

BOHOLINA, A NEW GENUS (COPEPODA: CALANOIDA) WITH TWO NEW SPECIES FROM AN ANCHIALINE CAVE IN THE PHILIPPINES

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Two new copepods were found in an inland marine cave in Bohol. The new genus, *Boholina*, is considered to belong to a family of its own, the Boholiniidae, showing affinities to both the Pseudocyclopidae and the Ridgewayiidae. The species have fused pedigers 4 and 5, a 3-segmented urosome in the female and a 4-segmented one in the male. The 5th legs and the widely separate gonopores in females are reminiscent of species of *Pseudocyclops*. The cephalosome is reminiscent of species of *Ridgewayia*. The two species *B. crassicephala* sp.n. and *B. purgata* sp.n. are best distinguished from each other by their relative length of the 1st antennae, the shape of the posterior corners of pedigers 2 and 3, and 5th legs of the males.

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INTRODUCTION

Copepods from marine caves primarily accessible through diving have been investigated in recent years. Caves in Bermuda are most extensively sampled and at least five new genera have been recorded there (BOXSHALL & ILIFFE 1986; FOSSHAGEN & ILIFFE 1985, 1988).

The investigation of cave copepods has produced interesting questions of both taxonomy and biography. New copepods from little known taxa such as the orders Platycopioidea and Misophrioida and the calanoid family Epacteriscidae have been discovered. All three groups retain primitive characters and all belong to an ancestral stock of copepods though through different lineages. Some cave copepods like those in the Misophrioida have related species in the deep sea.

In a survey of marine caves in the Philippines faunal assemblages similar to those in Bermuda were found. In this article a new genus with two species showing affinities to the Pseudocyclopidae and the Ridgewayiidae is described.

MATERIAL AND METHODS

Hundreds of specimens, both adults and copepodids, of the new species were collected with a swimmer-towed, fine-mesh plankton net at 0 to 2 m depths in a pool of San Vicente Cave, San Vicente, Bohol Island, Philippines on 9 April 1985. On this day the surface salinity was 9‰. The cave is located about 200 m inland from the coast in the village of San Vicente, near Baclayon at the southwestern corner of the island of Bohol in the central Philip-

ines. In addition to San Vicente Cave, collections were also made from 12 other nearby anchialine caves on Bohol and Panglao Islands, but no further specimens of *Boholina* were found.

The cave consists of a single collapse chamber open to daylight at one end and contains a several metres deep, anchialine pool about 25 m long and 10 m wide.

The pool is used by the local inhabitants for washing clothes, hence the water is milky and opaque from an overload of detergents. Considerable litter including many plastic bottles and bags was also present.

THE SPECIES

Family Boholiniidae fam. nov.

Until more representatives are known, the family shows the same diagnostic characters as given below for the single genus *Boholina*. It is characterized by well-developed mouthparts and primitive 3-segmented 1st to 4th legs. The 5th leg of the female has a 3-segmented exopod and a slightly reduced 2-segmented endopod. The right 1st antenna of the male is geniculate and the 5th legs are a highly complex grasping organ.

Boholina FOSSHAGEN gen.n.

Pedigers 4 and 5 fused. Rostrum downturned and rounded at its tip. Urosome 3-segmented in female and 4-segmented in male. Genital openings widely separate. Caudal rami produced into a pointed process distally. 1st antenna 25-segmented, with segments 8 and 9 partly fused. Endopod of 1st leg 3-segmented, each segment with a pointed outer distal corner, last segment without any outer seta and with a strong subapical spine. 4th leg with slightly modified terminal spines of exopod. 5th leg of female with a 2-segmented endopod. 5th legs of male

a complex grasping organ with highly modified exopods and reduced 1-segmented endopods.

Type species: *Boholina crassicephala* gen. et sp. nov.

Boholina crassicephala FOSSHAGEN gen. et sp.n.

Material. The species was obtained only at one locality, San Vicente Cave, Vicente, Bohol, Philippines, 9 April 1985 (111 ♀♀, 53 ♂♂, several copepodids).

Holotype. Adult female, total length 0.84 mm from San Vicente Cave, Vicente, Bohol, Philippines, 9 April 1985. One vial deposited in National Museum of the Philippines (NMP), Manila, Cat. No. NMCR 9766.

Paratypes. 21 ♀♀ and 10 ♂♂ from the same locality as the holotype deposited in NMP Cat. No. NMCR 9767. 20 ♀♀ and 10 ♂♂ deposited in the British Museum (Natural History), BM(NH), London, Cat. No. 1989. 48-57.

Etymology. From Bohol, diminutive. Crassus (L)-thick, cephalo (Gr)-head, refers to the thickened frontal part.

Description

Adult female (Figs 1,2)

Total length of 42 individuals ranged between 0,75 and 0,85 mm with an average of 0,81 mm. Front of prosome bears a clearly defined transverse crest-like structure. On urosome genital openings widely separate ventrally. Posterior ventral margin of genital segment with an alternating coarsely serrated and a finely striated margin.

1st antenna reaches slightly beyond pediger 3, well equipped with aesthetascs along its whole length and with particularly long setae on segments 3, 7, 9, 12, and 21.

2nd antenna with a distinctly 8-segmented exopod. Endopod distal segment bears a small serrated process on distal inner margin and setae cover more than half of distal outer margin.

Mouthparts well-developed and very similar to those of a *Ridgewayia* species (see *R. fosshageni* HUMES & SMITH).

Mandible bears a gnathobasis with short pointed teeth. 1st maxilla has four setae on second and third inner lobes. 2nd maxilla with five setae on its first lobe, one of which directed inwards, short, and slightly modified at its tip.

Maxilliped somewhat stouter and more compressed than that of *R. fosshageni*. First segment of basipod with eight setae. Endopod shorter than second segment of basipod. On endopod, second segment has a small process with a finely serrated margin.

The 1st leg differs in many ways from that of a *Ridgewayia* species. Second basipod with an outer

seta on its posterior side, a long median process, which is rounded distally. Exopod lacks an inner seta on first segment. First and second segments with a strong outer spine; second segment bears an outer process with a serrate distal part. Outer corner of each endopod segment pointed. Second segment with one medial seta on inner margin, third segment without a seta on outer margin and with a strong subapical inner spine.

2nd and 3rd legs similar to those of *R. fosshageni* in segmentation and setation except for an outer seta on second basipod of 3rd leg.

4th leg slightly modified in last segment of exopod. Longest terminal spine curved slightly inwards, and about two and a half times the length of adjacent terminal spine.

5th leg with a 3-segmented exopod and a 2-segmented endopod. First basipod bears an inner seta and second basipod an outer seta. Last segment of exopod with two long terminal spines of which inner one is slightly longer than outer one. Endopod bears one inner seta on first segment and seven setae on second segment.

Adult male (Fig. 3)

Total length of 23 individuals ranged between 0,70 and 0,77 mm with an average of 0,71 mm. Differs from female in its 4-segmented urosome, geniculate right 1st antenna, and in 5th legs. None of posterior margins of urosomal segments serrated. Right 1st antenna 21-segmented. Anterodistal margin of segment 19 extended into a short flattened and rounded process.

5th legs bear highly modified exopods, particularly on left side, and reduced 1-segmented endopods on both sides. Right exopod 1-segmented and armed with four strong spines, one at midlength of outer margin, one on distal outer margin, one terminal, and one subterminal. Last one smooth on inner side and serrated on outer side, other spines serrated on both sides. Right endopod broadest in its distal part, where it is evenly rounded. Armed with two slender spines on distal inner margin. Left exopod 3-segmented with a strong outer spine on first and second segments; last one serrated on outer margin only. Third segment complex with several flexible and irregular extensions and lobes. One inner long and seta-like tapering extension armed with fine setules on its distal part. Left endopod unarmed, pyriform, and broadest in its proximal part.

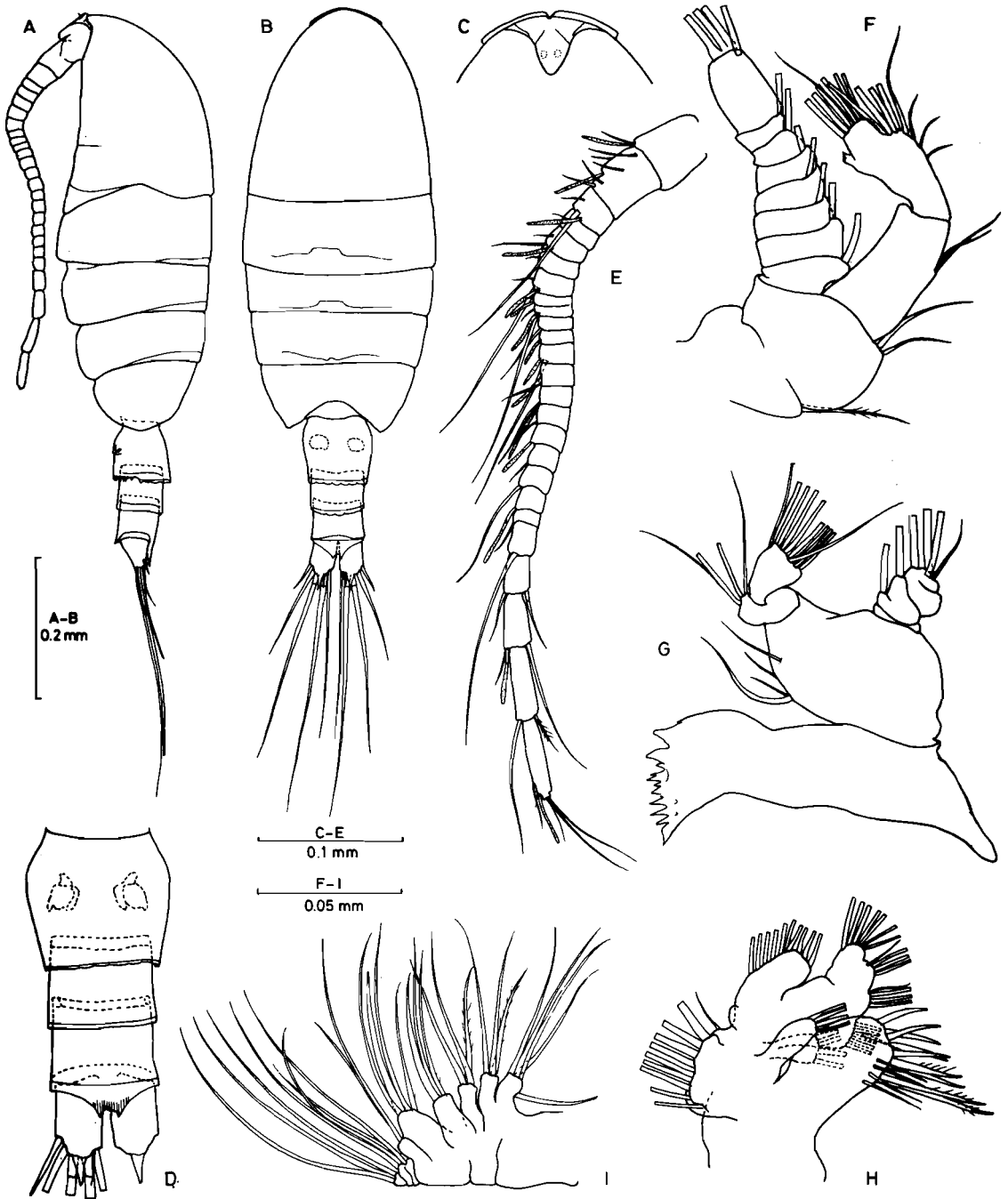


Fig. 1. *Boholina crassicephala* gen. et sp.n. ♀. A. Lateral view. B. Dorsal view. C. Rostrum and frontal part of head. D. Urosome dorsal view. E. 1st antenna. F. 2nd antenna. G. Mandible. H. 1st maxilla. I. 2nd maxilla.

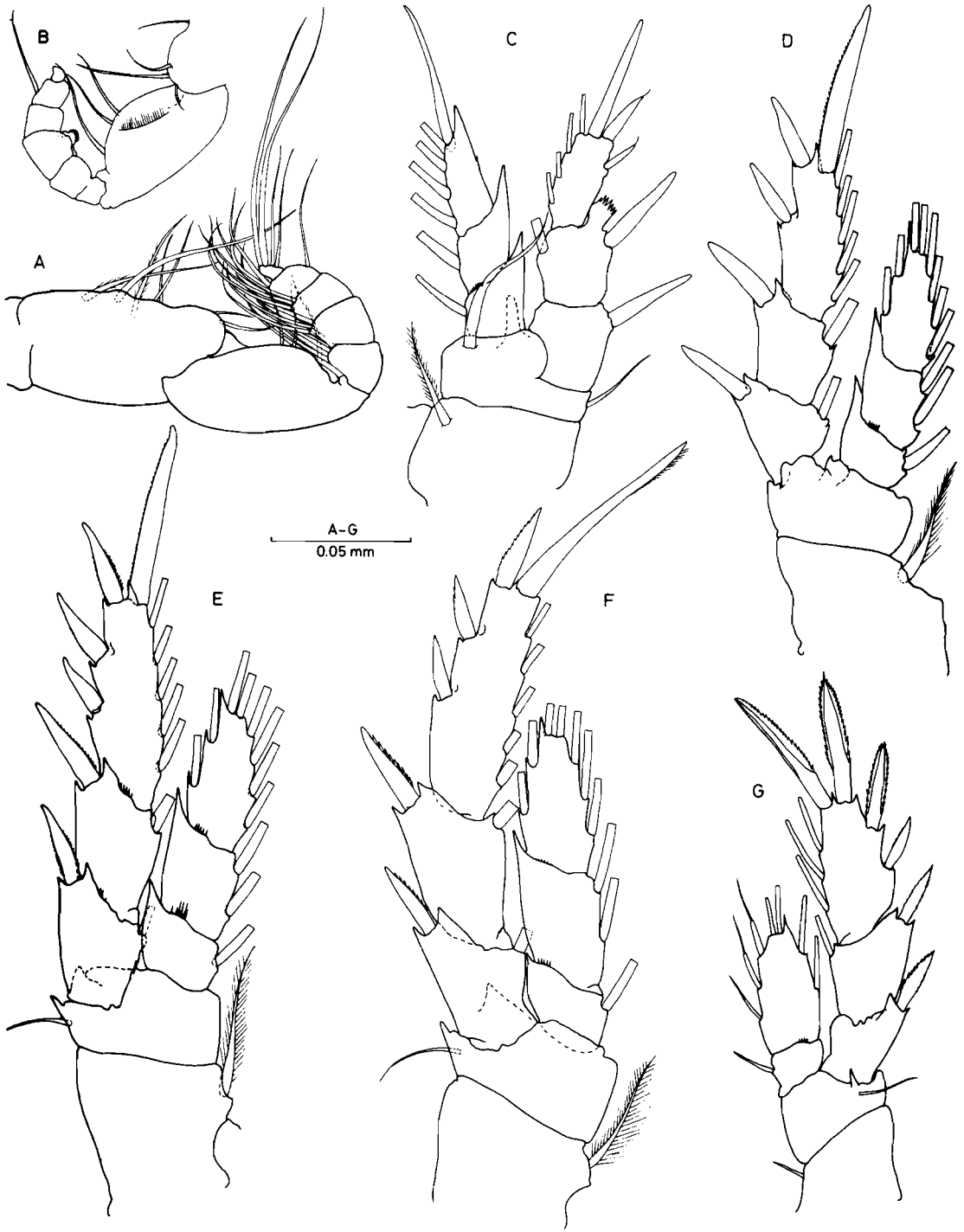


Fig. 2. *Boholina crassicephala* gen. et sp.n. ♀. A. Maxilliped. B. Maxilliped with setae partly omitted. C. 1st leg. D. 2nd leg. E. 3rd leg. F. 4th leg. G. 5th leg.

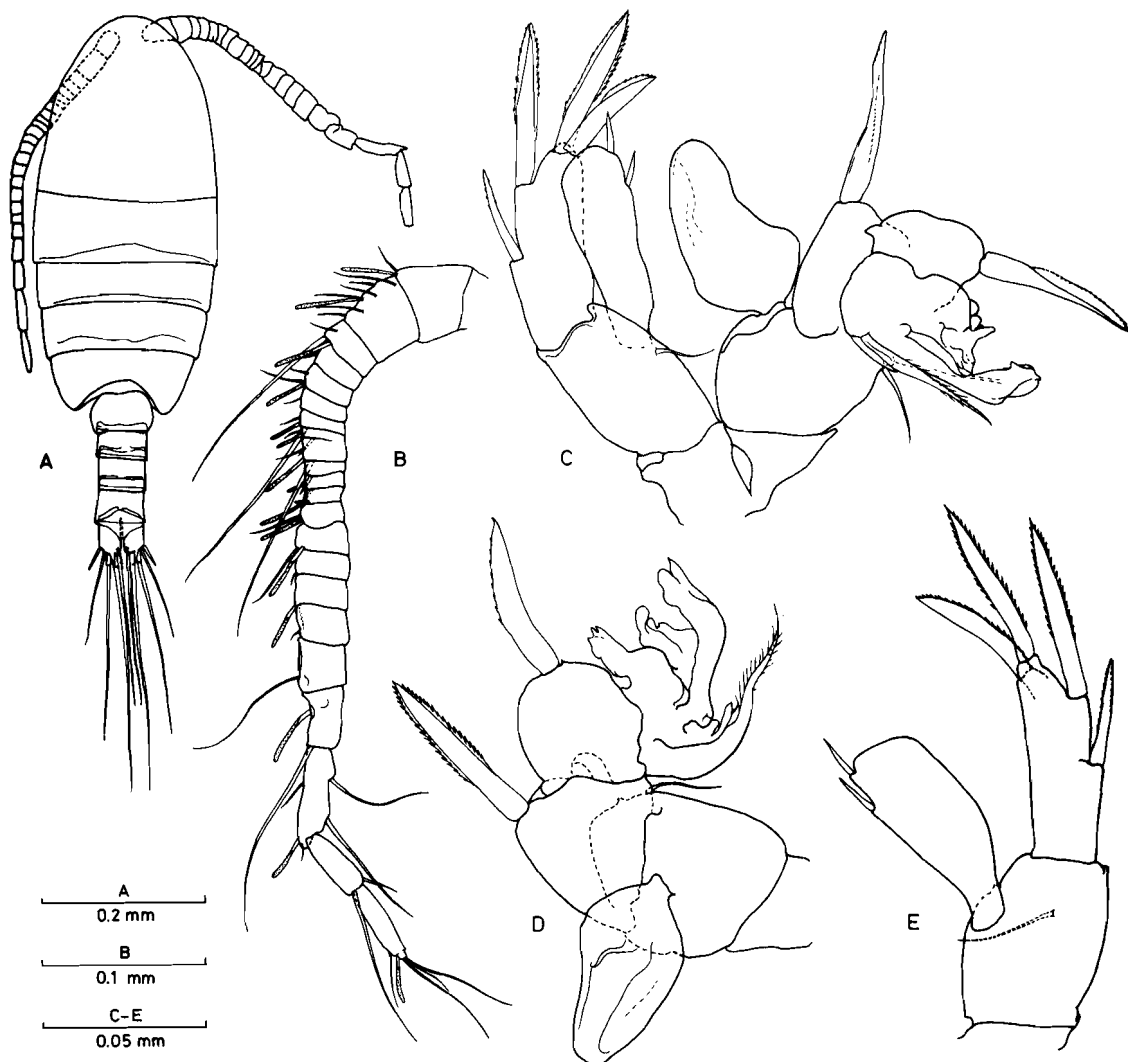


Fig. 3. *Boholina crassicephala* gen. et sp.n. ♂. A. Dorsal view. B. Right 1st antenna. C. 5th legs posterior view, with left exopod somewhat twisted. D. Left 5th leg anterior view. E. Right 5th leg anterior view.

Boholina purgata FOSSHAGEN gen. et sp.n.

Material. The species was obtained at one locality, San Vicente Cave, Vicente, Bohol, Philippines, 9 April 1985 (26 ♀♀, 29 ♂♂, several copepodids).

Holotype. Adult female, total length 0.75 mm from San Vicente Cave, Vicente, Bohol, Philippines, 9 April 1985. One vial deposited in NMP, Manila, Cat. No. NMCR 9768.

Paratypes. 10 ♀♀ and 10 ♂♂ from the same locality as the holotype, deposited in NMP Cat. No. NMCR 9769. 5 ♀♀ and 5 ♂♂ deposited in BM(NH), London, Cat. No. 1989. 58-67.

Etymology. *Purgatus* (L)-cleansed, refers to the use of detergents in the cave where the animal was caught.

Description

Adult female
(Fig. 4 A-D)

Total length of 25 individuals ranged between 0,73 and 0,79 mm with an average of 0,75 mm. Posterior corners of pedigers 2 and 3 pointed. Genital openings separated but not as widely as in the preceding species. Posterior ventral margin of genital segment very coarsely serrated. Midventral margin of third urosomal segment extended into a cleft-like structure similar to that on dorsal side but smaller in size.

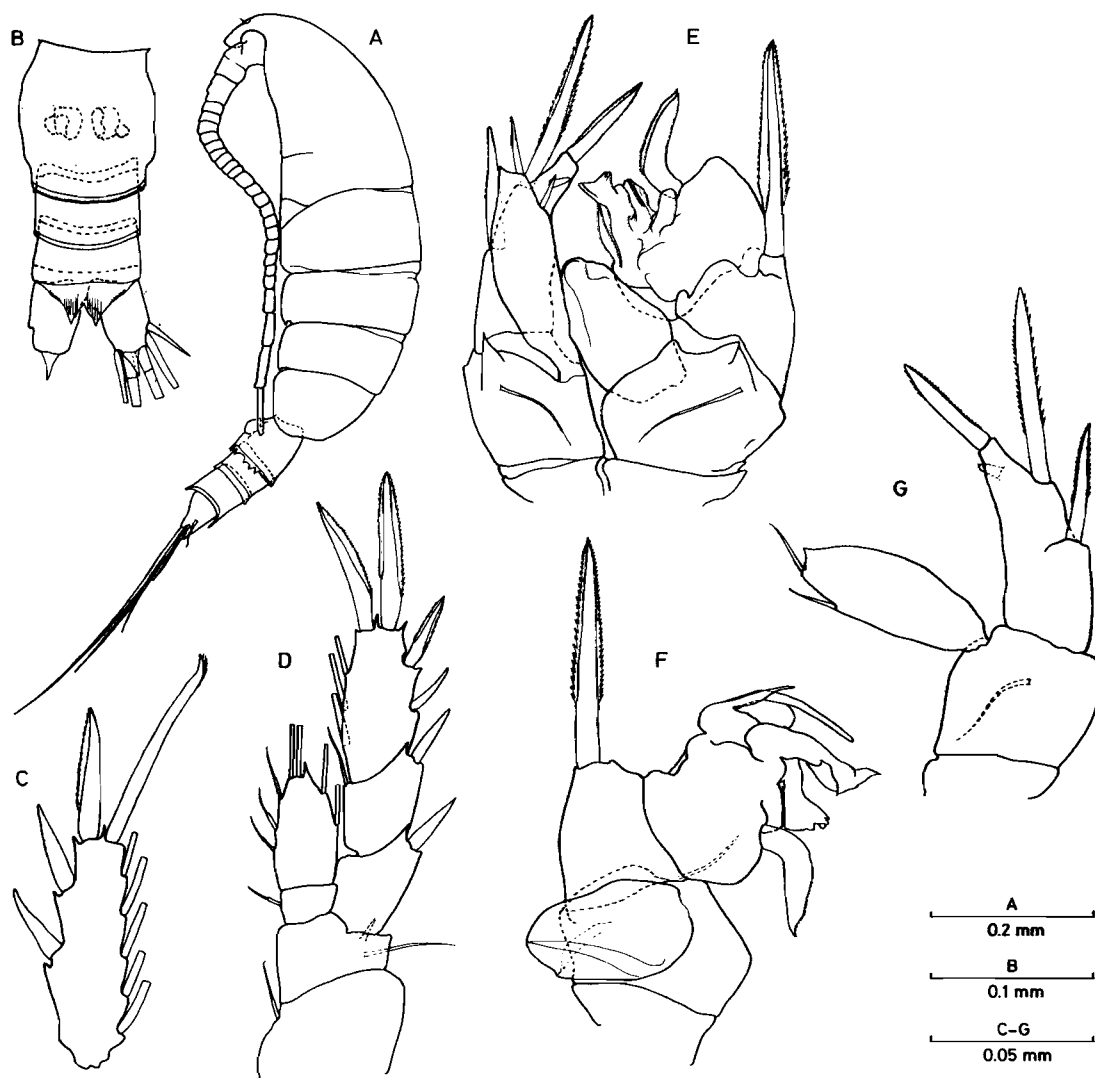


Fig. 4. *Boholina purgata* gen. et sp.n. A-D ♀, E-G ♂. A. Lateral view. B. Urosome dorsal view. C. 4th leg, distal segment of exopod. D. 5th leg. E. 5th legs posterior view. F. Left 5th leg anterior view. G. Right 5th leg anterior view.

1st antenna reaches beyond prosome to about the middle of genital segment. Segment 22 relatively longer than segment 21 than in the preceding species.

2nd antenna, mandible, 1st maxilla, and 2nd maxilla without any noticeable differences from those of *B. crassicephala*. In maxilliped no process could be discerned on second segment of endopod.

Only slight differences in legs of the two species, mostly in relative lengths of the two terminal spines of exopods of 2nd to 5th legs. In 2nd and 3rd legs the outer terminal spine half or slightly more the length of the inner one. In 4th leg the inner termi-

nal spine curved at its tip, and about one and a half times length of the outer one. In 5th leg the outer of the two terminal spines of exopod slightly longer than the inner one.

Adult male (Fig. 4 E-G)

Total length of 28 individuals ranged between 0,64 and 0,73 mm with an average of 0,68 mm. It differs from female in its 4-segmented urosome, geniculate right 1st antenna, and in 5th legs. Midventral posterior margin of last urosomal segment extended into two points like that of female.

1st antenna very similar to that of *B. crassicephala* in structure but reaching slightly beyond last segment of prosome.

5th legs the same general structure as those of *B. crassicephala* but differ in details. Right exopod armed with four spines, three strong ones and a small stout subterminal one on posterior side. Right endopod broadest at its midlength, pointed distally, and with two slender spines on inner distal margin. Left exopod bears a very long outer spine on first segment, and a strong outwardly curved spine on second segment. Third segment bears several irregular lobes and an inner long and smooth extension. Left endopod rounded, nearly symmetrical and broadest in its middle part.

Comparison of the two species

The species are very similar in size but may be best distinguished in the following characters.

A transverse frontal crest is only present in *B. crassicephala*. The posterior corners of pedigers 2 and 3 are rounded in *B. crassicephala* and pointed in *B. purgata*. The genital openings of the females are widely separate in both species but somewhat closer in *B. purgata*. The 1st antenna reaches slightly beyond pediger 3 in *B. crassicephala* and to the middle of the genital segment in *B. purgata*.

The longest spine on the last exopodal segment of 4th leg is straight in *B. crassicephala* and curved distally in *B. purgata*. The most conspicuous difference in the 5th legs of the males is in the right exopod, where four strong spines are present in *B. crassicephala* and three strong spines and a small one in *B. purgata*. Formalin-fixed specimens of both species have a brownish tinge particularly on the swimming legs.

DISCUSSION

WILSON (1958) found many similarities between *Pseudocyclops* and *Ridgewayia* but considered the different position of the genital openings, which are widely separate in *Pseudocyclops* and closely set in *Ridgewayia*, so essential as to keep the two genera in different families. ANDRONOV (1974) found the two families closely related and suggested the superfamily Pseudocyclopoidea to include them.

Boholina shows an array of characters from both the Ridgewayiidae and the Pseudocyclopoidea.

It is reminiscent of *Ridgewayia* in its cephalosome. The long 1st antenna has long setae on the segments corresponding to those of *Ridgewayia* and *Exumella* FOSSHAGEN, 1970, very similar 2nd antenna, and unmodified mouthparts like those of *Ridgewayia*.

Fused pedigers 4 and 5, modifications on the 1st leg, particularly on the endopod, and an outer seta on second basispod are features found in *Placocalanus insularis* FOSSHAGEN, 1970.

The most characteristic and apomorphic character of the Ridgewayiidae, the distinctly set off third segment of exopod of the 5th legs in females, however, is absent in *Boholina*. The 5th legs of the female *Boholina* are more suggestive of some species of *Pseudocyclops*. Another character shared with *Pseudocyclops* is the widely separate gonopores. The shortened 1st antennae with reduced number of segments, and a 2nd antenna with a 3-segmented endopod of *Pseudocyclops*, differ much from the conditions found in *Boholina*.

Characters like the modifications of the terminal spines of the exopods of the 4th legs and an inner seta on the first basispod of the female 5th leg in both species of *Boholina* are to our knowledge not found in any species of the Ridgewayiidae and Pseudocyclopoidea. These two families are so far found in benthic environments in shallow water and seem to share similar habitats.

Some species of *Ridgewayia*, however, have been found in swarms in vicinity of corals (ESTERLY 1911; FOSSHAGEN 1973) and associated with an actinarian (HUMES & SMITH 1974).

Boholina seems to live in a habitat different from that of the two families, as it was taken pelagic in a cave.

This biotope and the morphological differences from the Ridgewayiidae and the Pseudocyclopoidea seem to support the erection of the new family, the Boholiniidae.

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REFERENCES

- Andronov, V.N. 1974. Phylogenetic relation of large taxa within the suborder Calanoida (Crustacea, Copepoda). - *Zoologicheskii Zhurnal* 53:1002-1012.
- Boxshall, G.A. & T.M. Iliffe 1986. New cave-dwelling misophrioids (Crustacea:Copepoda) from Bermuda. - *Sarsia* 71:55-64.
- Esterly, C.O. 1911. Calanoid Copepoda from the Bermuda Islands. - *Proceedings of the American Academy of Arts and Sciences* 47:219-226.
- Fosshagen, Audun 1970. Marine biological investigations in the Bahamas. 15. *Ridgewayia* (Copepoda, Cala-

- noida) and two new genera of calanoids from the Bahamas. - *Sarsia* 44:25-58.
- 1973. A new genus and species of bottom-living calanoid (Copepoda) from Florida and Colombia. - *Sarsia* 52:145-154.
- Fosshagen, Audun & Thomas M. Iliffe 1985. Two new genera of Calanoida and a new order of Copepoda, Platycopioidea, from marine caves on Bermuda. - *Sarsia* 70:345-358.
- 1988. A new genus of Platycopioidea (Copepoda) from a marine cave on Bermuda. - *Hydrobiologia* 167/168:357-361.
- Humes, Arthur G. & Wayne L. Smith 1974. *Ridgewayia fosshageni* n.sp. (Copepoda:Calanoida) associated with an actinarian in Panama, with observation on the nature of the association. - *Caribbean Journal of Science* 14:125-139.
- Wilson, Mildred Stratton 1958. A review of the copepod genus *Ridgewayia* (Calanoida) with descriptions of new species from the Dry Tortugas, Florida. - *Proceedings of the United States National Museum* 108: 137-179.

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