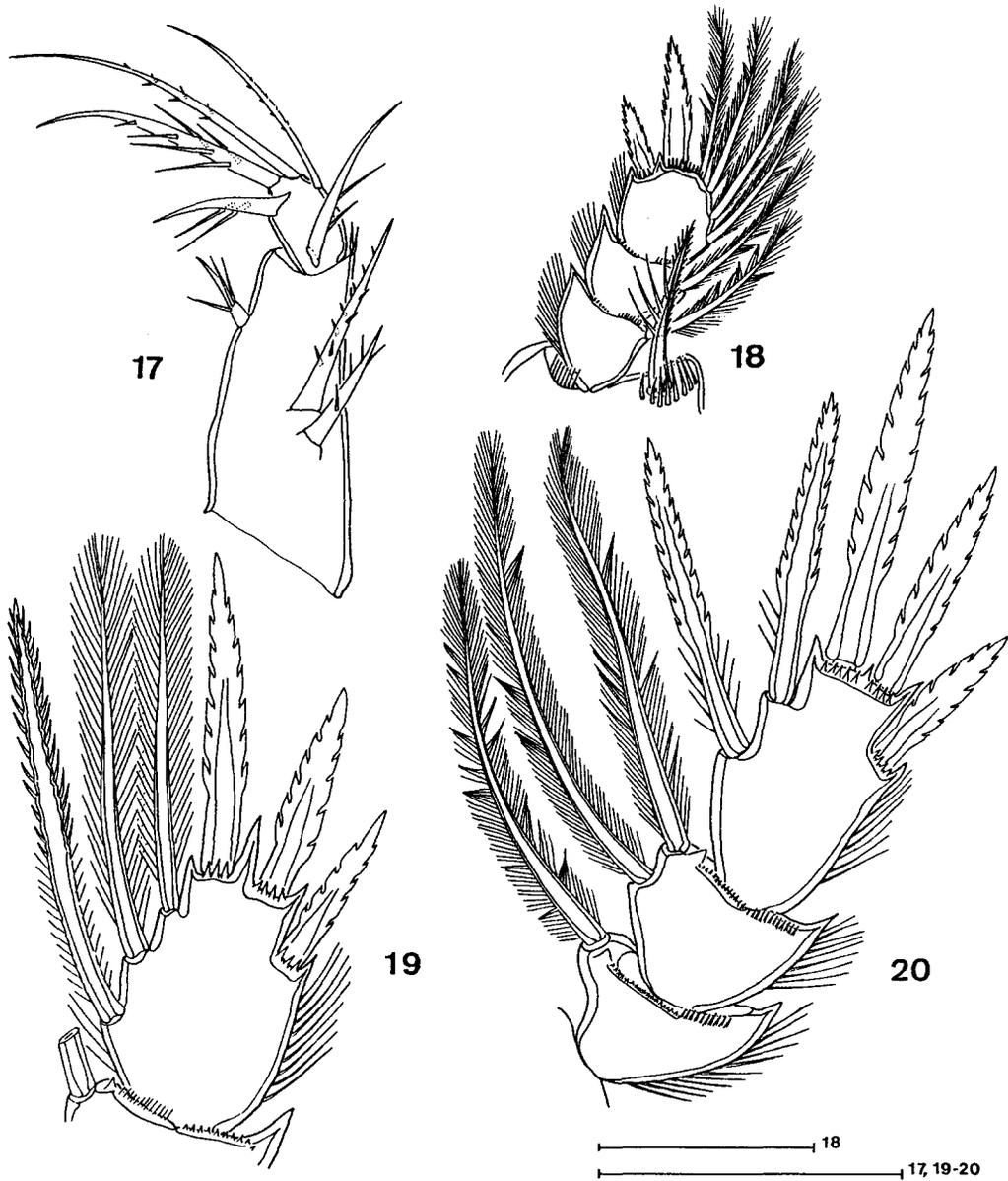
Etymology. The species is named after Dr B. H. Dussart, respected copepodologist.



Figs 12–16. *Halicyclops dussarti* sp.n. Female. 12. genital double somite, dorsal; 13. terminal portion of urosome, dorsal; 14. posterior borders of pre-anal and anal somites, ventral; 15. middle apical setae of caudal rami (outer middle apical seta broken near tip), dorsal; 16. maxilla, anterior. Scale bars = 50 μ m.

Differential diagnosis. Rocha (1991) grouped ten species of *Halicyclops* through their having the middle apical setae of the caudal rami ornamented only with setules, the fourth segment of the antennule of the female almost as long as wide to less than twice as long as wide, and the inner spine of the leg 1 basis reaching at least midlength of the third endopodal seg-

ment of leg 1. Among these species, *H. dussarti* is closer to *H. pilosus*, described by Rocha (1984) from northeastern Brazil, regarding the shape of the genital double somite and the structure of the third endopodal segment of leg 4. The two species can be separated by differences in the length of the basal spine of leg 1, the ornamentation of the middle apical setae of the caudal

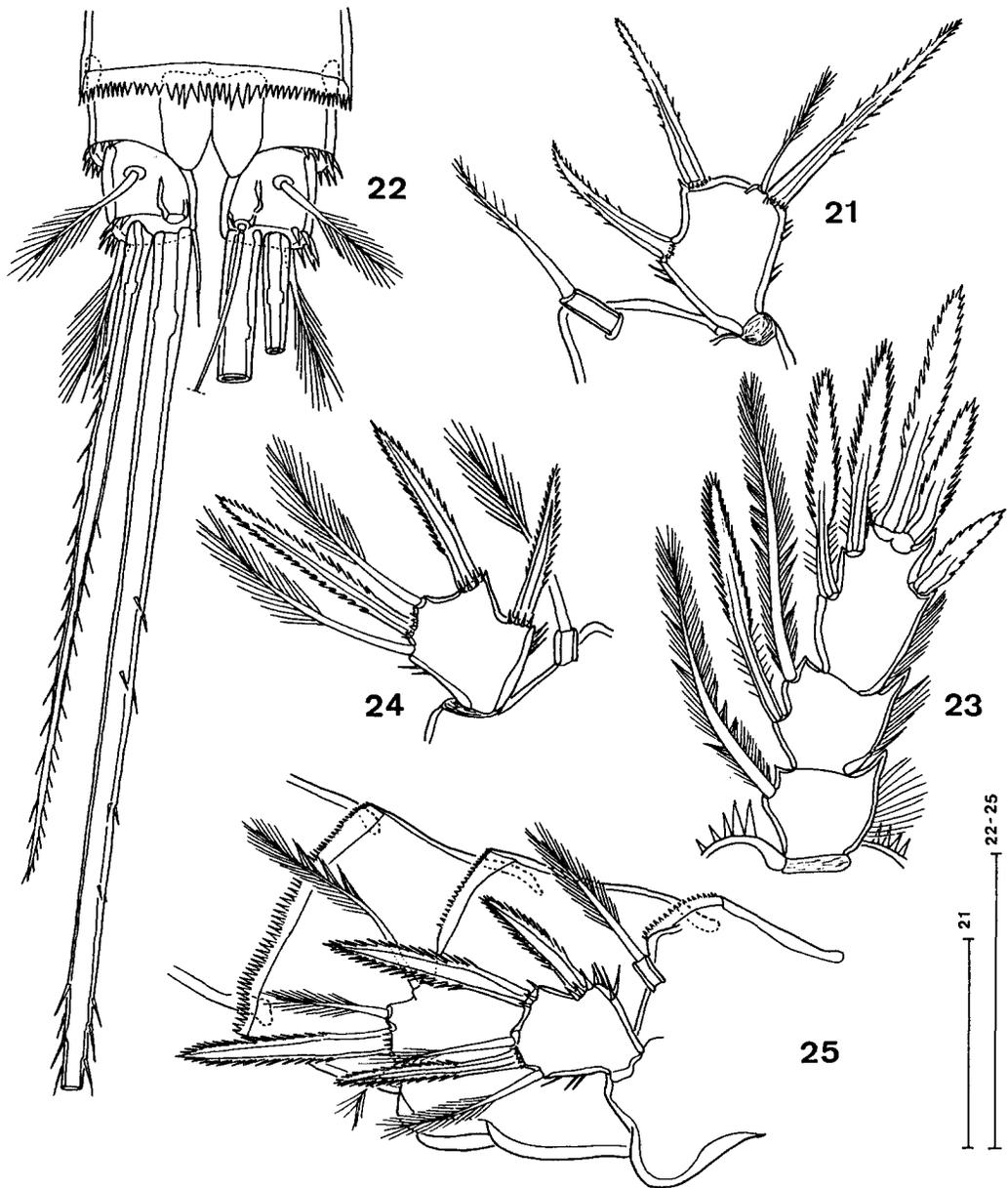


Figs 17–20. *Halicyclops dussarti* sp.n. Female. 17. maxilliped, inner surface view; 18. part of basis and endopod of leg 1, anterior; 19. third endopodal segment of leg 3, anterior; 20. endopod of leg 4, anterior. Scale bars = 50 μ m.

rami, and the shape as well as the relative lengths of the spines of the exopod of leg 5.

Halicyclops dussarti is the first species of this group of ten species known to have serrate hyaline frills on the posterior borders of cephalosome and pedigers 2 and 3. In *H. sinensis*, *H. coulli*, *H. laminifer*, *H. glaber*, *H. pilosus* and *H. hurlberti* the posterior borders of all

prosomes are smooth, as illustrated or described by Burckhardt (1913), Herbst (1977, 1982) and Rocha (1983b, 1984, 1991), respectively. *Halicyclops crassicornis* Herbst, 1955 also has prosomes with smooth posterior borders (Rocha, unpublished data). Such information is not provided by Lindberg (1941, 1949,



Figs 21–25. *Halicyclops dussarti* sp.n. Female 21. leg 5, anterior. Male. 22. terminal portion of urosome, dorsal; 23. endopod of leg 4, posterior; 24. leg 5 of a paratype, anterior; 25. anterior part of urosome of the other paratype with legs 5 and 6. Scale bars = 50 μ m.

1952) for the remaining species of the group, namely *H. canui*, *H. pilifer* and *H. blachei*.

Halicyclops sinensis, *H. crassicornis*, *H. glaber*, *H. pilosus*, *H. hurlberti* and *H. dussarti* have a short terminal segment of the antenna, its length being from 2 to about 2.5 times as long as the width. In the genus *Halicyclops*, a species excluded from the above group has

this segment at least 3 times longer than broad. Another character shared by the aforelisted six species, as well as *H. coulli* and *H. laminifer*, is that the exopodal spines of leg 1 are relatively longer than the equivalent spines of the other swimming legs. The states of these two characters are not known for *H. canui*, *H. pilifer* and *H. blachei*. Apart from this lack of knowledge,

these two characters could be useful in defining this group of species within the genus.

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