

Intertidal interstitial *Halicyclops* from the Brazilian coast (Copepoda: Cyclopoida)

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Abstract

H. tageae sp. n. and *Halicyclops ytororoma* sp. n. are described from the intertidal interstitial water of Brazilian beaches.

H. tageae is distinguished from all congeneric species by the number of setae on legs 1–4 endopodite 2 (1, 1, 2, 2) and by possessing a reduced inner spine on the leg 5 exopodite. It shares with *H. brevispinosus*, *H. pusillus* and *H. canui* the spine formula 2, 3, 3, 3 on exopodite 3 of swimming legs 1–4.

H. ytororoma closely resembles *H. gauldi* and differs from this species by having 4 setae on leg 1 endopodite 3; *H. gauldi* has 3 setae on this segment.

This is the first record of *Halicyclops* from marine interstitial water in Brazil.

Introduction.

Interstitial cyclopoids from the Brazilian coast have been investigated only by Herbst (1955) and Lotufo & Rocha (1991). Herbst (1986) listed 10 species of *Halicyclops* as inhabitants of marine interstitial water. The species described here are the first records of *Halicyclops* from this habitat in Brazil.

Material and methods

The interstitial fauna was collected in the intertidal zone of sandy beaches. Interstitial water, collected in holes dug in the beach during low tide, was filtered through a 200 μm mesh (Salvador, Bahia) or 125 μm mesh (State of São Paulo), and animals retained fixed in 4% formalin. Har-

pacticoids and specimens of *Neocyclops*, *Cyclopina* and *Procylopina* were collected with the *Halicyclops*.

Granulometric and salinity analysis were carried out only for samples from São Paulo.

Intact specimens were examined in 85% lactic acid, and dissected parts were mounted in glycerine in slides sealed with Glyceel for analysing variation in characters described, as well as for preparing and checking drawings. The figures were prepared using a camera lucida on Leitz Laborlux D phase-contrast microscope.

Part of the specimens examined was deposited in Museu de Zoologia da Universidade de São Paulo (MZUSP), São Paulo. Remaining material is in C.E.F. Rochas's collection at Departamento de Zoologia da USP.

The terminology applied to body and append-

age segmentation follows that of Huys & Boxshall (1991).

Taxonomy

Family Cyclopidae Burmeister

Subfamily Halicyclopinæ Kiefer

Halicyclops tagueae *sp. n.*

(Figs 1–16)

Material examined. – Brazil, State of Bahia, Salvador: Bregari Beach, 4 Nov 1985, 52 females and 6 males, col. C.E.F. Rocha. State of São Paulo: Ubatuba, Codó Beach, 6 Jul 1990, 30 females and 22 males, col. G. R. Lotufo. São Sebastião, Pontal da Cruz Beach, 17 Nov 1990, 1 female, col. G. R. Lotufo. Female holotype, 10 paratypes from Codó Beach and 10 paratypes from Bregari Beach in MZUSP (11168–11170).

Female. – Body length 330–430 μm (N = 10). Prosome:urosome ratio = 1.5–1.8:1. Hyaline frills of all prosomites smooth (Fig. 1). Genital double somite (Fig. 2) 1–1.2 times wider than long and expanded into lateral protrusions along anterior half. Seminal receptacle as in Fig. 2. Hyaline frills of posterior border of genital double somite and following somites finely denticulate. Hyaline frill of posterior dorsal border of preanal somite bearing more conspicuous denticles medially than laterally (Fig. 3).

Caudal ramus (Fig. 4) as long as wide. Lateral seta naked, inserted dorsally just posterior to midlength and as long as ramus. Dorsal seta about 4.3 times longer than ramus and set on conical protuberance reaching beyond basis of inner middle apical seta. Outer apical seta 3.2 times longer than inner apical seta. Inner apical seta short, slender. Inner middle apical seta sparsely spinulose proximally and finely plumose distally. Outer middle apical seta sparsely spinulose on both sides on proximal half; terminal half plumose on inner margin and with stiff setules gradually tapering towards tip of seta on outer margin.

Antennule (Fig. 5) 6-segmented. Armament as follows (Roman numeral = segment; Arabic

numeral = seta; sp = spine; ae = aesthetasc): I-8; II-12; III-4 + sp; IV-6 + ae; V-2; VI-10 + ae.

Antenna (Fig. 6) 3-segmented. Coxobasis with 2 inner distal setae. Endopodite with 1 inner seta on first segment; terminal segment 3.3 times longer than wide, with 5 inner marginal setae and 7 apical setae. Exopodite lacking.

Mandible as in *H. ytororoma* *sp. n.* (Fig. 25).

Maxillule (Figs 7 and 8) with enlarged precoxa bearing 4 setae on inner face and 4 strong spines on arthrite. Palp consisting of basis bearing 3 setae on inner margin, 1 proximal seta representing exopodite and endopodite 1-segmented with 3 setae.

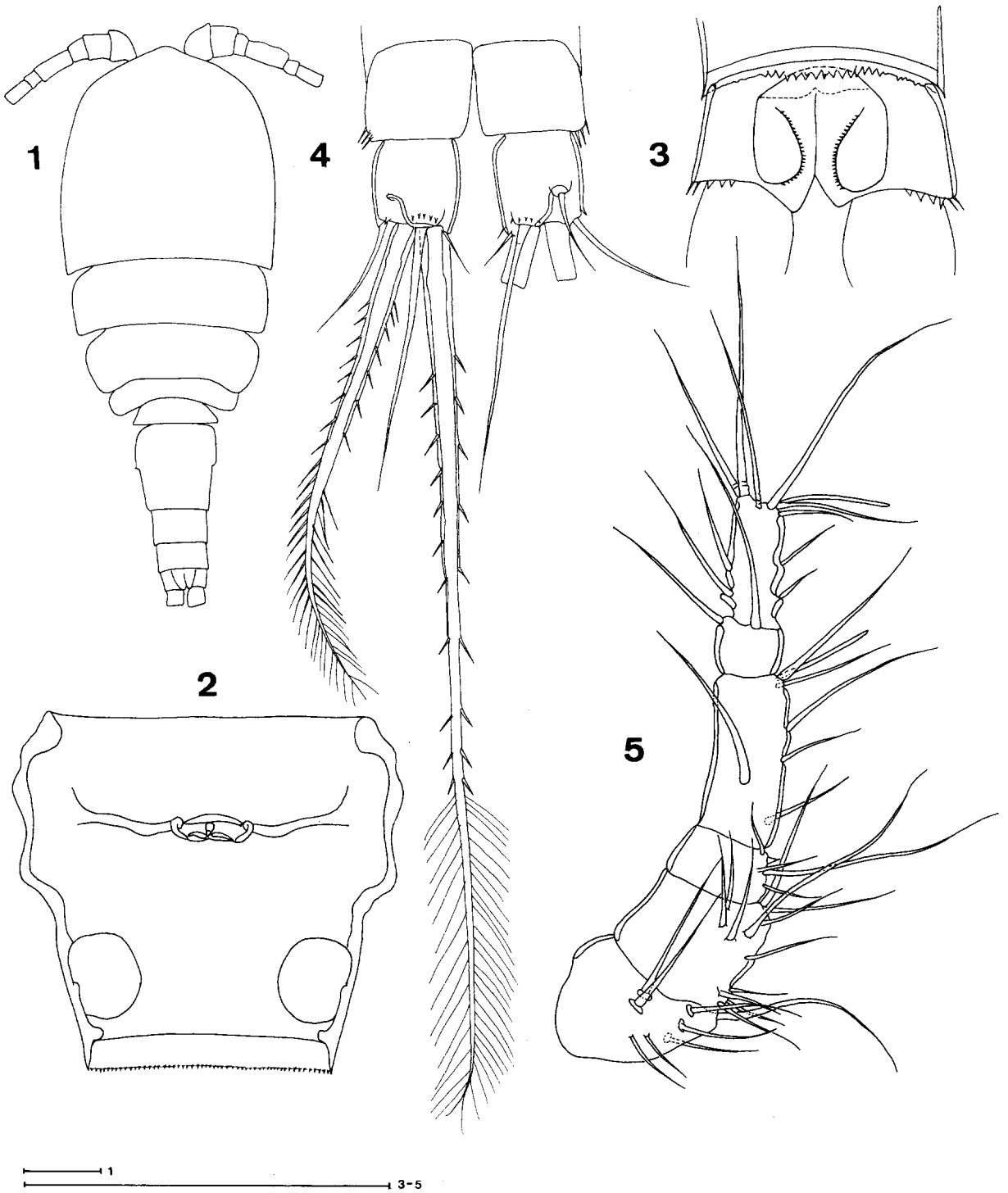
Maxilla consisting of praecoxa, coxa, basis and endopodite 1-segmented. Praecoxal endite with 2 plumose setae. Coxa with 2 endites; proximal endite represented by single seta; distal endite drawn out into claw and with seta. Basal endite comprising claw and 2 setae. Endopodite segment with 5 setae, 2 of them very short and thin.

Maxilliped (Fig. 9) 2-segmented. Proximal segment with 3 setae. Terminal segment with 2 inner and 3 apical and subapical setae.

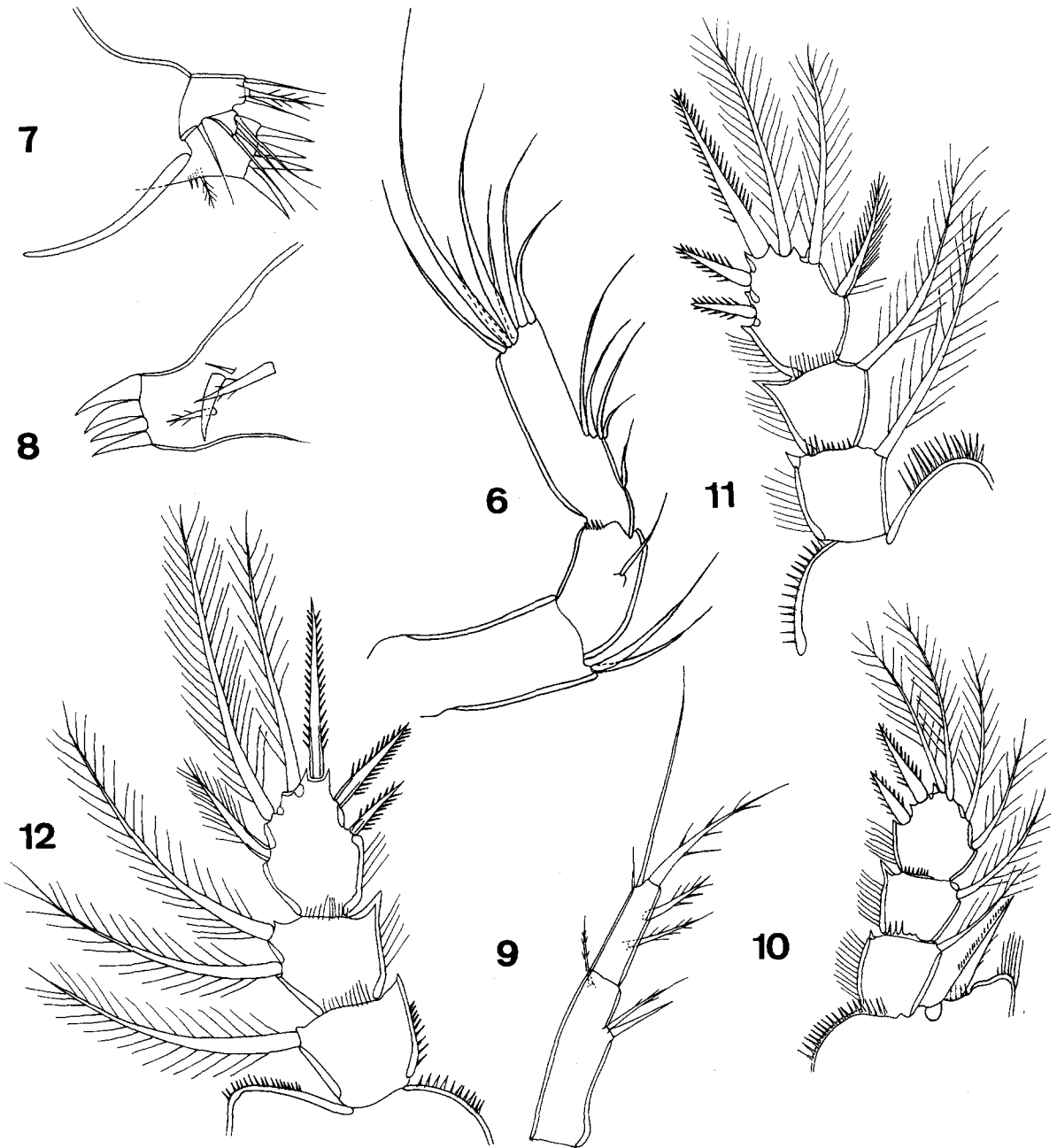
Legs 1–4 (Figs 10–13) armament as follows (Roman numerals representing spines; Arabic numerals indicating setae):

	Coxa	Basis	Endopodite	Exopodite
Leg 1	0-1	1-I	0-1; 0-1; II-4	I-1; I-1; II,5
Leg 2	0-1	1-0	0-1; 0-1; III-3	I-1; I-1; III,5
Leg 3	0-1	1-0	0-1; 0-2; III-3	I-1; I-1; III,5
Leg 4	0-1	1-0	0-1; 0-2; III-2	I-1; I-1; III,5

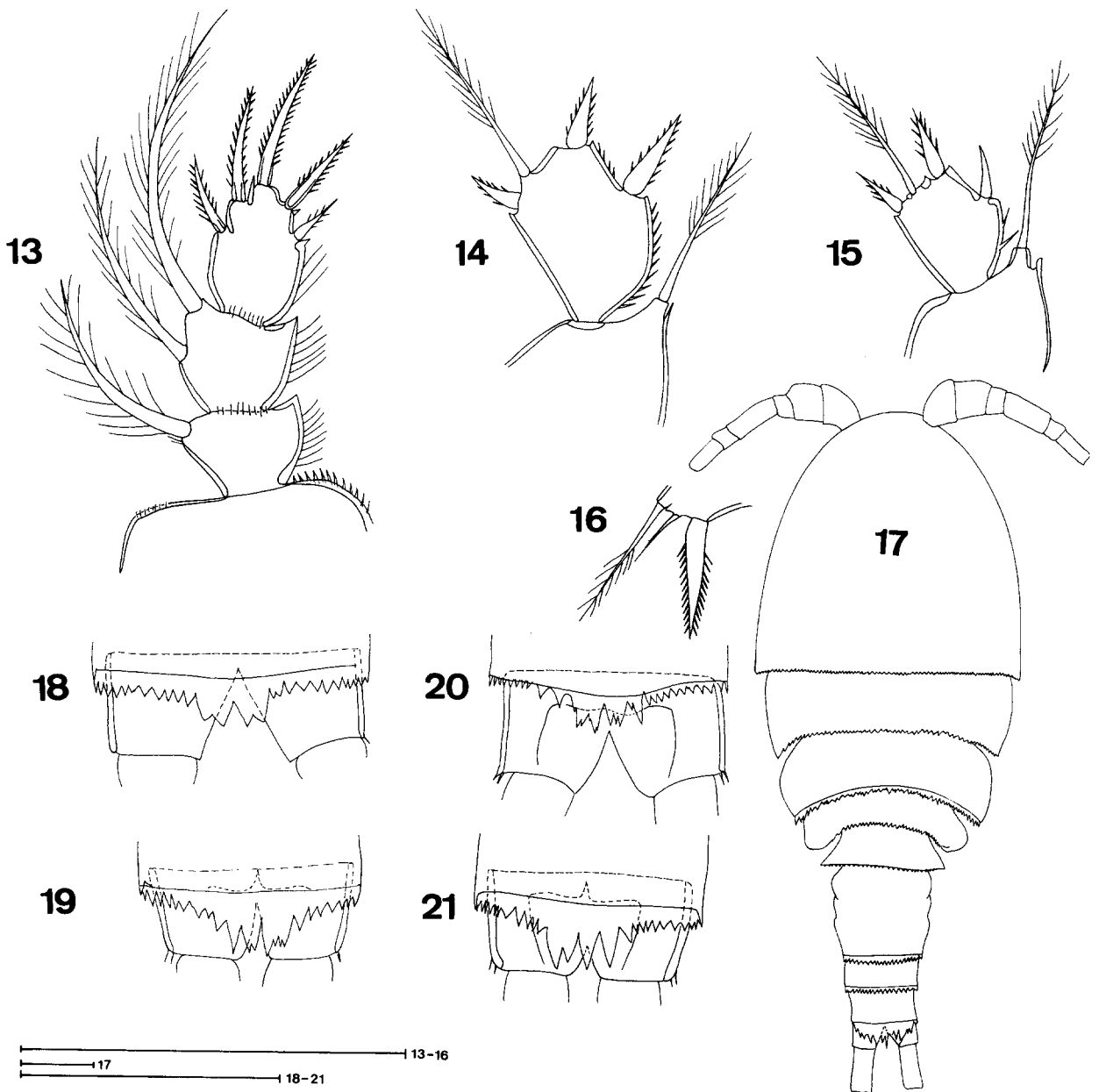
Legs 1–4 exopodite 1 with seta always shorter than segment. Leg 1 basis (Fig. 10) armed with serrate spine reaching distal border of endopodite 2. Leg 2 endopodite 3 (Fig. 11) bearing modified proximal seta as long as segment, plumose proximally and spinulose distally. Leg 3 endopodite 3 (Fig. 12) with modified proximal seta shorter and stouter than its homologue in leg 2. Leg 4 endopodite 2 (Fig. 13) with distal seta surpassing tip of inner apical spine of endopodite 3.



Figs 1-5. *Halicyclops tageae* sp. n. Female: 1. habitus, dorsal; 2. genital double somite, ventral, showing seminal receptacle; 3. anal somite, dorsal; 4. caudal rami, dorsal; 5. antennule. Scale bars = 50 μ m



Figs 6–12. *Halicyclops tageae* sp. n. Female: 6. antenna; 7. maxillule; 8. maxillule precoxa, inner face; 9. maxilliped; 10. leg 1 basis and endopodite; 11. leg 2 basis and endopodite; 12. leg 3 basis and endopodite. Scale bar = 50 μ m.



Figs 13–16. *Halicyclops tageae* sp. n. Female: 13. leg 4 basis and endopodite; 14. leg 5. Male: 15. leg 5; 16. leg 6; Figs 17–21. *Halicyclops ytororoma* sp. n. Female: 17. habitus, dorsal; 18–21. anal somite showing different shapes of pseudopericulum. Scale bars = 50 μm.

Leg 4 endopodite 3 (Fig. 13) 1.5 times longer than wide; inner apical spine as long as segment and 1.4 times longer than outer apical spine; both inner setae spiniform, shorter than segment, distal seta being twice longer than proximal seta.

Distal edge of leg 1 intercoxal sclerite with short hairs on pair of humps. Distal edges of legs 2–4 intercoxal sclerites straight and naked.

Leg 5 exopodite (Fig. 14) 1.5 times longer than wide, with 3 spines and 1 seta; all spines shorter

than segment and decreasing in length from outermost to innermost.

Male. – Body length 323–350 μm (N = 10). Prosome:urosome ratio = 1.5–1.7:1. Urosome with 6 somites. Geniculate antennule with 13 segments. Leg 5 exopodite (Fig. 15) as long as wide and bearing 3 spines and 1 seta; inner and outer apical spines serrate; lateral spine naked. Outer apical spine about 1.3 times longer than others. Leg 6 (Fig. 16) comprised of 1 inner serrate spine and 2 setae; median seta half length of outer seta.

The male is identical to the female in all other respects.

Habitat. Codó Beach: coarse sand (median grain size: 980 μm); salinity 1‰. Pontal da Cruz Beach: medium sand (440 μm); salinity 20‰. Bregari Beach: coarse sand (subjective analysis).

Etymology. This species is named after Dr Taguea K. S. Björnberg, eminent Brazilian zoologist.

Type locality. Codó Beach, Ubatuba, State of São Paulo, Brazil.

Differential diagnosis. *Halicyclops tagueae* sp. n. differs from all congeneric species by possessing a reduced inner spine in the female leg 5 exopodite. All specimens examined had this spine about half the length of the outer spine, which is usually the shortest spine on this segment.

The number of setae on the inner margin of legs 1–4 endopodite 2 usually registered in *Halicyclops* is 1, 2, 2, 2. *Halicyclops gauldi* Plesa, 1961 and *H. ytororoma* sp. n. are exceptions, and have seta formula 1, 1, 1, 1 on this segment. The armament of legs 1–4 endopodite 2 shown by *H. tagueae* (1, 1, 2, 2) is new for the genus and is another diagnostic character of the species, although not every species description in the genus mentions this character.

The number of spines on legs 1–4 exopodite 3 in *H. tagueae* is unusual in *Halicyclops* and occurs, among the species for which this character is known, only in *H. brevispinosus* Herbst, 1953,

H. pusillus Kiefer, 1954 and *H. canui* Lindberg, 1941.

H. brevispinosus, from interstitial water of the North Sea, resembles *H. tagueae* in having short spines on the leg 5 exopodite and spiniform setae on leg 4 endopodite 3. This species differs from *H. tagueae* by possessing a leg 4 endopodite 3 with setae longer than the segment and a leg 5 exopodite with an inner seta in the male.

H. pusillus, from interstitial water of Madagascar, is only 280 μm long. In this species, the leg 4 endopodite 3 bears setae and spines similar to those found in *H. tagueae*. The two species can be distinguished by the shape of the genital double somite and the presence of 2 inner setae on the leg 5 exopodite of the males of *H. pusillus*.

H. canui, from the eastern coast of India, bears long spines on the leg 5 exopodite. It also differs from *H. tagueae* in the shape of the genital double somite, proportions of the caudal rami, relative length of the caudal setae, and by possessing short setae on leg 4 endopodite 3.

Halicyclops ytororoma sp. n.
(Figs 17–31)

Material examined. Brazil. State of São Paulo. Carlos E. F. da Rocha collector: Ubatuba: Codó Beach, 4 Nov 1983, 21 females and 1 male. São Sebastião: Segredo Beach, 6 Jul 1983, 1 female and 2 males. Guilherme R. Lotufo collector: São Sebastião: São Francisco Beach, 17 Sep 1990, 9 females and 2 males; 11 Mar 1991, 10 females and 2 males; Olaria Beach, 15 Jun 1991, 7 males; Deserta Beach, 11 Mar 1991, 2 females; Porto Grande Beach, 11 Mar 1991, 1 female and 1 male; Pitangueiras Beach, 16 Sep 1990, 1 female and 1 male; 11 Mar 1991, 10 females and 1 male; Segredo Beach, 15 Jun 1991, 1 female. Ilhabela: Armação Beach, 6 Nov 1990, 2 females and 2 males; Pinto Beach, 6 Nov 1991, 1 female; 10 Mar 91, 1 female; Garapocaiá Beach, 6 Nov 1990, 1 female; Viana Beach, 6 Nov 1990, 2 females; Pequieá Beach, 10 Mar 1991, 1 female; Engenho D'Água Beach, 6 Nov 1990, 2 females. Female holotype from Codó Beach and 20 paratypes from

Codó, São Francisco and Olaria Beach in MZUSP (11171–11174).

Female. – Body length 380–480 μm (N = 10). Prosome:urosoma ratio = 1.4–1.7:1. Hyaline frills of all prosomites and urosomite 1 denticulate dorsally (Fig. 17). Genital double somite (Fig. 17) 1–1.2 times longer than wide and constricted at mid-length. Genital double somite and urosomites 3 and 4 with posterior border denticulate. Hyaline frill of posterior border of preanal somite enlarged dorsally forming pseudopericulum variable in shape (Figs 18–21).

Caudal ramus (Fig. 22) 1.9–2.1 times longer than wide. Lateral seta plumose and shorter than ramus (2.3:1). Dorsal seta about twice as long as ramus and set on conical protuberance reaching beyond basis of inner middle apical seta. Outer apical seta plumose, as long as ramus, and about 4.5 times longer than inner apical seta. Inner middle apical seta sparsely spinulose on both sides in proximal half; distal half more densely spinulose proximally and plumose distally. Outer middle apical seta sparsely spinulose on outer side and smooth on inner side proximally, and plumose on both sides distally.

Antennule (Fig. 23) 6-segmented. Armament as in *H. tageae*.

Antenna (Fig. 24) 3-segmented, armed as in *H. tageae* and with distal segment 3.5 times longer than wide.

Mandible (Fig. 25) reduced to coxa with gnathobase and palp comprised of 2 setae inserted on short protuberance.

Maxillule, maxilla and maxilliped as in *H. tageae*.

Legs 1–4 (Figs 26–28) armament as follows (Roman numerals representing spines; Arabic numerals indicating setae):

	Coxa	Basis	Endopodite	Exopodite
Leg 1	0-1	1-I	0-1; 0-1; II-4	I-1; I-1; III,5
Leg 2	0-1	1-0	0-1; 0-1; III-3	I-1; I-1; IV,5
Leg 3	0-1	1-0	0-1; 0-1; III-3	I-1; I-1; IV,5
Leg 4	0-1	1-0	0-1; 0-1; III-2	I-1; I-1; III,5

Leg 1 (Fig. 26) with basis bearing strong inner spine, serrate on outer margin and shorter than endopodite 1; exopodite 1 with short seta, as long as outer spine. Leg 2 differing from leg 3 (Fig. 27) in size and in having more slender spines; proximalmost seta on endopodite 3 modified in both legs. Leg 4 endopodite 3 (Fig. 28) about 1.5 times longer than wide and with 3 spines and 2 medial spiniform setae. Inner apical spine about 1.2 times longer than segment and twice length of outer apical seta. Distal seta as long as apical spine and 1.5 times longer than proximal seta. Leg 4 endopodite 2 (Fig. 28) with single plumose seta reaching beyond tip of endopodite 3 proximal seta.

Leg 5 exopodite (Fig. 29) almost as long as wide (1.1:1), quadrate, and armed with 1 seta and 3 serrate spines, all shorter than segment. Innermost spine 1.2 times longer than other 2 spines.

Male. – Body length 320–325 μm (N = 10). Prosome:urosoma ratio = 1.3–1.4:1. Urosoma with 6 somites. Geniculate antennule with 13 segments. Leg 6 (Fig. 30) with 1 inner serrate spine and 2 setae; median seta 1/3 length of spine and outer seta. One specimen from Codó Beach, Ubatuba, with anomalous leg 5, without inner spine (Fig. 31).

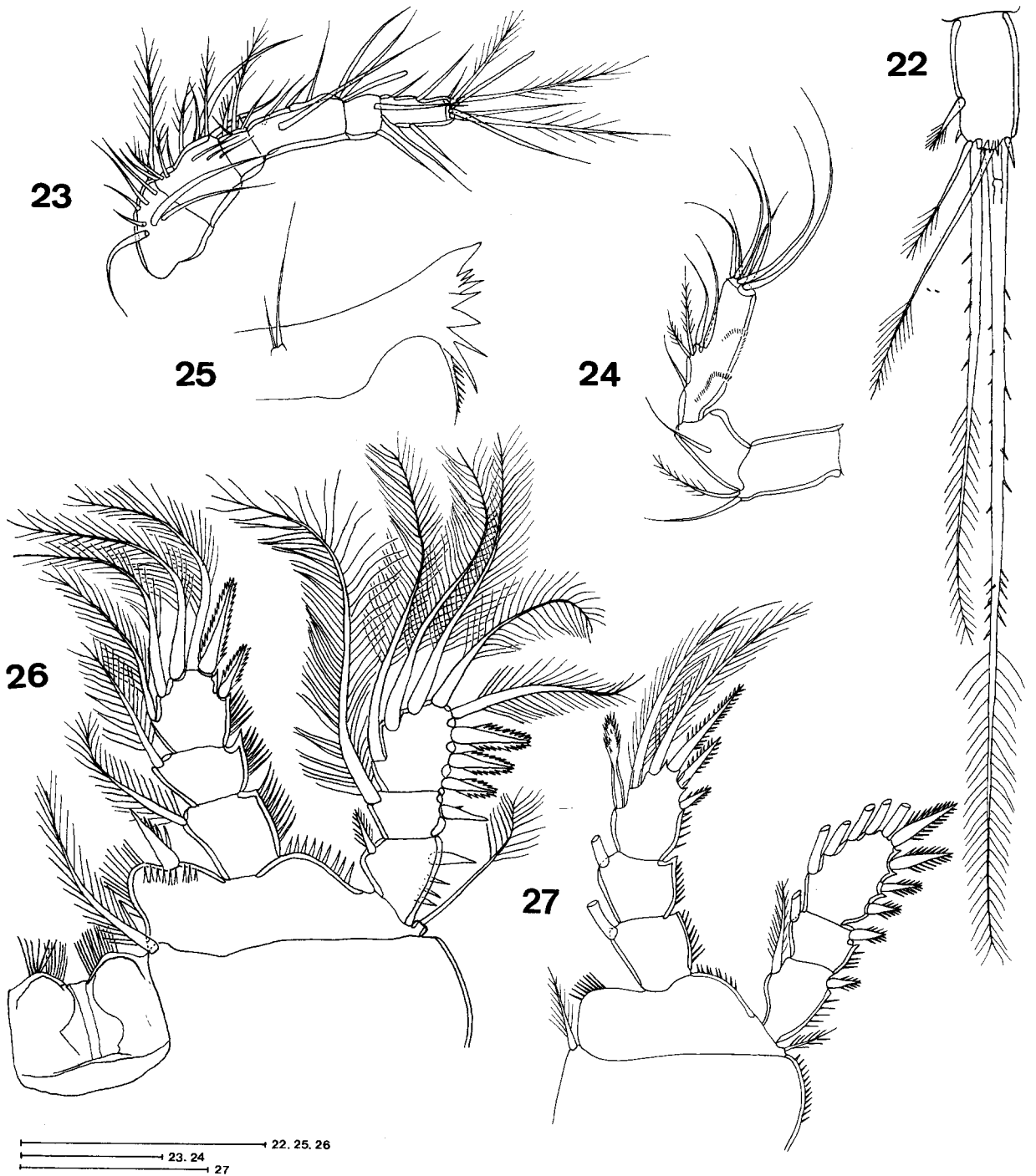
The male is identical to the female in all other respects.

Etymology. The specific name is derived from the Tupi-Guarani language and means springlet. It is used in reference to a groundwater seep that lowered the salinity of the interstitial water in Codó Beach, Ubatuba. The first record of this species was near this flow.

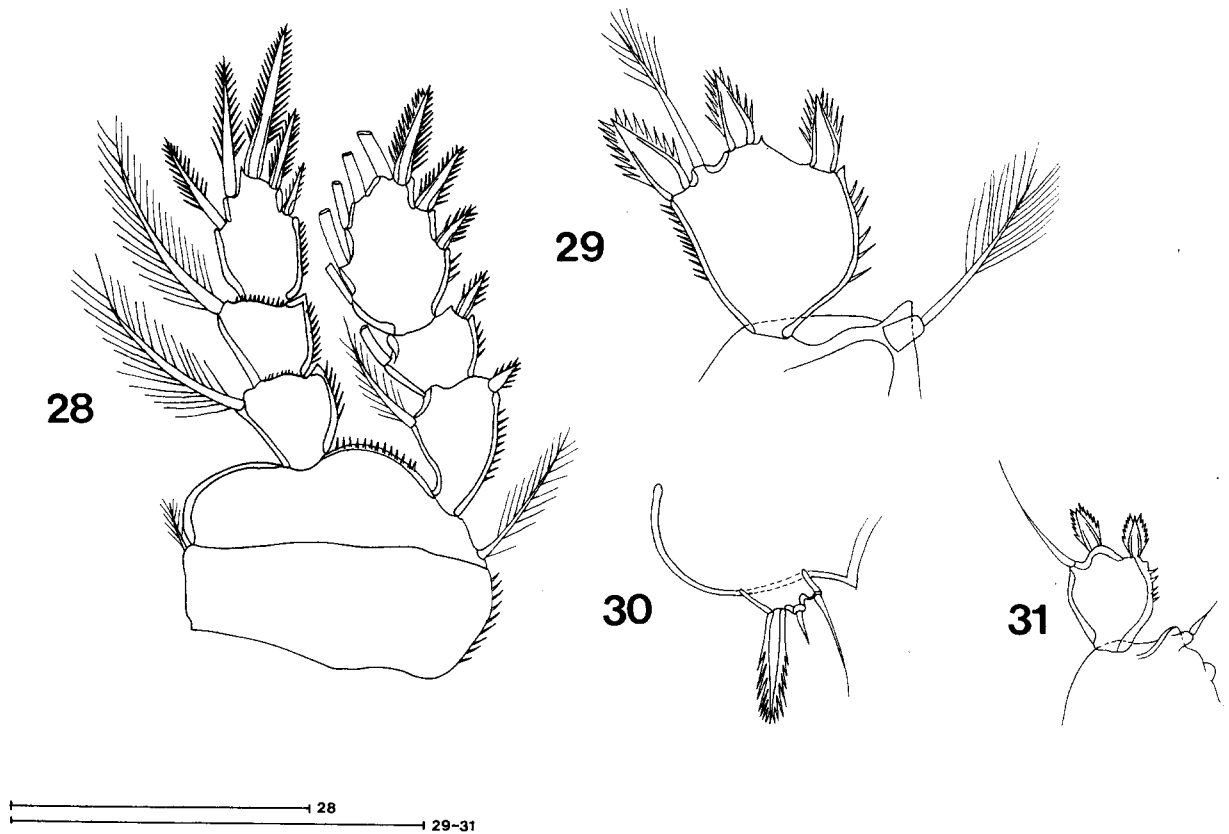
Habitat. Medium to very coarse sand (median grain size 300–1230 μm). Salinity ranging from 15 to 31‰.

Type-locality. Codó Beach, Ubatuba, State of São Paulo, Brazil.

Differential diagnosis. *H. ytororoma* sp. n. closely resembles *H. gauldi* Pleşa 1961 from interstitial



Figs 22–27. *Halicyclops ytororoma* sp. n. Female: 22. caudal ramus, dorsal; 23. antennule; 24. antenna; 25. mandible; 26. leg 1; 27. leg 3. Scale bars = 50 μ m.



Figs 28–31. *Halicyclops ytororoma* sp. n. Female: 28. leg 4; 29. leg 5. Male: 30. leg 6; 31. anomalous leg 5. Scale bars = 50 μ m.

water of a beach in Ghana. Both species share the same length:width ratio of the caudal rami, relative length of the caudal setae, shape of the genital double somite, structure of the leg 4 endopodite 3, and leg 5 exopodite in both sexes. It is noteworthy that the Brazilian species has just one seta on the endopodite 2 of all swimming legs, an unusual number of setae previously found only in *H. gauldi*.

In his description of *H. gauldi*, Pleša (1961) provided no information about the aspect of the hyaline frills along the posterior borders of the prosomites and the proximal seta on the legs 2 and 3 endopodite 3, as well as about the ornamentation of the middle apical setae of the caudal rami. According to Dr Pleša (*in litt.*), re-examination of *H. gauldi* type material revealed that those characters have the same structure observed in *H. ytororoma*.

From the original description, *H. gauldi* has only 3 setae on the inner margin of the leg 1 endopodite 3. *Halicyclops ytororoma* has 4 inner setae on this segment, the number commonly registered within the genus. Such a difference was confirmed by Dr Pleša (*in litt.*), giving support to our decision to separate the Brazilian specimens in a new taxon.

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