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THE SUBFAMILY CANDONINAE (CRUSTACEA, OSTRACODA) IN THE WEST INDIES

by

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SUMMARY

Nine new species, two new genera, and two new subgenera of the subfamily Candoninae are described, viz.: a species of the genus *Candonopsis*, *C. hummelincki*, probably epigeal, with a wide distribution; two new species of the genus *Pseudocandona*, both elongate in shape, *Ps. geratsi*, interstitial, in several states of Venezuela, and *Ps. antilliana*, epigeal, widespread throughout the Antillean Islands, including Cuba, Jamaica and Hispaniola; and two species of *Pseudocandona* with less elongate, reticulated carapaces and a straight dorsal margin, viz. *Ps. caribbeana*, interstitial, in brooks and small rivers in Jamaica and Venezuela, and *Ps. cubensis*, troglobitic, found in cave waters in Cuba.

A new hypogean genus of Candoninae, *Caribecandona*, is described, and divided into two subgenera, one endemic to Cuba (*Cubacandona* n. subgen., type-species *Candonopsis cubensis* Danielopol, 1978), and one endemic to Hispaniola (*Caribecandona* n. subgen., with three new species: *C. trapezoidea*, *C. auricularia* and *C. ansa*).

Another new hypogean genus, *Danielocandona*, with one new species, *D. lieshoutae*, was discovered in a well in Calabozo (Venezuela, Estado Guárico).

The two new genera, with their trapezoidal carapaces, seem to be relicts of an old tertiary fauna, which did not survive in epigeal waters, but only in hypogean habitats in the larger islands Hispaniola and Cuba, which are probably fragments of an old continental plate, and in the mainland of Venezuela. On the sampled smaller islands of the West Indies no hypogean freshwater Ostracoda seem to have evolved. This probably means that these islands are much younger, and could not recruit any hypogean species from the old Candoninae stock, the ancestral forms being by then probably extinct.

Il s'agit: d'une espèce probablement épigée et à large distribution, *Candonopsis hummelincki*; de deux espèces du genre *Pseudocandona*, les deux de forme allongée (*Ps. geratsi*, espèce interstitielle connue de plusieurs états de Venezuela, et *Ps. antilliana*, espèce épigée largement distribuée aux Antilles, y compris Cuba, la Jamaïque et Hispaniola); de deux espèces de *Pseudocandona* à carapace moins allongée, réticulée et à bord dorsal droit (*Ps. caribbeana*, espèce interstitielle de ruisseaux et de petites rivières de la Jamaïque et de Venezuela, et *Ps. cubensis*, espèce cavernicole de Cuba).

Un des genres nouveaux décrits est *Caribecandona*, au sein duquel on reconnaît deux sous-genres. Un de ceux-ci est endémique à Cuba: *Cubacandona* n. sg., érigé pour *Candonopsis cubensis* Danielopol, 1978, l'autre étant endémique pour Hispaniola (Haïti): *Caribecandona* n. sg., avec trois espèces: *C. trapezoidea*, *C. auricularia* et *C. ansa*.

Le second nouveau genre, *Danielocandona*, avec l'espèce nouvelle *D. lieshoutae*, a été découvert dans un puits à Calabozo (Venezuela, Estado Guárico).

Les deux genres nouveaux, avec leurs carapaces trapézoïdales, semblent être des relictés d'une vieille faune (du Tertiaire), faune n'ayant pas pu survivre dans les eaux épigées, mais uniquement dans des habitats hypogés des deux grands îles Hispaniola et Cuba, qui sont probablement des fragments d'une ancienne plaque continentale, ainsi que dans ceux de la partie continentale de Venezuela. Il semble que les Ostracodes hypogés d'eau douce sont absents des petites îles des Indes Occidentales; ceci montre probablement que ces îles sont beaucoup plus jeunes, n'ayant pas pu recruter des espèces hypogées à partir d'un ancien contingent de Candoninae (les formes potentiellement ancestrales étant probablement éteintes à l'époque où ce recrutement aurait pu se réaliser).

RÉSUMÉ

On décrit neuf espèces nouvelles, deux genres et deux sous-genres nouveaux, appartenant à la sous-famille Can-

INTRODUCTION

The main ostracod groups living in fresh water in the southern hemisphere as well as in Central America, are the Cypridinae, Cypridopsinae

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and Cyclopyridinae. The Darwinulidae, Candoninae and Limnocytheridae are poorly represented in this part of the world.

The West Indies present the same type of fauna. Limnocytheridae have not been encountered in the samples, Darwinulidae only sometimes in springs, most often the species *Darwinula stevensoni* (Brady & Robertson, 1868). Candoninae were scarcely encountered, mostly in wells and the interstitia of running waters.

The previous studies concerning the Ostracoda of the West Indies dealt with the genera *Heterocypris*, *Hemicypris*, and *Strandesia* (Broodbakker, 1982; 1983a, b, c), all belonging to the subfamily Cypridinae, and common and widespread in this region. Practically all species of this subfamily and of the subfamilies Cypridopsinae (Cyprettinae) and Cyclopyridinae, proved to be epigeal. In the present study the Candoninae are treated as a subfamily, consisting of epigeal as well as hypogean and partly hypogean genera. The well-known genera *Candonopsis* and *Pseudocandona* and two new hypogean genera have been encountered in the West Indies. The genus *Candonopsis* is represented by one new species which is present on several of the islands and on the mainland of Venezuela. The genus *Pseudocandona* is represented by four new species, of which two are closely related to already described taxa from the South and North American continents. One of the new genera was found in wells in Cuba and Haiti, while the other new genus was found in a well in Calabozo, Venezuela.

Until now only one hypogean freshwater species of Ostracoda has been described from the West Indies: *Candonopsis cubensis* Danielopol, 1978, which is now placed in one of the new genera. Another species, *Danielopolina orghidani* (Danielopol, 1972), was found in an anchihaline habitat in Cuba. This species belongs to the family Thaumatoocyprididae Müller, 1906, a family consisting of deep-sea species, except for this one.

Many West Indian islands have been extensively sampled by Dr. P. Wagenaar Hummelinck and the Amsterdam Expeditions to the

West Indian Islands (Prof. Dr. J. H. Stock, Dr. L. Botosaneanu, Dr. S. Weinberg, Ir. J. Notenboom). Furthermore, many stations have been sampled in Cuba by Dr. L. Botosaneanu, Dr. T. Orghidan and Dr. St. Negrea. Nevertheless, only a few species of hypogean freshwater Ostracoda have been found. Practically all these species belong to the subfamily Candoninae. It seems that most other epigeal freshwater, marine and brackish-water species were not capable to evolve into freshwater hypogean Ostracoda, with the possible exception of some species of the genus *Strandesia* and of the subfamily Thalassocypridinae. The latter species are, however, oculated, and not clearly morphologically adapted to a subterranean way of life.

MATERIAL AND METHODS

Most of the samples studied have been collected by the Amsterdam Expeditions to the West Indian Islands (1973-1982), and the expeditions of Dr. P. Wagenaar Hummelinck (1936-1973). For further details about the stations sampled, the reader is referred to Stock (1979) and Wagenaar Hummelinck (1940a-b, 1953, 1981). The samples of the Amsterdam Expeditions and of Dr. P. Wagenaar Hummelinck are abbreviated in the sequel as S and WH, respectively. More information about the samples containing ostracods is provided by Broodbakker (1982). The samples from Cuba have been collected by Dr. L. Botosaneanu in 1969 and 1973, and by Dr. T. Orghidan in 1969 and 1970. Some samples from Venezuela were collected by Dr. T. Orghidan in 1975. The samples taken by Dr. L. Botosaneanu are indicated with a B. One sample from the Cuevas de Bellamar, Matanzas (Cuba) has been collected by Prof. Dr. Cl. Delamare Deboutteville in 1974, another sample from Cuba by Dr. St. Negrea in 1969.

All material is deposited in the Zoölogisch Museum, Amsterdam (ZMA)

Descriptions of chaetotaxy of the limbs are made according to the system of Broodbakker & Danielopol (1982). Measuring of carapaces was done with a ruler on a sheet of white paper, on which the animals were projected by way of a camera lucida and a Reichert Diapan microscope. Microslides were made according to the method of Danielopol (1982b).

After every description of a genus or species follow some remarks about the ecology, as far as data are available. All species described belong to the subfamily Candoninae Von Daday, 1900, of the family Cyprididae Baird, 1845.

A NEW SPECIES OF *CANDONOPSIS*Genus *Candonopsis* Vávra, 1891

A new diagnosis of this genus is provided by Danielopol (1980a), together with a list of all *Candonopsis* species described. Klie (1932) divided the genus in three groups according to the presence or absence of medial teeth on one or both of the furcal claws.

The new species from the West Indies has medial teeth on both furcal claws. Other species with such furcal claws are: *C. solitaria* Vávra, 1895 (Zanzibar); *C. navicula* Von Daday, 1910 (East Africa); and *C. tenuis* Sars, 1896 (Australia).

***Candonopsis hummelincki* n. sp.**
(Fig. 1).

Material. — Holotype: ZMA Ost. 150.582, 1 ♀. Paratypes: ZMA Ost. 150.583, 2 dissected and 2 undisseminated females.

Type-locality: S 78/119, Virgin Gorda (British Virgin Islands), open half-natural well near Post Office of Spanish Town (18° 26' 42"N 64° 26' 26"W); water table at 2 m, water depth 1 m; chlorinity 640 mg/l; Cvetkov net; 24-IV-1978. Accompanying fauna: Polychaeta, Thermosbaenacea, Insecta, and *Cypretta* sp. (Ostracoda).

Other stations: WH 534, St. Martin, puddle in head of ravine, Colombier Valley (18° 04' 04"N 63° 03' 31"W); dimensions: 1/5 × 1/10 × 1/10 m; stagnant, not permanent, made by removing wet mud and leaf decay; bottom rock detritus with mud on chiefly dioritic rock, in narrow ravine of about 5 m deep; chlorinity 265 mg/l; 20-V-1949; 3 specimens.

S 78/171, Vieques, Pozo Preto, open well in village of Monte Santo (18° 07' 30"N 65° 27' 00"W); water depth 0.4 m; Cvetkov net; chlorinity 600 mg/l; 1-V-1978; 3 specimens. Accompanying fauna: mosquito larvae and *Cypretta* sp. (Ostracoda).

S 79/539, Haiti, open well of Gérard Gélain in Marin (Croix des Missions, Dépt. de l'Ouest) (18° 36' 31"N 72° 17' 31"W); very primitive, shallow well, water close to the surface; sediment pale; Cvetkov net; chlorinity 310 mg/l; 2 specimens. Accompanying fauna: Cyclopidae, Thermosbaenacea; Ostracoda: *Cypretta* sp., *Strandesia longula* Broodbakker, 1983c.

S 82/500, Venezuela, source transformed into well in "La Luisa", Peninsula de Morocoy, Edo. Falcon (10° 52' 03"N 68° 19' 27"W); at the base of a limestone wall near the road; stagnant, under a roof; dimensions: 1.5 × 0.5 m; water depth 0.5 m; Cvetkov net; chlorinity 145 mg/l; 28-II-1982; 1 specimen. Accompanying fauna: Tricladida,

Cyclopidae, Anura larvae; Ostracoda: *Strandesia venezolana* Broodbakker, 1983c, *Cypretta* sp., *Darwinula* sp.

S 82/522, Venezuela, hole dug in sandy sediments along the banks of Rio Mitare, about 100 m downstream of the Nacimiento de Rio Mitare, a large karst spring near Cabure, Sierra de San Luis, Edo. Falcon (11° 08' 24"N 69° 38' 38"W); chlorinity 60 mg/l; 3-III-1982; 4 specimens. Accompanying fauna: Nematoda, Oligochaeta, Insecta; Ostracoda: *Strandesia venezolana*, *Pseudocandona geratsi* n. sp.

S 82/535, Venezuela, hole dug in fine gravel and coarse sand along the banks of a trickle crossing the road, at 2.5 km from Curuao in the direction of Los Caracas, Dto. Federal (10° 36' 46"N 65° 22' 04"W); in the forest; chlorinity 40 mg/l; 6-III-1982; 1 specimen. Accompanying fauna: Nematoda, Oligochaeta, Cyclopidae, Harpacticoida, *Pisidium* (Bivalvia), Acarina (hyphorheobiont), Insecta.

S 82/537, Venezuela, hole dug in coarse gravel and sand between large stones, along the banks of a brook crossing the road, at 7.5 km from Curuao in the direction of Los Caracas (10° 36' 58"N 66° 23' 32"W); width 2 m, current moderate; chlorinity 25 mg/l; 6-III-1982; 4 specimens. Accompanying fauna: Oligochaeta, Diptera.

S 82/573, Venezuela, hole dug in coarse sand and gravel along the banks of Rio Zuata, 2 km N. of San Casimiro, Edo. Aragua (10° 00' 12"N 66° 59' 47"W); chlorinity 19 mg/l; 10-III-1982; 5 specimens. Accompanying fauna: Nematoda, Harpacticoida, *Calabozoa pellucida* Van Lieshout, 1983 (Isopoda), Coleoptera; Ostracoda: *Strandesia venezolana*, *Pseudocandona geratsi* n. sp.

Geographical distribution known. — Venezuela (Edo. Falcon, Aragua, Sucre and Dto. Federal), St. Martin, Virgin Gorda, Vieques, Haiti.

Description

Only females of this species have been encountered.

Carapace (figs. 1A-C):

The carapace is smooth and whitish transparent. Shape and duplicature as in *C. tenuis*. Greatest height behind the middle at two-fifths of the length, being 43% of the length. Greatest width at 50% of the length, being one-third of the length. Left valve slightly overlapping the right valve. The shape of the valves and the shape of the vestibule in both valves is about the same. Marginal pore canals barely visible, simple, anteroventrally in the right and anterodorsally in the left valve. Both valves

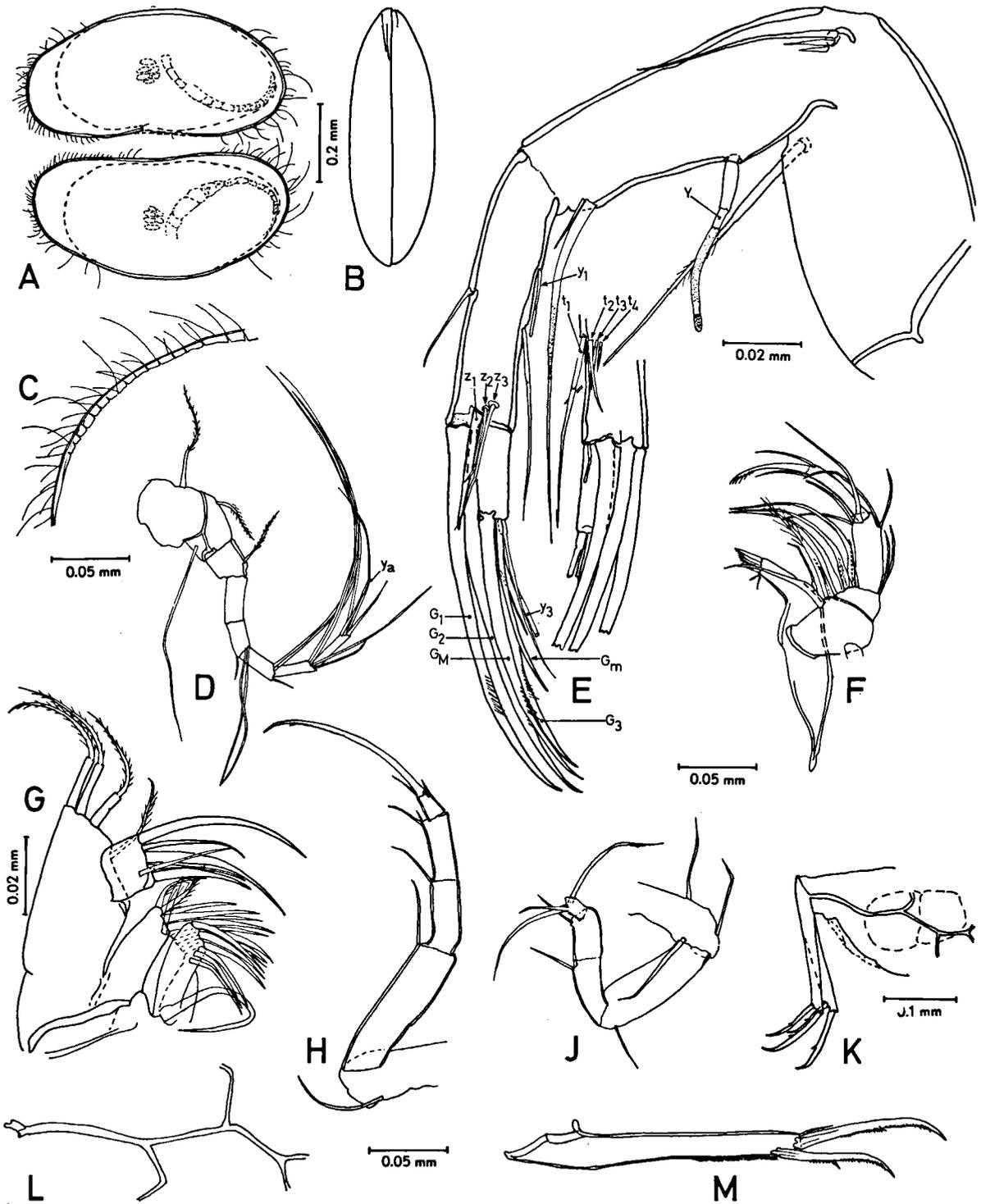


Fig. 1. *Candonopsis hummelincki* n. sp. (S 78/119, Virgin Gorda; A-D, G, ♀ no. 2; E-F, H-J, M, ♀ holotype; K, ♀ no. 3): A, left and right valve; B, carapace in dorsal view; C, detail of anterodorsal part of left valve; D, antennule; E, second antenna, with detail viewed from other side; F, mandibular palp; G, maxillula; H-J, first and second thoracopod; K, posterior part of body; L, furcal attachment; M, furca.

regularly arched. Ventral margin slightly sinuate. Posterior margin somewhat blunter than anterior margin.

Carapace length ranges from 0.65-0.68 mm, at a height of 0.32 mm, in the type-locality. There are no large differences in carapace size between the populations in different islands. In the different samples the carapace length ranges from 0.63-0.70 mm.

Antennule (A1) (fig. 1D):

I: A-1*l*(pl)-1*m*(pl), P-1*l*/II: A-1*m*(pl)/IV: A-2*l*, P-1*s*/V: A-2*l*, P-1*s*/VI: A-2*l*, P-1*l*-1*m*/VII: y_a -2*l*-1*m*(cs).

Aesthetasc y_a is 1.3 times the length of segment III. The proportional lengths of the segments III to VII are: 1.5: 1: 1.2: 1.2: 1.5.

Second antenna (A2) (fig. 1E):

Pr: P-1*l*(pl)/Exo: 1*m*(pl)-2*s*/E I: P-Y-1*m*(pa)-1*s*/E(II + III): A-1*s*, P- y_1 -1*m*(t_1)-3*s*($t_{2,4}$), D-1*s*(cs: z_1)-2*s*($z_2, 3$)- y_2 -3*l* ($G_1, 2, 3$:1ser)/E IV: D- y_3 -2*s*-1*m*(G_m :cs)-1*m*(G_M :1ser).

The aesthetasc Y is not strongly developed. Seta z_1 is transformed in a clawlike seta, and G_m is slender and only slightly longer than the longest seta of E IV. G_2 is well developed and long.

Mandibular palp (Mdp) (fig. 1F):

I: In-1*m*(S_1 :pu)-1*s*(S_2 :pu)-1*m*- α /II: In-3*l*(pu)-1*s*(pu)- β (pu), Ex-2*s*/III: In-1*m*-2*s*, Ex-1*m*-1*s*/IV: 1*m*(1ser)-2*s*.

The mandibular palp is very elongate, as in the *Candonopsis kingsleyi* (Brady & Robertson, 1870) group of species. E III is three and E IV is about seven times as long as wide. Both segments have the same length. Seta α is twice as long as seta β .

Maxillula (Mxu) (fig. 1G):

Mxup I: Ex-3*l*(pu)-1*m*(pu)/Mxup II: D-2*l*(cs)-1*m*(cs)-3*m*/Mastic I: In-1*l*, D-12*m*(?)/Mastic II: D-8*m*(?)/Mastic III: In-1*m*, D-2*m*(cs)-3*s*(pu)-5*m*(?).

There is only one seta at the interior of the first masticatory process, as in *C. boui* Danielopol, 1978.

Maxilla (Max):

Pr: A-2*s*(a), In-1*m*(b:pu)-1*s*/Mastic: D-12*s*/Exo: 3*s*(pu)/E: D-3*s*.

First thoracopod (T 1) (fig. 1H):

Pr: A-1*m*/E I: A-1*s*/E II: A-1*s*/E III: A-2*s*/E IV: D-2*s*-1*l*(G: 1ser).

The proportional lengths of segments and claw are: 5.5: 2.7: 2.6: 1: 7.0.

The distal claw is 2.6 times the length of E II.

Second thoracopod (T 2) (fig. 1J):

Pr: Ex-2*m*, In-1*m*/E I: P-1*s*/E II: P-1*s*/E III: P-1*s*/E IV: D-1*s*(pl)-1*m*(ser)-1*l*(pu).

The proportional lengths of E I-IV are: 4.5: 2.3: 1.8: 1. The distal setae of E IV are 45, 93 and 108% of the length of E I, respectively.

Furca (Fu) & furcal attachment (Fuat) (figs. 1M, L):

The posterior side of the furcal ramus (R) is pectinate for about one-third of its length. The distal claws are pectinate with two rows of teeth, separated by a stronger tooth. $G_a/R = 63\%$, $G_p/G_a = 81\%$, $s_a/G_a = 21\%$.

The furcal attachment is of the *Candonopsis* type (Rome, 1969).

Copulatory organs (fig. 1K):

The female copulatory organ has no special characters, the posterior side of the organ is flattened.

Taxonomic remarks. — *C. falklandica* Vávra, 1898, *C. anisitsi* Von Daday, 1905, and *C. columbiensis* (Méhes, 1913), all from South America, are not of the type with medial stronger teeth on the furcal claws. *C. brasiliensis* Sars, 1901, from Brazil has a different carapace shape. Sars (1901) did not indicate the type of furca of this species, nor any other internal character.

C. sp. (not *kingsleyi*), encountered by Tressler (1941) in Bromeliads in Puerto Rico is another species (Danielopol, 1982c).

The furca of *C. hummelincki* is of the *C. tenuis* group type, but the mandibular palp has extremely long segments, like in the *C. kingsleyi*

group. According to Sars (1896), *C. tenuis* has the same internal characters as *C. kingsleyi*, except for the furca.

Etymology. — The species is named in honour of Dr. P. Wagenaar Hummelinck, in recognition of his intensive investigations of the Caribbean islands, during which many ostracod samples used for our studies were obtained.

Ecology. — The fact that Sars (1901) raised two specimens of *C. brasiliensis* from dried mud seems to indicate that the genus *Candonopsis* can have resistant eggs, like many Cypridinae. Another possibility is that the two specimens were in a torpid state in the mud (Delorme & Donald, 1969). From Sars's description of *C. tenuis* it remains unclear if he obtained his specimens from dried mud, or from ostracod samples, or both.

Samples containing *C. hummelincki* were scarce. In all samples only a few specimens were present. The fact that the species was found on the islands of Hispaniola, Vieques, Virgin Gorda and St. Martin, as well as on the mainland of Venezuela, suggests a much wider distribution.

The species lives in the bottom substrates of running waters as well as in small shallow open wells. It was present in only one sample collected by Dr. P. Wagenaar Hummelinck, in a small puddle in a ravine on St. Martin. The species was accompanied by several other species of ostracods, but mostly by *Cyprretta* sp. It was found at chlorinities up to 640 mg/l. The wide distribution and the occurrence in the puddle on St. Martin, suggest that it is an epigeal species.

FOUR NEW SPECIES OF *PSEUDOCANDONA*

Genus *Pseudocandona* Kaufmann, 1900

The genus *Pseudocandona* was described very concisely by Kaufmann (1900) and was characterized by the absence of sexually dimorphic characters in the second antenna. The type-species of the genus is *Candona insculpta*

Müller, 1899. However, related species have been found which display sexually dimorphic characters in the second antenna.

Triebel (1963) placed the groups *rostrata* and *compressa* of the genus *Candona* Baird, 1845, in *Pseudocandona*, which he considered to be a subgenus. Petkovski (1969) gave the two groups the status of genus, because of the structure of the copulatory organs.

Within the genus *Pseudocandona* four main groups can be recognized:

- (1) the *rostrata* group, which has 2 + 3 setae at the interior side of the second segment of the mandibular palp (Mdp: II: In);
- (2) the *compressa* group, which has 2 + 4 or 2 + 5 setae at this place;
- (3) the *eremita* group, like *rostrata* with the 2 + 3 configuration, but with a triangular carapace (Danielopol, 1982a);
- (4) the Lake Baikal group of species, or *baikalensis* group, which has a round instead of a funnel-shaped structure at the proximal side of the Zenker's organ (Danielopol, 1978: 133).

Practically all groups and their main characters are discussed in Danielopol (1978, 1982a).

The four new species described in this study belong to the *rostrata* group, according to the chaetotaxy of the mandibular palp.

Pseudocandona geratsi n. sp.

(Figs. 2, 3)

Material. — One female holotype, one male allotype, one female paratype, and fragments of some other female specimens, partly dissected on one slide (ZMA Ost. 150.786).

Type-locality: Guarapiche, Venezuela (Edo. Sucre), hole dug in the bank of a river (10° 31' N 63° 24' W); 17-V-1975; coll. Dr. T. Orghidan. Accompanying ostracod species: *Candonopsis hummelincki*, *Darwinula* sp. and *Cypridopsis* aff. *vidua* (Müller, 1776).

Other stations (all in Venezuela): S 82/522, hole dug in sandy sediments along the banks of Rio Mitare, about 100 m downstream of the Nacimiento de Rio Mitare, a large karst spring near Cabure, Sierra de San Luis, Edo. Falcon (11° 08' 24" N 69° 38' 38" W); chlorinity 60 mg/l; 4 females and 2 juveniles. Accompanying fauna: Nematoda, Oligochaeta, Insecta; Ostracoda: *Strandesia venezolana*, *Candonopsis hummelincki*.

S 82/530, spring of Cipare, about 3 km N. of Guaibacoa, Edo. Falcon (11° 24' 51" N 69° 27' 22" W); modified spring, water collected in a covered concrete basin, depth 0.5 m; Cvetkov net; sandy bottom; chlorinity 330 mg/l; 5-III-1982; 1 juvenile and a carapace. Accompanying fauna: Oligochaeta, Gastropoda, Chironomidae; Ostracoda: *Cyprretta* sp.

S 82/531, hole dug in a bank of gravel and coarse sand with large boulders, in the middle of the fast running river Rio Acurigua, in village Acurigua, Sierra de San Luis, Edo. Falcon (11° 18' 54" N 69° 28' 48" W); width 5 m, water depth 0.5 m; chlorinity 80 mg/l; 5-III-1982; 1 female. Accompanying fauna: Oligochaeta, Insecta; Ostracoda: *Ps. caribbeana* n. sp.

S 82/573, hole dug in coarse sand and gravel along the banks of Rio Zuata, 2 km N. of San Casimiro, Edo. Aragua (10° 00' 12" N 66° 59' 47" W); chlorinity 20 mg/l; 10-III-1982; 1 female. Accompanying fauna: Nematoda, Harpacticoida, *Calabozoa pellucida* (Isopoda), Coleoptera; Ostracoda: *Candonopsis hummelincki*, *Strandesia venezolana*.

Geographical distribution known. —
Venezuela (Edo. Falcon, Sucre, Aragua).

Description

Only one male of this species has been encountered.

Carapace (figs. 2A-E):

In dorsal view greatest width at 50% of the length, being one-third of the length. Left valve slightly larger than and overlapping the right valve. Greatest height behind the middle at two-thirds of the length, length/height ratio about 2.

The shape of left and right valves is nearly the same. There is no clear dimorphism in the shape of the valves between males and females. Both valves regularly arched, oblong reniform in shape. The dorsal margin passes smoothly in the rounded anterior and posterior margins. Ventral margin slightly sinuate. Duplicature much wider anteriorly than posteriorly. Marginal pore canals indistinct. Valves sparsely hairy. Muscle scars as typical of the *Candoninae*.

The male allotype has a length of 0.77 mm and a height of 0.38 mm. The females from the type-locality are deformed because of decalcification, but they were 0.64 and 0.68 mm in length. The females from the other

localities range from 0.63-0.65 mm in length, except for the female from S 82/531, which is 0.76 mm long.

Antennule (A 1) (fig. 2F):

I: A-2l(pl), P-2l/II: A-1m(pl)/III: A-1l/IV: A-2l, P-1m/V: A-2l, P-1m/VI: A-3l-1m/VII: D-3l- y_a .

All setae seem to be long, but this is because segment III is very short. The proportional lengths of the segments III to VII are: 1: 1.3: 1.4: 1.6: 1.5.

Second antenna (A 2) (figs. 2G-H):

Pr: P-1m(pu)/Exo: 1m-1s/E I: P-Y-1m(pl)-1s/

♀: E (II + III): A-1s(pl), P- y_1 -2m(t_1 , t_2 :pl)-2s(t_3 , t_4), D- y_2 -3s(z_1 , z_2 , z_3)-1l(G_1 :ser)-1s(G_2 :ser)-1m(G_3 :ser)/E IV: D-2m(G_M , m:ser)-1m-1s- y_3 .

♂: E II: P- y_1 -1m(t_1), A-1s-1s(t_4), Ex-1m(t_2)-1s(t_3)/E III: D(Ex)-1s(z_1), D(In)-1s(z_2)-1m(z_3), D-2m(G_2 , z_3)-1l(G_1)/E IV: D-2m(G_M , m)-1m-1s- y_3 .

The chaetotaxy of t and z setae in the male is the same as in *Ps. serbani* Danielopol, 1982b (see Broodbakker & Danielopol, 1982). G_2 is slender, t_2 and t_3 are strongly developed "male" setae. Setae z_2 and z_3 have moved to the interior side of A 2, and z_1 has moved somewhat posteriorly. The male has a four-segmented endopodite, while in the female the second and third segments are fused, like in most female *Candoninae*, which means that this species is not a *Pseudocandona* species sensu Kaufmann. The other limbs have the same chaetotaxy in males and females.

Mandibular palp (Mdp) (fig. 2J):

I: In-1l-1l(S_1 :pu)-1s(S_2 :pu)- α /II: In-3l(pu)-1m(pu)- β , Ex-2m/III: In-1m-1s, Ex-3l, A-2l/IV: D-1l(cs:pu)-3m.

The γ seta is not special in this species, β does not seem to be plumose.

Maxillula (Mxu) (fig. 2L):

Mxup I: Ex-3l(pu)-1m(pu)/II: D-2m(cs)-2m(pu)-2m/Mastic I: In-1l-1m(pu), D-1l-10m(?)/2: D-8m(?)/3: In-1m, D-2m(cs)-8m(?).

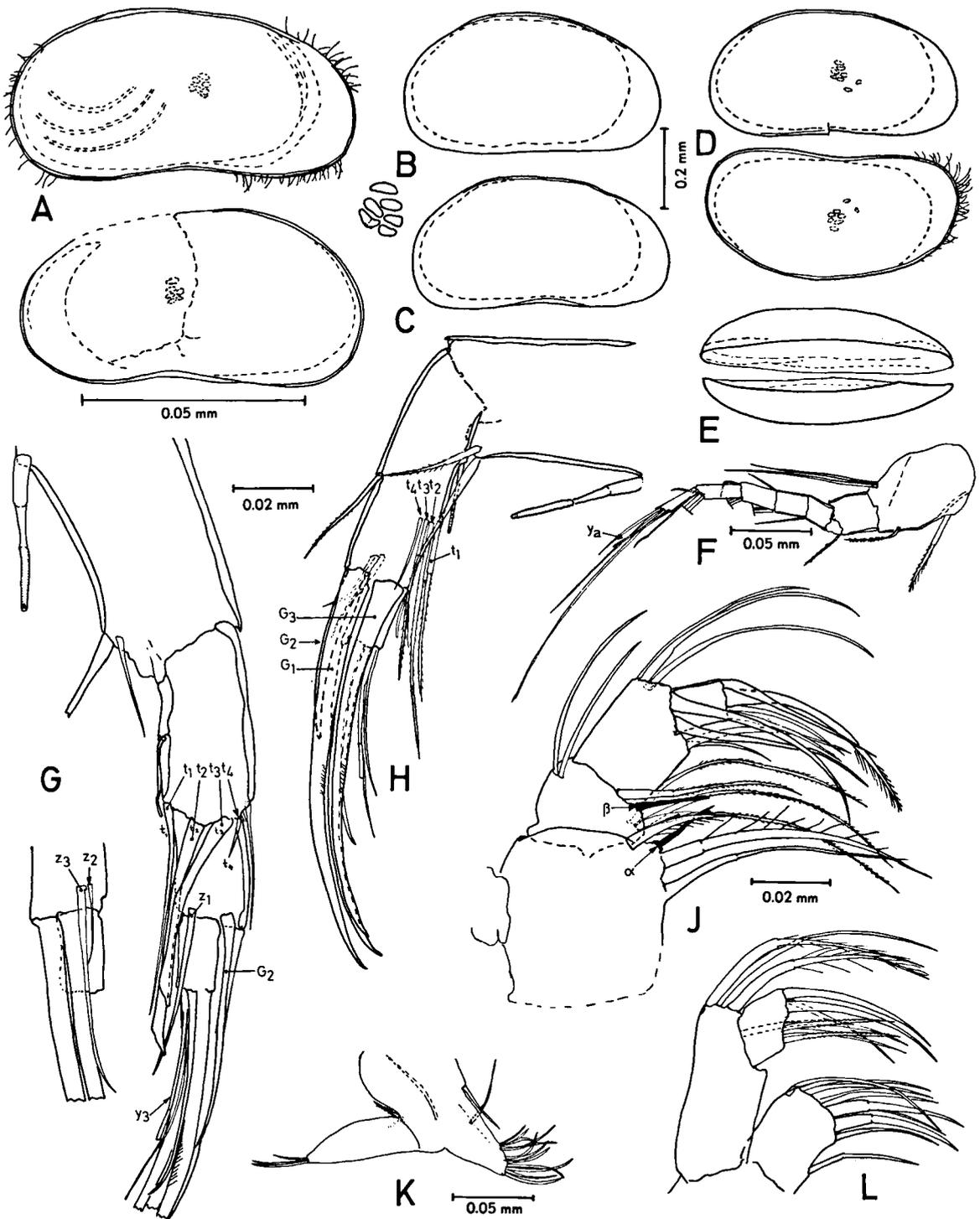


Fig. 2. *Pseudocandona geratsi* n. sp. (A-B, G, Guarapiche, Venezuela, Edo. Sucre: A, G, ♂ allotype; B, ♀ holotype; C, S 82/573, Venezuela, Edo. Aragua, ♀; D-F, H-L, S 82/522, Venezuela, Edo. Falcon, ♀ no. 1); A, D, right and left valve, E, in dorsal view; B, carapace in lateral view; C, right valve, with muscle prints; F, antennule; G-H, details of second antennae; J, mandibular palp; K, maxilla; L, maxillula.

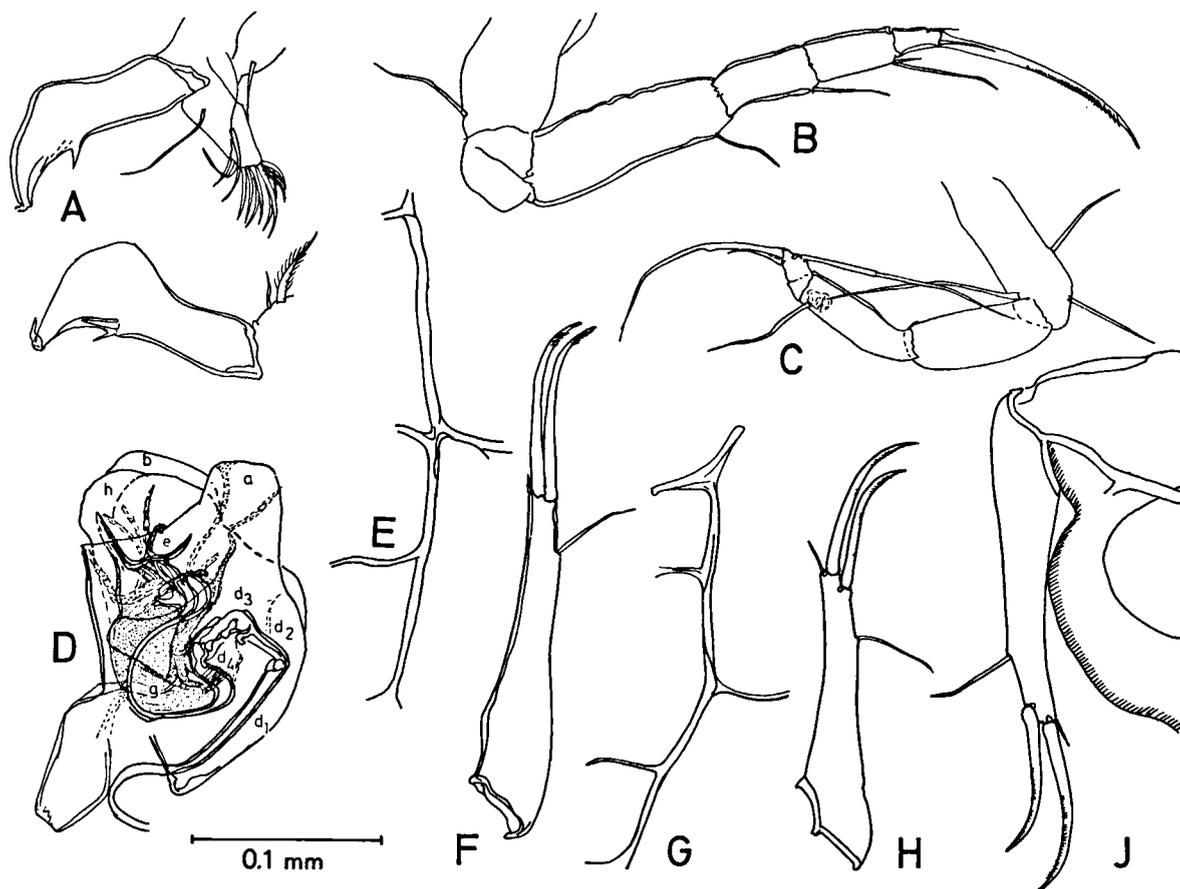


Fig. 3. *Pseudocandona geratsi* n. sp. (A-H, Guarapiche, Venezuela, Edo. Sucre: A-F, ♂ allotype; G, ♀ holotype; H, ♀ no. 2; J, S 82/531, Venezuela, Edo. Falcon, ♀): A, maxillae; B-C, first and second thoracopod; D, hemipenis (for explanation see text); E, G, furcal attachments; F, H, furcas; J, posterior part of body.

The chelate setae of the third masticatory process do not seem to be serrate.

Maxilla (Max) (figs. 2K, 3A):

Pr: A-1s(a), In-2s(b, d)/Mastic: D-12s(?) / Exo: P-1s(pl)-1s/E(♀): D-3s.

The maxilla has two small exopodal setae of which one is plumose (fig. 3A, below). The male endopodites are transformed into claws, of which the right one is more elongated. They are of the same type as in most other *Pseudocandona* species.

First thoracopod (T 1) (fig. 3B):

Pr: A-1m/E I: A-1s/E II: A-1s/E III: A-1m-1s/E IV: A-1s, P-1s, D-1/(G:ser).

The proportional lengths of segments and claw

are: 4.6: 2.1: 1.9: 1: 5.1. The terminal claw is 2.4 times the length of E II and 1.1 times the length of E I.

Second thoracopod (T 2) (fig. 3C):

Pr: Ex-2m, In-1l/E(II + III): P-1m/E IV: D-1l(ser)-1(pl)-1s.

All setae are plumed. The second and third endopodite segments are fused.

Furca (Fu) & furcal attachment (Fuat) (figs. 3E-H):

There seems to be some sexual dimorphism. In the male, G_p has the same length as G_a , while in the female G_p/G_a is 83%. Seta s_a seems to be somewhat shorter in the male (s_a/G_a is 10% in the male and 20% in the female). G_a/R is 65%

in both male and female. Because of the shorter G_p in the female, s_p/G_p is 48% in females and 60% in males.

One of the branches of the furcal attachment has moved anteriorly in the male, when compared with the female furcal attachment (figs. 3E, G).

Copulatory organs (figs. 3D, J):

The female copulatory organ is rounded posteriorly and has no other special characteristics (fig. 3J).

The Zenker's organs of the male have seven whorls of spines, like most other Candoninae.

The terminology of Danielopol (1969, 1982b) is used for the internal structure of the hemipenis. The shape of the hemipenis is of the typical *Pseudocandona* type, with all distal lobes pointing backwards, a blunted lobe 'a' and more rounded 'b' and 'h' lobes. The part 'M' (g) is very difficult to recognize, it is only weakly sclerotized. Several sclerotized structures are visible in the distal part of the hemipenis, which could belong to the bursa copulatrix (e). The parts 'd₁₋₄' of the labyrinth are all clearly visible.

Taxonomic remarks. — The species shows close affinities with *Ps. annae* (Méhes, 1913) from Colombia. However, the carapace shape and the male copulatory organ are different. The male *Pseudocandona* described by Furtos (1936) as *Ps. annae* must be another species according to her drawings. It is probably closely related to *Ps. geratsi*, *Ps. annae*, and even closer to *Ps. antilliana* n. sp., which is described next. *Ps. geratsi* also shows some affinities with *Ps. elliptica* Furtos, 1933, from Ohio.

Etymology. — The species is named in honour of Drs. A. G. M. Gerats, a true friend and promising plant geneticist.

Ecology. — Only a few samples containing this species were found. These were practically all from coarse sediments along the banks of small streams and rivers, with chlorinities up to 330 mg/l. The morphological characteristics do not

indicate interstitial adaptation, but according to the definition of Danielopol (1980b), a species is supposed to be hypogean or "true interstitial" until proof of the contrary is obtained.

***Pseudocandona antilliana* n. sp.**
(Figs. 4, 5)

Material. — Holotype: ZMA Ost. 150.588, 1 female. Paratypes: ZMA Ost. 150.589, 1 dissected and about 100 undissected females.

Type-locality: S 79/549, Haiti, well of Emile Magloire at Ti Mouillage, about 40-50 m from the littoral, Dépt. du Sud-Est (18° 14' 01"N 72° 22' 26"W); water table at 3 m, water depth 1 m; chlorinity 70 mg/l; Cvetkov net; 13-XI-1979. Accompanying fauna: Cyclopidae, Gastropoda, Acarina, Insecta; Ostracoda: *Strandesia longula*, *Cyprretta* sp.

Only in one sample a male of this species was encountered, which was used for the description: B 69/44, Cuba, Cueva del Agua, in a place called "El Veral" (Peninsula de Guanahacabibes, Prov. Pinar del Rio), close to the littoral (21° 57'N 84° 31'W); small cave pool situated at 4.5 m below the bottom of the cave; limestone bottom with stones and some fine sediment; fresh clear water; pH 8; temp. 23.1°C; 3-VI-1969. Coll. St. Negrea. Only one male and a carapace, no other Ostracoda.

Other stations: S 82/519, Venezuela, Manantial "Quevey" in La Peña (near San Luis), Sierra de San Luis, Edo. Falcon (11° 07' 22"N 69° 45' 07"W); spring in the mostly dry bed of a rivulet with large boulders; muddy, much detritus; hand net; chlorinity 205 mg/l; 3-III-1982; 4 specimens. Accompanying fauna: Nematoda, Oligochaeta, Tricladida, Insecta; Ostracoda: *Strandesia venezolana*.

S 82/523, Venezuela, hole dug in fine red clayish sediment and gravel, between large boulders along the banks of Rio Hueque, where it crosses the road from Cabure to Pueblo Nuevo, Sierra de San Luis, Edo. Falcon (11° 08' 45"N 69° 31' 26"W); mountain river; chlorinity less than 1 mg/l; 4-III-1982; 1 specimen. Accompanying fauna: Nematoda, Gastropoda, Diptera.

WH 72, Curaçao, Boca di Leeuw, Hato (12° 11' 05"N 68° 56' 54"W); slowly flowing, permanent, natural, built-in spring; dimensions: 2 × 1.5 × 0.3 m; in coral-limestone and some shale, with clayish mud and brickwork; no vegetation; clear water; chlorinity 30 mg/l; sampled at 13-X-1936 and 29-VIII-1949; 1 and 3 specimens. Accompanied by *Darwinula stevensoni* (Brady & Robertson, 1870) (Ostracoda).

WH 74, Curaçao, Bron Cajoeda, Hato; spring in small basin of brickwork; permanent; overflowing; in coral-limestone and shales; chlorinity 300-1100 mg/l; sampled at 1-X-1936, 5-V-1949 and 27-VIII-1955; 7, 4 and 6 specimens. Accompanied by *Darwinula stevensoni* (Ostracoda).

WH 77, Curaçao, Bak Rincón, Hato; probably permanent pools of variable depth, yielded 3 specimens at 11-X-1936, together with *Cypridopsis* sp. and *Darwinula stevensoni*. The spring from which this water originates yielded 4 specimens at 15-X-1967. The spring is captured in an overflowing cemented cistern on coral-limestone and shale; water depth 1 m; clear water; chlorinity 150 mg/l.

WH 788, Barbados, Ronald Tree's pool, N. of Bellair's Holetown; cemented basin in garden; dimensions: 5 × 4 × 1 m; crowded with water lilies, *Chara*, *Nelumbo* and algae; chlorinity 640 mg/l; 21-II-1964; 25 specimens. Accompanying Ostracoda: *Potamocypris* sp., *Cypridopsis* aff. *vidua*, *Stenocypris major* (Baird, 1859).

WH 851, Martinique, Rivière Oman, 2 km N. of Anse des Trois Rivières; large pool in almost stagnant rivulet; pasture-like area; very muddy; turbid; chlorinity 2130 mg/l; 12-VII-1967; 1 specimen. Accompanying fauna: Decapoda, Heteroptera; Ostracoda: *Heterocypris punctata* Keyser, 1975 and *Cypridopsis* sp.

WH 740A, La Désirade, muddy pool about 30 m from Source de Cybèle; dimensions: 1 × 1 × 0.2 m; chlorinity 225 mg/l; 24-I-1964; 6 specimens. Accompanying Ostracoda: *Cypridopsis* sp.

S 78/43, Antigua, large covered basin with small opening in Parish of St. Paul, S. of Falmouth (17° 05' 06"N 61° 44' 14"W); windpump ruined; Cvetkov net; chlorinity 1400 mg/l; 13-IV-1978; 9 specimens. Accompanying fauna: Cyclopidae, Phyllopora, *Pyrgophorus* (Gastropoda); Ostracoda: *Physocypris affinis* Klie, 1933.

S 78/44, Antigua, John Hughes well, S. of road (= Mill Hill), Parish of St. Mary (17° 02' 37"N 61° 49' 09"W); round, diam. 2 m; largely covered; clean water; chlorinity 920 mg/l; 13-IV-1978; 1 specimen. Accompanying fauna: Cyclopidae, *Pyrgophorus*; Ostracoda: *Physocypris affinis*, *Strandesia sphaeroidea* Broodbakker, 1983c.

WH 546, Dog Island, well near N. coast; stagnant, probably permanent; excavated 0.5 m below surface; dimensions: 2 × 2 × ?1 m; in limestone; some mud; clear water; chlorinity 1410 mg/l; 17-VI-1949; 1 specimen. Accompanying Ostracoda: *Darwinula stevensoni*.

S 78/107, Anegada, Smith's well in the Settlement (18° 43' 16"N 69° 19' 03"W); chlorinity 1160 mg/l; only a valve.

S 78/172, Vieques, open well behind a house in Monte Santo (18° 07' 34"N 65° 26' 55"W); water table at 0 m, water depth 0.3 m; 1-V-1978; 1 specimen. Accompanying fauna: Oligochaeta, Cyclopidae; Ostracoda: *Cyprretta* sp.

Samples taken in Haiti: S 78/212, Dépt. du Sud-Est, covered well in Cayes-Jacmel, backyard of house (18° 13' 54"N 72° 23' 49"W); diam. 1 m; water table at 7 m, water depth 1 m; Cvetkov net; chlorinity 40 mg/l; 5-V-1978; 2 specimens. Accompanying fauna: Oligochaeta, Cyclopidae, Culicidae, Gastropoda.

S 79/529, Dépt. de l'Ouest, hole dug in gravel and moving sand along the banks of the fast running brook Balisaille, there where it cuts the road Santhier - Croix des Bouquets (18° 32' 40"N 72° 05' 37"W); chlorinity 36

mg/l; 9-XI-1979; 2 specimens. Accompanying fauna: Oligochaeta, Polychaeta, Insecta; Ostracoda: *Strandesia stocki* Broodbakker, 1983c.

S 79/630, Dépt. de l'Artibonite, Source "Tête Nègre", close to the road from Mirebalais to Lascahobas (18° 49' 40"N 72° 05' 06"W); four very small limnocyrenes, almost stagnant, no exit; chlorinity 23 mg/l; 28-XI-1979; 1 specimen. Accompanying fauna: Cyclopidae, Insecta, Gastropoda; Ostracoda: *Stenocypris major*, *Strandesia stocki*, *Cyprretta* sp.

S 79/638, Dépt. de Grande Anse, well of the corn-mill, in the centre of Jérémie, about 120 m from the littoral (18° 39' 27"N 74° 08' 44"W); narrow; masonry inside; covered; water table at 0.1 m, water depth 1.8 m; chlorinity 250 mg/l; 1-XII-1979; 1 specimen. Accompanying fauna: Oligochaeta, Cyclopidae, Diptera; Ostracoda: *Cyprretta* sp.

S 79/639, Dépt. de Grande Anse, Berquer well at Jérémie, Paul Emile Jean-Michel street, about 100 m from the sea (18° 38' 32"N 74° 07' 05"W); masonry inside; open; clean; water table at 4 m, water depth 0.8 m; chlorinity 130 mg/l; 1-XII-1979; 1 specimen. Accompanying fauna: Oligochaeta, Cyclopidae, hadziid Amphipoda, Insecta, Gastropoda; Ostracoda: *Cyprretta* sp.

S 79/657 Dépt. de Grande Anse, spring at Beaucalin, on the road along the river La Grande Anse (18° 35' 36"N 74° 11' 57"W); slight water supply; dug in sand and calcareous gravel; chlorinity 16 mg/l; 5-XII-1979; 3 specimens. Accompanying fauna: Oligochaeta, Isopoda, Diptera, Pisces.

Samples from Cuba: B 69/1, Cueva Majaes, 20 km S.E. of Santiago de Cuba, Prov. Granma (named Prov. de Oriente until 1975), small cave pools; depth 0.1 to 0.3 m; much guano; 23-III-1969; 6 specimens, accompanied by carapaces of Darwinulidae. Coll. L. Botosaneanu.

Carapaces of the species were found in: B 69/18, Cueva del Fustete, S. side of the Gulf of Guacanayabo, Prov. Granma; B 69/26, Cueva del Aqua and B 69/32, Cueva del Indio, both in the Sierra de Cubitas, Prov. Camagüey; B 69/45, Cueva de Pio Domingo, in the Sierra de Los Organos, Prov. Pinar del Rio; and B 69/26, Cueva de Bellamar, Matanzas, Barrio Guanábana, 1.4 km S. of the Gulf of Matanzas, large cave with more than 3 km of galleries, many cave pools, very small and up to 3-4 m length. Prof. Dr. Cl. Delamare Deboutteville found on 12-III-1973, 13 specimens of the species, and some Darwinulidae, in this cave.

More information about the Cuban caves is provided in Botosaneanu (1970).

Geographical distribution known. — Jamaica, Cuba, Haiti, Vieques, Anegada, Antigua, Dog Island, La Désirade, Martinique, Barbados, Curaçao, Venezuela.

Description

It is postulated that the species is parthenogenetic in most of its populations, since only one male was found in only one of the many samples containing this species.

Carapace (figs. 4A, 5A-C):

The carapace is smooth and whitish transparent. Hinge adont. Muscle scars as typical of Candoninae. In dorsal view greatest width at 50% of the length, being about one-third of the length. Left valve larger than and overlapping the right valve. In lateral view greatest height behind the middle at 30% of the length, being 45% of the length. In the female the dorsal margin is straight in the medial part and progresses with an angle of 30° in the anterior margin and with an angle of 45° in the posterior margin. In the male the dorsal margin is more inclined downward anteriorly, and passes more smoothly in the posterior and anterior margins. Both anterior and posterior margins are rounded. In the female the anterior margin is more blunted and in the male the posterior margin. The ventral margin is slightly sinuate in the left, and somewhat more sinuate in the right valve. Both valves possess short simple marginal pore canals in the anterior part, and barely visible ones in the posterior part. Duplicature much larger anteriorly than posteriorly in both valves. Selvage and flange not pronounced.

In the type-locality, female carapace length ranges from 0.79 to 0.86 mm for adult females. Mean length is 0.82 ± 0.02 mm. In the male specimen from Cuba the left valve measures 0.82×0.38 mm, and the right valve 0.80×0.35 mm. In Curaçao, female carapace lengths range from 0.69 to 0.86 mm in three different localities (table I). The lengths of the few specimens from other localities, e.g. in Haiti, fit within this length range. The variation in carapace length will be discussed at the end of this section.

Antennule (A 1) (fig. 4B):

I: A-1l(pl)-1m(pl), P-2l/II: A-1m(pl)/III: A-

1l(pl)/IV: A-2l, P-1m/V: A-2l, P-1m/VI: A-2l-1m-1m(pl)/VII: D- y_a -1l(cs:1ser)-2l.

The proportional lengths of the segments III to VII are: 1: 1.2: 1.2: 1.4: 1.3.

Second antenna (A 2) (figs. 4C-D, 5G):

Pr: P-1m(pl)/Exo: 1m(pu)-2s/E I: P-Y-1m(pu)-1s/E(II + III): A-1s(pu), P- y_1 -1s(t_1 :pu)-3s(t_2 , 3, 4), D- y_2 -1s(z_1 :cs)-2s(z_2 , 3)-2l(G_1 , 3:ser)-1m(G_2 :ser)/E IV: D-2m($G_{M,m}$:ser)-1m-1s- y_3 .

In contrast to *Ps. geratsi* the female z_1 seta is transformed into a chelate seta as in *Ps. serbani*. In the male, E II and E III are separated and the t setae are transformed into "male" t setae as in *Ps. geratsi*, *Ps. serbani*, and most other Candoninae with a totally developed A2. The z setae have the typical male positions and shapes as in the species mentioned above. G_2 is smaller and more slender in the male (fig. 5G).

Mandibular palp (Mdp) & maxillula (Mxu) (figs. 4E, H):

Mdp: I: In-1l-1l(S_1 :pu)-1s(S_2 :pu)- α /II: In-4l(pu)- β , Ex-2m/III: In-2m, Ex-3m, A-1l-1m/IV: D-1m(cs:pu)-1m(cs:ser)-2s.

The chaetotaxy of the mandibular palp and the maxillula are of the same type as in *Ps. geratsi*.

Maxilla (Max) (figs. 4J, 5H-J):

The female maxillae have two 'a' setae instead of one as in *Ps. geratsi*. The shape of the male maxillar endopodites is more elongated and the two ventral spines are longer than in *Ps. geratsi*. The other characters are the same in both species.

Thoracopods 1 & 2 (T 1, T 2) (figs. 4F-G):

The chaetotaxy of T 1 and T 2 is the same in male and female, and like that of *Ps. geratsi*. Only the longer seta of T 1: E III is 1.2 times the length of E IV, while in *Ps. geratsi* it is more than twice the length of this segment.

Furca (Fu) & furcal attachment (Fuat) (figs. 4K, 5F):

G_p/G_a is 82-92%, s_p/G_p is 42-47%, s_a/G_a is 10%, $d(s_p-G_p)/R$ is 21%. G_a is about half of the

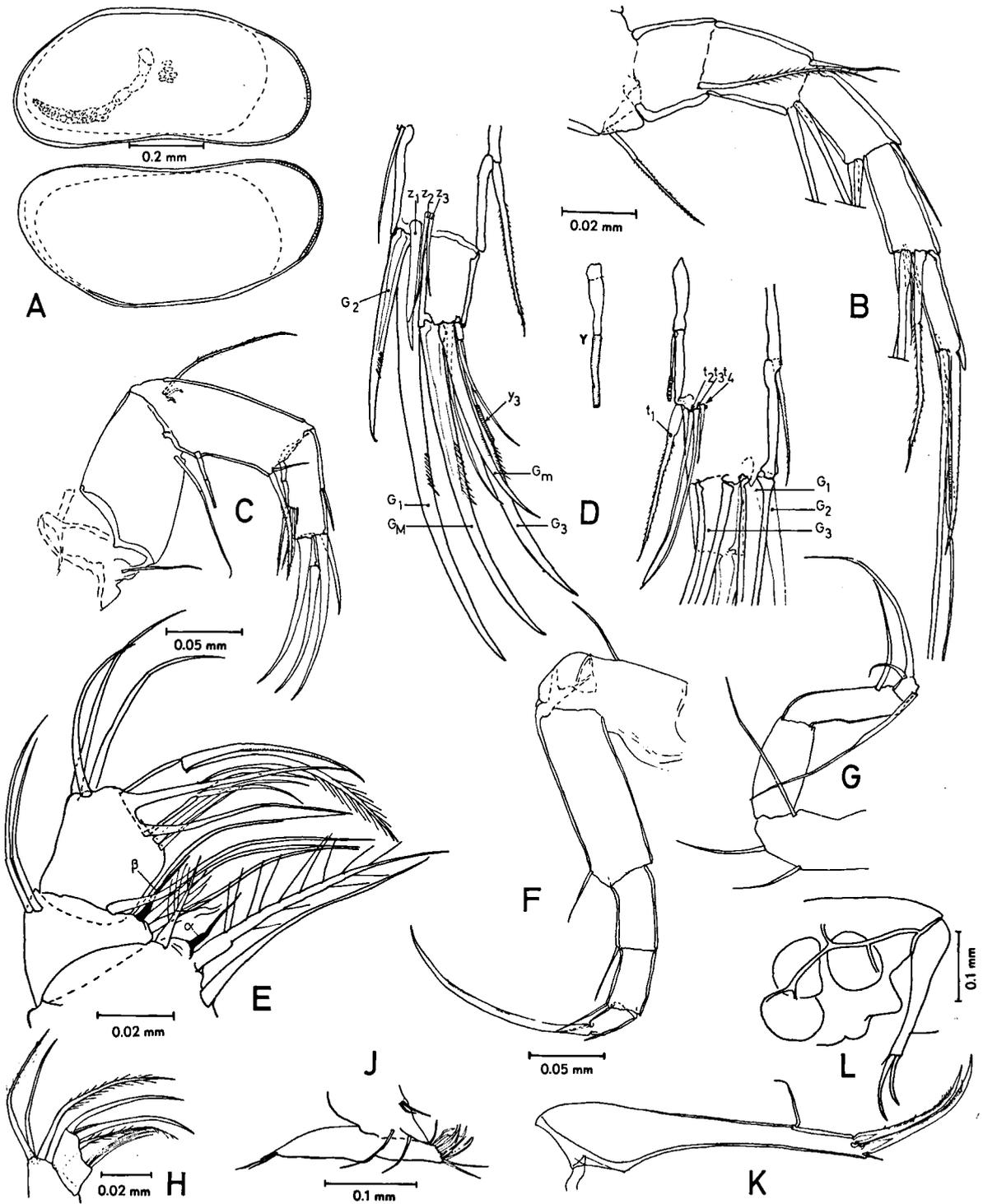


Fig. 4. *Pseudocandona antilliana* n. sp. (S 79/549, Haiti, ♀ holotype): A, right and left valve; B, antennule; C-D, second antenna, with details viewed from exterior and interior side; E, mandibular palp; F-G, first and second thoracopod; H, maxillular palp; J, maxilla; K, furca; L, posterior part of body.

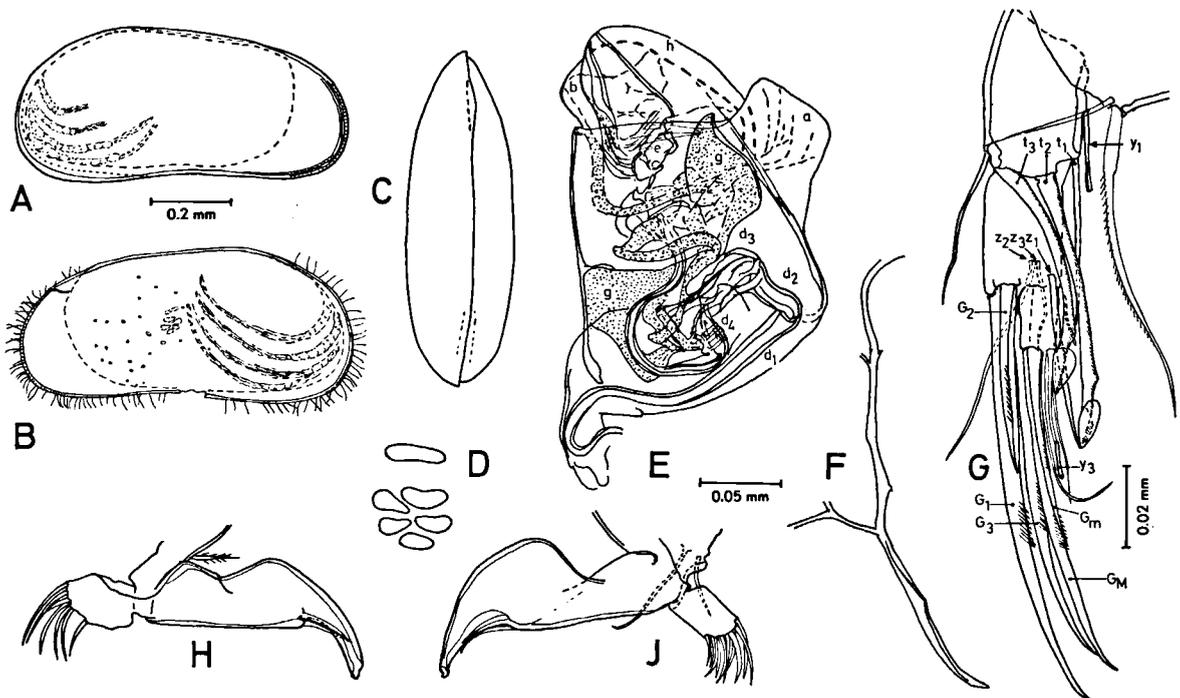


Fig. 5. *Pseudocandona antilliana* n. sp. (B 69/44, Cuba, ♂): A, carapace in lateral (A) and dorsal (C) view; B, left valve; D, muscle prints; E, hemipenis (for explanation see text); F, furcal attachment; G, distal part of second antenna; H-J, left and right maxillae.

length of the ramus, which is less than in *Ps. geratsi*. In *Ps. geratsi* the ramus is shorter and stouter. In both sexes of *Ps. antilliana* the furca is 13 times as long as wide, while in females of *Ps. geratsi* it is 7-8 times as long as wide (width measured at s_p).

The furcal attachment in females of both species is the same. The attachment of the male of *Ps. antilliana* is probably damaged.

Copulatory organs (figs. 4L, 5E):

The female copulatory organ has a triangularly shaped obtusion, while it is rounded in *Ps. geratsi*.

The Zenker's organ has seven whorls of spines. The hemipenis is of the typical *Pseudocandona* type, as in *Ps. geratsi*. Lobes 'b' and 'h' are different from those in *Ps. geratsi*, while lobe 'a' is practically the same, only somewhat broader. Part 'M' (g) is totally different from that in *Ps. geratsi*. The distal part of this lobe is wide and terminally pointed. The lower parts of 'g' are about the same as in *Ps.*

geratsi. The sclerified parts of the bursa copulatrix (e) seem to be different from those in *Ps. geratsi*, but its exact homologies are difficult to ascertain. The labyrinth is the same as in *Ps. geratsi*.

Etymology. — The species is named after the Antilles, alluding to its very wide distribution throughout these islands.

Taxonomic remarks. — The species shows very close affinities with *Ps. annae*. Eventually it could be the same species. According to the drawings of Méhes (1913) the shape of male and female carapace is somewhat different. Only with the original material at hand it can be ascertained if it is the same species. However, Méhes found males as well as females in his population from Colombia near Bogotá at an altitude of 2640 m. It is possible that the male specimen described by Furtos (1936) as *Candona annae* is a representative of *Ps. antilliana*. The similarities between her drawing of the

hemipenis and that of the specimen from Cuba is striking, especially the shape of lobes 'a', 'b', 'h', and the lower and distal parts of 'g', which are vaguely indicated in her drawing. The shape of male maxillae and furca are the same. Only the carapace of her specimen seems to be shorter and more compact, but this could be a mistake in the drawing, because the overall shape of this carapace is the same. *Ps. elliptica* Furtos, 1933, from Ohio is another species which is probably closely related with *Ps. antilliana*. The shape of the carapace is similar but more rounded, and the male maxillae are more irregularly formed in this species.

There seem to be some differences between specimens from different islands and stations, especially in size. However, none of these differences, especially in the furca and in the shape of the carapace, is significant. One specimen from Vieques (east of Puerto Rico) is really aberrant. It is much smaller than adult specimens from other populations, but yet mature and ovigerous. Because of lack of material it was impossible to check if the population on Vieques is significantly different from the other populations.

Probably there are several subspecies in the different islands. From most stations only a few specimens are available, which makes it difficult to decide if certain differences between specimens are significant or not. This holds especially true for Venezuela, where a few specimens were found in which the distance s_p - G_p in the furca is larger than in other populations. The matter is even more complicated because the species seems to be parthenogenetic in most of the cases. As in the Candoninae in Europe, it is probably practically impossible to find differences between populations which consist only of females, while in populations with males interpopulational differences can be found. Therefore it is probably better to accept all populations as being *Ps. antilliana* until more material is available.

In Haiti at S 79/518, a source in the southwestern part of the island, a male specimen of a *Pseudocandona* probably related to both species described was encountered. The

carapace of this specimen was destroyed. However, the shape and structures of furca, hemipenis and maxillae were clearly different from both other species. *Ps. antilliana* was found at about 60 km west and east of this station.

Carapace length. — Another character which could give some indication about differences between populations is the length of the carapace. In table I most samples containing *Ps. antilliana* are listed, with type of habitat and ranges of carapace length.

At Curaçao the carapace length ranges from 0.67 to 0.86 mm. Especially in the samples from station WH 74, taken at different dates, it is clear that large differences in carapace length can be found, even in the same station. The total variation on Curaçao as a whole, is the same as in station WH 74 alone. All carapace lengths measured for samples from the other islands fall within this range too.

In Cuba, where most samples were collected in cave pools, carapace lengths vary from 0.65 to 0.89 mm, a range even wider than at Curaçao. On Barbados two size classes were found within one sample, with a 0.06 mm difference in their means.

These results suggest that the variation in carapace length is not caused by genetical differences between populations, but rather by environmental factors, as found for the genera *Heterocypris* and *Hemicypris* in the Caribbean (Broodbakker, 1983a, b).

Ecology. — *Ps. antilliana* has a wide distribution, reaching from Venezuela, over most Antillean islands, to Haiti and Cuba, and probably even to Florida. The distribution suggests that *Ps. antilliana* also inhabits those Antillean islands where it has not yet been encountered. If this is true, it is strange that the species was never found on Aruba and Bonaire, islands which have been intensively sampled by both Prof. Dr. J. H. Stock and Dr. P. Wagenaar Hummelinck. It is more likely that the species sometimes reached certain islands by dispersion, and disappeared again because of un-

TABLE I

Size range of the carapaces, and type of habitat, of most of the samples containing *Pseudocandona antilliana* n. sp.

Island or country	Station code	Type of habitat	Size range (mm) (mean ± S.D.)	(n)
Venezuela	S 82/519-523	interstitial of river and spring	0.80	(3)
Curaçao	WH 72-72a-72b	permanent spring in walled-in basin	0.72 - 0.78	(8)
Curaçao	WH 74 (1936)	permanent spring in small basin	0.67 - 0.73	(7)
	WH 74a (1949)	permanent spring in small basin	0.77 - 0.86	(4)
	WH 74c (1955)	permanent spring in small basin	0.72 - 0.77	(6)
Curaçao	WH 77A-77b	permanent spring in cistern + overflow	0.77 - 0.81	(9)
Barbados	WH 788	cemented basin in garden	0.75 - 0.84	(25)
		two size classes:	0.77 ± 0.01	(15)
			0.83 ± 0.01	(10)
Martinique	WH 851	pool in rivulet	0.77	(1)
La Désirade	WH 740A	pool, 30 m from a source	0.69 - 0.70	(6)
Antigua	S 78/43	large covered basin with small opening	0.72 - 0.77	(9)
Antigua	S 78/44	round well, largely covered	0.81	(1)
Dog Island	WH 546	permanent, excavated small well	0.81	(1)
Vieques	S 78/172	open shallow well	0.66	(1)
Haiti	S 78/212	covered well	0.81	(2)
Haiti	S 79/529-630- 638-639-657	brook, spring, covered well, open well, spring	0.73 - 0.79	(3)
			0.84 - 0.86	(5)
Jamaica	S 82/105	springs in riverbank	0.69 - 0.75	(2)
Cuba	B 69/1	cave pool	0.65 - 0.73	(6)
Cuba	B 69/18	cave pool	(only carapaces)	
			0.77 - 0.89	(10)
Cuba	B 69/30-32a-45a	cave lake, cave pools	(only carapaces)	
			0.71 - 0.81	(17)
Cuba	B 69/26	cave pools ("gours")	(only carapaces)	
			0.66 - 0.76	(18)
			0.71 ± 0.03	(18)
Cuba	Delamare Deboutte- ville (1974)	cave pools ("gours")	0.67 - 0.74	(13)
			0.70 ± 0.025	(13)
Cuba	Orghidan (1970)	no data	0.75 - 0.85	(8)
			0.80 ± 0.037	(8)

favourable conditions or competition with other species of ostracods.

Ps. antilliana is encountered mostly in springs, cave pools and wells, but sometimes also at the bottom of running waters. Once it was found in a water basin in a garden, where 25 specimens have been collected, which is a high number compared with the number of specimens found in other samples. In this basin it was accompanied by three other species of ostracods. In most springs and cave pools it is accompanied

by Darwinulidae. In most other samples it is accompanied by Cypridopsinae, *Cypretta* sp., or *Strandesia* species.

The species is found at chlorinities ranging from 0 to 1410 mg/l.

Ps. antilliana occurs mostly in more permanent habitats of low chlorinity. There is no indication in the morphological characteristics that the species is adapted to subterranean habitats. The competitive abilities of the species are assumed to be low, because it is practically

always encountered in small numbers and in few samples, notwithstanding its wide geographical distribution.

Another explanation can be that *Ps. antilliana*, like *Candona decora* Furtos, 1933, has no resistant eggs but can survive only in a torpid state when the situation becomes unfavourable, and is therefore less easily transported from pool to pool by passive dispersion, in contrast to many Cypridinae species. This might explain the fact that the species is more or less confined to more permanent habitats, and is encountered in relatively low numbers. Low numbers and the absence of resistant eggs were recorded for *C. decora* by McLay (1978), based on observations in a temporary pool with four species of ostracods in Canada. McLay suggests that *Candona's* strategy of going into a torpid state when the situation becomes unfavourable is not well suited in areas with arid summers. It seems that his conclusion can be extended to explain the low number of epigeal samples in which Candoninae are present, and the low number of specimens, if present.

***Pseudocandona caribbeana* n. sp.**
(Figs. 6A-D, G, K-N, P-R, U-V)

Material. — Holotype: ZMA Ost. 150.802, one female (0.73 mm). Paratype: ZMA Ost. 150.803, one female, and some valves.

Type-locality: S 79/49, Jamaica, three holes dug in sand and gravel at the water line of the 1 m wide brook Brays River, bridge 25 of road A 3 (18°15'13"N 76°48'06"W); 25-X-1969. Accompanying fauna: Polychaeta, Gastropoda, Insecta.

Other stations: S 79/52, Jamaica, two holes dug in gravel along the banks of the Roaring River, a 1.5 m wide shallow brooklet W. of Annoto (18°14'42"N 76°49'07"W); moderate current; 26-X-1979. Accompanying fauna: Oligochaeta, Polychaeta, Cyclopidae, Gastropoda, Diptera (ZMA Ost. 150.805).

S 82/531, Venezuela, hole dug in a bank of gravel and coarse sand between large boulders in the middle of the fast running river Rio Acurigua, Acurigua, Sierra de San Luis, Edo. Falcon (11°18'54"N 69°28'48"W); water depth 0.5 m, width 5 m; chlorinity 80 mg/l; 5-III-1982; 2 specimens. Accompanying fauna: Oligochaeta, Insecta; Ostracoda: *Ps. geratsi* n. sp. (ZMA Ost. 150.804).

Description

Only females of this species are known.

Carapace (figs. 6A-D):

The carapace is reticulate by irregularly shaped pits. The colour is whitish transparent. In dorsal view greatest width at 50% of the length, being 35% of the length. Because of the straight dorsal margin, the greatest height can be found at one-third as well as at two-thirds of the length. The dorsal margin passes with an angle of 30° into the anterior, and of 40° into the posterior margin. Anterior and posterior margins are rounded. Ventral margin slightly sinuate. Duplicature anteriorly twice as wide as posteriorly. Marginal pore canals simple and straight, less inconspicuous in the left valve. Selvage and flange not pronounced. Valves moderately hairy. Muscle scars as typical of the Candoninae.

The female holotype has a carapace length of 0.73 mm. The paratype measures 0.71 × 0.36 mm. The carapace length in station S 79/52 ranges from 0.70 to 0.75 mm. The female from S 82/537, Venezuela, has a carapace length of 0.62 mm.

Antennule (A 1) (fig. 6G):

Chaetotaxy the same as in the other *Pseudocandona* species. The proportional lengths of the segments III to VII are: 1: 1.4: 1.4: 1.7: 1.5, which is nearly the same as in *Ps. geratsi*. The aesthetasc y_a is 2.2 times as long as segment VII, and the shortest seta of this segment is 2.6 times as long, which is relatively longer than in both other species.

Second antenna (A 2) (fig. 6K):

The chaetotaxy seems to be the same as in *Ps. geratsi*, but no claw-like z_1 is visible. Only two t setae are visible, but probably there are more. The aesthetasc y_3 is 48% of the length of G_M , which is about the same length as in *Ps. geratsi* (43%). The z setae are 1.5-2.5 times as long as segment E IV.

The chaetotaxy of the mandibular palp, maxillula, maxilla, and thoracopods 1 & 2 (figs. 6L-N, P-R), is identical with that in *Ps. geratsi*.

Furca (Fu) & furcal attachment (Fuat) (fig. 6U):

The general shape of the furca is the same as in females of *Ps. geratsi*. G_a/R is the same (65%), G_p/G_a is 89%, s_a/G_a is 19%, s_p/G_p is 55%, values slightly larger than or the same as in *Ps. geratsi*. The distance s_p-G_p is 22% of R, which is about the same as in females of *Ps. geratsi* (19%). The furcal attachment is the same as in *Ps. geratsi* females.

Copulatory organs (fig. 6V):

The shape of the posterior part of the female copulatory organ is rounded and the same as in *Ps. geratsi*.

Taxonomic remarks. — See after the description of the next species.

Ecology. — Only a few samples with this species were found. In Jamaica it was found in sand and gravel beds of small brooklets (1-1.5 m wide), of unknown chlorinity (but fresh). In Venezuela the species was found in coarse sand with pebbles on the bank of a small river, also fresh (chlorinity 80 mg/l), together with *Ps. geratsi*. According to the definition of Danielopol (1980b) this species is assumed to be "true interstitial" until further evidence proves the contrary.

Pseudocandona cubensis n. sp.

(Figs. 6E-F, H-J, O, S-T, W)

Material. — Holotype: 1 female. Paratypes: 1 female and 4 juveniles, 1 valve (ZMA Ost. 150.809).

Type-locality: B 73/67, Cuba, a few enormous pools in the Cueva de las Represas, which is part of Cueva del Segundo Cauce of the Gran Caverna de Santo Tomas, Prov. Pinar del Rio (22°23'N 83°57'W); depth down to 3 m; a temporary river had filled up the pools; 12-IV-1973. Accompanied by an unknown ostracod species.

Other station: B 73/37, Cuba, cave rimstone pools ("gours"), in Cueva la Campana, in the mountain Loma de Cupeyillo, 20 km W. of Gibara, Prov. Granma (21°12'N 76°29'W); fine sediment; 8-III-1973; 8 specimens (1 adult) (ZMA Ost. 150.843). Both samples collected by L. Botosaneanu.

Geographical distribution known. — Cuba.

Description

Only females of this species are known.

The chaetotaxy of all appendages is practically the same as in *Ps. caribbeana*. Only differences will be indicated.

Carapace (figs. 6E-F):

The carapace shape, reticulation, and other characters, are the same as in *Ps. caribbeana*. The two females from the type-locality are sized: 0.69 × 0.33 mm and 0.71 × 0.35 mm. The female from B 73/37 has a length of 0.58 mm.

Antennule (A 1) (fig. 6H):

The proportional lengths of the segments III to VII are: 1: 1.4: 1.3: 1.4: 1.4, which means that only segment VI is relatively shorter than in *Ps. caribbeana*. However, aesthetasc y_a and the shortest seta of segment VII are much longer, 3.9 and 3.2 times as long as segment VII, respectively.

Second antenna (A 2) (fig. 6J):

The z setae and G_2 are relatively shorter, and aesthetascs Y and y_3 are longer, y_3 is 65% of the length of G_M .

The chaetotaxy of the mandibular palp, maxillula and maxilla is the same as in *Ps. caribbeana*.

Thoracopod 1 (T 1) (fig. 6O):

Segment E I is relatively longer than in *Ps. caribbeana*, and the longer seta on segment E III is much longer, being 3.8 times the length of E IV. The proportional lengths of segments and claw are: 5.1: 2.6: 2.0 (2.2 in *Ps. caribbeana*): 1: 6.6.

Thoracopod 2 (T 2) (fig. 6S):

On the protopodite of T 2 there is only one seta instead of two at the exterior side.

Furca (Fu) (fig. 6T):

The furca is somewhat more elongate than in *Ps. caribbeana*. However, the differences are only minor. The anterior claw is somewhat longer, and the posterior seta is shorter.

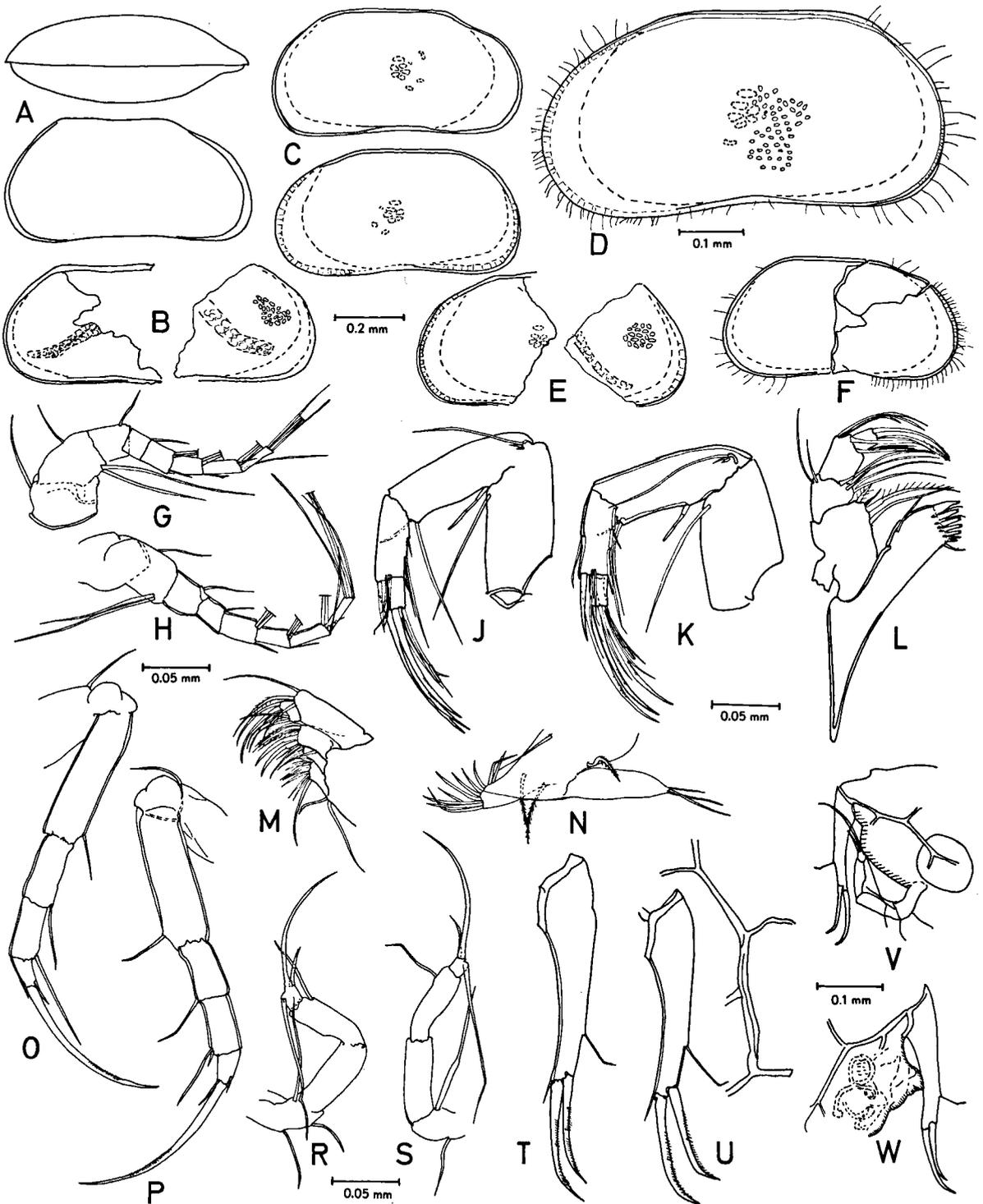


Fig. 6. A-D, G, K-N, P-R, U-V, *Pseudocandona caribbeana* n. sp. (A-C, G-V, S 79/49, Jamaica: A-B, V, ♀ no. 2; G, K-N, P-R, U, ♀ holotype; D, S 82/537, Venezuela, ♀ no. 1); E-F, H-J, O, S-T, W, *Pseudocandona cubensis* n. sp. (B 73/67, Cuba; E, O, S-T, ♀ holotype; F, H-J, W, ♀ no. 2): A, carapace in dorsal and lateral view; B, parts of right and left valve; C, empty valves; D-E, left valves; F, right valve; G-H, antennules; J-K, second antennae; L, mandible with mandibular palp; M, maxillula; N, maxilla; O-P, first thoracopod; R-S, second thoracopod; T-U, furcas with furcal attachment; V-W, posterior parts of body.

Copulatory organs (fig. 6W):

The shape of the female copulatory organ is like that of *Ps. antilliana*, with a triangular obtusion posteriorly.

Taxonomic remarks about *Ps. caribbeana* and *Ps. cubensis*. — Both species are closely related. Only one mature female of *Ps. caribbeana* was found in Venezuela, which was notably smaller than the specimens from Jamaica. The differences between this specimen and the others from Jamaica were not large enough to define a new species. More material is needed to discover eventual differences between the populations from Jamaica and Venezuela.

The carapace shape of specimens from Cuba, Jamaica and Venezuela is practically the same. The differences between the Cuban and Jamaican populations are small but consistent, especially in the shape of the female copulatory organs.

Concerning the structure of the mandibular palp, both species belong to the *rostrata* group, because there are 2 + 3 setae present at the interior side of the second segment. The shape of the carapace is the same as that in two cavernicolous species from Indiana (U.S.A.), *Ps. marengoensis* and *Ps. jeanneli*, both described by Klie (1931). Klie (1938) provided a table with relative lengths and numbers of some setae of thoracopod 2 and furca. Most of these characters seem to be very variable within the *rostrata* group, and have limited value for deciding about the subgeneric status of the species in question. Most European subterranean species belong to the *Ps. rostrata* group, many having more or less rounded, somewhat trapezoidal carapaces. However, the carapaces of the two Caribbean species have most affinities with those of the species from Indiana, having straight dorsal margins and reticulated valves. It is proposed to place these four species in a new group, the *caribbeana* group, which, like the *rostrata* group, has 2 + 3 setae at the interior side of segment II of the mandibular palp, and furthermore the following characters:

(1) Carapace trapezoidal, with rounded anterior and posterior margins, and a straight

dorsal margin of variable length. Surface reticulated by way of small round and irregularly shaped pits. Carapace length 0.62 to 0.75 mm.

(2) T 2: the short distal seta of E IV is 2 to 2.5 times the length of E IV. E II and E III are fused. Protopodite with 2 or 3 setae.

(3) Furca: stout with strong claws, which are straight at first and bent at the tips, armed with two rows of small spines. Claw G_a is about 0.6 times the length of the ramus. Seta s_p is as long as or longer than the distance s_p-G_p .

It seems that the species of the *caribbeana* group are parthenogenetic.

Ecology of *Ps. cubensis*. — Two samples containing the species were from cave pools in Cuba. Therefore the species is supposed to be hypogean according to the definition of Danielopol (1980b), until other evidence proves the contrary.

A NEW HYPOGEAN GENUS FROM HAITI AND CUBA

In some wells of Haiti a new genus of Candoninae was discovered. *Candonopsis cubensis* Danielopol, 1978, from Cuba, appeared to have strong affinities with this genus and was therefore placed in another subgenus of the new genus.

Caribecandona n. gen.

The new genus is close to the genus *Candonopsis*. In both genera the maxillar exopodite consists of three setae, the furca has no posterior seta, and thoracopod 2 possesses a seta at the second endopodal segment. The genus *Caribecandona* has the first two characters also in common with the genus *Cryptocandona* Kaufmann, 1900, and part of the genus *Mixtacandona* Klie, 1938.

The carapace shape of *Caribecandona* is trapezoidal or triangular (with trapezoidal valves), while in most *Candonopsis* it is elongated. Except for the sexual dimorphism of the second antenna, which is common in the Candoninae, the male also has a lateral pro-

TABLE II

Differential characteristics of the two subgenera of *Caribecandona* n. gen.

Characteristics of	<i>Caribecandona</i> n. subgen. type-species: <i>C. trapezoidea</i>	<i>Cubacandona</i> n. subgen. type-species: <i>C. cubensis</i>
A 1	6 segments, III and IV fused	7 segments
A 2 in male	4 endopodal segments, 2 transformed t setae	E(II + III) fused, t setae not transformed
Distal claws of A 2 and T 1	1 short row of denticles	1 short row and distal blade-like structure
T 2: Pr: Ex	2 setae	1 seta
Distal claws of furca	1 claw and 1 spine (G _p reduced to spine)	2 claws
Hemipenis: a ₁	rounded	quadrate
a ₂	acuminate	rounded

tubercle at the interior side of the fourth endopodal segment, in contrast to the other *Candoninae*. The third segment of the mandibular palp is 2.7 times the length of the fourth segment, while it is 1-1.5 times that length in *Candonopsis*. The shape of the male maxillar endopodites is also different compared with *Candonopsis*. In *Candonopsis* the proximal part is swollen and progresses smoothly in the elongated narrow distal part, which does not possess a terminal soft claw, left and right maxillae are asymmetrical. In *Caribecandona* they are more symmetrical, more elongate and narrow, and longitudinally twisted. They have a strongly developed subterminal claw accompanied by a small spine, and terminate in soft claws.

The lateral shield of the hemipenis consists of a proximal and a distal lobe, a₁ and a₂, while in *Candonopsis* there is only one lateral lobe a. The furcal claw(s) possess no hooks and are long compared with the ramus (0.75-1.0 times as long).

The genus *Caribecandona* can be divided into two subgenera:

- (1) *Caribecandona* n. subgen., with the type-species *Caribecandona trapezoidea*, which is one of the three new species described in this article. The subgenus is probably endemic to Haiti.
- (2) *Cubacandona* n. subgen., with the type-species *Candonopsis cubensis*, which is the

single presently known species of this subgenus, and probably endemic to Cuba.

A differential diagnosis of the two subgenera is given in table II.

DESCRIPTION OF THREE NEW SPECIES OF *CARIBECANDONA* S. STR., FROM HAITI

Caribecandona trapezoidea n. sp. (Figs. 7A-B, 8 A-G, 9A-E, 10A-G, 11E-F)

Material. — Holotype: 1 female (ZMA Ost. 150.794). Allotype: 1 male; paratypes: 1 male and 2 females dissected, and about 35 undissected males and females. Type-locality: S 78/203, Haiti, round covered well near a house in Gressier, N. side of road D 200, Dépt. de l'Ouest (18°32'23"N 72°31'13"W); diam. 1 m; water table at 2.5 m, water depth 0.3 m; chlorinity 40 mg/l; Cvetkov net; 5-V-1978. Accompanying fauna: Oligochaeta, Cyclopidae, Thermosbaenacea, mosquito larvae; Ostracoda: *Cypretta* sp.

Other stations: S 79/533, Haiti, Groureau well, at Groureau, hamlet of Cazeau, Croix des Missions, Dépt. de l'Ouest (near the road on a private property) (18°34'53"N 72°16'16"W); rich in sediment; water table at 3 m, water depth 1.75 m; 10-XI-1979; 38 specimens. Accompanying fauna: Cyclopidae, Harpacticoida, Thermosbaenacea, hadziid amphipods, Insecta; Ostracoda: *Chlamydotheca unispinosa* (Baird, 1862).

In the following six stations in Haiti, only one or two specimens were found, all were collected with a Cvetkov net:

S 78/205-206, two open wells close to the road from Gressier to Léogâne, near rum distillery, Dépt de l'Ouest (18°32'27"N 72°33'50"W); diam. 0.7 m; water table at 5

m, depth 1-1.5 m; dug in stone and black soil; chlorinity 40 mg/l; 5-V-1978. Accompanying fauna: Cyclopidae, mosquito larvae; Ostracoda: *Strandesia longula*, *S. stocki*, *Chlamydotheca unispinosa*.

S 79/536, open well of Thérèse Célamy, Groureau, Cazeau, Croix des Missions, Dépt. de l'Ouest (18°35'03"N 72°16'23"W); dug in accretion of land; water table at 3 m, water depth 2.8 m; chlorinity 18 mg/l; 10-XI-1979. Accompanying fauna: Cyclopidae, Thermosbaenacea, hadziid Amphipoda, Diptera; Ostracoda: *Strandesia stocki*, *Chlamydotheca unispinosa*, *Stenocypris major*.

S 79/560, open well of Jacques Simein, at Marigot, E. of the village, Dépt. du Sud-Est (18°13'51"N 72°18'52"W); masonry until the bottom; clean, water table at 4 m, water depth 1 m; chlorinity 31 mg/l; 16-XI-1979. Accompanying fauna: Cyclopidae, *Anopsilana acanthura* (Notenboom, 1981) (cirolanid Isopoda), hadziid Amphipoda, *Typhlatya* (Decapoda); Ostracoda: *Strandesia longula*, *S. stocki*, *Chlamydotheca unispinosa*, *Cypretta* sp.

S 79/591, well Frank Mezidor, at the end of St. Marc on the new road to Port au Prince, Dépt. de l'Artibonite (19°05'29"N 72°42'04"W); covered; muddy; dug in sand; water table at 7.3 m, water depth 1.7 m; chlorinity 45 mg/l; 22-XI-1979. Accompanying fauna: Oligochaeta, Cyclopidae, Diptera; Ostracoda: *Strandesia stocki*.

S 79/597, well "Portail Guêpe", at Saint Marc, on the road to Gonaïves, about 100 m from the sea, Dépt. de l'Artibonite (19°07'23"N 72°41'44"W); dug in limestone; water table at 2.5 m, water depth 0.5 m; chlorinity 230 mg/l; 22-XI-1979. Accompanying fauna: Cyclopidae, Cladocera, Insecta; Ostracoda: *Strandesia stocki*, *Cypretta* sp.

S 79/606, well of Irène Nelson, at Verrettes on the large road along the Rivière de l'Artibonite, Dépt. de l'Artibonite (19°05'46"N 72°29'45"W); dug in sand; partly walled-in; water clear; partly covered; water table at 1.8 m, water depth 2 m; chlorinity 190 mg/l; 23-XI-1979. Accompanying fauna: Cyclopidae, fragment of hadziid amphipod; Ostracoda: *Stenocypris major*.

Description

Carapace (figs. 7A-B, 8A-F):

The carapace is whitish transparent. The surface is covered by large elongate polygonal markings, composed of small granulations, moderately hairy, with longer hairs posteriorly than anteriorly. Muscle scars as typical of the Candoninae.

In dorsal view greatest width at 50% of the length, being 40% of the length. Greatest height can be from about one-third to two-thirds of the length, because of variation in the shape and breadth of the dorsal ridge. Left valve larger than and overlapping the right

valve at all sides. Height 55-60% of length. Dorsal margin straight and narrow in the right valve. In the left valve the dorsal ridge is wider, with a more or less straight inner margin and a rounded outer margin.

The dorsal margin passes with an angle of 30° and a slight indentation in the right valve, in the broadly rounded anterior margin. The dorsal margin passes with an angle of 45° in the posterior margin, which is at first straight, but at the end rounded, when passing into the ventral margin. Ventral margin more or less straight.

Duplicature twice as wide anteriorly as posteriorly. Marginal pore canals distinct anteriorly as well as posteriorly, anteriorly wider and more pronounced, straight and simple. There are only minor differences between males and females.

Carapace length ranges from 0.64-0.70 mm for males and females in the type-locality, with a mean carapace length for adult specimens of: 0.67 ± 0.02 mm (n females = 11, n males = 10). In sample S 79/533 there was a larger range in carapace length, with three size classes: 0.48 to 0.51 mm (n = 6); 0.58 to 0.67 mm (n = 12); and 0.71 to 0.73 mm (n = 5), of which the cause is unknown.

The few animals found in other samples varied from 0.67 to 0.77 mm in length. Some variation in carapace shape is shown in figs. 8A-G. This variation is also found within samples.

Antennule (A 1) (fig. 9B):

I: A-2*m*, P-2*l*/II: A-1*m*/(III + IV): A-2*l*, P-1*s*/V: A-2*l*, P-1*s*/VI: A-2*l*, P-1*l*-1*m*/VII: D-1*l*(*y*_a)-1*m*-2*l*.

Segments III and IV are fused and the former segment III does not carry an anterior seta anymore. The proportional lengths of the segments (III + IV) to VII are: 2.7: 1.2: 1.3: 1. The aesthetasc *y*_a is very long, being twice the length of segment (III + IV).

Second antenna (A 2) (figs. 9A, C):

Pr: P-1*m*/Exo: 2*s*-1*m*/E I: P-Y-1*l*-1*s*/.....

♀: E (II + III): A-1*s*, P-*y*₁-3*m*(*t*₁, ₂, ₃)-1*s*(*t*₄),

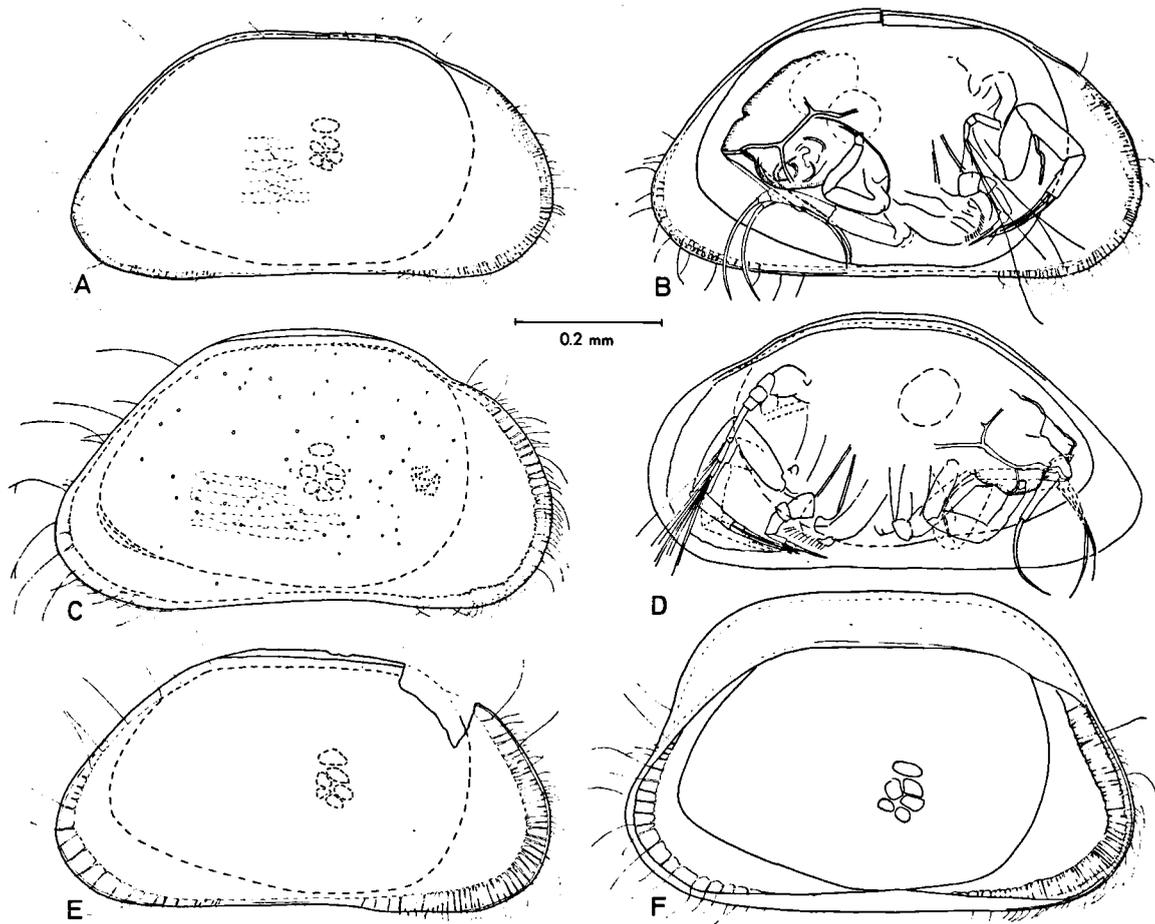


Fig. 7. A-B, *Caribecandona trapezoidea* n. gen., n. sp. (S 78/203, Haiti, ♀ holotype); C-D, *Caribecandona auricularia* n. sp. (S 79/578, Haiti, ♀ holotype); E-F, *Caribecandona ansa* n. sp. (S 79/601, Haiti, ♀ holotype): A, C-E, right valves; B, F, left valves; B, left valve with undissected animal; D, right valve with undissected animal.

D- y_2 -3s(z_1 , 2, 3)-3l(G_1 , 2, 3:ser)/E IV: D-2m- y_3 -1m(G_m)-1l(G_M :ser).

♂: E II: A-1s, P- y_1 -1m(t_1), Ex-2l(t_2 , 3)-1s(t_4)/E III: D(Ex)- y_2 -1s(z_1 :cs)-1s(G_2 :cs)-1l(G_3 :ser), D(In)-2s(z_2 , 3)-1l(G_1 :ser)/E IV: D-1l(G_M :ser)-1s(G_m :cs)-2m- y_3 .

In the female, claw G_2 is normally developed, while in the male it is reduced to a claw-like seta. The chaetotaxy of the male is as typical of most Candoninae with male t setae and transformed z setae; seta z_3 is tiny, and G_m is also much reduced. Segment IV has a protuberance at the anterior side which is typical of the genus. The structure of the distal part of the second antenna (especially z and G setae) is the

same as in *C. cubensis*. However, the armature of the distal claws is different.

Aesthetasc Y is strongly developed, as in *C. cubensis* and *Candonopsis putealis* Klie, 1932. This strongly indicates a subterranean mode of life. Aesthetasc y_3 is 60% of the length of G_M .

Mandibular palp (Mdp) (fig. 9D):

I: In-1m(pu)-1m(S_1 :pu)-1s(S_2 :pa)- α /II: Ex-2s, In-1m(pu)-1s(β :pu)-3l(pu)/III: Ex-1l-1m-1s, In-1m-2s, A-1m-1s/IV [fused with 1m(cs:ser)]: Ex-1m, In-1m-1s.

The structure of the mandibular palp is the same as in *C. cubensis*. The fourth segment is

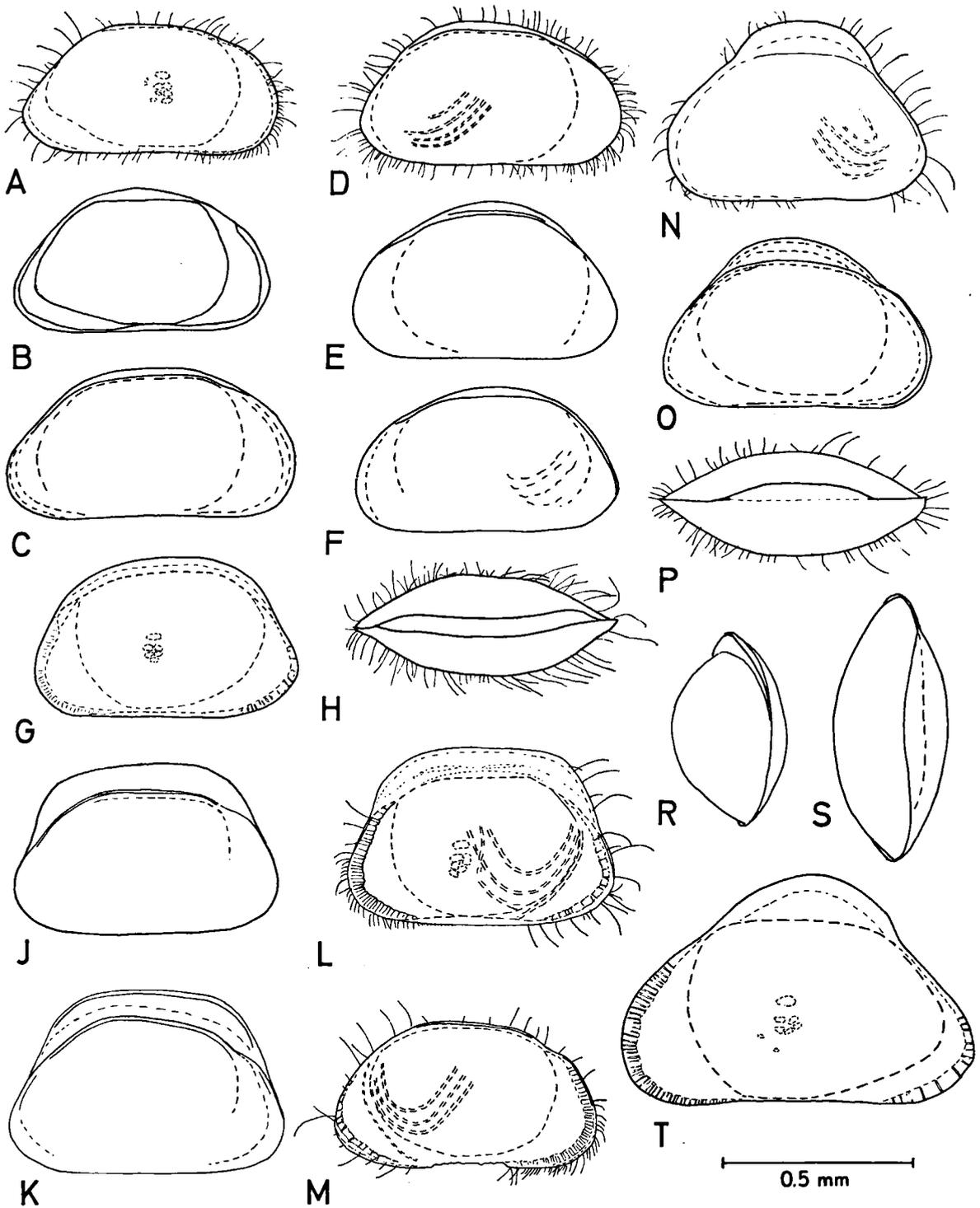


Fig. 8. A-F, *Caribecandona trapezoidea* n. gen., n. sp. (A-B, D-G, S 78/203, Haiti: A-B, ♀ no. 3; D, F, undissected ♂♂; C, S 79/606, Haiti, ♀); G-M, *Caribecandona ansa* n. sp. (S 79/601, Haiti: G, ♂ paratype; H-J, ♀ holotype; K, ♂ allotype; L-M, ♂ no. 2); N-S, *Caribecandona auricularia* n. sp. (S 79/578, Haiti: N, ♂ allotype; O-S, ♂ no. 2); T, *Caribecandona* sp. (S 79/527, Haiti, empty valve): A, M, right valves; B, L, T, left valves; C, H-J, undissected ♀ paratypes; D-G, K, N-S, undissected ♂ paratypes; H, P, carapaces in dorsal view; R, carapace in posterior view; S, carapace in ventral view; T, left valve.

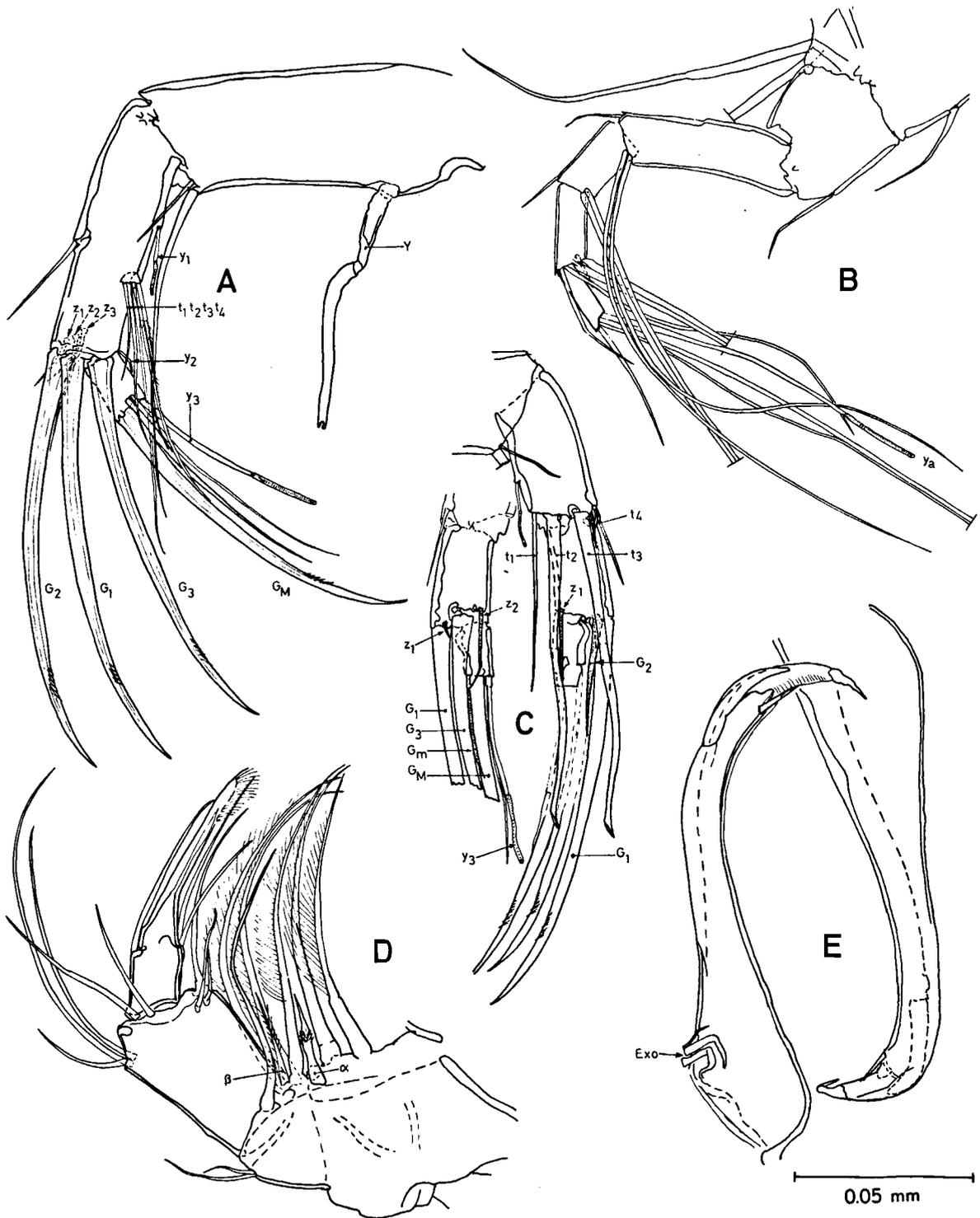


Fig. 9. *Caribecandona trapezoidea* n. gen., n. sp. (S 78/203, Haiti: A-B, ♀ holotype; C, E, ♂ allotype; D, ♀ no. 3): A, second antenna; B, antennule; C, distal part of second antenna, from interior and exterior side; D, mandibular palp; E, maxillar endopodites.

fused with the terminal claw. Segment III is 2.5 times the length of segment IV.

Maxillula (Mxu) (fig. 10A):

Mxup I: Ex-3*l*-1*m*/II: D-2*l*(cs)-2*m*-2*s*/Mastic I: D-12*m*/II: D-8*m*(?)/III: In-1*m*(pu), D-4*m*-1*s*(pu)-2*m*(cs).

The claw-like setae of mastic 3 are smooth.

Maxilla (Max) (fig. 9E):

♀: Pr: A-1*s*(a), In-1*m*(b:pu)-1*s*/Mastic: D-12*s*/Exo: 2*s*(pu)-1*s*/E: D-3*s*.

The chaetotaxy of both male and female maxillae is as in other Candoninae, they possess one 'a' seta and three exopodal setae. The male maxillar endopodites have changed in elongated, distorted claws. An exact description is given in the diagnosis of the genus. Because of the torsion, the proximal part of the endopodite seems to be wide at one side and narrow at the other. It seems to be hollow when viewed from the dorsal interior side. The position of the subterminal exterior claw is also difficult to see because of the torsion. In figs. 10 O-P, the distal part of the maxilla of *Caribecandona auricularia* n. sp. is shown from different angles.

Thoracopod 1 (T 1) (fig. 10B):

Pr: A-1*m*/E I: A-1*s*/E II: A-1*s*/E III: A-2*s*/E IV: D-2*s*-1*l*(G:ser).

The proportional lengths of the segments I to IV and claw are: 6.3: 3.5: 2.7: 1: 10.2.

Thoracopod 2 (T 2) (figs. 10C-D):

Pr: Ex-1*l*-1*m*, In-1*l*/E I: P-1*m*/E II: P-1*s*/E III: P-1*s*/E IV: D-1*s*(pu)-1*m*(pu)-1*l*(pu).

The proportional lengths of E I to IV are: 5.5: 2.7: 2.5: 1.

Furca (Fu) & furcal attachment (fuat) (figs. 10E-G):

The furca consists of a ramus and one serrate anterior claw. The posterior claw is reduced to a short spine-like seta, which is only slightly longer than seta s_a . There is no seta s_p present, as in the genus *Candonopsis*. $G_a/R = 1.0$; $G_p/G_a = 0.1$ and $s_a/G_a = 0.06$.

The furcal attachment is simple in the male, with only one side branch. In the female there are three side branches, as in the other Candoninae described in this paper. The first side branch is bifurcate.

Copulatory organs (figs. 7B, 11B, E-F):

The female copulatory organ is rounded posteriorly. There are no other special characters.

The hemipenis of the male consists of three lobes, a flat distal, lateral lobe, 'a₁', with a rounded tip; a proximal pointed, flat lateral lobe, 'a₂'; and the medial lobe 'b', which is more or less quadrangular, with a protruding distal part. The labyrinth is as in *Candonopsis*, which means that part 'd₄' is missing. The bursa copulatrix is surrounded by some strongly sclerified parts, especially one elongated pointed process (f), which is connected proximally by other structures with a twisted more or less S-shaped, elongate structure (g), which might be homologous with part 'M' in the other Candoninae. The distal part of the copulatory tube is crumpled up and covered by a transparent granulated membranous structure, which can be seen best when the hemipenis is in erection, with the copulatory tube (ct) extending (fig. 11F).

The Zenker's organ contains seven whorls of spines. There seem to be four testicular lobes at the inner side of the valves.

***Caribecandona auricularia* n. sp.**

(Figs. 7C-D, 8N-S, 10L-P, 11D, G-J)

Material. — Holotype: 1 female (ZMA Ost. 150.797). Allotype & paratype: 2 dissected males (ZMA Ost. 150.798).

Type-locality: S 79/578, Haiti, well of Mrs. Tissé-Coriolan, at Dumonet, between Caiman and Debas, about 200 m of the "Trou Caiman", a large karst spring, Dépt. de l'Ouest (18°38'58"N 72°06'58"W); well dug in sandy bottom; water table at 5.1 m, water depth 0.9 m; chlorinity 420 mg/l; Cvetkov net; 21-XI-1979. Accompanying fauna: Cyclopidae, Phyllopora, *Anopsilana* sp. (Isopoda), hadziid Amphipoda, *Pyrgophorus* (Gastropoda); Ostracoda: *Chlamydotheca unispinosa*, *Physocypria* sp.

The species was not found in any other sample. In one sample a carapace and a valve were found of a species

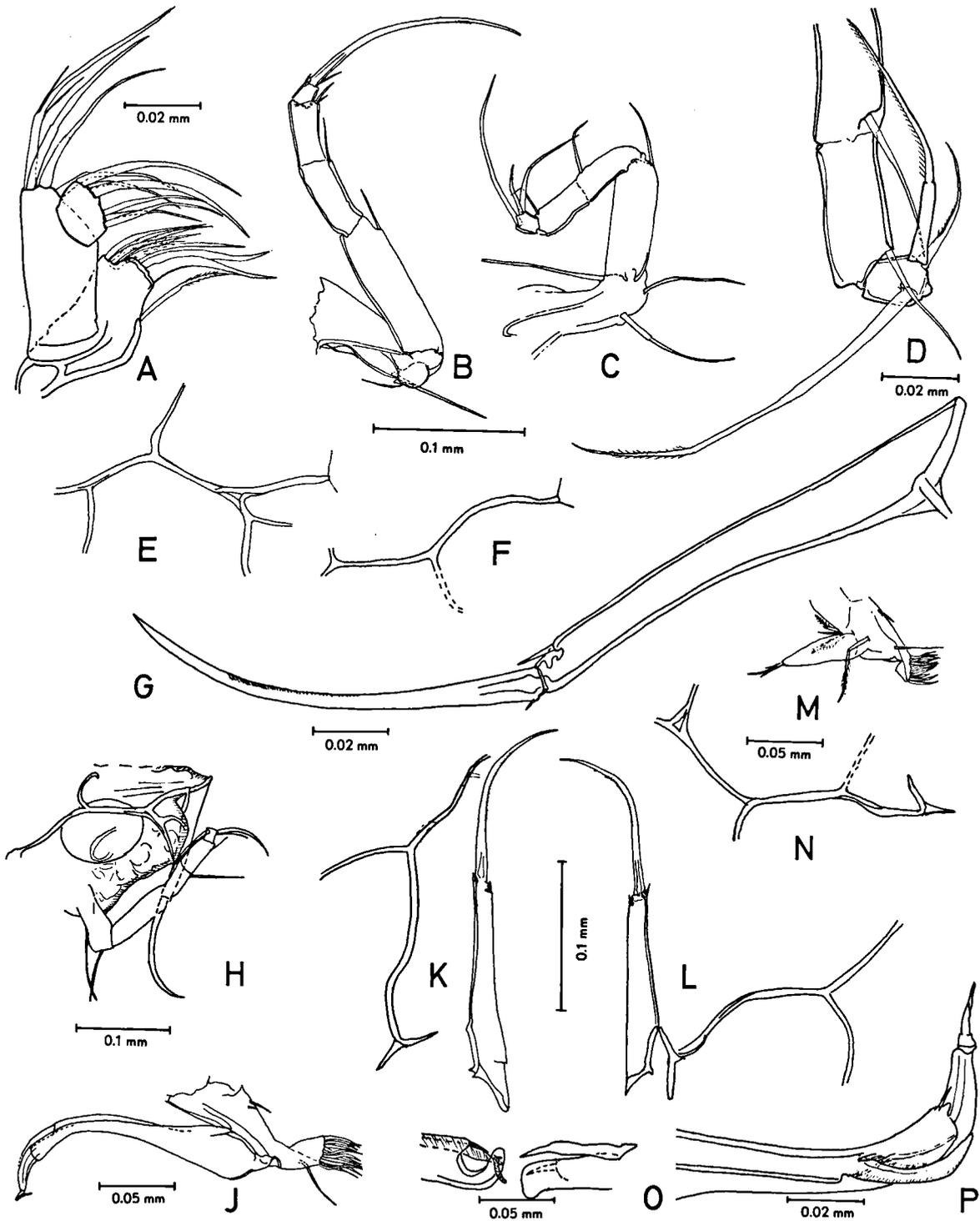


Fig. 10. A-G, *Caribecandona trapezoidea* n. gen., n. sp. (S 78/203, Haiti: A-B, D-E, G, ♀ holotype; C, F, ♂ allotype); H-K, *Caribecandona ansa* n. sp. (S 79/601, Haiti: H, ♀ holotype; J-K, ♂ allotype); L-O, *Caribecandona auricularia* n. sp. (S 79/578, Haiti: L, P, ♂ allotype; M-N, ♀ holotype; O, ♂ no. 2): A, maxillula; B, first thoracopod; C-D, second thoracopod with detail of distal part; E-F, furcal attachments; G, furca; H, posterior part of body; J, M, O-P, maxillae, and details of distal parts of endopodites; K-L, furcas with furcal attachments; N, furcal attachment.

which looks like *C. auricularia*, but which is much larger (fig. 8T). It is therefore referred to as *Caribecandona* sp. This carapace and valve have been found in S 79/527, the interstitial of the border of "Étang Saumâtre", only 25 km from S 79/578, in the same hydrogeographic region.

Description

Carapace (figs. 7C-D, 8N-S):

Most characteristics of the carapace are the same as in *C. trapezoidea*, especially the shape and structure of the right valve. The surface reticulation of the valves is also the same, as are the structure of the duplicature and the pore canals. However, the left valve possesses a rounded dorsal protuberance, or comb. The size of this protuberance seems to be variable, because it is different in the two males encountered (figs. 8N-O). Since only two males and one female, of which the left valve is destroyed, were found, this variation can only be established qualitatively.

The right valve of the female holotype measures 0.68×0.37 mm. The left valves of the males measure 0.68×0.47 and 0.71×0.44 mm, and the right valves 0.66×0.38 and 0.68×0.37 mm, respectively. The carapace of the *Caribecandona* sp. which was found in sample S 79/527 measures 0.93×0.60 mm for the left, and 0.91×0.47 mm for the right valve, thus much larger (fig. 8T).

Appendages (figs. 10L-P):

The structure and chaetotaxy of all appendages, except for the hemipenis, are the same as in *C. trapezoidea*.

Hemipenis (figs. 11D, G-H):

The anterodistal part of the medial lobe (b) is less pointed and pronounced than in *C. trapezoidea*. The lateral lobe a_2 is totally different from the corresponding part in *C. trapezoidea*. It is less independent from the other lobe a_1 , shorter, less protruding and more blunted. The structure of the inner parts of the hemipenis, and of lobe a_1 is the same as in *C. trapezoidea*.

Etymology. — *Auricularia* means "like an ear", alluding to the "ear"-like process at the dorsal margin of the carapace.

Caribecandona ansa n. sp.

(Figs. 7E-F, 8H-M, 10H-K, 11A, C)

Material. — Holotype: 1 female (ZMA Ost. 150.800). Allotype & paratypes: 2 dissected males, 1 aberrant male, 19 undissected males and females (ZMA Ost. 150.801).

Type-locality: S 79/601, Haiti, well of Gaby Gabriel, at Dessalines (Street Jacques Ier), Dépt. de l'Artibonite ($19^{\circ}15'36''N$ $72^{\circ}31'01''W$); well dug in sediments of sand and gravel, not covered, walled-in to certain height; water table at 8 m, water depth 3 m; Cvetkov net; chlorinity 140 mg/l; 23-XI-1979. Accompanying fauna: Hirudinea, Cyclopidae, Thermosbaenacea, hadziid Amphipoda, Hydracarina, Insecta, Lamellibranchia. No other Ostracoda.

This species was only encountered in the type-locality.

Description

Carapace (figs. 7E-F, 8G-M):

Most characteristics of the carapace are just as in both other species. Here too, as in *C. auricularia*, the only real difference is the presence of a dorsal protuberance, or comb, at the dorsal margin of the left valve, which runs from the anterior to the posterior border. The upper margin of this comb is practically straight. As in *C. auricularia*, the size of this protuberance seems to be variable which can be seen from the variation in the height of the carapace, compared with the length. One male specimen was found in which the dorsal protuberance was practically absent. Only a broad dorsal ridge remains in this specimen (fig. 8G). However, the structure of the hemipenis was the same as in normal specimens of *C. ansa*.

The dimensions of the left and right valves of the female holotype are: 0.69×0.44 and 0.67×0.35 mm, respectively, and of the male allotype 0.71×0.48 and 0.69×0.41 mm, respectively. It was impossible to ascertain the sex of the remaining specimens without dissection. However, there seems to be no difference in size between males and females. The mean length of the specimens is 0.67 ± 0.02 mm ($n = 19$), and the mean height 0.43 ± 0.02 mm ($n = 18$). Perhaps males are somewhat larger, because the four specimens recognized as males ranged from 0.69-0.71 mm in length. In the right valve of the male, the highest part seems to be posterior of the middle at two-thirds of the

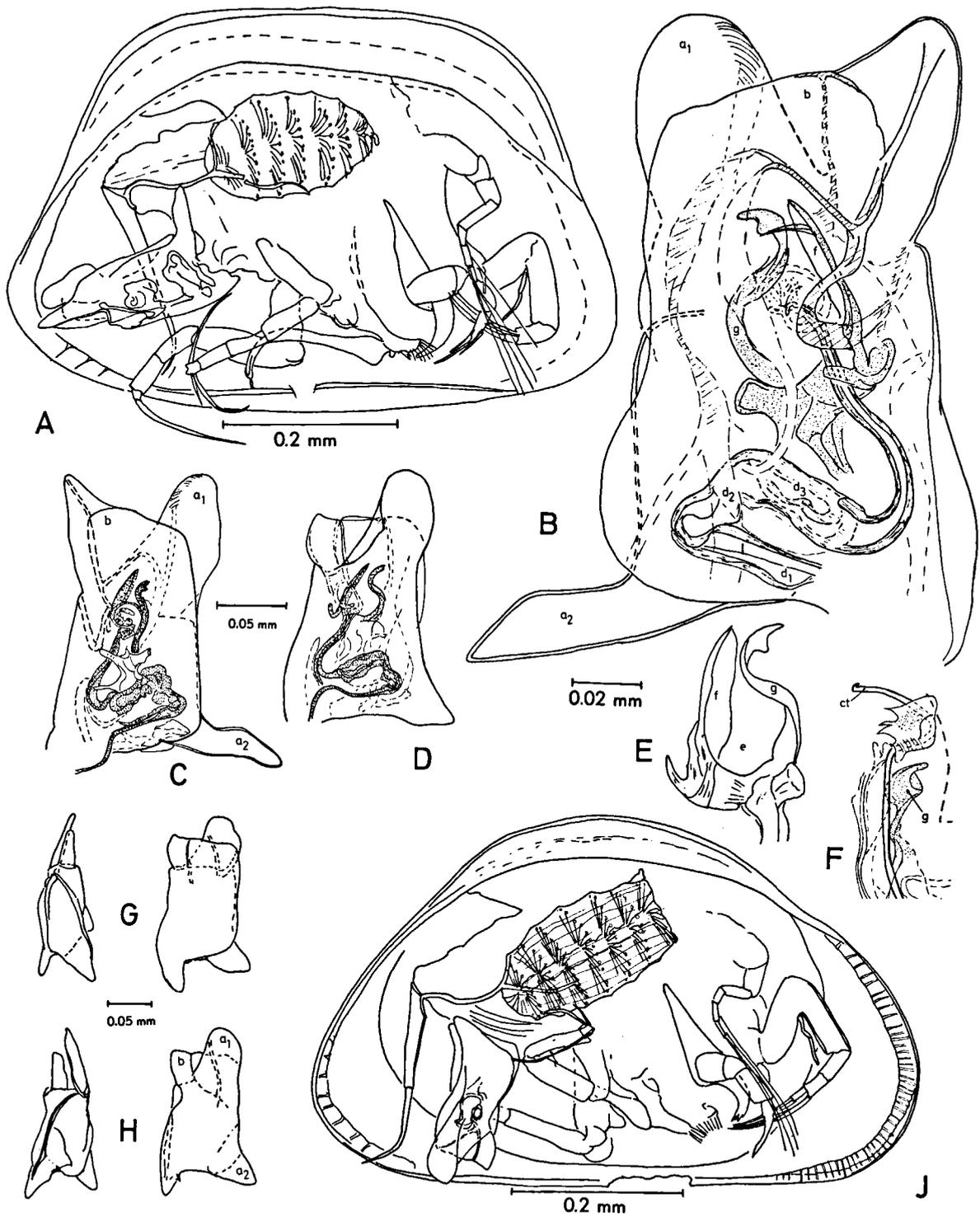


Fig. 11. A, C, *Caribecandona ansa* n. sp. (S 79/601, Haiti, ♂ allotype); B, E-F, *Caribecandona trapezoidea* n. gen., n. sp. (S 78/203, Haiti, ♂ allotype); D, G-J, *Caribecandona auricularia* n. sp. (S 79/578, Haiti: D, ♂ allotype; G-J, ♂ no. 2): A, J, left valve with undissected animal; B, D, right hemipenis; C, left hemipenis; E, detail of sclerified parts of bursa copulatrix; F, copulatory tube and part of bursa copulatrix in partial erection; G, left hemipenis in dorsal and laterointerior view; H, right hemipenis in ventral and lateroexterior view. (For explanation see text.)

length, while in the female the dorsal margin is more or less parallel with the ventral margin.

Appendages (figs. 10H-K):

The structure and chaetotaxy of all appendages, except for the hemipenis, are the same as in both other species.

Hemipenis (fig. 11C):

The anterodistal part of the medial lobe b is more pointed, and lobe a₂ is more elongated than in *C. trapezoidea*. The other internal parts, and lobe a₁, are similar to those of the other two species. The overall structure of the hemipenis shows more resemblance to that of *C. trapezoidea*, than to that of *C. auricularia*.

Etymology. — From the Latin *ansa*, meaning handle, alluding to the dorsal protuberance of the carapace, which has the appearance of a handle.

COMPARATIVE REMARKS ABOUT THE *CARIBECANDONA* SPECIES

The fact that most of the internal characteristics of the three species are the same, indicates that they are very closely related. The only structural differences are the shape of the dorsal protuberance of the left valve, which is practically absent in *C. trapezoidea*, rounded in *C. auricularia*, and more elongated with a straight upper margin in *C. ansa*; and the shape of lobes b and a₂ in the hemipenis. The shape and size of the dorsal margin or protuberance seems to be very variable within the three species. Considering the characteristics of the hemipenis, *C. trapezoidea* and *C. ansa* have more affinities with each other than with *C. auricularia*.

Ecology and distribution of *Caribecandona*

Only two samples containing many specimens of *C. trapezoidea* were found. In the other samples, the species is represented only by one or two specimens. The species has always been found in wells, covered as well as open, dug out mostly in a sandy or sedimental bottom. In most samples it was accompanied by epigean

ostracod species, and other epigean animal groups, but also by hypogean animals, like *Thermosbaenacea*, *Harpacticoidea*, prawns of the genus *Typhlatya*, cirrolanid isopods of the genus *Anopsilana*, and hadziid amphipods. The ostracod species most commonly found in the samples were: *Chlamydotheca unispinosa* and *Strandesia stocki*, two epigean species, very common in Haiti.

Only three specimens of *C. auricularia* were found in a well dug in sandy soil, with a chlorinity of 420 mg/l. The species was accompanied by blind Amphipoda, specimens of *Anopsilana* sp., and epigean fauna, including *Chlamydotheca unispinosa* and *Physocypria* sp. (Ostracoda).

C. ansa was found in only one well, dug in sediments, with a chlorinity of 140 mg/l. It was accompanied by *Thermosbaenacea*, hadziid Amphipoda, and epigean fauna, but no Ostracoda.

A carapace and a valve of *Caribecandona* sp. were found in the interstitial on the border of the Étang Saumâtre.

The fact that the three species of *Caribecandona* were found only in wells, often accompanied by hypogean fauna, especially when abundant, seems to point to a subterranean way of life. The fact that most wells were dug in sand or other sediments suggests that the species are interstitial. Further evidence of an interstitial and stygobiont way of life is found in morphological characteristics, like the hyper-development of the aesthetascs Y and y₃ of the second antenna, and the reduction of segments and setae on some of the appendages. The species are small, (about 0.7 mm), but not as small as the species from Venezuela described in the sequel (0.4 mm).

C. trapezoidea was found in different hydrogeographical areas, on both sides of the Neiba plain, a plain connecting the southwestern part of Haiti with the rest of the island, which was submerged during high sea levels in the Pliocene, and probably also in the Pleistocene (Pregill & Olson, 1981). This seems to indicate that the species already existed before the flooding of the plain.

C. ansa has been found only once, in the central part of Haiti (fig. 12, no. 601), in a hydrogeographical region just north of the most northern locality where *C. trapezoidea* has been encountered, though only at a distance of 25 km.

C. auricularia has been found in one of the hydrogeographical areas where *C. trapezoidea* also occurs, near the north coast of the Étang Saumâtre (fig. 12, no. 578). The valve and carapace of *Caribecandona* sp. were found at the southern border of this lake.



Fig. 12. Map of Haiti, with stations sampled during the Amsterdam Expeditions to the West Indian Islands in 1978 and 1979. Main rivers are indicated. Only stations where species of the subfamily Candoninae were found are shown.

It seems that the species of *Caribecandona* in Haiti are not separated by geographical barriers, only *C. ansa* could be hydrogeographically isolated from *C. trapezoidea* (if the latter species will not be encountered in the northern parts of Haiti, which have not been sampled extensively). So at least three, and probably four, very closely related species have developed in a restricted area, in contrast to the other Candoninae and Cypridinae in the West Indies, which are represented by relatively fewer species in each island, or with a much wider distribution (Broodbakker, 1982; 1983a, b, c). The same phenomenon is found in species of *Metacypris* (*Elpidium*) from Cuba, and in other

animal groups like the Drosophilidae of Hawaii. Danielopol (1975) described three new species of *Elpidium* from bromeliads in Cuba. The three species are very closely related and differ only in details of the structure of hemipenis and valves. It seems that differences in the structure of the genital organs insure sexual isolation, because of their sensual function. The interspecific differences in the structure of the hemipenis were always accompanied by differences in the structure of the valves. The same phenomenon is found in the species of *Caribecandona* from Haiti, which also differ only in the structure of the valves, especially the shape of the dorsal protuberance, and the structure of the hemipenal lobes.

An extreme example of species richness because of sexual selection, is the family Drosophilidae. It is probable that the 508 species which are now known from the Hawaiian islands are all descendants of a single ancestral individual (Kaneshiro, 1983). The different species have arisen from differences in the structure of male genitalia, or from different mating behaviour. It seems that in *Caribecandona* as well as in *Elpidium* and the Drosophilidae, sexual selection has been the most important factor for the evolution of new species.

Since isolation is achieved sooner in hypogean species, because of their limited capacities for dispersion, this could be an explanation for the evolution of four species of *Caribecandona* in a restricted area, by way of subsequent isolation of populations of an ancestral species, which could be *C. trapezoidea*, since this species has the widest distribution.

A NEW HYPOGEAN GENUS OF CANDONINAE FROM VENEZUELA

During the Amsterdam Expeditions of 1982, we paid a visit to the small town of Calabozo, in the Estado Guárico in Venezuela, some 180 km south of Caracas. In this town many wells have been dug, mainly in breccias, which seem to be old river sediments. In one of these wells, about fifty specimens of a very small ostracod were

found, together with specimens of a new hypogean isopod, belonging to the new suborder Calabozoidea. In the other wells sampled in Calabozo no more ostracods of this species were found, while in many of these wells *Calabozoa pellucida* Van Lieshout, 1983, and *Bogidiella neotropica* Ruffo, 1952, a hypogean amphipod, were found. The small ostracods turned out to belong to a new genus of Candoninae, because of many special characters.

Danielocandona n. gen.

Type-species: *Danielocandona lieshoutae* n. sp. (by monotypy).

The genus has the following unique characteristics compared with the other Candoninae:

- (1) The second segment of the maxillular palp is elongated with only one serrate claw-like seta and two flexible setae.
- (2) The furca possesses only one distal claw, which is fused with the ramus. The other setae have disappeared.
- (3) The second and third endopodal segments of the walking leg (T 1) are fused, and the former second segment does not carry a seta.
- (4) The distal part of the copulatory tube in the hemipenis of the male is bifid.

The carapace shape is trapezoidal, like in *Caribecandona*, *Mixtacandona*, and the other species mentioned in this article. The carapace is very small, about 0.4 mm, as in *Nannocandona faba* Ekman, 1914 (epigean), and *Pseudocandona triquetra* (Klie, 1936) (hypogean), thus the species is one of the smallest Candoninae.

The first antenna has the segments III + IV and V + VI fused, like in the genus *Nannocandona* Ekman, 1914.

The clasping organs of the male maxillae are symmetrical with thin distal fingers, as in the genus *Mixtacandona*.

The walking leg is as in *Phreatocandona motasi* Danielopol, 1978 (fig. 2, p. 24), with a very long seta on the third endopodal segment and without setae on the protopodite and the first endopodal segment. This last characteristic it

also shares with some species of the genus *Mixtacandona*.

The second and third endopodal segments of the cleaning leg (T 2) are fused, and the fourth segment bears only one long seta, as in the genus *Pseudocandona*. Of the two remaining small setae of segment four, one is very short, as in some species of the genus *Mixtacandona*. The protopodite does not bear an interior seta as in the genus *Terrestriocandona* Danielopol & Betsch, 1980.

The Zenker's organ possesses six whorls of spines, as in *Pseudocandona similampadis* Danielopol, 1978, and the *Pseudocandona* species from Lake Baikal.

The hemipenis has a distally rounded lateral lobe, as in the genera *Pseudocandona*, *Caribecandona* and *Mixtacandona*. The bursa copulatrix is open, as in some *Mixtacandona* species. Part d₄ of the labyrinth is absent, as in the genera *Candonopsis*, *Caribecandona* and *Mixtacandona*. There seem to be three testicular lobes in the valves, as in the genus *Mixtacandona*.

Etymology. — The name of the genus is a contraction of part of the name of Dr. D. L. Danielopol and of the generic name *Candona*, because the new genus belongs to the subfamily Candoninae. The genus is named after Dr. Danielopol in recognition of his large contribution to the knowledge of the taxonomy and evolution of hypogean Candoninae. Furthermore, the author acknowledges his great help during this study.

Danielocandona lieshoutae n. sp. (Figs. 13, 14)

Material. — Holotype: 1 female (ZMA Ost. 150.792). Allotype: 1 male, paratypes: 2 males and 2 females dissected, and about 50 undissected males and females (ZMA Ost. 150.793).

Type-locality: S 82/557, Venezuela, Edo. Guárico, round open well of Nancy de Venega, Calabozo, quarter Misión (8°55'17"N 67°27'00"W); diam. 2 m. water table at 2.5 m, water depth 0.6 m; dug out in breccias, upper part cemented; chlorinity 50 mg/l; 10-III-1982. Accompanying fauna: Oligochaeta, Harpacticoidea, *Calabozoa pellucida* (Isopoda), Insecta, Gastropoda.

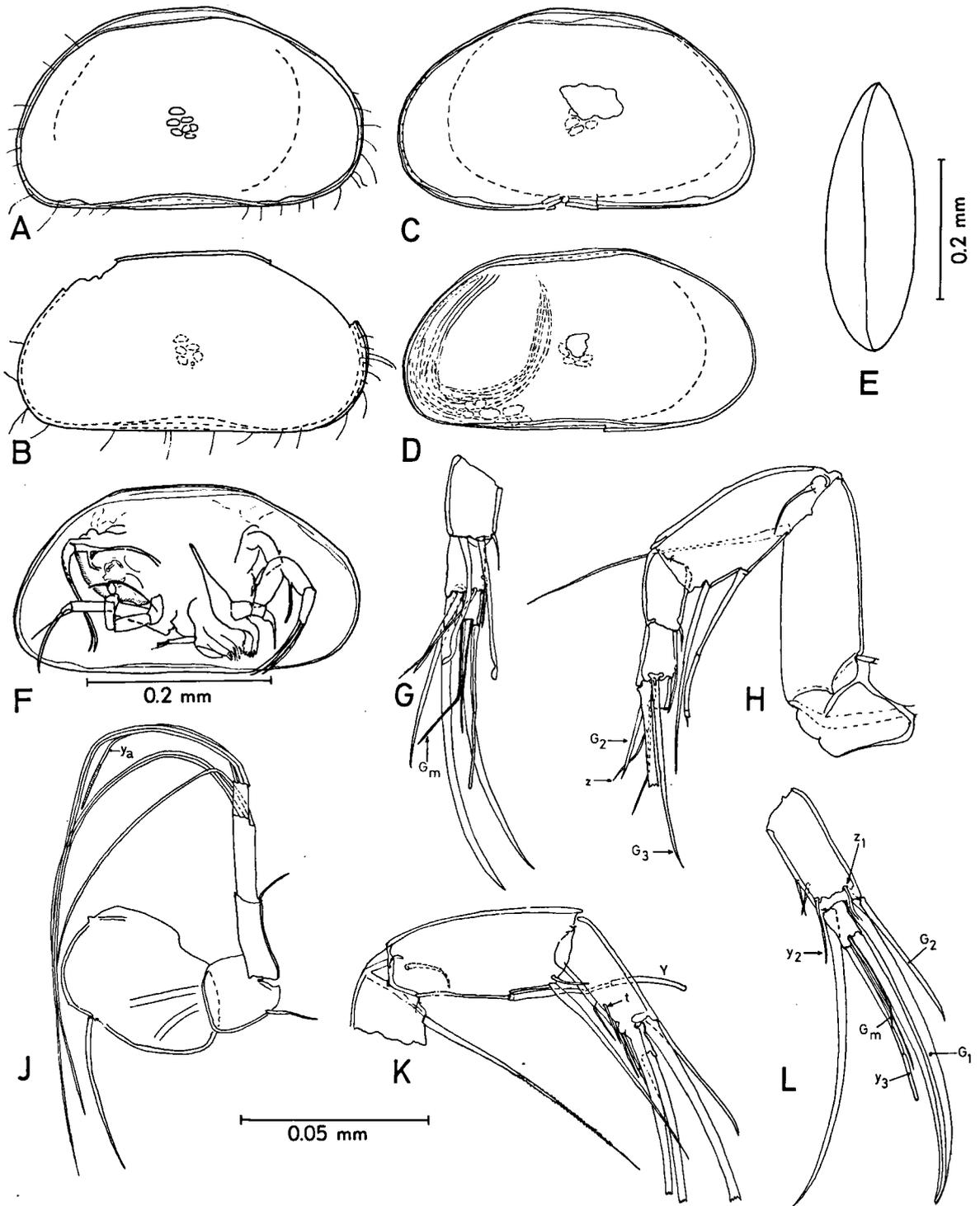


Fig. 13. *Danielocandona lieshoutae* n. gen., n. sp. (S 82/557, Calabozo, Venezuela, Edo. Guárico: A-B, F, J-L, ♀ holotype; C-D, G-H, ♂ allotype): A, C, left valves; B, D, right valves; E, carapace in dorsal view; F, undissected animal in left valve; G-H, K-L, details of second antenna in interior and exterior view; J, antennule.

Description

Carapace (figs. 13A-F):

The carapace has a rounded trapezoidal shape. In dorsal view greatest width at 35-50% of the length, being about 35% of the length. Greatest height in front of the middle at 60-65% of the length, being 50-60% of the length. Surface densely punctate, and sparsely hairy. Muscle scars as typical of the Candoninae. Carapace whitish transparent. Left valve larger than and overlapping the right valve at all sides. Dorsal margin straight but sloping slightly in posteroventral direction. The dorsal ridge is broader in the left valve. The dorsal margin passes with angles of about 30° in the broadly rounded anterior and posterior margins. Ventral margin straight, the inner margin sinuous in the middle. In the left valve there are two small rounded protuberances at the inner posteroventral and anteroventral sides. Marginal pore canals indistinct. Duplicature broader anteriorly than posteriorly, ventrally and dorsally practically absent. There are only minor differences between males and females.

Carapace length varies for females and males from 0.37 to 0.40 mm. The mean dimensions of the carapace are: 0.38 × 0.21 mm for both males and females (both: $n = 10$, S.D. = 0.01).

Since the species is very small it is possible that some small setae have been overlooked.

Antennule (A 1) (fig. 13J):

I: A-1//II: A-1*m*/(III + IV): A-1*s*/(V + VI): A-3//VII: D-2*l*-1(*y_a*).

Segments III + IV and segments V + VI are fused, therefore 1/2 (III + IV) is used as reference for the chaetotaxy system. The two posterior setae and one anterior seta of the first segment have disappeared. The seta of the former third segment, the long setae of the former fourth segment, and the setae of the former fifth segment have likewise disappeared. At the former sixth segment three long setae, and at the former seventh segment two long setae have remained. The aesthetasc *y_a* is relatively long, being nearly three times as long as segment III + IV.

Second antenna (A 2) (figs. 13G-H, K-L):

Pr: P-1//Exo: 1*s*/E I: P-Y-1*l*-1*s*/...../E IV: D-1*m*-1*m*(*G_m*)-*y₃*-1(*G_M*).

♀: E(II + III): P-1*s*(*y₁*)-1*s*(*t*), D-1*s*(*y₂*)-1*s*(*z*)-2(*l*(*G_{1,3}*))-1*m*(*G₂*).

♂: E II: P-1*s*(*y₁*), Ex-2*m*(*t_{2,3}*)/E III: D(Ex)-1*m*(*z*)-1*m*(*G_{2:cs}*), D(In)-1(*G₁*)-1*m*(*G_{3:cs}*).

In both male and female *G₂* is reduced to a claw-like seta, and *y₁*, *y₂* and *G_m* look like normal setae. There is only one *z* seta visible. Only one *t* seta is visible in the female, whereas in the male there are two male *t* setae like in most other Candoninae. *G₃* is slender and claw-like in both sexes. The exopodite seems to consist of only one small seta. Segments E(II + III) are fused in the female and divided in the male. The aesthetascs Y and *y₃* are strongly developed, which indicates a subterranean mode of life.

Mandibular palp (Mdp) (fig. 14A):

I: In-1*m*(*S_{1:pu}*)-1*s*(*S_{2:pu}*)- α /II: In-3*m*-1*m*(β)/III: Ex-1*s*-1*m*, In-1*s*-1*m*/IV: (fused with: 1*m*:ser) In-1*s*, Ex-1*s*.

As in A 1 and A 2, many setae have disappeared, exterior as well as interior setae. Seta β looks like a normal seta. The terminal seta is fused with the fourth segment and has a blade-like appearance.

The mandible possesses seven terminal teeth, three plumose setae anterodistally, one longer seta anteriorly, and two small plumose setae posterodistally, as in the other Candoninae.

Maxillula (Mxu) (fig. 14B):

Mxup I: Ex-2*m*/II: D-1*s*(*cs*:2ser))-2*s*/Mastic I: D-4*s*/II: D-6*s*/III: D-2*s*(*cs*:2ser)-4*s*.

As in the other limbs, many setae have disappeared. Mxup II bears only three setae instead of six, one of which is claw-like and serrate. The third masticatory process bears two serrate claw-like setae as in many other Candoninae and Cypridinae. All other setae are simple and there are only few in comparison with other species.

Maxilla (Max) (fig. 14C):

The masticatory process seems to bear six setae,

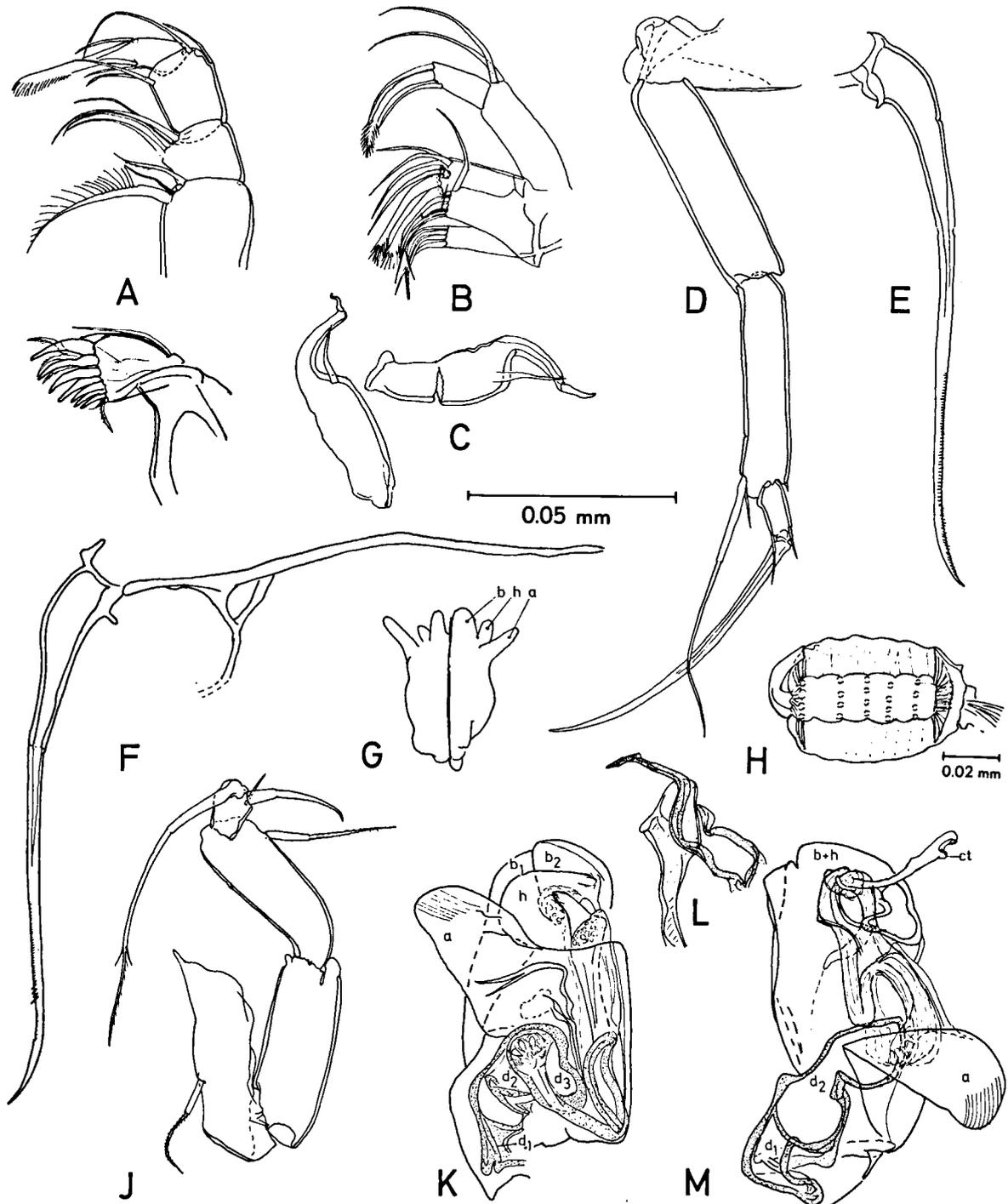


Fig. 14. *Danielocandona lieshoutae* n. gen., n. sp. (S 82/557, Calabozo, Venezuela, Edo. Guárico: A-C, E, G, J, L, ♂ no 3; D, H, M, ♂ allotype; F, ♀ holotype; K, ♂ no. 2): A, mandibular palp and distal part of mandible; B, maxillula; C, maxillar endopodites; D, first thoracopod; E, furca; F, furca with furcal attachment; G, hemipenis in dorsal view; H, Zenker's organ; J, second thoracopod; K, right hemipenis; L, detail of copulatory tube with distal parts of bursa copulatrix; M, hemipenis in erection. (For explanation see text.)

and the endopodite in the female three short setae. No other setae could be found in the maxillae of the specimens dissected. Neither exopodal setae, nor one of the a, b, or c setae were found.

The endopodites in the male are transformed into symmetrical clasping organs, with thin distal tips and long flexible second teeth (fig. 14C).

Thoracopod 1 (T 1) (fig. 14D):

E(II + III): D(A)-1*l*-1*s*/E IV: D-2*s*-1*l*(G).

The second and third endopodite are fused. The setae of Pr, E I and the former E II have disappeared. One of the setae of E(II + III) is very long, being 90% of the length of the terminal claw, probably this seta has a sensory function. E I is about as long as E(II + III), E IV is nearly 30% of the length of E I.

Thoracopod 2 (T 2) (fig. 14J):

Pr: Ex-1*m*(pu)/E(II + III): P-1*m*(pu)/E IV: D-1*l*(pu)-1*m*(cs)-1*s*.

The protopodite is devoid of one exterior and one interior seta. One of the minor setae of E IV is very short. E(II + III) and E I have about the same length.

Furca (Fu) & furcal attachment (Fuat) (figs. 14E-F):

The furca is whip-like, as in the species of the subfamily Cypridopsinae. All setae are absent, the anterior claw is fused with the ramus, the point of fusion being visible at one-third of the length. The terminal part of the furca is serrate for about 40% of its length. No trace is visible of the posterior claw.

The furcal attachment is straight and simple with an eye-like loop and short side branch at about one-quarter of the length of the main branch (fig. 14F).

Copulatory organs (figs. 13F, 14G-H, K-L):

The female copulatory organs have no special characters. The posterior part of the body is flatly rounded. Ovigerous females carried only two or three eggs, another indication of a subterranean life style (Danielopol, 1980b).

The Zenker's organ in the male has six whorls of spines, unlike most other Candoninae, which have seven.

The peniferum of the male hemipenis consists of three lobes, a distally rounded lateral one (a), and two distal lobes (b, h), of which one (b) seems to be folded. Both lobes are distally blunted, but when viewed from the ventral or dorsal side they are rounded (fig. 14G). The labyrinth is primitive, part d_4 is missing, while part d_3 looks simple. It is shown extended in fig. 14L. The bursa copulatrix is open, and surrounded by weakly sclerotized, elongate rods, which are difficult to recognize separately, in particular since the copulatory tube (ct) is coiled terminally. The distal part of the tube is bifurcate, as can be seen clearly in fig. 14M. Some of the distal internal parts and the copulatory tube are shown in fig. 14L.

There seem to be three testicular lobes in the valves.

Taxonomic remarks. — Most remarks and comparison with other species and genera have already been made in the description of the genus. There is no clear or close relation with any of the known genera. The species especially attracts attention because of the strong reduction of setae and segments. Many of the setae which are present in other Candoninae as well as in Cypridinae have disappeared.

Etymology. — The species is named in honour of Mrs. Sylvia van Lieshout, who took part in the Venezuelan expedition of 1982, and who described the new suborder of the Calabozoidea.

Ecology and zoogeography. — The species was encountered only in one well, dug in alluvial deposits of probable Quaternary origin. These deposits consist of conglomerates of gravel and sand. The sand is coloured red-brown by a large amount of iron. The fact that the species was accompanied by the subterranean, probably interstitial, isopod *Calabozoa pellucida*, is an indication that the well is connected with a phreatic system of considerable

size, since *C. pellucida* has been found in many other wells around Calabozo.

There are several reasons to assume the species to be hypogean and interstitial: (1) the small size of the carapace; (2) the strong reduction of setae and segments; (3) the strong development of the aesthetascs Y and y_3 of the second antenna and y_a of the antennula; (4) the low number of eggs in ovigerous females.

No clear relation can be found with any other genus of the subfamily Candoninae. It is possible that *Danielocandona* is a relict of an old group of Candoninae species, which has adapted to a hypogean, interstitial mode of life. The same seems to hold true for the isopod *Calabozoa* which, like *Danielocandona*, seems to be intermediary between other groups of Isopoda (Van Lieshout, 1983). Both *Calabozoa* and *Danielocandona* probably belong to a very old stock of species. It is possible that the species were forced into the groundwater because of the climat getting hotter. However, this remains speculative.

ORIGIN AND PHYLOGENETIC TRENDS OF CARIBECANDONA AND DANIELOCANDONA

The trend towards development of trapezoidal and triangular carapaces has been repeated several times, within *Caribecandona*, *Danielocandona* and some *Candonopsis* species, but also in some *Candona* species from Lake Ohrid, species of the genus *Mixtacandona* Klie, 1933 and *Pseudocandona* from subterranean habitats in Europe, and in species of *Baikalocandona* Mazepova, 1976 and *Pseudocandona* from Lake Baikal. Most other Candoninae have a more elongated and/or rounded carapace.

One of the trapezoidal *Candonopsis* species is *C. putealis* Klie, 1932 from a spring in Java (Indonesia), which is supposed to be hypogean because of long Y and y_3 aesthetascs and the absence of an eye. However, in the structure of the appendages it is like the elongated species of *Candonopsis*. The hemipenis has an acuminate lobe 'a' and a medial short lobe 'b', as in other *Candonopsis* species. The clasping organs of the male maxillae, and the hook on the posterior

claw of the furca, are likewise as in other *Candonopsis* (Klie, 1932; Danielopol, 1980a).

The two other, more or less triangular, *Candonopsis* species are: *C. thienemanni* and *C. trichota*, both described by Schäfer, 1945, from groundwater habitats in Greece. These two species have some morphological characteristics in common with *Caribecandona*. In these species the segments III and IV of the mandibular palp have a length ratio of 1.5: 1. The furcal claws do not possess hooks. However, in these species there is only one lobe 'a' in the hemipenis, the length/width ratio of Mdp: IV is 3.0: 1, and the clasping organs of the maxillae are long and without protuberances, characteristics found in other *Candonopsis* species as well (Schäfer, 1945).

The species of *Pseudocandona* from Lake Baikal have trapezoidal carapaces, but the internal characters are more like those in other *Pseudocandona* species, and not like those in *Caribecandona* and *Danielocandona* (Bronstein, 1947). The same holds true for the triangular and trapezoidal *Candona* species from Lake Ohrid, which are internally like the other *Candona* species. The species described by Mazepova (1976) as *Baikalocandona* are intermediary between *Candona* and *Pseudocandona*. The carapaces of some of these species are strikingly similar to those of *Caribecandona*, but the structure of the male maxillae and furca are totally different, and more as in the other genera mentioned. Mazepova (1976) considers the genera *Pseudocandona* and *Baikalocandona* as unsuccessful lateral branches of the Candoninae, and assumes the Baikal species belonging to these genera to be of relict origin.

Danielopol (1978) did not find any phylogenetical affinities, when comparing the trapezoidal and triangular Candoninae species from European groundwater, with some species of this type from Lake Baikal and Ohrid. He is of the opinion that the trend for developing trapezoidal carapaces has developed independently in different parts of the world. The differences in the structure of the limbs between the geographically different groups seem to indicate that this hypothesis could be correct, and

that the similarity in carapace shape is some sort of convergent evolution. The trend for the development of this type of carapaces seems to be stronger in relatively stable habitats, like subterranean systems and otherwise physically and biologically stable habitats, like Lakes Baikal and Ohrid, as hypothesized by Danielopol (1980) for Candoninae with elongate carapaces with a pointed posterior.

It seems that most of these trapezoidal Candoninae are remnants, or derived from remnants, of several Tertiary groups of Candoninae, which do not have a strong phylogenetic relationship with each other. In all groups the carapace developed or preserved a triangular or trapezoidal form.

In the West Indies this old group only survived in hypogean habitats, and was replaced in epigeal habitats by "modern" elongate Candoninae, and by Cypridinae and Cypridopsinae. The connection between the species from Venezuela and those of Haiti must have been broken since a long time, because both genera are fairly different. The affinities between the species of *Caribecandona* from Cuba and Haiti are much stronger, but nevertheless both subgenera are clearly different.

The fact that this type of Candoninae is only present in the islands Hispaniola and Cuba, which are both possibly fragments of an old continental plate, and in the mainland of Venezuela, together with a probably relict species of isopod, is another argument for the assumption that these species are relicts of an old Candoninae fauna. The islands of Puerto Rico and Jamaica have not been sampled extensively enough to draw any conclusions about the possible occurrence of this type of Candoninae in these islands. In all other smaller islands of the West Indies no interstitial or hypogean ostracod species appear to have evolved, which seems to indicate that these islands are much younger, and could not recruit interstitial freshwater species from this old stock, since by then the ancestral forms were probably extinct. It is also possible that the groundwater species from Haiti, Cuba, and Venezuela have migrated into the groundwater

because of the arid, hot climates which have occurred, especially in the Pleistocene (Pregill & Olson, 1981). The epigeal representatives of this old group could have become extinct because of the changes in climate and the competition with the younger groups of Cypridinae and Cypridopsinae (Cyprettinae).

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