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ARUBOLANA IMULA N. GEN., N. SP., THE FIRST HYPOGEAN CIROLANID ISOPOD CRUSTACEAN FOUND IN THE LESSER ANTILLES

by

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ABSTRACT

Arubolana imula, a new stygobiont isopod genus and species of the family Cirolanidae is described from Aruba (Netherlands Antilles). The new taxon has been discovered in an artificial tunnel, used for the production of industrial water, cut into calcareous rocks from marine origin which were rather recently uplifted above sea level (90,000-500,000 years B.P.). This is the first hypogean cirolanid that becomes known from the Lesser Antilles.

The quite characteristic and simplified morphology of the posterior maxillae and maxillipeds, the subterminal position of the appendix masculina, and the prehensile nature of the first and second pereiopods, distinguish the new genus very clearly from all other hypogean genera in the family Cirolanidae. The feeble development of the retinacula on the endite of the maxilliped indicates a certain affinity to the epigean genus *Eurydice*.

RÉSUMÉ

Arubolana imula, espèce nouvelle stygobionte appartenant à un genre nouveau d'Isopodes Cirolanidés, est décrite d'Aruba (Antilles Néerlandaises). Le nouveau taxon a été découvert dans une galerie artificielle, servant à l'alimentation en eau industrielle, creusée dans des calcaires d'origine marine, assez récemment soulevés (90.000-500.000 années A.P.). C'est le premier Cirolanide hypogé qu'on connaisse des Petites Antilles.

Des caractères forts originaux dans la morphologie simplifiée des maxilles postérieures et des maxillipèdes, la position subterminale de l'appendice masculin et la structure préhensile des péréiopodes 1 et 2, distinguent de façon très nette le nouveau genre de tous les autres genres hypogés de la famille des Cirolanidae. Le faible développement des rétinacles sur l'endite du maxillipède indique une affinité avec *Eurydice*, genre épigé.

INTRODUCTION

Subterranean, aquatic Isopoda of the family Cirolanidae have been found in the eastern U.S.A., Mexico, around the Mediterranean, in East Africa and in Madagascar (Monod, 1975: fig. 2). In the Caribbean area, hypogean cirolanids were only known from Cuba **). In the present paper a new genus and species of this family is described from Aruba, an island in the Leeward Group of the Lesser Antilles.

The new taxon, named *Arubolana imula*, was discovered in a man-made tunnel, nearly 700 m long, slightly over 1 m wide and about 2.5 m high, cut into uplifted marine limestone terraces. The tunnel reaches down to the groundwater, which is used for water supply by the Lago (= Esso) Oil Company's refinery on Aruba. Near its entrance (through a vertical shaft) the tunnel's distance to the sea is the shortest, viz. about 160 m. At the northeastern end, the distance to sea is the greatest, viz. some 670 m. Since the water is pumped up in considerable quantities, there is a slow flow in the tunnel. During a visit to the tunnel in 1978, the water was knee-deep, brackish (chlorinity 3600 mg/l). Apart from some glimpses of light falling through a couple of ventilation shafts, the tunnel is completely dark. More details about this locality can be found in Hummelinck (1979: 41, 49, figs. 22-24).

In addition to the cirolanid isopod, the water in the tunnel harboured many *Metaniphargus* (Amphipoda, Gammaridae) and a few *Typhlatya* (Decapoda, Macrura).

*) Report no. 5 is published in the same issue of this journal.

**) A new genus and species found by Dr. Jerry H. Carpenter on San Salvador Island (Bahamas) will be described by its discoverer in Int. J. Speleol.

TAXONOMIC PART

Arubolana n. gen.

Diagnosis. — Cirolanidae. Blind, unpigmented (except for brown mandibular masticatory blade). Body rather wide, flat, presumably not able to roll into a ball; pleonites 1 to 5 distinct; pleonites 2 to 4 with angularly produced posterolateral margins; pleonite 5 without free lateral margins (type *b* of Bowman, 1975).

First antenna shorter than peduncle of second antenna; peduncle of first antenna 3-segmented, of second antenna 5-segmented; flagellum of first and second antenna with relatively few segments (6 and 8, respectively, in the holotype of the type-species). Mandibles and first maxilla normal, second maxilla 4-segmented, endite unarmed, exopodite with only 4 major setae. Maxillipedal endite with 2 setae; retinacula vestigial; endopodite ("palp") 4-segmented.

Pereiopods 1 and 2 strongly prehensile, 3 through 7 ambulatory. Rami of pleopods 1-2 undivided, exopodites of pleopods 3-5 two-segmented; exopodites of pleopods 1-5 and endopodites of pleopods 1 and 2 setiferous; endopodite of pleopod 3 small. Appendix masculina falciform, pointed, subterminally implanted on the median endopodite margin of pleopod 2. Uropodal endopodite broadly foliaceous; exopodite smaller and narrower.

Type-species. — *Arubolana imula* n. sp.

Etymology. — *Arubolana* (gender feminine) is a combination of letters, with distinct allusions to the island of Aruba and *Cirolana*, the type-genus of the family Cirolanidae; *imula* (Latin, cf. Catullus) means the very lowest, referring to the subterranean habitat of the animal.

Arubolana imula n. sp.

Material examined. — West Indian Islands Expedition sta. 78/290, 1 ♂ (holotype), Aruba: Mangel Cora Tunnel (Lago Colony), approximate position 12°25'13"N 69°52'10"W, 16 May 1978. Zoölogisch Museum Amsterdam coll. no. ZMA Is. 100.648 a, b.

Description. — Body (fig. 1) rather wide, only about 2.3 times as long as wide. Length 2.9 mm. Coxal plates well developed on all pereionites; posteroventrally pointed. Pleonite 1 partially covered by pereionite 7. Pleonites 2 to 4 almost as wide as pereionite 7; epimera 2 to 4 triangular. Telson trapezoidal (fig. 1), narrower at the posterior margin which is slightly concave, vaguely crenate, armed with a few minute setules (fig. 2).

Antenna 1 short, reaching to the anterior margin of pereionite 1 (fig. 1); peduncle segments 1 and 2 short, segment 3 elongate (fig. 3); flagellum 6-segmented, subequal to peduncle segment 3; flagellum segment 1 very short, armed with 3 setae; segment 2 elongate, armed with 1 seta; segment 3 short, squarish and with 2 setae; segments 4 and 5 very small, segment 6 longer again (fig. 4). Most setae naked, but 2 plumose setae on peduncle segment 2 and 1 plumose seta on flagellum segment 1. Rostrum small, rectangular.

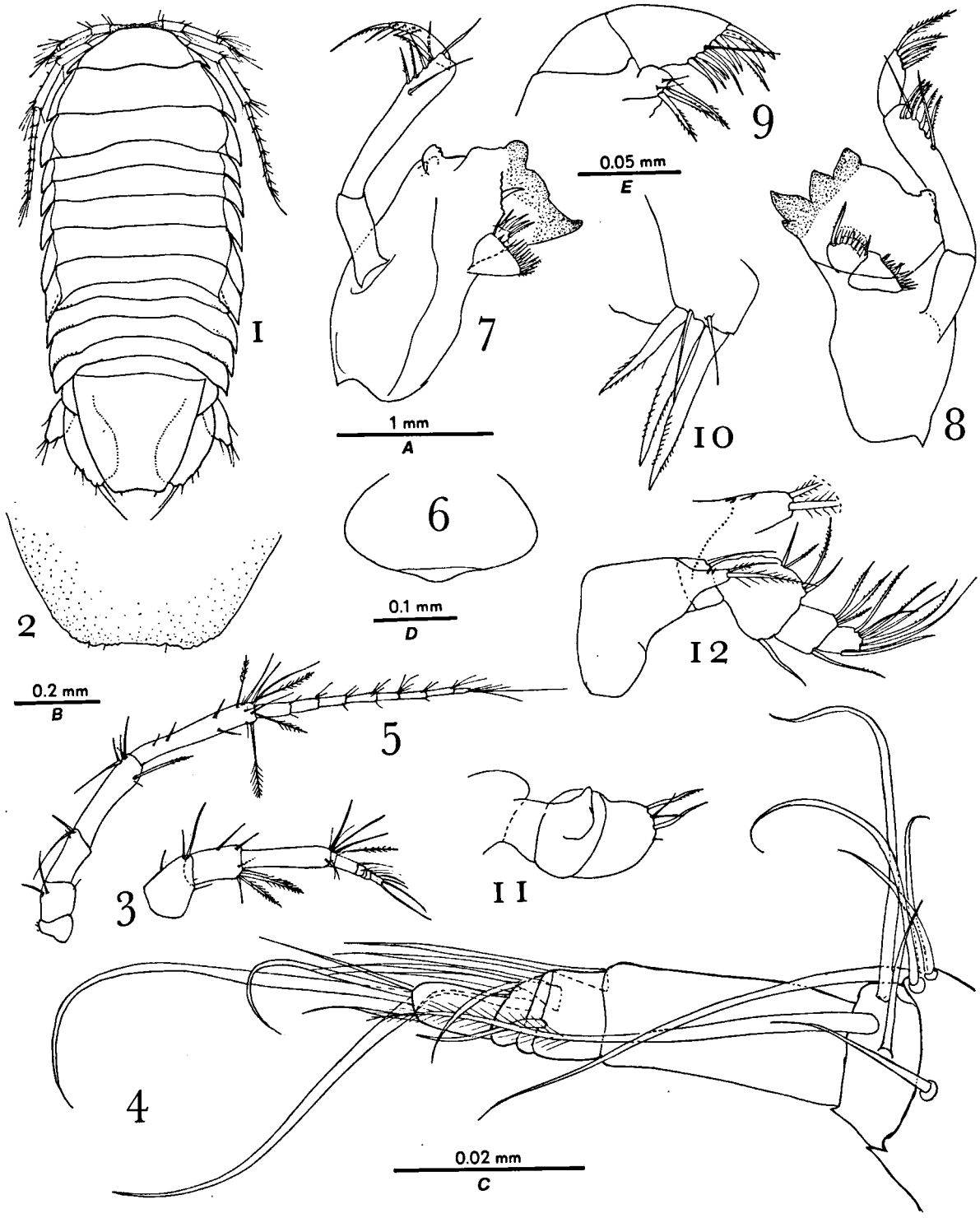
Second antenna reaching to pereionite 4 (fig. 1) with a 5-segmented peduncle, segment 5 being the longest; flagellum about as long as peduncle segments 4 and 5 combined (fig. 5). Labrum (fig. 6) roughly ovate, unarmed.

Mandibles (figs. 7, 8) slightly asymmetrical. Lacinia mobilis triangular, armed with about 11, finely pectinate, spines; incisor with 5 (left) and 7 (right) spines. Palp slender; segment 2 with a distal group of 5 or 6 stiff setae; segment 3 with 4 shorter median setae and 1 longer terminal seta.

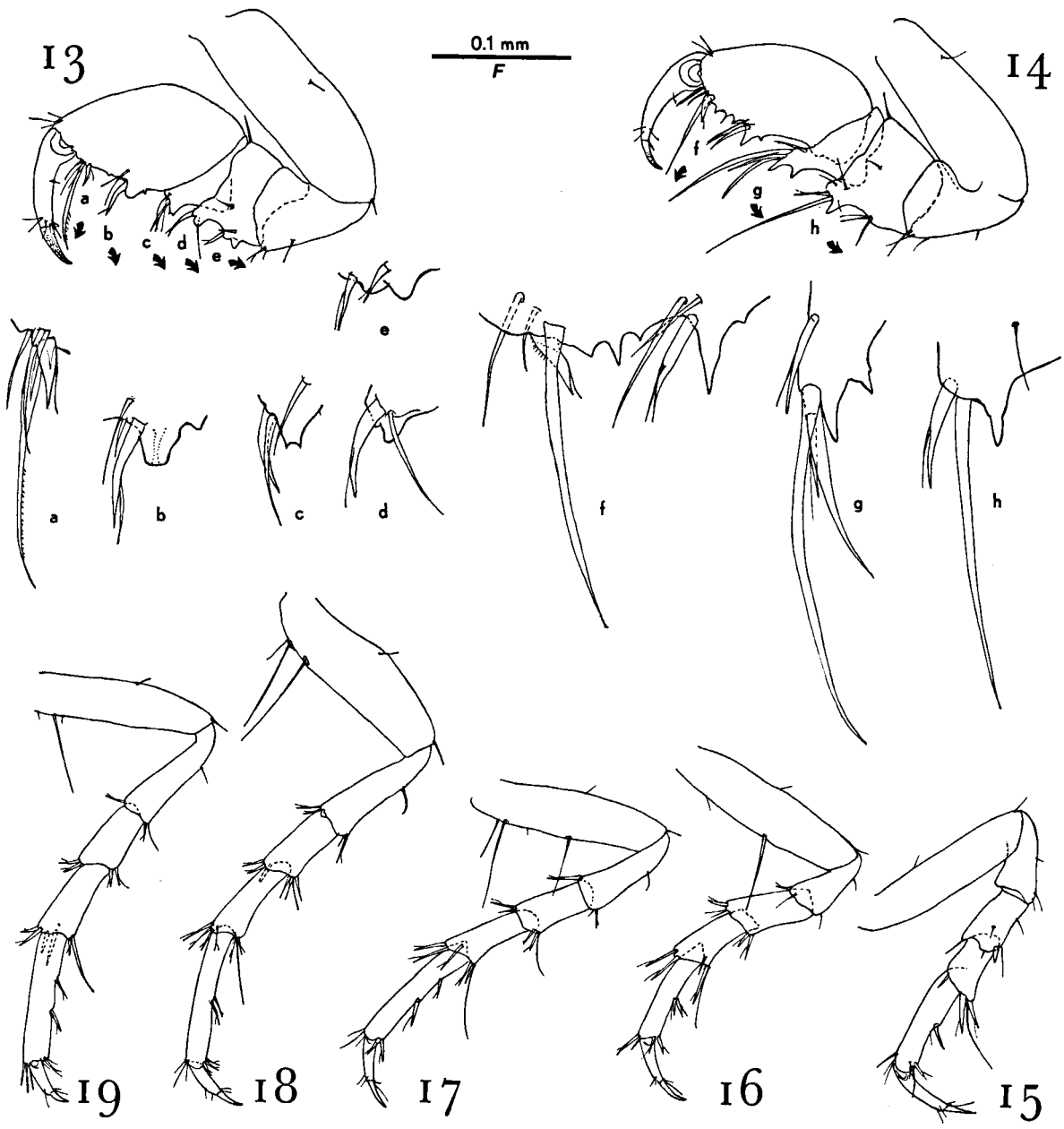
First maxilla (fig. 9) with rounded endite ("inner lobe") armed with 3 long barbated setae and 2 setules (fig. 10); outer lobe apparently 2-segmented, segment 1 unarmed, segment 2 with 11 distal spines and 1 seta.

Second maxilla (fig. 11) consisting apparently of 4 segments; segment 1 unarmed; segment 2 produced into an unarmed endite ("endopod" or "inner lobe"); two ovate segments seem to represent the exopodite, distally armed with 2 shorter and 2 longer setae; no palp.

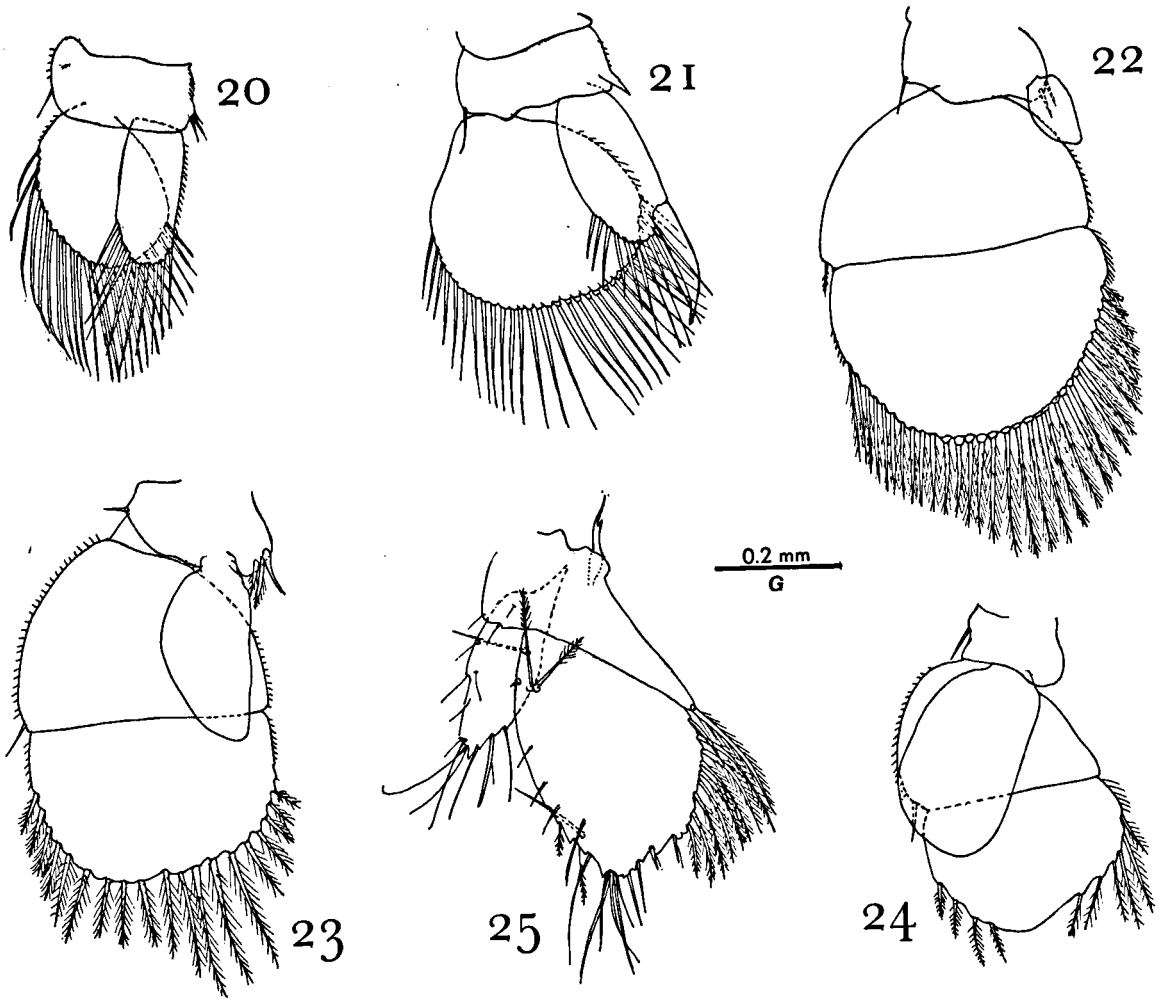
Maxilliped (fig. 12) with finger-shaped endite, armed with 2 plumose setae and 2 minute spiniform retinacula. Endopodite ("palp") 4-segmented; segment 1 squarish, with 1 seta; segment 2 the largest, with 4 + 1 setae; segment 3 squarish,



Figs. 1-12. *Arubolana imula* n. gen., n. sp., ♂ holotype: 1, entire animal, dorsal (scale A); 2, pleotelson, dorsal (B); 3, first antenna (B); 4, distal part of first antenna (C); 5, second antenna (B); 6, labrum (D); 7, left mandible (D); 8, right mandible (D); 9, left first maxilla (D); 10, endite of first maxilla (E); 11, left second maxilla (D); 12, left maxilliped (D), with detail of endite.



Figs. 13-19. *Arubolana imula* n. gen., n. sp., ♂ holotype: 13, first pereiopod (scale B) (the spiniferous processes *a* and *b* of the propodus, *c* of the carpus, and *d* and *e* of the merus are shown more enlarged — to scale F — below); 14, second pereiopod (scale B) (the propodal margin *f*, the carpal margin *g*, and the meral angle *h* are shown more enlarged — to scale F — below); 15, third pereiopod (B); 16, fourth pereiopod (B); 17, fifth pereiopod (B); 18, sixth pereiopod (B); 19, seventh pereiopod (B).



Figs. 20-25. *Arubolana imula* n. gen., n. sp., ♂ holotype: 20, first pleopod (scale G); 21, second pleopod (G); 22, third pleopod (G); 23, fourth pleopod (G); 24, fifth pleopod (G); 25, uropod (B). The ciliation of the setae is not shown in figs. 20 and 21.

with 3 + 1 setae; segment 4 the smallest, with 7 setae.

First pereiopod (fig. 13) strongly prehensile; merus, carpus and propodus very heavy, posterior margin with 2 groups of processes, spines, and setae on the merus (fig. 13d, e) (one such group on the carpus (fig. 13c) and 2 on the propodus (fig. 13a, b).

Second pereiopod (fig. 14) strongly prehensile too; one group of processes + spines + setae on the merus (fig. 14h), one group on the carpus (fig. 14g) and 2 merging groups (fig. 14f) on the propodus. Pereiopods 3 to 7 slender, ambulatory (figs. 15-19).

Pleopod 1 consisting of an ovate exopodite and a subrectangular endopodite of equal length; both rami with numerous plumose setae (fig. 20).

Pleopod 2 (fig. 21) with a very broad, rounded exopodite, armed with numerous plumose setae, and a narrow, oblong endopodite. The latter is armed with a laterotermínal row of some 10 plumose setae; subterminally, on the medial margin, a falciform, spine-like process with a simple apex, slightly shorter than the length of the endopodite, represents the appendix masculina.

Pleopod 3 (fig. 22) with large 2-segmented exopodite; basal segment with 1 laterodistal setule and a medial row of cilia; distal segment with

numerous plumose setae. Endopodite very small, fleshy, shaped like a pointed egg, unarmed.

Pleopod 4 (fig. 23) differs from pleopod 3 in having a larger fleshy endopodite, and in having less numerous, and shorter, plumose setae on the 2nd exopodite segment.

Pleopod 5 (fig. 24) has a still larger, unarmed, endopodite; the armature of the 2nd exopodite segment is reduced to some 10 short plumose setae.

Uropod (fig. 25) with an oblong, narrow exopodite, armed with several short naked setae. Exopodite much wider and longer than endopodite, laterally armed with long plumose setae, distally and medially with shorter, usually naked, setules. Protopodite wedge-shaped (similar to that found in *Cirolana*, cf. Hansen, 1905: 339), with 1 proximolateral reversed spine and one distolateral plumose seta.

DISCUSSION

The present, unfortunately unique, specimen is undoubtedly a male: it has an appendix masculina on the endopodite of the 2nd pleopod. We are nevertheless in doubt whether it is full-grown, because of its small size (body length 2.9 mm, against 8 to 33 mm in most other hypogean genera of the family; however, *Faucheria* of 3.5 mm long, *Saharolana* of 4.5 to 5 mm and *Troglocirolana* of 3.5-6.5 mm, come close to the small size of *Arubolana*). Also the low number of flagellar articles in the first and second antennae may point to an immature stage. However, in two other small-sized genera mentioned above (*Faucheria* and *Saharolana*), the antennae are pauci-articulated like those of *Arubolana*. Since at least Racovitza's (1912) excellent illustrations of *Faucheria faucheri* (Dollfus & Viré, 1900) are based on adult specimens, it is clear that adults can have few-segmented flagella. On the other hand, the mandibular masticatory blade of *Arubolana* is strongly sclerotized, allusive of a full-grown stage of development.

In juvenile males, the appendix masculina usually is still short (vide Racovitza, 1912: pl. XVII fig. 41), but in the present specimen of *Arubolana* it seems well developed.

At any rate, adult or not, the animal shows several highly characteristic features which indicate beyond doubt that it represents a new genus. The characters separating *Arubolana* from all other hypogean genera in the family Cirolanidae are:

(1) the pereiopods 1 and 2 are prehensile, whereas pereiopods 3 to 7 are ambulatory (this combination was not yet found; genera with 0, 1 or 3 prehensile pereiopods were known, but not with 2; see also Bowman, 1964);
(2) the second maxilla has a very simplified structure (instead of 3 distomedial spiniferous and/or setiferous lobes, as encountered in the other genera, only one armed lobe is present);
(3) the appendix masculina (on the endopodite of pleopod 2) is subterminally located, instead of subbasically as in almost all other genera (in *Faucheria*, however, it is terminal);
(4) the endopodite ("palp") of the maxilliped consists of 4 segments only (5 in the other genera).

Another point of interest which may be revealed here, is the vestigial condition of the retinacula on the maxillipedal endite. As was stressed by Hansen (1905: 340 & footnote) the presence or absence of retinacula separates the group of *Cirolana* — *Conilera* from the *Eurydice*-group. *Arubolana* seems to represent a transition between the two.

Summarizing, *Arubolana* shows a mixture of apomorphic and plesiomorphic characters. The pleonal segmentation is no doubt plesiomorph, as is the structure of the uropod. The transformation from unmodified (ambulatory) pereiopods to modified (prehensile) pereiopods has reached in *Arubolana* the penultimate stage of advance. The simplified structure of the second maxilla, and to a lesser degree also of the maxilliped, appear to be highly apomorphic characters.

ZOOGEOGRAPHIC REMARKS

The Cirolanidae occur both in marine and in continental waters, in the latter case mostly in hypogean habitats. Almost all stygobiontic members of the family are believed to be descended directly from marine ancestors stranded during the Cenozoic. A possible exception might be *Antrolana lira*

Bowman, 1964, from Madison Cave, in the Appalachian Valley, Virginia, found in an area that was not in connection or even close to the sea during the Cenozoic (Bowman, 1964: 234).

The origin of *Arubolana*, the new taxon from Aruba, from marine ancestors, offers no particular problems. Aruba emerged through a number of geotectonic oscillations since the late-Miocene or Pliocene (De Buisonjé, 1974). The limestones in which the Mangel Cora Tunnel (the type-locality) is cut, are at the boundary of the Lower Terrace and the Middle Terrace I level (terminology of De Buisonjé & Zonneveld, 1976). The uplifting of the Middle Terrace I above sea level took place roughly 500,000 years B.P., whereas the upper units of the Lower Terrace group have ages of about 90,000-130,000 years (Herweijer & Focke, 1978). Of course no evolutionary conclusions can be drawn from the relatively young age of the sediments at the type-locality, but at any rate *Arubolana* cannot be older than the late-Miocene/Pliocene period (12-20 million years B.P.), before which Aruba was still under the sea surface.

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REFERENCES

BOWMAN, T. E., 1964. Antrolana lira, a new genus and species of troglobitic cirolanid isopod from Madison Cave, Virginia. Int. J. Speleol., **1** (1/2): 229-236, pls. L-LVII.

——, 1975. A new genus and species of troglobitic cirolanid isopod from San Luis Potosí, México. Occ. Pap. Mus. Texas Tech Univ., **27**: 1-7, figs. 1-4.

BUISONJÉ, P. H. DE, 1974. Neogene and quaternary geology of Aruba, Curaçao and Bonaire. Uitg. natuurw. StudKring Suriname, **78**: 1-293, 4 maps.

BUISONJÉ, P. H. DE & J. I. S. ZONNEVELD, 1976. Caracasbaai: A submarine slide of a huge coastal fragment in Curaçao. Nieuwe Westind. Gids, **5**: 55-88.

HANSEN, H. J., 1905. Revision of the European marine forms of the Cirolaninae, a subfamily of Crustacea Isopoda. J. Linn. Soc., London, (Zool.) **29** (192): 337-373, pls. XXXIII-XXXV.

HERWEIJER, J. P. & J. W. FOCKE, 1978. Late pleistocene depositional and denudational history of Aruba, Bonaire and Curaçao (Netherlands Antilles). Geologie Mijnb., **57** (2): 177-187.

HUMMELINCK, P. WAGENAAR, 1979. De grotten van de Nederlands Antillen. Caves of the Netherlands Antilles. Uitg. natuurw. StudKring Suriname, **97** (Natuurhist. Reeks, 1): 1-176.

MONOD, T., 1975. Sur la distribution de quelques Crustacés Malacostraces d'eau douce ou saumâtre. XVIIe Congr. int. Zool., Monaco, 25-30 Sep. 1972. In: Mém. Mus. natn. Hist. nat. Paris, (A) (Zool.) **88**: 98-105, figs. 1-2.

RACOVITZA, E.-G., 1912. Cirolanides (première série). Archs. Zool. exp. gén., (5) **10**: 203-329, figs. i-viii, pls. XV-XXVIII.

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