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# *Troglocyclops janstocki*, new genus, new species, a very primitive cyclopid (Copepoda: Cyclopoida) from an anchialine cave in the Bahamas

Carlos Eduardo Falavigna da Rocha[1] & Thomas M. Iliffe[2]
[1] *Departamento de Zoologia, Instituto de Biociências, Universidade de São Paulo, Caixa Postal 20520, 01452–990, São Paulo, Brazil*
[2]*Department of Marine Biology, Texas A&M University at Galveston, P.O. Box 1675, Galveston, TX 77553, USA*

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## Abstract

*Troglocyclops janstocki* is proposed to accommodate cyclopids from Hatchet Bay Cave, Eleuthera Island, Bahamas. The species is the most primitive member of the Halicyclopinae because of the presence of 15-segmented antennules, mandibular palp reduced to 3 setae, one of them quite long and plumose, a bisegmented maxillary endopodite, and 3 segments in the maxilliped endopodite. These copepods possess the first pediger still distinct, being partially enclosed dorsally and laterally by a carapace-like extension of the posterior margin of the dorsal cephalic shield. This latter character represents a plesiomorphic state shared with the primitive cyclopinids and, within the Cyclopidae, only with the Euryteinae. The new taxon is the only known species of Halicyclopinae having two apical spines on the terminal segment of the exopodite of legs 2 to 4, and the intercoxal sclerites of the legs 1 and 2 sexually dimorphic. The phylogenetic importance of each of these characters is discussed.

## Introduction

Living together with *Speleoithona eleutherensis* Rocha & Iliffe, 1991 in Hatchet Bay Cave, Bahamas, new cyclopids were discovered and are described herein. They represent a new genus of Halicyclopinae related to the marine and brackish *Neocyclops*, a genus frequently recorded from interstitial waters (Herbst, 1986).

These new copepods are phylogenetically important as they display primitive states of several characters never before found within the Halicyclopinae and even the family Cyclopidae.

## Habitat

Eleuthera is an elongate island situated on the eastern edge of the Great Bahama Bank in the central Bahamas. The topography consists of low, rounded hills of eolian limestone. Hatchet Bay Cave is located several kilometers north of the settlement of Hatchet Bay and about 1 km inland from the west coast. The lowest level of this cave contains an anchialine pool about 3 m deep in total darkness. Surface salinity, temperature and dissolved oxygen concentration were 32 ppt, 21.7 °C and 6 ppm, respectively. Other troglobitic fauna inhabiting this pool included the cyclopoid copepod *Speleoithona eleutherensis*, the halocyprid ostracods *Danielopolina bahamensis* and *Deeveya jillae*, described by Kornicker & Iliffe (1989), a possible new genus of calanoid copepod (A. Fosshagen, pers. comm.), and a macellicephalan polychaete identified by Marian H. Pettibone (in litt., 1986) as perhaps a young *Pelagomacellicephala iliffei* (Pettibone, 1985).

## Methods

Copepods were collected by the junior author using a 92 μm mesh plankton net towed slowly through the water column of the cave pool while wading or swimming in water depths to 3 m. After sorting, specimens were preserved in 10% formalin solution.

Whole specimens were examined in temporary lactic acid mounts. Fragments of cover glass were used to

support the cover glass of the preparation. After examination, the specimens were returned and preserved in 70% ethanol.

Dissected specimens had been previously stained with chlorazol black E. Complete dissections were made of a male and a female, and their parts mounted in slide preparations of glycerine sealed with Glyceel. Dissected and whole specimens were examined for variation in characters described, and the drawings made, using a camera lucida on a Leitz Laborlux D phase-contrast microscope.

## Taxonomy

Family Cyclopidae Burmeister, 1834
Subfamily Halicyclopinae Kiefer, 1927
*Troglocyclops* gen. n.

*Genus Diagnosis.* First pediger proximally fused to cephalosome and partly enclosed dorsally and laterally by carapace-like extension of posterior margin of dorsal cephalic shield; caudal rami longer than last 3 urosomites combined; seminal receptacle divided into two parts by transversal slightly curved bar; antennule of 15 segments in female and 16 in male; mandibular palp represented by 3 setae located directly on gnathobasis, and different in length; maxilla endopodite 2-segmented; maxilliped endopodite 3-segmented; seta formula of maxilliped 3, 2, 0, 3, 3; terminal segment of exopodite of legs 2–4 with 2 apical spines; terminal segment of both rami of leg 4 with inner setae modified, being plumose on proximal third and with serrate hyaline lamella on distal two-thirds; leg 5 3-segmented, bearing 3 spines and 1 seta on exopodite in female and 3 spines and 3 setae in male; sexual dimorphism in intercoxal sclerites of legs 1 and 2 consisting of pair of spiniform projections in males.

*Type species.* *Troglocyclops janstocki* sp. n. (by monotypy).

*Etymology.* From the Greek "troglo" referring to cave.

*Troglocyclops janstocki* sp. n.
(Figs 1–21)

*Material examined.* BAHAMAS, Eleuthera Island, Hatchet Bay Cave: 7 females, 26 males and 23 copepodids, 15 June 1986, T. M. Iliffe col. Female holotype (USNM 257141), and 35 paratypes (USNM 257142) in National Museum of Natural History, Smithsonian Institution, Washington, D. C.; 6 paratypes (1993.6 and 1993.7–11) in The Natural History Museum, London; 6 paratypes (MZUSP 11428 and 11429) in Museu de Zoologia, Universidade de São Paulo, São Paulo.

*Female.* Body length 970–1080 $\mu$m. ($N$ = 6). Prosome (Fig. 1) little longer than urosome (1–1. 18 : 1). First pediger (Fig. 1) narrower than second pediger, proximally fused to cephalosome, and partly enclosed dorsally and laterally by carapace-like extension of posterior margin of dorsal cephalic shield. Posterior borders of all prosomites smooth. First urosomite (Fig. 2) with each posterior corner projected laterally and posteriorly, ending in spine each. Genital double somite with several small lateral expansions on anterior half; seminal receptacle as represented by Fig. 2. Posterior border of genital double somite and of 2 subsequent urosomites with serrate lamella. Anal somite longer than preceding somite, tapering posteriorly; pseudoperculum absent. Caudal rami (Fig. 3) longer than length of 3 last urosomites combined; length of caudal ramus 10 times greatest width at base and 20 times least width at midlength of ramus. Lateral seta implanted on posterior third, not reaching apex of ramus. Inner apical seta about 1.8 times longer than outer apical seta. Middle setae plumose, inner middle seta being twice length of outer middle seta. Dorsal seta twice longer than outer apical seta.

Antennule (Fig. 4) of 15 segments and armed as follows: 8, 4, 2, 6, 4, 1 + spine, 2, 2, 0, 1, 1 + aesthetasc, 2, 2, 2 + aesthetasc, 7 + aesthetasc.

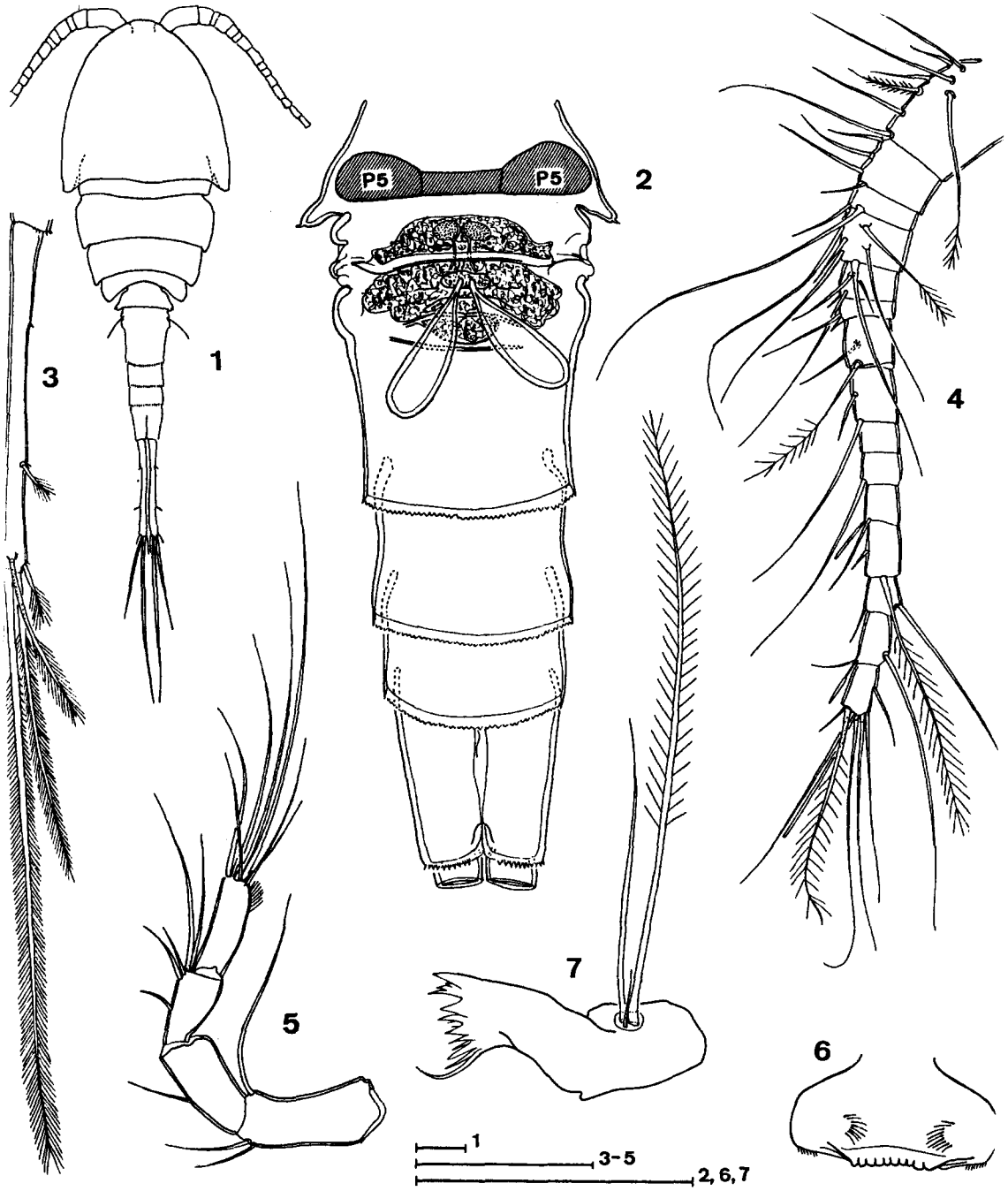
Antenna (Fig. 5) 4-segmented; basis with outer seta (exopodite) and 2 inner setae; endopodite 1 with seta; endopodite 2 with 1 middle seta, 2 subterminal setae and 2 terminal setae on inner margin; endopodite 3 bearing 7 apical setae and setules distally on outer margin.

Labrum (Fig. 6) with row of spinules on posterior corners, and bearing pair of semicircular rows of setules on ventral surface.

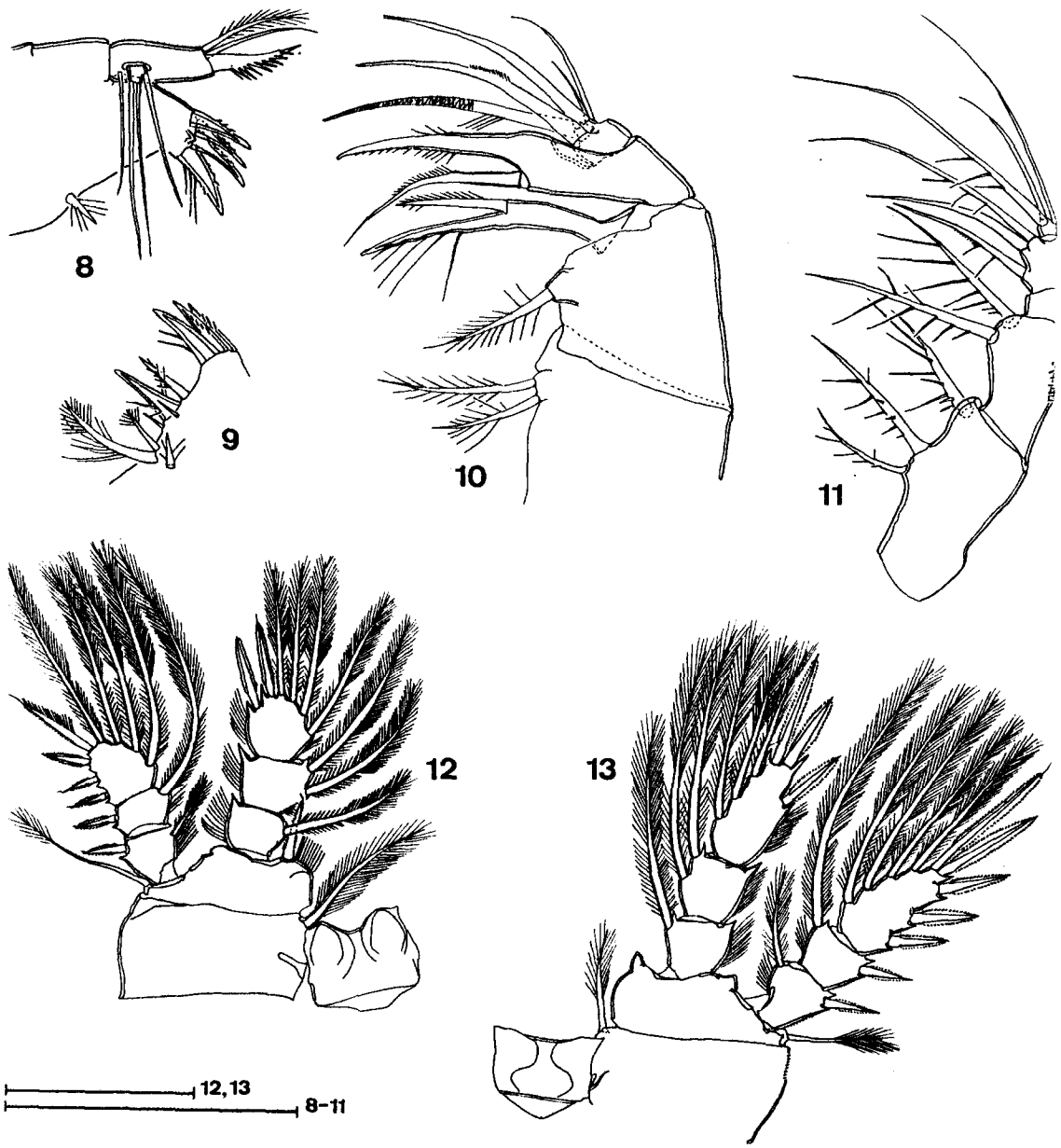
Mandible (Fig. 7) with palp consisting of 3 setae located directly on gnathobasis; outermost seta plumose and twice longer than innermost seta; middle seta tiny.

Maxillule (Figs 8, 9) with structure and armament common within Cyclopidae.

Maxilla (Fig. 10) 5-segmented and with 2, 3, 2, 2, 3 setae. Maxilliped (Fig. 11) of 5 segments, consecutively with 3, 2, 0, 3, 3 setae.



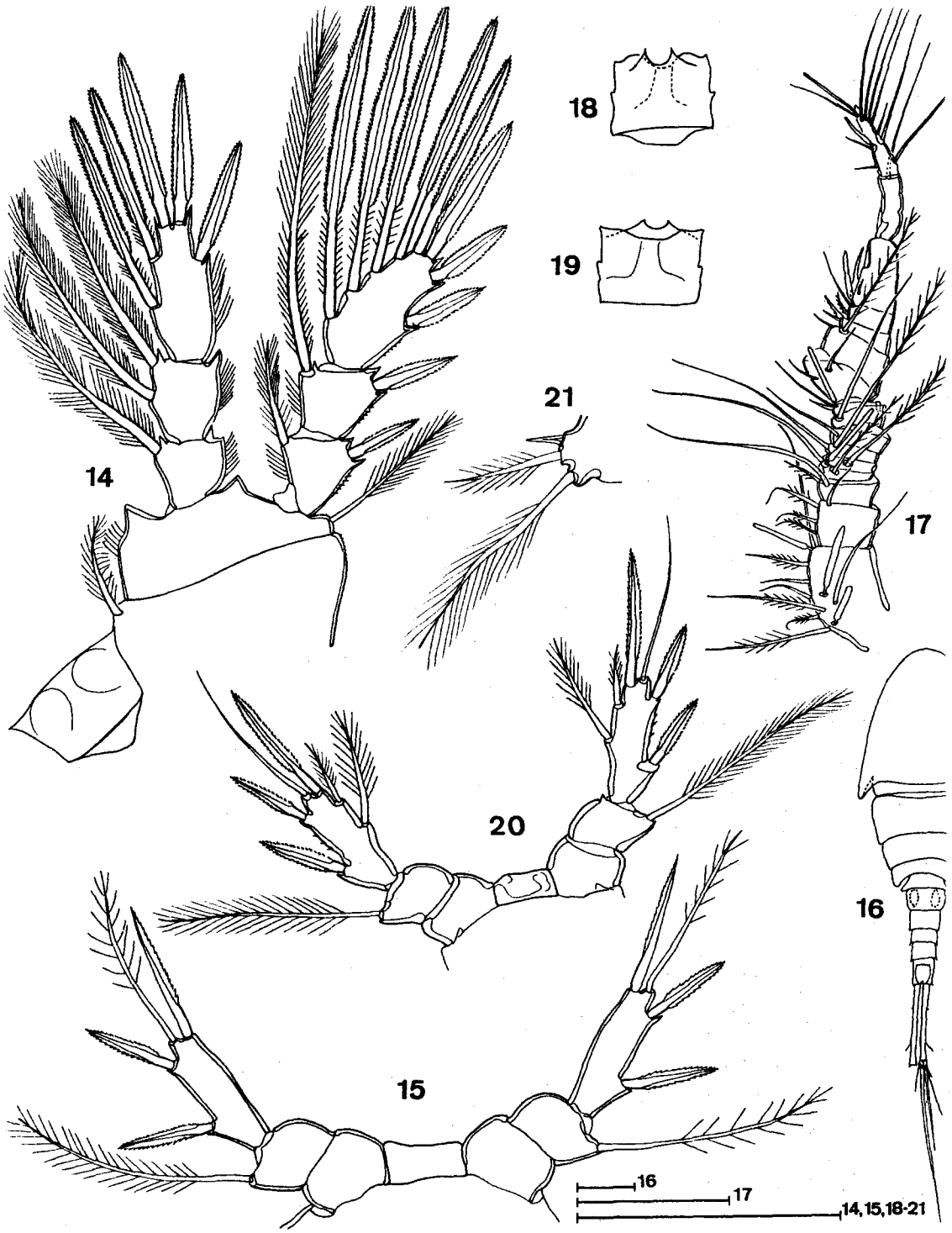

*Figs 1–7. Troglocyclops janstocki* gen. et sp. n. Female. 1 – Habitus, dorsal. 2 – Urosome showing seminal receptacle and pair of spermatophores attached to ventral copulatory pore, ventral. 3 – Caudal ramus, dorsal. 4 – Antennule. 5 – Antenna. 6 – Labrum, frontal. 7 – Mandible. Scale bars = 50 $\mu$m.




*Figs 8–13. Troglocyclops janstocki* gen. et sp. n. Female. 8 – Maxillule. 9 – Armature of the maxillule praecoxa. 10 – Maxilla. 11 – Maxilliped. 12 – Leg 1. 13 – Leg 2. Scale bars = 50 $\mu$m.

Legs 1–4 (Figs 12–14) armed as follows (Roman numerals representing spines; Arabic numerals indicating plumose setae; Arabic numerals followed by *, indicating plumose/serrate setae):

| | Coxa | Basis | Exopodite | | | Endopodite | | |
|---|---|---|---|---|---|---|---|---|
| | | | 1 | 2 | 3 | 1 | 2 | 3 |
| Leg 1 | 0–1 | 1–I | I–1; | I–1; | III,I + 1,3 | 0–1; | 0–2; | I,I + 1,3 |
| Leg 2 | 0–1 | 1–0 | I–1; | I–1; | III,II,4 | 0–1; | 0–2; | I,II,3 |
| Leg 3 | 0–1 | 1–0 | I–1; | I–1; | III,II,4 | 0–1; | 0–2; | I,II,3 |
| Leg 4 | 0–1 | 1–0 | I–1; | I–1; | II,II,4* | 0–1; | 0–2; | I,II,2* |




*Figs 14–21. Troglocyclops janstocki* gen. et sp. n. Female. 14 – Leg 4. 15 – Pair of legs 5. Male. 16 – Habitus, dorsal. 17 – Antennule. 18 – Leg 1 intercoxal sclerite. 19 – Leg 2 intercoxal sclerite. 20 – Pair of legs 5. 21 – Leg 6. Scale bars = 50 $\mu$m.

Leg 1 (Fig. 12) bearing spine on inner corner of basis; outer apical spine of exopodite 3 serrate on outer margin, plumose on inner margin, and ending in a filament. Leg 2 and leg 3 (Fig. 13) differing in size only. Three proximalmost inner setae of leg 4 exopodite 3 modified, being plumose on basal third and with serrate hyaline lamella on both margins on distal 2/3; distal most inner seta with basal portion naked. Leg 4 endopodite 2 (Fig. 14) with 2 inner plumose setae. Leg 4 endopodite 3 about twice longer than wide, and bearing 3 spines and 2 modified setae; inner apical spine 1.2 times longer than outer apical spine, both longer than endopodite 3; outer marginal spine shorter than endopodite 3; both inner setae similar in structure to inner setae of leg 4 exopodite 3 and not reaching tip of inner apical spine.

Pair of legs 5 (Fig. 15) joined by intercoxal sclerite. Each leg 3-segmented; coxa naked; basis with plumose outer seta; exopodite 2.5 times longer than wide and with 3 spines and 1 seta; inner spine 1.5 times longer than of outer spines.

*Male.* Body length 710–860 $\mu$m ($N$ = 12). Prosome:urosome ratio = 1.02–1.14 : 1. Corners of cephalosome (Fig. 16) more produced than in female. Antennule of 16 segments and armed as in Fig. 17. Intercoxal sclerite of leg 1 and leg 2 (Figs 18, 19) with pair of spiniform projections. Leg 5 (Fig. 20) differing from that of female in having 2 inner setae on exopodite; proximal inner seta twice longer than distal inner seta; P6 (Fig. 21) represented by short inner spine and 2 setae; outer seta twice longer than middle seta.

*Etymology.* This species is named after the eminent carcinologist Dr Jan H. Stock.

## Remarks

*Troglocyclops* is included in the Halicyclopinae because of the general structure of the leg 5. It is distinguished from all known Halicyclopinae in possessing the seminal receptacle divided into two parts by a transversal bar, the first pediger proximally fused to the cephalosome and partially enclosed by a carapace-like extension of the posterior margin of the cephalic shield, the antennule of 15 segments, the mandibular palp reduced to 3 setae, the maxillary endopodite bisegmented, the maxilliped endopodite with 3 distinct segments, the presence of 2 spines at the apex of the terminal segment of the exopodite of legs 2–4, and the sexual dimorphism in the armature of the intercoxal sclerite of legs 1 and 2, as well as in the number of setae on the inner margin of the leg 5 exopodite. Within the Halicyclopinae the new genus shares with *Neocyclops* the structure of the legs 4 and 5 of the female.

The mandibular palp in Halicyclopinae was known hitherto as having two short unequal setae, as in *Halicyclops* and most of the *Neocyclops* species, or lacking these setae, as in *N. salinarum* Gurney (according to Por, 1973), and *N. medius* Herbst, 1955. The structure of the mandibular palp of *Troglocyclops* closely resembles the pattern commonly observed in the other two subfamilies of Cyclopidae.

The number of segments of the maxillary endopodite of *Troglocyclops* is the highest observed within the Halicyclopinae, since all the other genera of the subfamily have the maxilla endopodite unisegmented. A bisegmented maxilla endopodite like that of *Troglocyclops*, has been found in several genera of Cyclopinae, another subfamily of Cyclopidae (Monchenko, 1974; Herbst, 1988; Rocha & Bjornberg, 1988, etc.). Therefore it is unlikely to regard as valid Ho & Thatcher's (1989) proposition that the maxilla with an unisegmented endopodite would be one of the synapomorphies of Cyclopidae.

The number of segments of the maxilliped endopodite of *Troglocyclops* seems to be of great phylogenetic significance. In the phylogenetic analysis of the cyclopoid families proposed by Ho & Thatcher (1989), the families Cyclopidae, Oithonidae and the cluster of parasitic families are separated from the primitive Cyclopinidae by possessing a maxilliped with bisegmented endopodite. Rocha & Iliffe (1991) added Speleoithonidae to this group. The discovery of a maxilliped with 3-segmented endopodite in *Troglocyclops* indicates that this synapomorphy should be reviewed. At the same time it corroborates the position of the Cyclopidae within the Cyclopoida in Ho & Thatcher's cladogram.

Cyclopidae has been described as having the first pediger fused to the cephalosome (Sars, 1913–1918; Kiefer, 1929; Dussart, 1969). *Troglocyclops* is the first genus of the family with that somite free, although being reduced and partially hidden under the cephalosome. Giesbrecht (1900), and more recently Humes (1991), indicated that the first pediger might be free in the genus *Euryte* by their figures showing the habitus of entire females of *E. robusta* and *E. bellatula*, but made no mention of the structure of that somite in the descriptive text. The examination of specimens of *E.*

*longicauda* by one of us (C. E. F. da Rocha) confirmed the separation of the first pediger from the cephalosome in *Euryte*. This character is shared with the cyclopinid genera *Cyclopina* and *Procyclopina*. If we consider that this family is considered the sister group of all the other families of Cyclopoida (Ho & Thatcher, 1989), it might represent an intermediary condition between the plesiomorphic state (first pediger somite free from the cephalosome and well-developed) and the apomorphic state (complete fusion of that somite to the cephalosome) found in all the other genera of Cyclopidae.

Based on the characters discussed above, it seems reasonable to assume that *Troglocyclops* diverged early from the cyclopid lineage. In Bahamian anchialine caves, its further evolution involved developing characteristic features such as the inner apical spine on the terminal segment of exopodite of legs 2–4 and the sexual dimorphism in the armature of the intercoxal sclerites of the legs 1 and 2, while retaining several primitive characters.

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