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# A new species of *Erebonectes* (Copepoda, Calanoida) from marine caves on Caicos Islands, West Indies

Audun Fosshagen[1] & Thomas M. Iliffe[2]
[1] *Dept. of Fisheries and Marine Biology, University of Bergen, Høyteknologisenteret, N-5020 Bergen, Norway*
[2] *Texas A & M University at Galveston, Dept. of Marine Biology, P.O.Box 1675, Galveston, TX 77553, USA*

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**Abstract**

*Erebonectes macrochaetus* was collected from two anchialine caves on Caicos Islands. This is the second species of the genus, and considerably smaller than its congener only known from caves in Bermuda. The most pronounced morphological differences between the two species are found in the furcal setae, mandible, first leg, and the fifth legs of the male. In *E. macrochaetus* one furcal seta on left side is extremely elongated, the endopod of mandible is reduced, and in first leg the first segment of endopod has an elongated process on its outer distal corner.

## Introduction

Several cave localities around the world have been investigated for calanoid copepods by the authors. From Bermuda Fosshagen & Iliffe (1985) described *Erebonectes nesioticus* which they considered to be one of the most primitive within the order Calanoida. It has ancestral characters like 27-segmented antennule, indications of a 4-segmented endopod of the antenna (Huys & Boxshall, 1991) and all legs of female with 3-segmented rami. *E. nesioticus* belongs to the family Epacteriscidae consisting of the three genera *Epacteriscus* Fosshagen, 1973, *Enantiosis* Barr, 1984 and *Erebonectes* Fosshagen, 1985 (in Fosshagen & Iliffe, 1985). All species have been recorded from caves, *Enantiosis* and *Erebonectes* exclusively in caves, but *Epacteriscus* also from dredgings outside caves (Fosshagen, 1973). In this paper we describe a second species of *Erebonectes* collected during two expeditions to marine caves in Caicos Islands.

## Material and methods

Only three specimens were obtained in two localities from Caicos Islands: Middle Caicos, Conch Bar Cave, 29 October 1982, one copepodid stage V, total length 0.89 mm collected with a plankton net from 0–1 m depth; Providenciales Island, The Hole, 17 May 1991, one female holotype, total length 0.97 mm, and one male paratype, total length 1.03 mm, collected with a plankton net from 0–5 m depth. The type material is kept in The British Museum (Natural History), BM (NH), London. Holotype. BM (NH) Cat. No. 1993.407. Paratype. BM (NH) Cat. No. 1993.408. The terminology used is that by Huys & Boxshall (1991).

Etymology. The specific name *macrochaetus* refers to the well-developed seta on left furcal ramus.

## Description

*Erebonectes macrochaetus Fosshagen sp.n.*

Adult female (holotype). Figs 1, 2, 3A–C. The body is slender (Fig. 1B) and 0.97 mm in total length. The last somite of prosome extends backwards to the middle of the genital double somite. The urosome is 4-segmented with last somite partly hidden under the preceding one. The genital double somite has a cone-like structure on its ventral surface. The furcal rami bear five elements distally:

1. An outer spine,
2. A seta densely set with slender spinules proximally which gradually become setules towards distal end,
3. The longest seta, on left side, more than 1.5 times the length of the body,
4. An inner plumose seta, and
5. A small dorsally directed plumose seta. The rostrum bears two filaments (partly broken off).

The antennule is 27-segmented (Fig. 1E) with segments 10 and 11 partially fused. It extends backwards

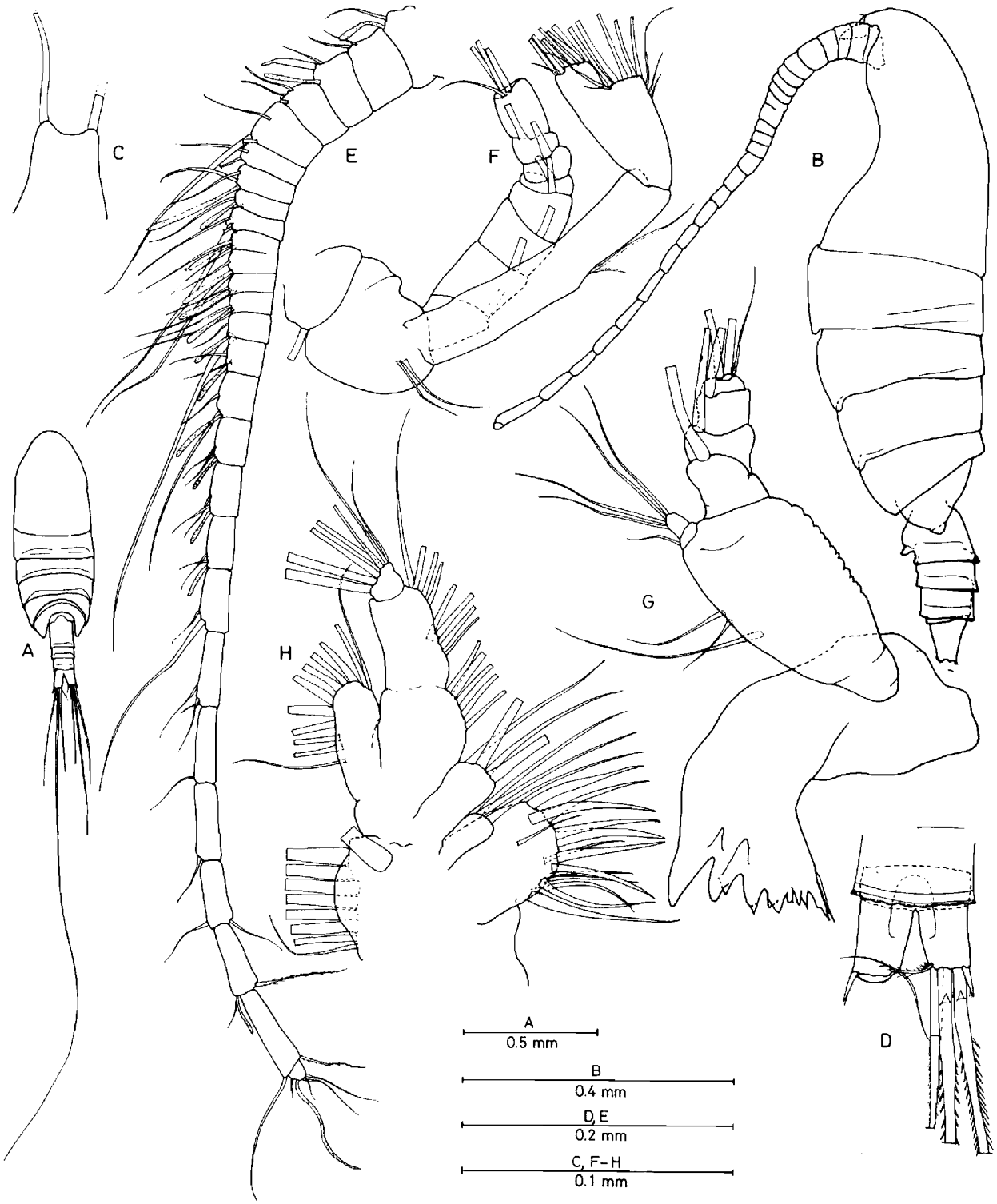


*Fig. 1.* *Erebonectes macrochaetus* sp.n. female (holotype). A. Dorsal view. B. Lateral view. C. Rostrum. D. Furcal rami, dorsal view. E. Antennule. F. Antenna. G. Mandible. H. Maxillule.

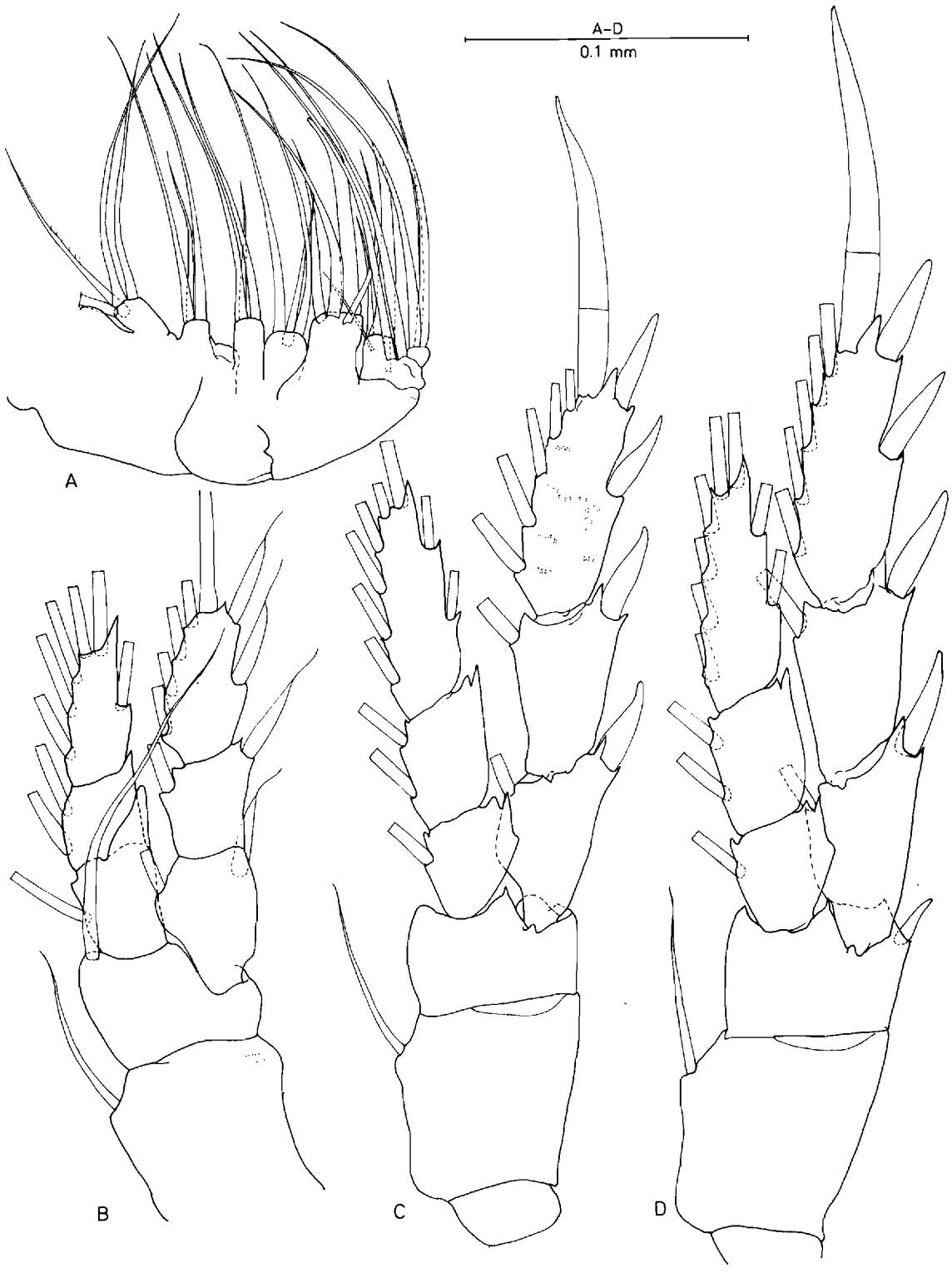


*Fig. 2.* *Erebonectes macrochaetus* sp.n. female (holotype). A. Maxilla. B. Leg 1. C. Leg 2. D. Leg 3.

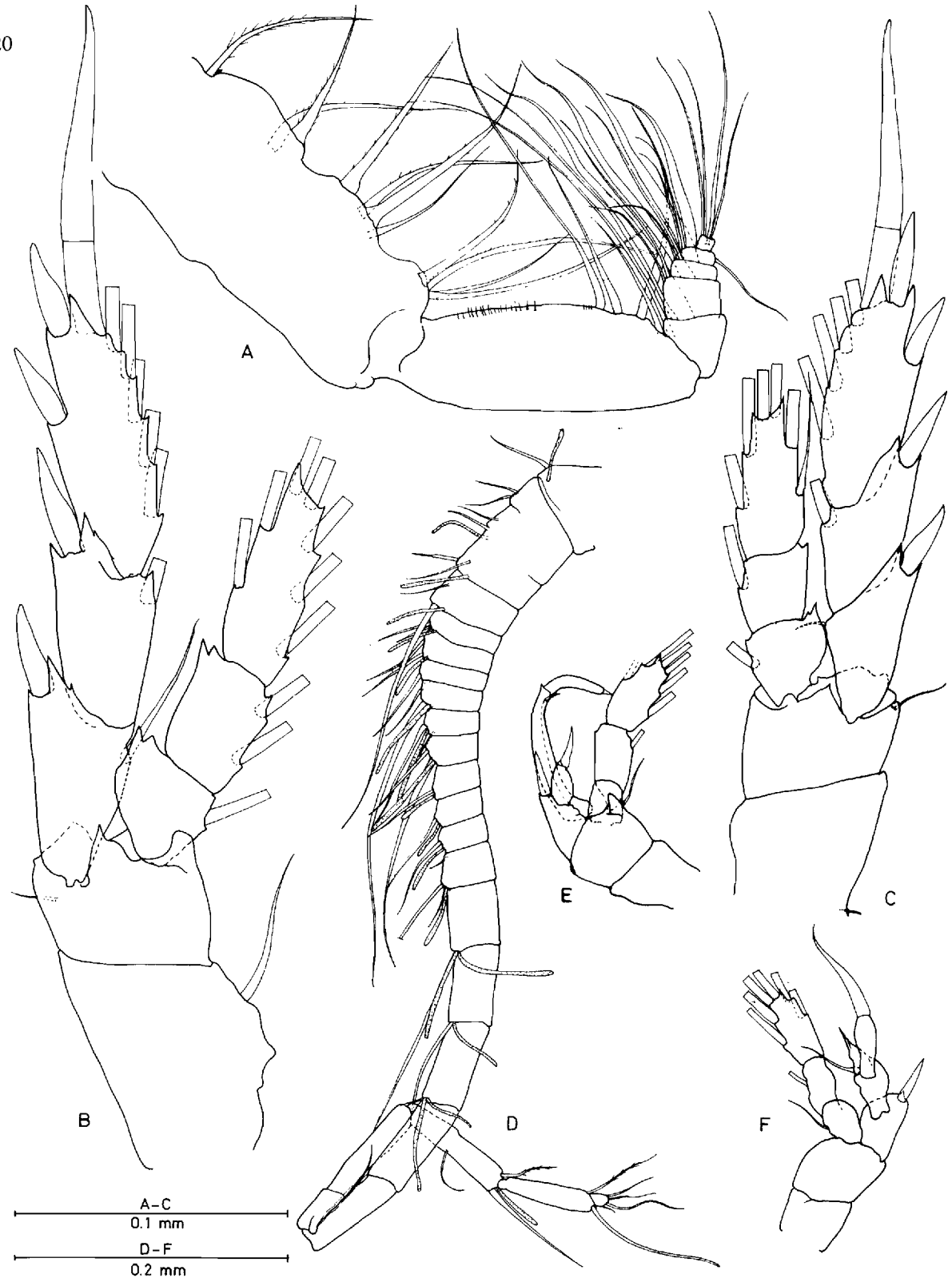


*Fig. 3.* *Erebonectes macrochaetus* sp.n. A-C female (holotype), D-F male (paratype). A. Maxilliped. B. Leg 4. C. Leg 5. D. Right antennule. E. Left leg 5, anterior view. F. Right leg 5, anterior view.

to the posterior end of urosome somite 3. The antenna is (Fig. 1F) similar to that of *E. nesioticus*. The mandible (Fig. 1G) has an endopod of reduced size, with one seta on first segment and four on second segment. The outer margin of basis is crenulated, and the inner margin bears three setae of unequal lengths. The ventralmost tooth on gnathobase is simple and not bicuspid like that of *E. nesioticus*. The maxillule (Fig. 1H) has a greater number of setae than *E. nesioticus* in the following parts: nine on coxal epipodite, five on distal basal endite, and clusters with four, four and seven setae on endopod. The maxilla (Fig. 2A) has four setae of first praecoxal endite, otherwise similar to that of *E. nesioticus*. The maxilliped (Fig. 3A) has an endopod which is more compressed and with weaker setae than those of *E. nesioticus*.

In most parts the swimming legs (Fig. 2B-D, Fig. 3B-C) are similar to those of *E. nesioticus*, but with the following differences: the first endopodal segment of first leg has a lobe-like extension on its outer distal corner, the basis of second leg lacks an outer spine, and the longest terminal exopodal spine of third segment of all legs is relatively longer than that of *E. nesioticus*. There are minute spinules (not all shown in figures), particularly on the third exopodal segment of second to fifth legs.

Adult male (paratype) (Fig. 3D-F). The body is 1.03 mm in total length. It differs from the female in the urosome, the right antennule, and in the fifth legs. The urosome is 5-segmented, with first four somites of equal length, and with last somite very short. The longest furcal seta on left side is slightly less than 1.5 times the total length of the body. The right antennule (Fig. 3D) is 23-segmented. Segment 2 consists of three fused or partially fused segments. Segment 20 seems to be relatively longer than the corresponding one in *E. nesioticus*. Its folded position makes observations of the geniculation area difficult; some elements seem to be lacking.

In the fifth legs the endopods are unmodified, the exopods are highly modified as in *E. nesioticus*, but in a different way. In the left leg (Fig. 3E) the first exopodal segment bears an outer regular spine. On the same segment, proximally on inner margin, there arises a strong curved appendage which is slightly longer than the endopod. In about the middle of its distal half it bears a slender inner spine. Further distally it is devided by a suture and the appendage curves abruptly inwards and tapers into a point. A small bulbous appendage with a long terminal spine is situated distally on the inner margin of first exopodal segment. The right exopod (Fig. 3F) is 3-segmented with its first segment bearing a strong outer spine. The second segment has an inner seta, and the distal part of the segment ends in a pointed process. The third segment is elongated and tapers gradually into a long recurved smooth part.

## Results

The differences between the two *Erebonectes* species are most pronounced in their size, in the shape of their furcal setae, the mandible, the maxillule, the first leg, and in the exopods of the male fifth legs. The total length of the female *E. macrochaetus* is 0.97 mm while one *E. nesioticus* from Bermuda measured 1.90 mm. The furcal setae and the mandible are in the most apomorphic state in *E. macrochaetus*, while the maxillule is more plesiomorphic in *E. macrochaetus*. *E. macrochaetus* has one furcal seta less than *E. nesioticus* at its terminal part. Probably seta II, according to the classification of Huys & Boxshall (1991), is missing. Further seta III is transformed into a spine and setae IV and V are ornamented with spinules and setules.

The endopod of the mandible in *E. macrochaetus* is more reduced than in *E. nesioticus* by having less setae. A gradual tendency towards a reduction of the endopod is found among the genera in the following order: *Erebonectes* has a 2-segmented endopod, *Enantiosis* a 1-segmented one (Barr, 1984), and *Epacteriscus* with only one seta left as a rudiment of the endopod (Fosshagen, 1973). The crenulation on the outer margin of the basis in *E. macrochaetus* is to our knowledge a character unique to the species. The plesiomorphic condition of the maxillule in *E. macrochaetus* is shown in most parts by the greater number of setae than in *E. nesioticus*. An exception is a missing outer seta on the basis of *E. macrochaetus*. The extension on the outer part of the first endopodal segment of the first leg of *E. macrochaetus* is a character found among certain species of the Ridgewayiidae and Boholiniidae (Fosshagen, 1970; Fosshagen & Iliffe, 1989). In particular the left exopods of the male fifth legs in the two species show different structures and homologous parts are not easily recognized. This is also partly related to the scarcity of material, with only one male of each species available, and with different orientation of the limbs.

Both species are obtained in anchialine caves in their most remote parts. The caves both in Caicos Islands and Bermuda have extensive underground pas-

sages, and the hitherto accessible parts may not be the preferred biotope for *Erebonectes*. The two species are separated by *ca* 1200 km of deep ocean, and Bermuda is an isolated oceanic island which has never been connected to the mainland. One of the enigmatic questions is how species with such a specialized way of life may have a distribution like this. Some other cave-living species in the Epacteriscidae under study show a Tethyan pattern of distribution. Species of *Enantiosis* are found in the Caribbean and on Bermuda, and an as yet undescribed new genus, closely related to *Enantiosis*, is found in caves in the Canary Islands (personal observations). Also in the troglobitic crustacean class Remipedia congeneric species have been reported from the Bahamas and the Canary Islands (Schram, 1986).

## Discussion

Both caves are situated in an area with considerable deposits of limestone and with well-developed karst topography. The Hole at Providenciales is a sheer-walled, cenote-like pit, 1.1 km inland from the nearest open water on the south coast. A 15 m long by 10 m wide lake, open to daylight, is situated at the bottom of the 15 m deep entrance pit. The 6 to 8 m deep lake is completely choked by breakdown and surface debris such that no human-sized passages extending off from it were found. Salinity was uniform with depth at 31 ppt. A variety of other troglobitic crustaceans had previously been found to inhabit this cave. The ostracod *Deeveya spiralis* represents a new subfamily, Deeveyinae, within the family Halocyprididae (Kornicker & Iliffe, 1985). *Speonebalia cannoni*, representing a new genus, is the first troglobitic lepostracan (Bowman *et al.*, 1985). *Bahadzia stocki*, from a new genus of hadziid amphipods, has congeners inhabiting caves in the northern Bahamas, the island of Cozumel off the Caribbean coast of Yucatan and Haiti (Holsinger & Yager, 1985). *Bahadzia* may be an ancient relict derived from an early hadziid fauna in the old Tethys seaway (Holsinger *et al.*, 1985).

Conch Bar Cave at Middle Caicos Island is reported to be more than 2.5 km long (Gregor, 1981), and the largest and most significant cave in the Turks and Caicos group. The cave is developed in a coastal dune-derived ridge (Conch Bar Hill) located 500 m inland from the open ocean. It consists of multiple levels, the lowest of which is permanently flooded with tidal brackish waters 10 or more metres deep. Surface salinity in the pools was 23 ppt. in October 1982. Other crustaceans found in the cave include the amphipod *Spelaeonicippe provo*, the shrimps *Barbouria cubensis* and *Typhlatya garciai*, a new species of troglobitic mysid, *Stygiomysis clarkei* described by Bowman *et al.* (1984). The present plankton samples from both caves contained numbers of an unidentified cyclopoid copepod.

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