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AMSTERDAM EXPEDITIONS TO THE WEST INDIAN ISLANDS, REPORT 12 *)

SOME NEW HYPOGEAN CIROLANID ISOPOD CRUSTACEANS FROM HAITI AND MAYAGUANA (BAHAMAS)

by

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ABSTRACT

A new stygobiont genus of Isopoda Cirolanidae, *Haitilana*, with two new species, *H. radicicola* and *H. acanthura*, are described from groundwaters in Haiti. These are the first hypogean cirolanids recorded from the island of Hispaniola. The new genus is mainly characterized by its pleon segmentation, the clearly prehensile first pereiopods and weakly prehensile second and third pereiopods, and the 2- and 5-segmented pedunculus of antennae 1 and 2, respectively. *Haitilana* shows the greatest morphological resemblance to *Antrolana lira* Bowman, 1964, from the Appalachian Valley, Virginia, U.S.A. The localities where *Haitilana* was found, have been flooded by the sea during the Cenozoic. Regression seems to be the most plausible explanation for the evolution of *Haitilana*.

Another new stygobiont cirolanid, *Bahalana cardiopus*, is described from a cave on Mayaguana, an island of the Bahamas. This species is congeneric with *Bahalana geracei* Carpenter, 1981, from the island of San Salvador (Bahamas). Clearly distinctive of *B. cardiopus* are the unarmed endopodites of pleopods 3 to 5, and the armature of the maxillipedal endite. The Bahama archipelago is an accumulation area. *Bahalana* has been found in meso- and polyhaline waters. Dispersal (from marine ancestors) seems to be the most plausible explanation for the evolution of *Bahalana*.

RÉSUMÉ

Un genre nouveau d'Isopodes Cirolanides, *Haitilana*, avec deux espèces nouvelles (*H. radicicola* et *H. acanthura*) sont décrits d'eaux souterraines de Haïti. Ce sont les premiers Cirolanides hypogés à être découverts à Hispaniola. Le nouveau genre se caractérise surtout par la segmentation de son pléon, par ses premiers péréiopodes nettement préhensiles et par des péréiopodes de la 2ème et 3ème paires faiblement préhensiles, ainsi que par les antennes 1 et 2 ayant des flagelles de 2 et de 5 articles respectivement. Du point de vue morphologique, *Haitilana* ressemble le plus à *Antrolana lira* Bowman, 1964, connue de l'Appalachian Valley, Virginia, U.S.A. Les localités où *Haitilana* a été capturée ont été submergées par la mer au cours du Cénozoïque, et c'est ce que Stock appelle „Regression model" qui semble être l'explication la plus plausible pour l'évolution des *Haitilana*.

Un autre Cirolanide stygobie nouveau, *Bahalana cardiopus*, est décrit d'une grotte de Mayaguana, île appartenant aux Bahamas. Cette espèce est congénérique de *B. geracei* Carpenter, 1981, de l'île de San Salvador (Bahamas), dont elle se distingue par les endopodites inermes des pléopodes 3 à 5 et par l'ornementation de l'endite du maxillipède. L'archipel des Bahamas est une aire d'accumulation, et *Bahalana* a été trouvée dans des eaux meso- et polyhalines. C'est la dispersion, à partir d'ancêtres marins, qui semble être l'explication la plus plausible pour l'évolution des *Bahalana*.

INTRODUCTION

During the Amsterdam Expedition to the West Indian Islands of 1979, stygobiont isopods of the family Cirolanidae have been found on several islands. J. H. Stock and S. Weinberg found them in two caves in the Bahamas, Lighthouse Cave on San Salvador island, and Mount Misery Cave on Mayaguana. The cirolanid of Lighthouse Cave is being described by Carpenter (1981) and has been named *Bahalana geracei*. The cirolanid from Mount Misery Cave is a new species, likewise of the genus *Bahalana*, and will be described here as *B. cardiopus*.

L. Botosaneanu and the present author found hypogean cirolanids at three different places on Haiti: in a large karst spring used as groundwater catchment and in two shallow wells. These are the first stygobiont cirolanids discovered in Hispaniola, the island of which Haiti forms the western part. A new endemic genus is erected for them, with two new species: *Haitilana radicicola* and *H. acanthura*.

Up to now, stygobiont cirolanids were known from Cuba, San Salvador island, Aruba, Mexico, and the U.S.A. (Texas and Virginia) (see fig. 9).

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Presently, they are known from Mayaguana and Haiti as well. Furthermore, they are found around the Mediterranean, in eastern Africa (Somalia) and in Madagascar.

TAXONOMIC PART

Haitilana n. gen.

Diagnosis. — Cirolanidae. Blind, unpigmented (except for sclerotized masticatory blade, spines on the exopodite of maxilla 1 and the tips of the dactyls of the pereiopods). Body cannot roll into a ball; rather wide, flat. Posterolateral margins of head partly surrounded by pereionite 1.

Pleonites 1 to 5 distinct, pleonites 2 to 4 with angularly produced posterolateral margins; lateral margins of pleonite 1 covered by those of pereionite 7 (type *B* of Bowman, 1975).

Antennae implanted near the anterior margin of the head. First antenna longer than the peduncle of the second; peduncle of the first antenna 2-segmented, of the second antenna 5-segmented; flagellum of the first and second antennae with numerous segments (see table I).

Mandibles and maxillae clearly cirolanid. Maxillipedal endopodite 5-segmented; endite with 2 coupling spines and several plumose setae.

Pereiopods increasing in length in posterior direction; pereiopod 1 clearly, pereiopods 2 and 3 weakly prehensile; remaining pereiopods ambulatory, slender.

Rami of pleopods 1 and 2 undivided; exopodites of pleopods 3 to 5 2-segmented; exopodites of pleopods 1 to 5 and endopodites of pleopods 1 and 2 armed with numerous plumose setae. Appendix masculina basal, implanted on the median margin of the endopodite, its medial margin with preapical serrations.

Uropodal protopodite wedge-shaped, exopodite and endopodite subequal; exopodite oblong and narrow, endopodite triangular.

Telson shaped like a human tongue, margins rounded, caudal end armed.

Type species. — *Haitilana radicicola* n. sp.

Etymology. — *Haitilana* (gender feminine), from Haiti + (*Ciro*)*lana*.

Haitilana radicicola n. sp. Figs. 1, 2, 3 a-e.

Material. — Amsterdam Expeditions to the West Indian Islands, Sta. 79/633, 1 ♂ (holotype), 7 ♂♂ and 16 ♀♀ (paratypes). Haiti: Source Débarasse near Jérémie (approximate position 18°39'08"N 74°11'30"W), 1 Dec. 1979. Zoölogisch Museum Amsterdam coll. no. Is. 105.164 a-b, 105.167 a-b.

Description. — Males range to a maximum length of 6.3 mm, females to 6.5 mm. Body rather wide, 2.8 times as long as wide (fig. 1a).

All pereionites, except for the first, with coxal plates; posterior corners of coxal plates 2 and 3 rounded, those of 4 to 7 posteroventrally pointed (figs. 1a, 1m); lateral margin of pleonite 1 covered by coxal plate of pereionite 7; pereionite 1 slightly longer than the others, pereionites 2 to 4 and 5 to 7 mutually of about the same size. Pleonites 1 to 3 almost as wide as pereionite 7; epimera 2 to 4 posteroventrally pointed, elongately triangular (fig. 1m). Dorsal surface of pleonite 1 parly covered by pereionite 7. Lateral margins of pleonite 5 covered by epimera of pleonite 4.

Telson shaped like a human tongue, its lateral margins rounded, posterior margin with several short setae and 4 small spines (fig. 1b).

Antenna 1 longer than the peduncle of antenna 2, reaching to the middle of pereionite 1 (fig. 1a). Peduncle 2-segmented, both segments long and equal in size; segment 1 with a depression into which fits peduncle segment 1 of antenna 2. Flagellum 10- to 12-segmented, first segment twice as long as the others; flagellum segments with 1 or 2 aesthetes on ventral surface (figs. 1c, 1d).

Antenna 2 reaching to the middle of pereionite 4 (fig. 1a). Peduncle 5-segmented, segments 4 and 5 about twice as long as the others. Flagellum about twice as long as the peduncle, 22- to 27-segmented, without aesthetes (fig. 1e).

Frontal lamina (fig. 1l) well developed, lateral margins concave, anterior end wider than posterior end.

Clypeus and labrum (fig. 1l) forming together an oval structure with a slight, rounded concavity on its posterior margin.

Mandibles asymmetrical (fig. 3 a & b); left mandible overlapping the right one. Palp slender, segment 2 with a distal group of 11 to 16 slender spines (4 of which are longer), segment 3 with

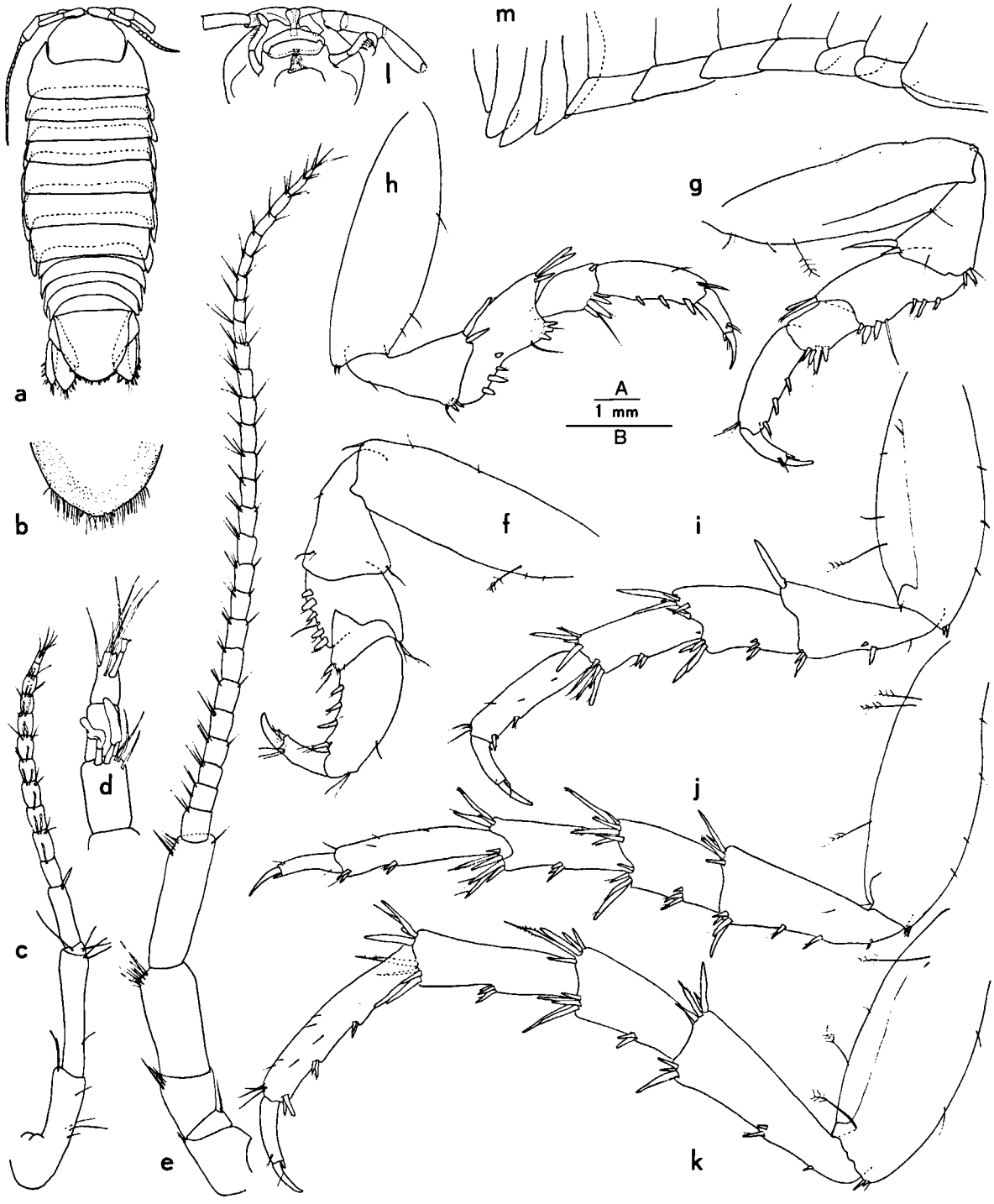

Fig. 1. *Haitilana radicicola* n. sp., a-k, ♂ holotype: a, entire animal, dorsal (scale A, left A_1 and right A_2 only partially represented); b, telson, dorsal (B); c, first antenna (C); d, first antenna, distal part (D); e, second antenna (C); f, first pereiopod (C); g, second pereiopod (C); h, third pereiopod (C); i, fourth pereiopod (C); j, fifth pereiopod (C); k, sixth pereiopod (C).
l-m, ♂ paratype: l, head, ventral (B); m, pereion and pleon, lateral (B).

11 or 12 small marginal spines and 3 longer terminal spines. Incisor right with 9 or 10, left with 11 small spines. Lacinia mobilis elongated, armed with 13 to 17 small spines and with fine cilia.

Maxilla 1 (fig. 3c). Distal armature of exopodite consisting of 1 minute spinule and 10 strongly sclerotized spines; three innermost spines with 1 medial denticle, other spines with 2 or more denticles. Endite armed with 3 spines, of which 1 is longer than the two others.

Maxilla 2 (fig. 3e) with 4 and 8 to 10 slender elements on palp and exopodite, respectively. Endopodite with 5 slender spines and 3 or 4 plumose setae.

Maxilliped (fig. 3d) with 5-segmented endopodite; segment 1 squarish, armed with 1 setiform element; segment 2 trapezoidal, armed with 6 or 7 medial and 1 lateral setiform element; segment 3 the largest, squarish, armed with 15 to 17 medial and 4 to 5 lateral setiform elements; segment 4 with 10 to 13 medial and 2 to 3 lateral setiform elements; segment 5 the smallest, with about 20 setiform elements. Endite armed with 5 plumose setae (3 terminal) and 2 coupling hooks (retinacula).

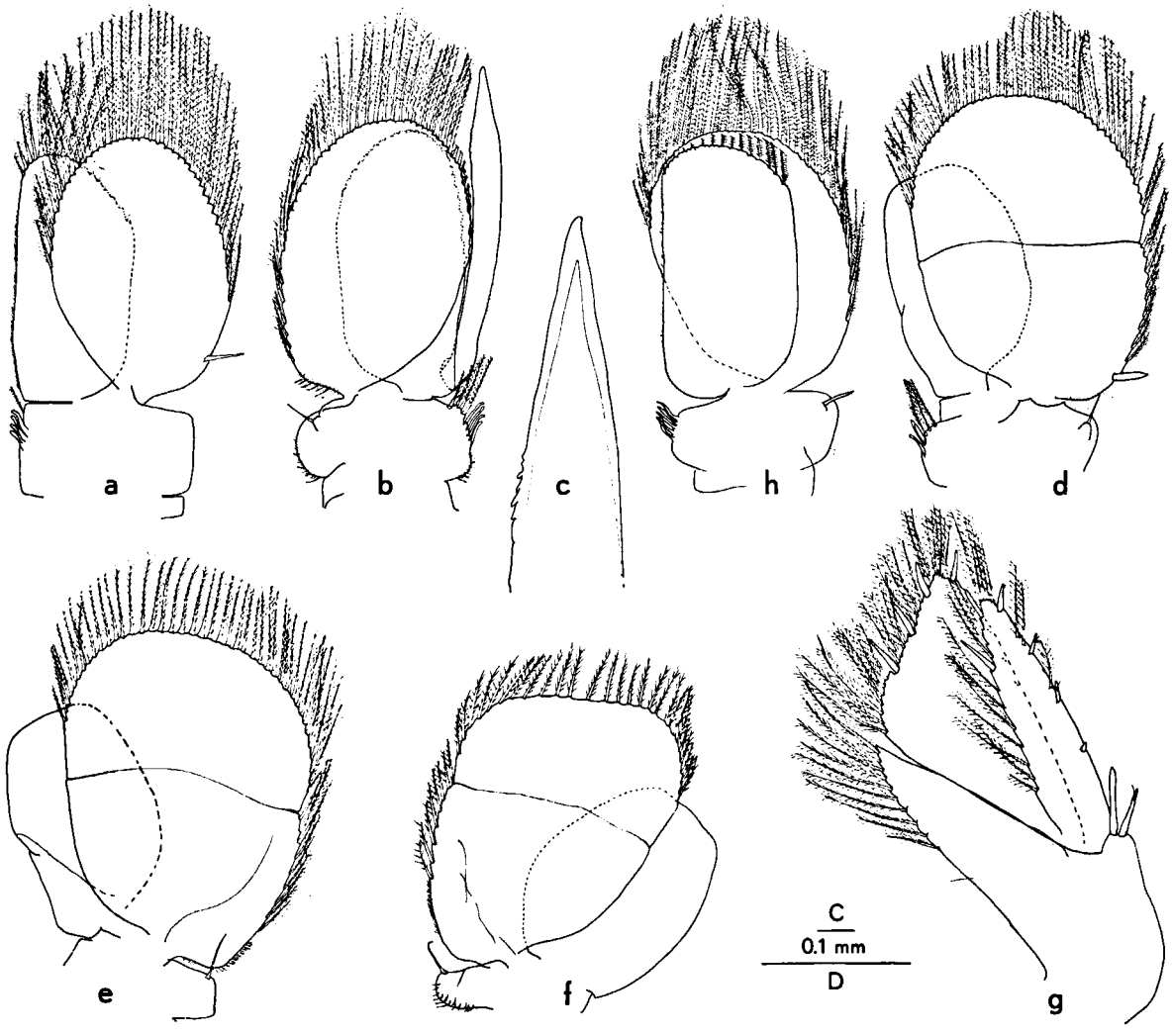

Fig. 2. *Haitilana radicicola* n. sp. a-g, ♂ holotype: a, first pleopod (scale C); b, second pleopod (C); c, second pleopod, apex appendix masculina (D); d, third pleopod (C); e, fourth pleopod (C); f, fifth pleopod (C); g, uropod (C). h, ♀ paratype: second pleopod (C).

Pereiopod 1 (fig. 1f) clearly prehensile; basis and ischium scarcely armed; merus squarish, posterior margin armed with 5 blunt spines and 1 setiform element; carpus with 1 or 2 small spines and 4 setiform elements (1 longer); propodus about twice as long as wide, posterior margin with 3 or 4 widely-spaced spines, distally with 2 setiform elements on the anterior, and 4 such elements on the posterior margin; dactylus with terminal claw, with 2 spines and a group of 6 setiform elements.

Pereiopod 2 (fig. 1g) weakly prehensile, slightly more slender than pereiopod 1; basis scarcely armed; ischium armed with a posteroterminal group of 2 and an anteroterminal group of 2 or 3 spines; merus rectangular but with a concave posterior margin; this margin bears two groups, each of 3 spines, and 3 anterodistal spines; carpus squarish, with a posterodistal group of 4 spines and 1 setiform element; propodus more than twice as long as wide, posterior margin with 3 widely-spaced spines; dactylus with 1 distal spine and 1 setiform element, in addition to the claw.

Pereiopod 3 weakly prehensile, similar to pereiopod 2 (fig. 1h).

Pereiopods 4 to 7 (figs. 1i, 1j, 1k) increasing in length, slender, and ambulatory.

Pleopod 1 (fig. 2a): lateral margin of protopodite with 4 spines and 1 seta; exopodite and endopodite of equal length, armed with plumose setae; exopodite ovoid, with 1 subbasal spine; endopodite rectangular, lateral margin with a row of fine cilia.

Pleopod 2 (♂) (fig. 2b): lateral margin of protopodite armed with 4 spines and 3 or 4 plumose setae; exopodite and endopodite of equal length, armed with numerous plumose setae, both ovoid; appendix masculina laterally inserted on the base of the endopodite, and longer than the latter, straight, its lateral margin with a proximal row of short cilia, its medial margin with minute, blunt, preapical serrations (fig. 2c).

Pleopod 2 (♀) (fig. 2h): lateral margin of protopodite with 4 spines and 3 plumose setae; exopodite and endopodite of equal length, armed with plumose setae; exopodite ovoid, endopodite rectangular (as in uropod 1); lateral margin of endopodite with a row of fine cilia.

Pleopods 3 and 4 (figs. 2d, 2e) with a large, 2-segmented exopodite; basal segment with a lateral row of plumose setae; distal segment with numerous plumose setae; endopodite a little smaller, unarmed and ovoid.

Pleopod 5 (fig. 2f) differs from pleopods 3 and 4 in having a lower density of setae.

Uropodal protopodite wedge-shaped, armed with 2 spines on its laterodistal margin, and with 8 to 10 plumose setae on its mediodistal margin; exopodite a little shorter than the endopodite, oblong and narrow, armed with 6 spines and numerous plumose setae; endopodite triangular, much wider than the exopodite, armed with 4 spines and numerous plumose setae (fig. 2g).

Intraspecific variation. — A good number of individuals of this new species was present in the Source Débarasse sample (Sta. 79/633), enabling us to get an idea of the intraspecific variation in a population of a hypogean cirolanid. Variation was mainly found in the antennae and the mouthparts. In table I a number of counts based on the holotype and three paratypes are enumerated. Variable are the number of flagellum segments of the antennae and the armature of the mandibular incisor and lacinia mobilis.

Constant characters are:

— the number of terminal spines on the third mandible palp segment;
— the number of spines on the endite of maxilla 1;
— the number of slender spines on the palp of maxilla 2;
— the number of plumose setae on the endite, and the number of setiform spines on the first endopodite segment of the maxilliped;
— the number of spines on the uropodal proto-, endo-, and exopodite;
— the presence of 4 small spines on the posterior margin of the telson.

Etymology. — The proposed specific name, *radicicola*, is composed of the Latin words *incola* (inhabitant) and *radix* (root), alluding to the place where the animals have been found, under a blanket of *Ficus* roots in a large karst spring used as groundwater catchment.

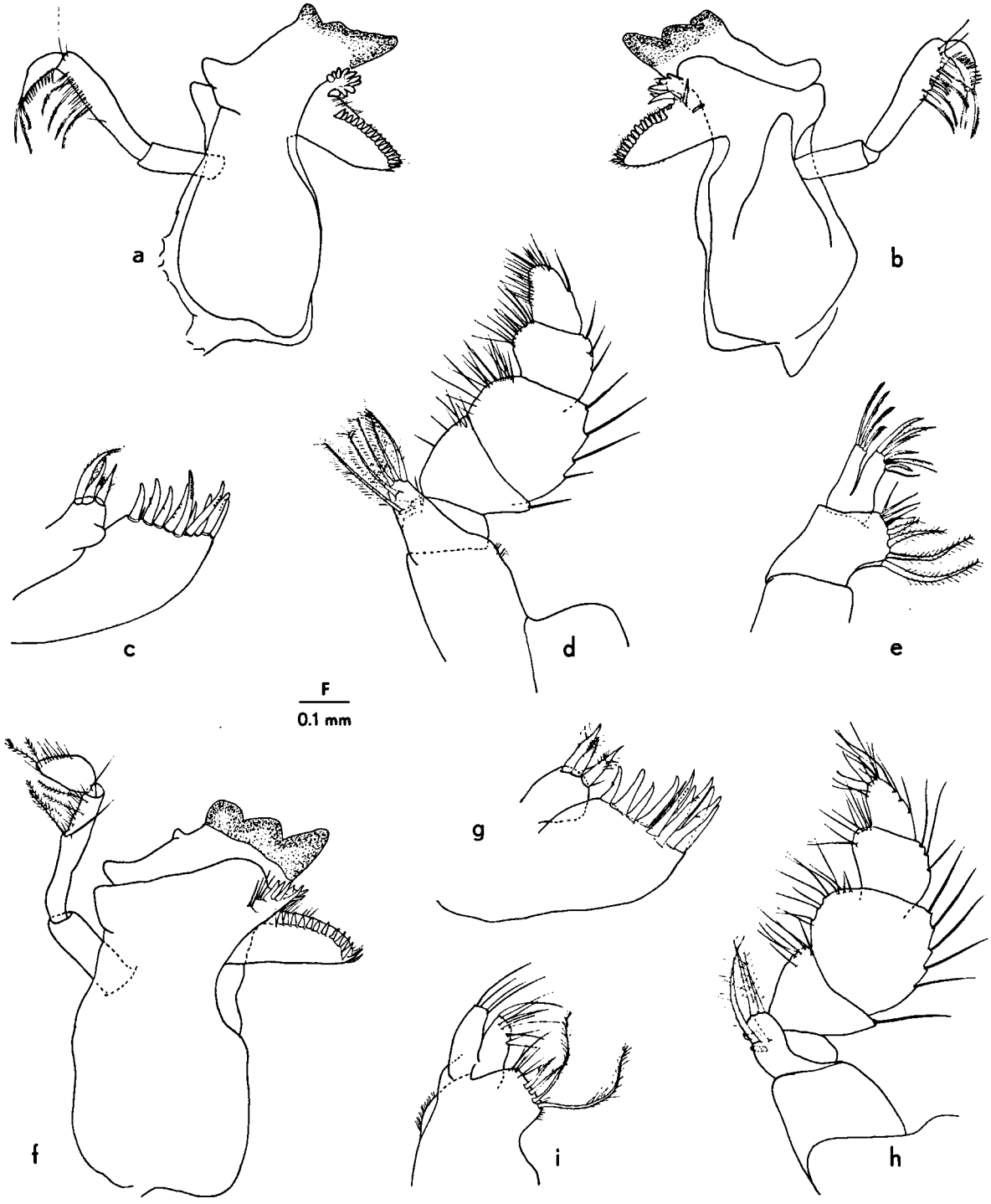

Fig. 3. a-e, *Haitilana radicicola* n. sp., ♂ holotype: a, left mandible (scale F); b, right mandible (F); c, first maxilla (F); d, maxilliped (F); e, second maxilla (F).
f-i, *Haitilana acanthura* n. sp., ♀ holotype: f, right mandible (F); g, first maxilla (F); h, maxilliped (F); i, second maxilla (F).

TABLE I

Variation range in certain characters of four individuals of *Haitilana radicicola* from "Source Débarasse".

Characteristics	holotype ♂	paratypes		
		♂	♀ (a)	♀ (b)
antennae				
numb. segm. flagellum A1	12	12	11	10
numb. segm. flagellum A2	27	25	22	23
mandible right				
numb. spines incisor	10		8	8
numb. spines lac. mob.	13		16	
numb. dist. spines palp segm. 2	ca. 12		17	16
numb. term. spines palp segm. 3	3		3	3
numb. marg. spines palp segm. 3			11	
mandible left				
numb. spines incisor	11		8	8
numb. spines lac. mob.	15		17	17
numb. dist. spines palp segm. 2	12			14
numb. term. spines palp segm. 3	3			3
numb. marg. spines palp segm. 3	ca. 10			
maxilla 1				
numb. spines endite	3	3	3	3
numb. spines exopodite	10	10	11	10
maxilla 2 right				
numb. spines palp	4	4	4	4
numb. spines exopodite	8	8		9
numb. spines endopodite (longer)	9(4)	9(4)	9(4)	8(4)
maxilliped				
numb. plum. setae endite	5	5	5	5
numb. spines endop. segm. 1	1	1	1	1
uropod				
numb. spines protopodite	2	2	2	2
numb. spines endopodite	4	4	4	4
numb. spines exopodite	6	6	6	6
telson				
numb. little spines post. margin	4	4	4	4

Habitat. — *Haitilana radicicola* was found in a large karstic spring (Source Débarasse) which arises from a middle terrace at the foot of a higher terrace (Morne Débarasse), ca. 2.5 km from the Caribbean Sea. This locality is situated some 2 km from the airstrip of Jérémie. These middle and higher terraces are composed of Eocene and Paleocene limestones. Since 1951, the spring is used as a water catchment for the drinkwater supply of the small town of Jérémie. The water catchment can be entered through a metal gate; first there is a small room (cut out in the rock) with several concrete tanks, which are fed by fast running water flowing through a partially man-made cleft of some 10 m long; this cleft, or diaclase, is 0.4 to 0.6 m high and is totally dark. The water is ca. 0.1 m deep, it has a temperature of 24.7° C and a chlorinity of 20.6 mg/l. *Ficus* roots enter the diaclase through the roof, and partially cover walls and floor. The cirolanids were found in the water between the *Ficus* roots and the floor; the water running over and through the roots harboured many *Hyalella* (Amphipoda), Gastropoda, and Elmidae (Coleoptera). One specimen of the isopod was also found under a stone outside the water catchment, in a small auxiliary spring.

Haitilana acanthura n. sp. Figs. 3 f-i, 4, 5.

Material. — Amsterdam Expeditions to the West Indian Islands, Sta. 79/560, 1 ♀ (holotype) and 1 ♀ (paratype). Haiti: Marigot, well of Jacques Simein (approximate position 18°13'51"N 72°18'52"W), 16 Nov. 1979. Zoölogisch Museum Amsterdam coll. no. Is. 105.163 a-b, 105.166 a-b.

Description. — Both specimens are 7 mm long. The body is 2.3 times as long as wide. Pereionites similar to those of the former species. Pleonites 1 to 3 almost as wide as pereionite 7. Epimera 1 to 3 posteroventrally pointed; epimere 4 obtuse, its lateral margins partially covered by epimere 3. Pleonite 1 partially covered by pereionite 7; lateral margins of pleonite 5 covered by those of pleonite 4.

Telson (fig. 4e) shaped as a human tongue, lateral margins rounded, posterior margin with plumose setules and 10 to 12 small spines.

Antenna 1 (fig. 4b) longer than the peduncle of antenna 2, reaching beyond the middle of pereionite 1; peduncle 2-segmented, both segments elongate, segment 2 a little longer than segment 1; peduncle segment 1 with a depression into which fits peduncle segment 1 of antenna 2. Flagellum 9-segmented, first two segments of equal length; segments 3 to 9 with aesthetes on the ventral surface (segments 5 to 8 with 2 aesthetes, the others with one).

Antenna 2 (fig. 4a) reaching to the middle of pereionite 5; peduncle 5-segmented, segments 4 and 5 about twice as long as the others. Flagellum about 19-segmented, without aesthetes.

Frontal lamina well developed, rectangular, anterior end a little wider than posterior end.

Clypeus and labrum form together an oval structure with a slight rounded concavity at the posterior margin.

Mandibles (fig. 3f) asymmetrical; left mandible overlapping the right one. Palp slender, segment 2 with a distal group of about 16 setae (of which 4 are longer), segment 3 with about 9 smal marginal setae and 2 longer terminal setae. Incisor right and left with 7 small spines. Lacinia mobilis elongate, armed with 15 (right) or 18 (left) small spines, anterior margin basally with some cilia.

Maxilla 1 (fig. 3g): exopodite distally with 12 sclerotized spines, one of which is slender; the innermost spine has a small medial denticle, spines 2 to 4 are unarmed. Endite with 3 distal elements.

Maxilla 2 (fig. 3i) with 4 and 10 setae on palp and exopodite, respectively; endopodite with 5 naked and 4 plumose setae.

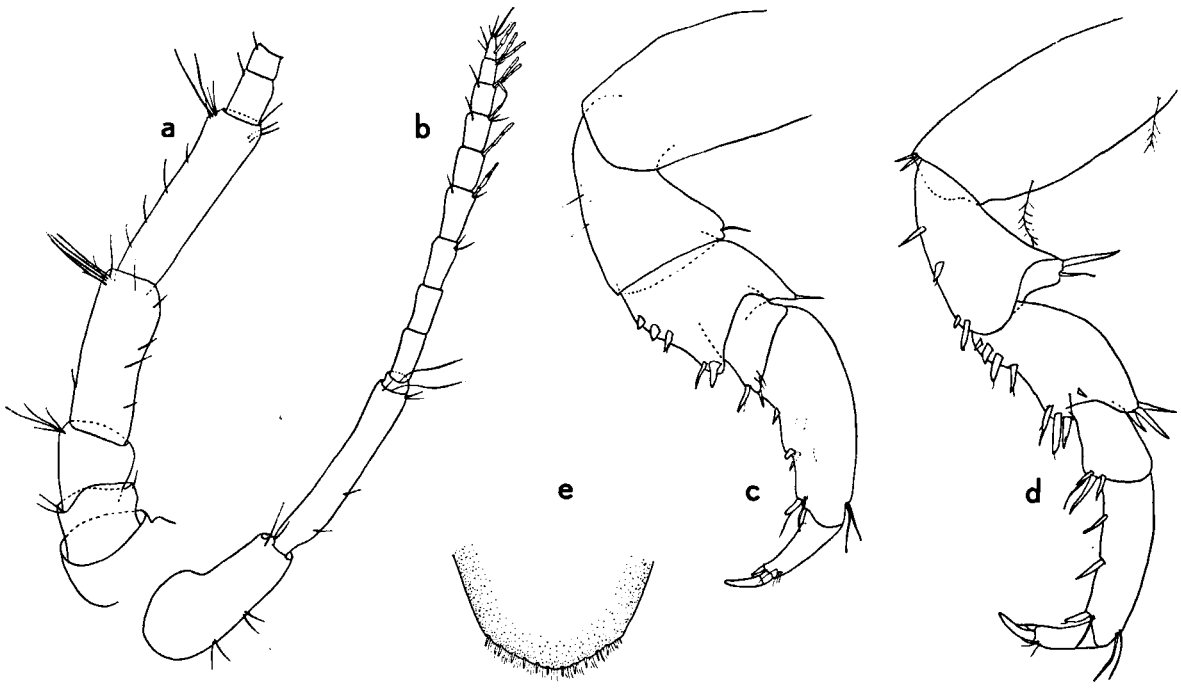

Fig. 4. *Haitilana acanthura* n. sp., ♀ holotype: a, basal part of second antenna (scale C); b, first antenna (C); c, first pereiopod (C); d, second pereiopod (C); e, telson, dorsal (B).

Maxilliped (fig. 3h) with 5-segmented endopodite; segment 1 squarish with 1 setiform spine; segment 2 triangular, armed with 1 lateral and 3 to 5 medial setiform elements; segment 3 the largest, squarish, armed with 4 or 5 lateral and 6 to 11 medial setiform elements; segment 4 with 3 lateral and 6 to 9 medial setiform elements; segment 5 the smallest with 9 to 12 setiform spines. The armature of the endite is different in the two specimens available: the holotype has 3 terminal plumose setae on the left side, 3 plumose setae (2 terminal) on the right side, and on both sides 2 coupling hooks; the paratype has 3 plumose setae (2 terminal) and 2 coupling spines on the left side, and 4 plumose setae (3 terminal) and 3 coupling spines on the right side.

Pereiopod 1 (fig. 4c) clearly prehensile; basis and ischium scarcely armed; merus squarish, posterior margin with a subbasal group of 3 small spines, and a distal group of 1 spine and 1 setiform element; carpus with 1 group of 4 spines (2 smaller); propodus about twice as long as wide, posterior margin with 3 widely spaced spines, 4 distal setiform elements, and 2 anterodistal setiform elements; dactylus distally with a claw, 2 spines and an anterodistal group of 3 setiform elements.

Pereiopod 2 (fig. 4d) weakly prehensile, strongly built; basis scarcely armed; posterior margin of ischium with 1 + 1 + 2 spines, anterodistal corner with 1 spine and 1 setule; merus longer than wide, posterior margin with 4 isolated spines and a distal group of 3 spines and a setule, anterodistal corner with 3 spines; carpus squarish, with posterodistal group of 3 spines and 1 seta; propodus more than twice as long as wide, posterior margin with 2 isolated spines and a distal group of 1 spine and 1 seta; distal end of dactylus with 1 robust spine and some setules; ungulus rather slender.

Pereiopod 3 built as pereiopod 2.

Pereiopods 4 to 7 increasing in length, slender and ambulatory.

Pleopod 1 (fig. 5a): protopodite with a median group of 4 spines; exo- and endopodite of equal length, armed with plumose setae; exopodite ovoid, armed with a subbasal spine; endopodite rectangular.

Pleopod 2 (fig. 5b): protopodite with 3 spines and 2 setae on lateral margin; exo- and endopodite similar to those of pleopod 1.

Pleopods 3 and 4 (figs. 5c, 5d) with large, 2-segmented exopodite, basal segment with a lateral row of plumose setae, distal segment with numerous plumose setae, all around its margin; endopodite a little smaller than exopodite, ovoid, practically unarmed.

Pleopod 5 (fig. 5e) differing from pleopods 3 and 4 in having less setae.

Uropodal protopodite wedge-shaped (fig. 5f), armed with 3 spines on its laterodistal corner, and with 6 plumose setae on its mediodistal margin; exopodite less long and less wide than the endopodite, oblong and narrow, armed with 7 spines (5 lateral, 2 medial), and numerous plumose setae; endopodite more or less triangular, armed with 6 spines and numerous plumose setae.

Distinction. — This species has a significantly larger number of spines on the posterior border of the telson, and shows certain other differences as well, compared to *H. radicicola* (see table II).

Etymology. — The proposed specific name, *acanthura* is composed of the Greek words ἄκανθα = spine, and οὐρά = tail, alluding to the armature of the telson, an important difference between *H. acanthura* and *H. radicicola.*

Habitat. — *Haitilana acanthura* was caught by means of a Cvetkov net in the well of Jacques Simein, near the East end of the village of Marigot, at some 300 m from the seashore. The well is situated on the lower terrace, dating from Pleistocene age; the adjacent middle terrace is of Eocene/Paleocene age. The lower terrace is mainly composed of river sediments (gravel, sand and clay). The well, 5 m deep, is regularly cleaned. The water, 1 m deep, has a temperature of 25° C and a chlorinity of 30.8 mg/l.

In addition to the cirolanids, the well houses *Typhlatya* (Decapoda), Amphipoda, Cyclopoida (Copepoda), and Ostracoda.

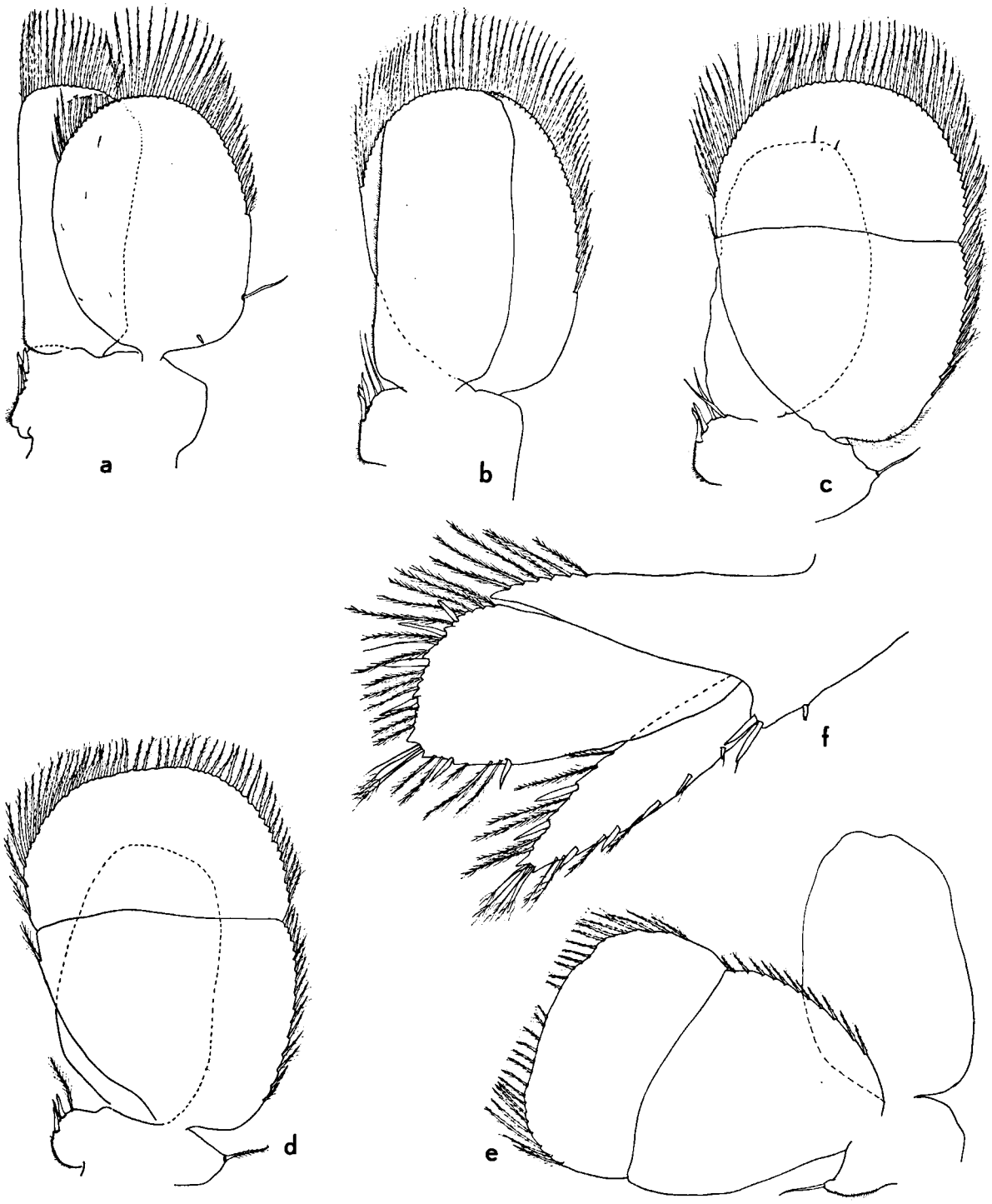

Fig. 5. *Haitilana acanthura* n. sp., ♀ holotype: a, first pleopod (scale C); b, second pleopod (C); c, third pleopod (C); d, fourth pleopod (C); e, fifth pleopod (C); f, uropod (C).

TABLE II

Comparison of meristic characteristics in some specimens of three isolated populations of *Haitilana*.

Characteristics	*H. radicicola* (24 specimens)	*H. acanthura* (2 specimens)	*H.* sp. (2 specimens)
body			
length (mm)	to 6.5	to 7	6 and 7.5
length/width ratio	2.8	2.3	3.3
antenna 1			
numb. segm. flagellum	10-12	9	8-9
length ratio peduncle segm. 3 to 2	1	1.5	1.5
length ratio peduncle segm. 1 to 2	2	1	1-2
antenna 2			
numb. segm. flagellum	22-27	19-25	20
mandible right			
numb. spines incisor	8-10	12	10
numb. spines lac. mob.	13-16	15	15
numb. term. spines palp segm. 3	3	2	1
mandible left			
numb. spines incisor	8-11	10	10
numb. spines lac. mob.	15-17	18	17
numb. term. spines palp segm. 3	3	2	1
maxilla 1			
numb. spines endite	3	3	3
numb. spines exopodite	10-11	12	11
maxilla 2			
numb. spines palp	4	4	4
numb. spines exopodite	8	9	10
numb. spines endopodite (longer)	9(4)	9(4)	10(3)
maxilliped			
numb. plum. setae endite	5	3	2
numb. spines endopodite:			
segment 1	1	0	1
segment 5	16-20	13	12
uropod			
numb. spines protopodite	2+0	2+1	2+1
numb. spines endopodite	4	6	6
numb. spines exopodite	6	7	7
telson			
numb. little spines post. margin	4	10-12	10

Haitilana sp.

Material. — Amsterdam Expeditions to the West Indian Islands, Sta. 79/578, 2 ♀ ♀. Haiti: Dumonet (between Débas and Caïman, west of Thomazeau), well of Mme. Tissé-Coriolan (approximate position: 18°38'58"N 72°06'58"W), 21 Nov. 1979. Zoölogisch Museum Amsterdam coll. no. Is. 105.165 a-b.

Remarks. — Unfortunately, one of the available specimens was damaged (both of them were dead when caught). It is hard to decide whether or not these specimens belong to *H. acanthura*, to which they resemble most. In table II a number of characteristics of the three samples of *Haitilana* used for this study are enumerated. The characters found to be constant in *H. radicicola* (cf. table I) are considered as the most important ones for taxonomic purposes.

Haitilana sp. resembles *H. acanthura* on account of the armature of the uropods and the telson. Characters unique for *Haitilana* sp. are the length/width ratio of the body, the number of terminal spines on mandible palp segment 3, the number of elements on the second maxillar endopodite, and the number of spines on the maxillipedal endite (cf. table II).

Habitat. — The present two specimens were caught by means of a Cvetkov net in the well of Mme. Tissé-Coriolan at Dumonet, in the lowland plain, called Cul de Sac. This plain was still flooded by the sea during the Pleistocene. The well is 6 m deep and dug out in sand. The water is 1 m deep, has a temperature of 27.2° C and a chlorinity of 422 mg/l. The well lies some 30 m above the sea level and is situated 200 m from the Trou Caïman, a shallow lake. In addition to the cirolanids, the sample contained Amphipoda, *Monodella* (Thermosbaenacea), Cyclopoida (Copepoda), Ostracoda, Phyllopoda, and Gastropoda.

RELATIONSHIPS OF *HAITILANA*

The combination occurring in *Haitilana* of a pleon segmentation of "type *B*" (Bowman, 1975) and of clearly prehensile pereiopods 1, has been found up to now only in the cirolanid genera *Antrolana* (Appalachian Valley, Virginia) and *Typhlocirolana* (Mediterranean belt). Rioja (1957) has described the genus *Troglocirolana* from Cuba, characterized by the same pleon segmentation as *Haitilana*, but with semi-prehensile first pereiopods.

Of the genus *Antrolana* only one species is known, *A. lira* Bowman, 1964. In my opinion, *Antrolana* appears to be the closest relative of *Haitilana*. However, it differs clearly in its greater body length (up to 12 mm), the produced anterior margin of the head, the 6-segmented peduncle of the second antenna, the narrow frontal lamina, the armature, with 7 spines, of the palp of the second maxilla, the hooked appendix masculina, bearing a seta on the apex, and the less wedge-shaped uropodal protopodites.

Typhlocirolana has a number of characters by which it clearly differs from *Haitilana*: the body length is up to 15 mm, the body shape (narrow, with parallel margins and rather loosely articulated somites, being more rounded in cross-section), the short, 3-segmented peduncle of the first antenna, the 6-segmented peduncle of the second antenna, the produced frontal lamina, and the longer first pleonite, overreaching the other pleonites.

As point of fact, the differences between the first pereiopods of *Troglocirolana* and *Haitilana* are small. Clearly different are the ovate body, the pereionites 4 and 5 (which are the longest), the broad and rounded telson with a crenulate lateral margin, the 6-segmented peduncle of the second antenna, and the palp of the second maxilla provided with 5 spines. Despite these differences, *Troglocirolana* appears to be related to *Haitilana*.

Genus **Bahalana** Carpenter, 1981.

Thanks to the courtesy of Dr. J. H. Carpenter, I had the privilege to have a preview of his manuscript in press, containing the formal description of this genus. The type-species, *B. geracei*, and so far unique representative of *Bahalana*, was collected in Lighthouse Cave, San Salvador island, Bahamas. The collections of the Amsterdam Expeditions to the West Indian Islands contained a number of specimens of *B. geracei* taken at the type-locality.

Bahalana geracei Carpenter, 1981.

Material. — Amsterdam Expeditions to the West Indian Islands, Sta. 79/186, 5 ♀♀, 1 ♂ (1 ♀ and 1 ♂ are damaged). Bahamas: San Salvador island, Dixon Hill Lighthouse Cave (approximate position 24°05'44"N 74°27'07"W), 24 Nov. 1979. Zoölogisch Museum Amsterdam coll. no. Is. 105.186 a-b.

Remarks. — The four undamaged females are 6, 12, 12 and 14 mm long. Their avarage length/width ratio is 2.3. Carpenter recorded a length/width ratio of 3 for his specimens. In general, the specimens examined from the West Indian Islands Expedition conform the description of *B. geracei*.

Bahalana cardiopus n. sp. Figs. 6, 7, 8.

Material. — Amsterdam Expeditions to the West Indian Islands, Sta. 79/143, 1 ♀ (holotype) and 2 ♀♀ (paratypes, one of which smaller and damaged). Bahamas: Mayaguana, Little Bay, Mount Misery Cave (approximate position 22°25'49"N 73°02'34"W), 12 Nov. 1979. Zoölogisch Museum Amsterdam coll. no. Is. 105.161 a-b, 105.162 a-b.

Description. — Holotype and undamaged paratype both 10 mm long; body about 2.5 times as long as wide. Unable to roll into a ball. Head

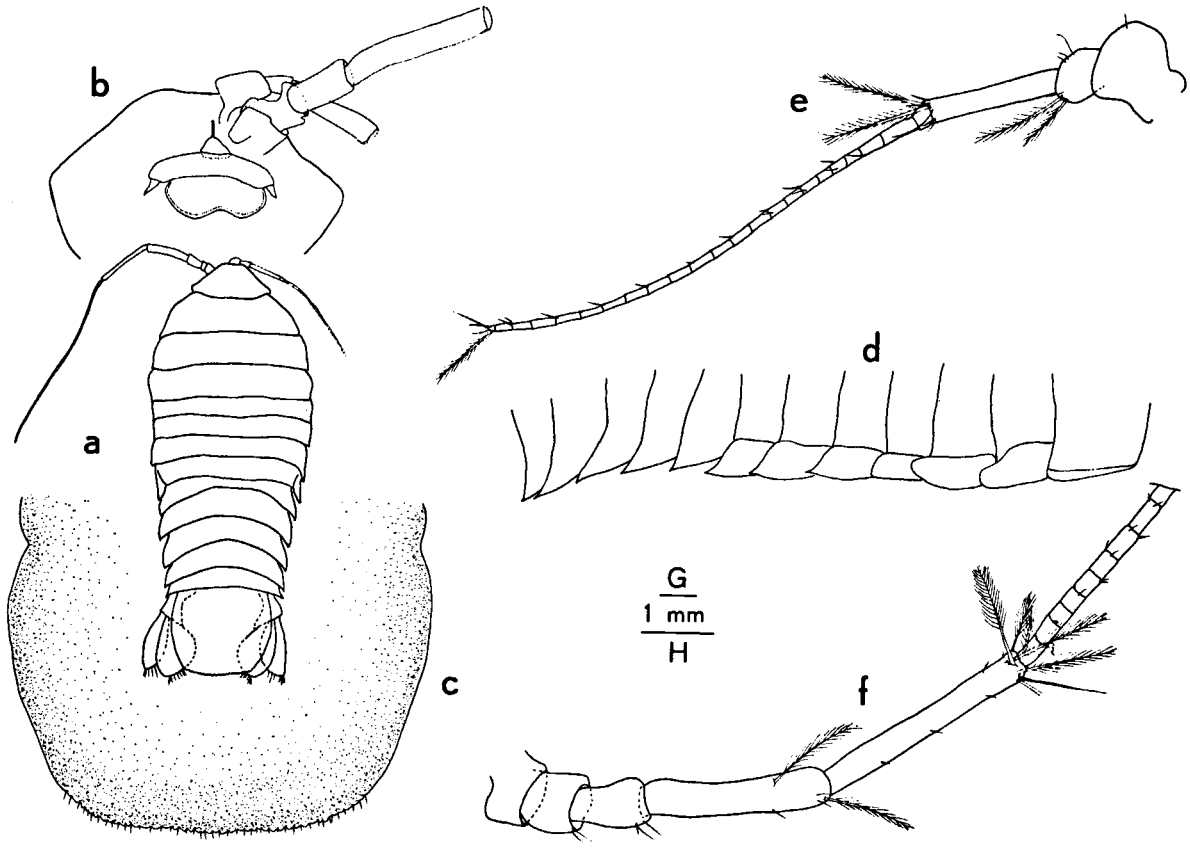

Fig. 6. *Bahalana cardiopus* n. sp., ♀ holotype: a, entire animal, dorsal (scale G, left A_1 and right A_2 not shown); b, head, ventral (H); c, telson, dorsal (H); d, pereion and pleon, lateral (H); e, first antenna (I); f, peduncle second antenna (I).

wider than long, anterior margin straight. All pereion somites, except the first, with coxal plates; posterior corner of coxal plates 2 and 3 rounded, those of pereionite 4 rectangular, those of pereionites 5 to 7 pointed (fig. 6d). Pereionite 1 slightly longer than the other pereionites, pereionites 4 to 7 approximately equal in length, pereionites 2 and 3 intermediate (fig. 6a). Pleonites 1 to 5 distinct, with angularly produced lateral margins, those of pleonite 5 slightly produced.

Telson squarish (fig. 6c), a little wider than long, lateral margins rounded, posterior margin with about 50 crenulations; in each notch a setule is inserted. Lateral margin unarmed.

Antenna 1 longer than the peduncle of antenna 2, reaching to the posterior margin of pereionite 2 (fig. 6a); peduncle 4-segmented, segments 1 and 2 small, segment 3 a little less than twice as long as segments 1 and 2 together, segment 4 very short; segments 1 and 2 with a depression into which fit segments 1 and 2 of antenna 2; segments 3 and 4 bear a few distal sensorial setae. Flagellum 19- to 22-segmented; segment 1 twice as long as segment 2 (fig. 6e).

Antenna 2 reaching the posterior margin of pereionite 7; peduncle 5-segmented; segment 1 with an anteromedial knob; segments 1 to 3 short, subequal, segments 4 and 5 each about as long as segments 1 to 3 combined; segment 5 with about 5 sensorial setae. Flagellum of about 32 segments.

Frontal lamina (fig. 6b) a poorly developed, narrow carina, posterior end wider, triangular, and partly covered by the clypeus.

Posterior margin of labrum with a rounded concavity (fig. 6b).

Mandibles asymmetrical (fig. 7a), left mandible overlapping the right one. Palp segment 2

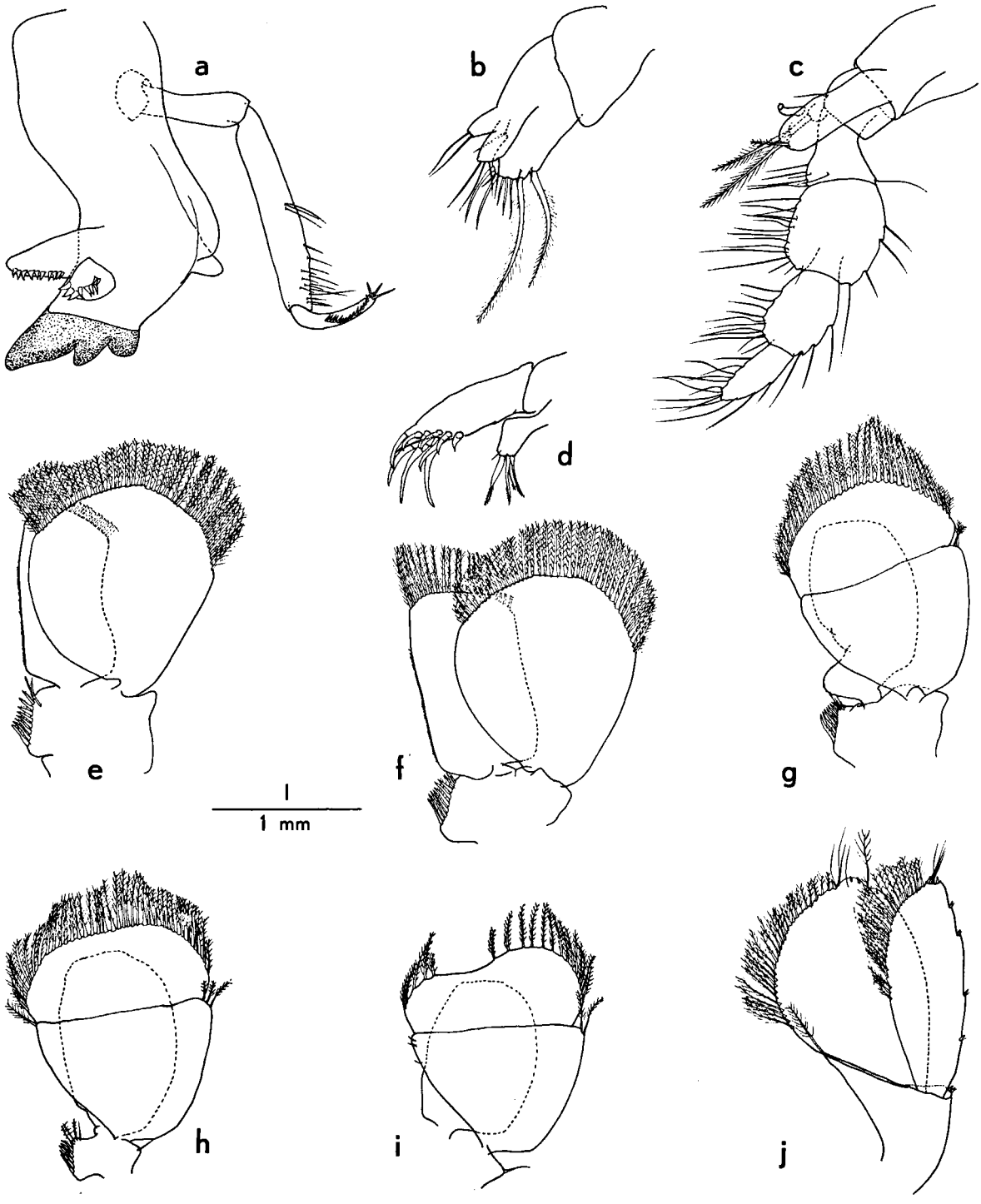

Fig. 7. *Bahalana cardiopus* n. sp., ♀ holotype: a, right mandible (scale K); b, second maxilla (K); c, maxilliped (K); d, first maxilla (K); e, first pleopod (I); f, second pleopod (I); g, third pleopod (I); h, fourth pleopod (I); i, fifth pleopod (I); j, uropod (I).

about twice as long as segment 1 with a row of about 18 setiform elements in its distal half; segment 3 slightly less than half as long as segment 2, with 15 small marginal spines and 3 terminal ones. Incisor with about 10 spines; lacinia mobilis triangular, with about 12 small spines.

Maxilla 1 (fig. 7d) with 11 sclerotized spines on the exopodite, first and third inner spines with 1 medial denticle, second inner spine unarmed; 4 spines and a setule on the endite.

Maxilla 2 (fig. 7b) armed with 2 and 4 setiform elements on palp and exopodite, respectively; endopodite distally with 8 naked and 2 plumose setae, basally with 1 setiform element.

Maxilliped (fig. 7c): Endopodite 5-segmented; segment 1 squarish, armed with 1 setiform element; segment 2 trapezoidal with 1 lateral and 5 to 7 medial setae; segment 3 the largest, squarish, armed with 4 lateral and 11 to 16 medial setae; segment 4 longer than wide, armed with 3 lateral and 8 or 9 medial setae; segment 5 linear, bearing about 14 setae. Endite armed with one coupling spine and 3 plumose setae (one shorter).

Pereiopods 1 to 3 prehensile, dactylus and propodus both very elongate.

Pereiopod 1 (fig. 8a): Inner side of merus produced into a slender projection that reaches to 3/4 of the propodus; this projection is armed on its posterior margin with 5 small, subdistal spines; carpus very small.

Pereiopod 2 (fig. 8b): Basis scarcely armed; outer side of ischium with a distal projection which extends about halfway the merus; outer side of merus with a long, falcate projection which extends to the base of the dactylus, inner margin with 2 small spines and a knob tipped with a setule; inner margin of the carpus with a distal projection which extends to about the middle of the propodus.

Pereiopod 3 (fig. 8c): Projection on ischium as in P2, inner spine longer than in P2; projection on outer side of merus as in P2, projection on inner side half as long as the carpus; inner projection on the carpus overreaching half the propodus.

Pereiopods 4 to 7 similar (figs. 8 d-g), ambulatory and longer than pereiopods 1 to 3; ischium with 2 to 4 distal and 2 or 3 inner spines; merus with 3 to 6 distal and 2 to 3 inner spines; carpus with 3 to 6 distal and 5 to 9 inner spines; propodus with 3 distal and 5 to 9 inner spines; dactylus about 1/4 of the propodus, with 1 terminal spine; ungulus about 1/3 of the dactylus, armed with 3 to 4 spinules of varying sizes.

Pleopod 1 (fig. 7e): Protopodite with a median row of about 10 spines; exopodite about twice as wide and as long as the endopodite; distal margins of endo- and exopodite with a row of plumose setae; median margin of endopodite straight, with a row of fine cilia.

Pleopod 2 (fig. 7f): Protopodite with a median row of 8 spines and 4 short plumose setae; endopodite slightly wider than in pleopod 1.

Pleopods 3 and 4 (figs. 7g, 7h): Protopodite medially with 5 to 7 spines and 4 to 5 short plumose setae; exopodite with partial transverse suture, basal segment with 2 or 3 lateral setae, distal segment with numerous plumose setae; endopodite smaller than exopodite, ovoid, unarmed.

Pleopod 5 (fig. 7i): Exopodite heart-shaped, with transverse suture, basal segment with about 2 lateral setae, distal segment sparsely armed with about 20 plumose setae, placed in two groups; endopodite ovoid, unarmed, smaller than the exopodite.

Uropodal protopodite strongly produced into an acute mediodistal projection, bearing 1 apical seta; laterodistally with 2 short spines; exopodite about half as wide as the endopodite, medial margin with plumose setae, apically with a tuft of 4 setae and 2 short spines, lateral margin with 4 short spines; endopodite a little longer than the exopodite, medial margin with plumose setae, apically with some 4 short spines and a few naked setae, lateral margin unarmed; dorsal surface of endopodite with 2 sensorial setae (fig. 7j).

D i s t i n c t i o n. — In the diagnosis of the genus *Bahalana*, Carpenter (1981) mentions the presence of setation on the endopodites of pleopods 3 to 5; this setation is absent in *B. cardiopus*. On account of the correspondence in body shape, in pleon segmentation, in the curiously shaped pereiopods 1 to 3, in the mouthparts, and in the pedunculus of the antennae, it appears justifiable to

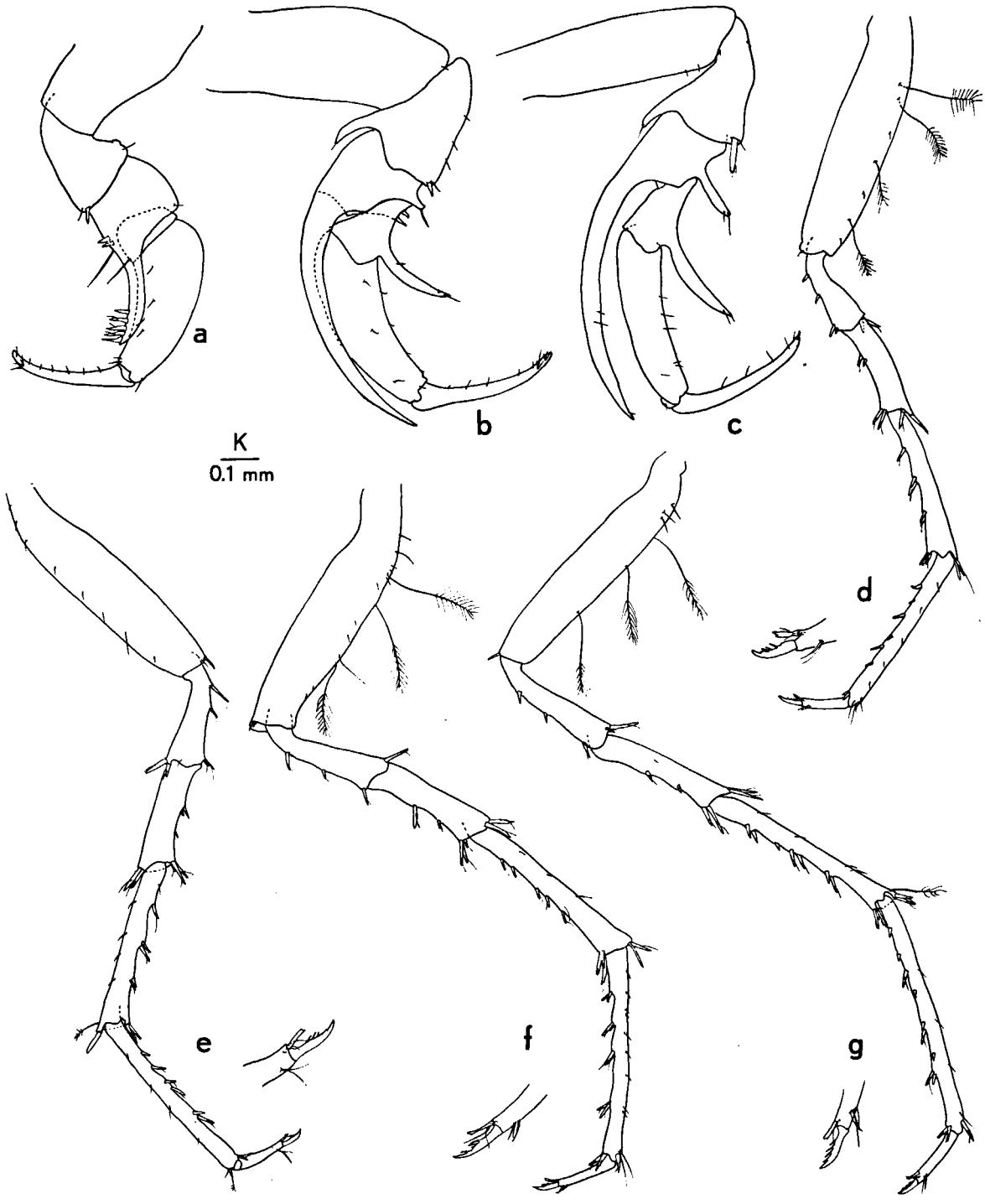

Fig. 8. *Bahalana cardiopus* n. sp., ♀ holotype: a, first pereiopod (scale I); b, second pereiopod (I); c, third pereiopod (I); d, fourth pereiopod (I), detail (K); e, fifth pereiopod (I), detail (K); f, sixth pereiopod (I), detail (K); g, seventh pereiopod (I), detail (K).

consider *B. cardiopus* congeneric with *B. geracei*, the type-species of *Bahalana*.

B. cardiopus is distinguished not only by the lack of armature on the endopodities of pleopods 3 to 5, but also by the shape of the pleopodal endo- and exopodites, the armature of the maxillipedal endite, and the shape and armature of the mandibular lacinia mobilis.

Etymology. — The specific name, *cardiopus*, is composed of the Greek words καρδία (= heart) and πούς (= leg), alluding to the cordiform exopodite on the fifth pleopod. This character forms a clear distinction between *B. cardiopus* and *B. geracei*.

Habitat. — Mayaguana is composed of reef limestones and debris from the Cretaceous period and younger. In the late Tertiary or Quaternary, this part of the Bahama archipelago has raised above sea level. The type-locality, Mount Misery Cave, is a small cave, located some 600 m from the seaboard and ca. 10 m above sea level. The entrance of the cave is situated in the vertical part of a cliff at the inland side of a high ridge, and leads to a slightly down-sloping gallery. The cirolanids were found in a muddy hole filled with water (probably the water table), in total darkness. Tidal influence is presumed to be present. The water had a chlorinity of 9682 mg/l. No accompanying fauna was observed.

RELATIONSHIPS OF *BAHALANA*

As Carpenter (1981) notes, none of the other cirolanid genera appears to be closely related to *Bahalana*. The genus is especially unique because of the construction of the first three pereiopods. The discovery of *B. cardiopus* in Mayaguana has not changed this morphological notion.

Mayaguana is separated from the type-locality of *B. geracei*, San Salvador island, by deep water (>200 m). The habitat of *B. geracei*, in the Lighthouse Cave, is considered anchihaline by Carpenter (1981); he supposes the species to be an ecological missing link in the evolution of hypogean cirolanids. The waters of Mount Misery Cave, the habitat of *B. cardiopus*, may be anchihaline as well, since the presence of tidal influence cannot be excluded. During the Amsterdam Expedition to the West Indian Islands of 1979, J. H. Stock and S. Weinberg took water samples in both the Lighthouse Cave (23 November 1979) and Mount Misery Cave (12 November 1979), the former had a chlorinity of 21264 mg/l, the latter of 9682 mg/l, in both cases much too high to allow classification as "inland waters".

ZOOGEOGRAPHIC REMARKS

Most cirolanid isopods are marine, but some are found in hypogean habitats. It is assumed that the latter evolved from marine ancestors. Colonization of hypogean habitats may possibly have occurred by stranding of marine populations (regression) or by dispersal (Stock, 1977, 1980).

A number of characteristics occur in stygobiont cirolanids in different stages of apomorphy. The characteristics involved touch the pleon segmentation, the setation and segmentation of the pleopods, the construction of the pereiopods, and the number of peduncle segments in the second antenna. Racovitza (1912) already pointed out certain of these trends. Also within one genus, different characters show different stages of apomorphy. The origin of this mosaic pattern could rest upon differences among ancestral populations, but also upon joint or successive action of dispersal and regression. These two processes could, moreover, have been repeated in different geological periods.

Regression seems to form a plausible explanation for the origin of *Haitilana*. The localities where members of this genus have been found lie slightly above sea level and not far from the seaside. During the Cenozoic these localities were inundated by the sea (Geol. Map Haiti, 1972).

The Bahama archipelago is, in contrast with the rest of the West Indies, an accumulation area. In geologically fairly recent times, the low islands have come above sea level as a result of conglomeration and accumulation of reef debris due to wind and the wash of the waves (Doran, 1955). The groundwater of these small and low islands

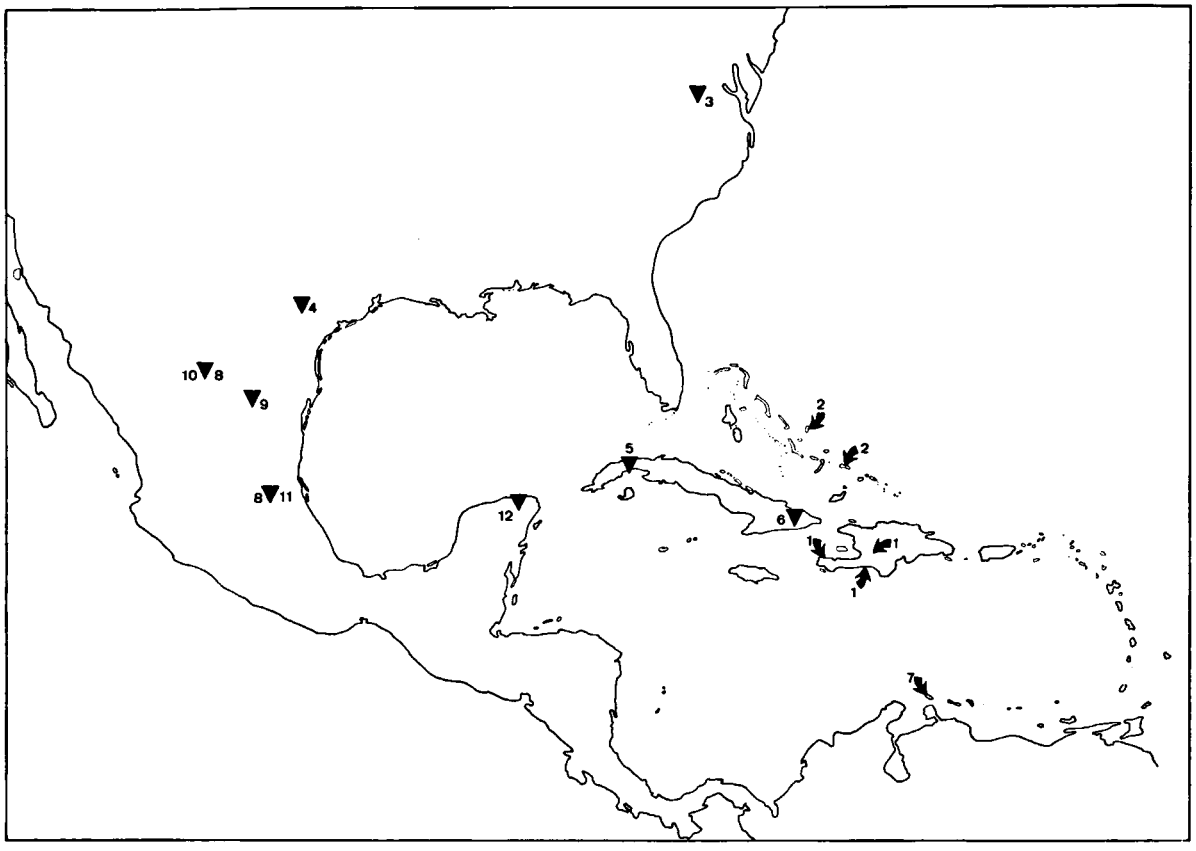

Fig. 9. Distribution of troglobiont cirolanid genera in the New World. 1, *Haitilana*; 2, *Bahalana*; 3, *Antrolana*; 4, *Cirolanides*; 5, *Troglocirolana*; 6, *Haptolana*; 7, *Arubolana*; 8, *Speocirolana*; 9, *Conilera* (= *Speocirolana* ?); 10, *Sphaerolana*; 11, *Mexilana*; 12, *Creaseriella*.

has connections with the sea through fissures and dissolution effects, the latter possibly originating from sea level drops during the Glacials (cf. Harmon et al., 1981). *Bahalana* has been found in meso- and polyhaline (maybe anchihaline) groundwaters of two Bahamian islands (San Salvador and Mayaguana). Dispersal, from some marine stock, appears to be a plausible explanation for the origin of *Bahalana*.

Since *Antrolana lira* has been found in the Appalachian Valley in Virginia, it forms a unique case among the stygobiont cirolanids of the New World. This area has not been in connection with the sea since the Permian (Bowman, 1964). On account of morphological resemblances, there is some affinity between *Haitilana* and *Antrolana*. This affinity, if it is not based on parallelism, possibly reflects a common ancestor. This common ancestor may have lived in the Gulf of Mexico or the Caribbean Sea during the late Cretaceous or Cenozoic. *Antrolana* or its direct ancestor could have reached its present distribution area by northward dispersal through subterranean pathways. However, such a dispersal is hard to accept because the geological barriers were (and are) almost unsurmountable (Bowman, 1964).

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