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PODOCOPID OSTRACODA OF BERMUDIAN CAVES

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SUMMARY

About 33 species have been identified in 52 samples of podocopid Ostracoda collected in 24 inland marine caves on bermuda. One genus (*Aponesidea*) and 10 species are described as new, 11 have been previously described, and 12 are reported in open nomenclature. At least 12 species are endemic to Bermuda, while another 9 species are widely distributed in carbonate environments of the Caribbean-Antillean region. The majority are not restricted to the caves but occur also in sediments collected from Harrington Sound, Castle Harbour, North Lagoon, the South Shore, and other open-water localities of Bermuda. Four fresh- to brackish-water species belong to ecologically tolerant and geographically widely dispersed genera.

RÉSUMÉ

Approximativement 33 espèces ont été déterminées dans 52 échantillons d'Ostracodes Podocopides recueillis dans 24 grottes marines de l'intérieur des Bermudes. Un genre (*Aponesidea*) et 10 espèces sont décrits ici comme nouveaux; 11 espèces étaient déjà décrites, et la présence de 12 autres est mentionnée de manière incomplète. Au moins, 12 espèces sont endémiques pour les Bermudes, tandis que 9 autres espèces sont largement distribuées dans des milieux carbonatés des Caraïbes (Antilles). Dans leur majorité il s'agit d'éléments non restreints au milieu des grottes, mais trouvés aussi dans les sédiments échantillonnés à Harrington sound, Castle Harbour, North Lagoon, South Shore, et dans d'autres localités similaires des Bermudes (eaux marines ouvertes). Quatre espèces dulcaquicoles-salmastricoles appartiennent à des genres écologiquement tolérants et à vaste distribution géographique.

INTRODUCTION

The inland marine caves of Bermuda comprise a diverse range of habitat types. Caves situated along the coastline often act as tidal springs with flow changing direction every 6 hours with the tides. Owing to the abundant food supply, the walls and ceilings of such caves are literally covered with encrusting organisms including sponges, hydroids, and bryozoans. Those caves which act as major tidal conduits to inshore water bodies, in particular the nearly enclosed and tidally dampened Harrington Sound, have moderate currents flowing through them. Farther inland into the caves, where water currents and food transport from open waters decrease, a reduction in the number of species occurs. Caves with the poorest connection to the sea are characterized by very clear waters

with no suspended matter and low rates of sedimentation. Animals inhabiting such isolated caves typically are troglobitic species, some of which are relicts of formerly widespread groups.

Over 200 species of macro-invertebrates are known from Bermuda's marine caves (Sket & Iliffe, 1980; Iliffe et al., 1983). Biogeographical relationships among the cavernicolous species suggest more than one route of colonization. Some apparently originated from stocks transported from the Bahamas and the Caribbean via the Gulf Stream, some may represent groups that survived on submerged and emergent sea mounts along the Mid-Atlantic Ridge, some are relict deep-sea fauna, while others may be Tethyan relicts (Iliffe et al., 1983).

New species previously described from the Bermuda caves include *Atlantasellus cavernicolus*, an isopod representing a new family (Sket, 1979); *Miostephos leamingtonensis*, a new calanoid copepod (Yeatman, 1980); *Apseudes bermudeus*, a new hermaphroditic tanaidacean (Bacescu, 1980); *Cocoharpinia iliffei*, a gammaridean amphipod from a new genus (Karaman, 1980a); *Idunella sketi*, a new species of gammaridean amphipod (Karaman, 1980b); *Somersiella sterreri* and *Typhlatya iliffei*, two new species of caridean shrimp (Hart & Manning, 1981); *Mesonerilla prospera*, a new archiannelid polychaete (Sterrer & Iliffe, 1982); and *Bermudalana aruboides*, representing a new genus of cirolanid isopods (Bowman & Iliffe, 1983).

We now describe the podocopid ostracodes collected from 24 marine caves in Bermuda, which represent the full spectrum of habitat types.

HABITAT

Bermuda's caves are situated in the Pleistocene eolian limestones which cap a mid-ocean volcanic sea mount (Bretz, 1960; Land et al., 1967). They were formed during glacial low sea-level stands, and as postglacial sea levels rose, the caves were flooded with sea water. Extensive horizontal passages adorned with stalactites and stalagmites exist in water depths of 17 to 20 m (Iliffe, 1981). Exploration and mapping of the underwater caves utilizing advanced cave diving techniques has led to better understanding of their origins and history.

The characteristics of the caves from which podocopid ostracodes were collected are summarized in table I, while their locations are given in fig. 1. A brief description of each cave follows.

Bee Pit, located in the heavily karstified Walsingham area, contains a single soil-floored pool in near-total darkness. Castle Grotto is a former commercial cave situated on the edge of Castle Harbour and contains a shallow silt-floored pool. A shallow pool in Cathedral Cave, on the grounds of the Grotto Bay Hotel, is blocked by breakdown. Cherry Pit Cave, another of the Walsingham Caves, has noticeable water currents passing through an underwater room in near total darkness. Christie's Cave, despite being located in a collapse sink within 30 m of Castle Harbour, is apparently well isolated from direct contact with open waters. Cripplegate Cave, a tidal spring on Harrington Sound, is part of the Palm Cave System. Four other entrances to this cave system—Myrtle Bank, Palm, Sailor's Choice, and Straw Market—are interconnected by

TABLE I

Charactistics of Bermuda cave pools and other waters from which Ostracoda were collected. Although surface waters in most cave pools are brackish, normal open water salinities are reached at depths of several meters. Tide range and lag are expressed in respect to open ocean tides.

Cave or water body	Maximum depth (m)	Surface salinity (‰)	Tide range (%)	Tide lag (min.)	Sediment types	Connection to the sea
1. Bee Pit	3	21.8			soil	weak currents
2. Castle Grotto	3	36.4	85	10	silt	tidal spring
3. Cathedral Cave	6	15.9			soil, silt	weak currents
4. Cherry Pit Cave	12	28.5			silt	moderater currents
5. Christie's Cave	6	6.9			rock	isolated
6. Cripplegate Cave	2	36			rock, gravel	tidal spring
7. Deep Blue Cave	23	27.2			silt, rock	weak currents
8. Emerald Sink	16	26.4	41	95	silt	moderate currents
9. Fern Sink	24	18.0			silt, rock	isolated
10. Green Bay Cave	20	23.6	22	151	silt, rock	tidal spring to isolated
11. Grenadier Pool	6	21.5	64	61	silt	moderate currents
12. Little River Cave	3	36			rock, gravel	tidal spring
13. Long Rock Sink	6	36			silt	moderate during storms
14. Myrtle Bank Cave	20	32.2			silt	moderate currents
15. Palm Cave	20	26.3	55	57	silt	moderate currents
16. Prospero's Cave	18	12.0	62	63	silt	weak currents
17. Roadside Cave	6	30.2	57	71	rock	isolated
18. Sailor's Choice Cave	20	21.5			silt	moderate currents
19. Small Fish Pond Cave	15	33.0			detritus, rock	isolated
20. Straw Market Cave	20	19.3	53	58	silt	moderate currents
21. Tucker's Town Cave	24	21.4	62	58	sand, detritus	isolated
22. Walsingham Cave	20	18.8	63	53	silt	moderate currents
23. Walsingham Sink Cave	18	17.9	60	61	soil, silt	weak currents
24. Wonderland Cave	16	11.2	62	68	rock	isolated
Harringtong Sound	25	36	30	165	silt, rock	strong currents

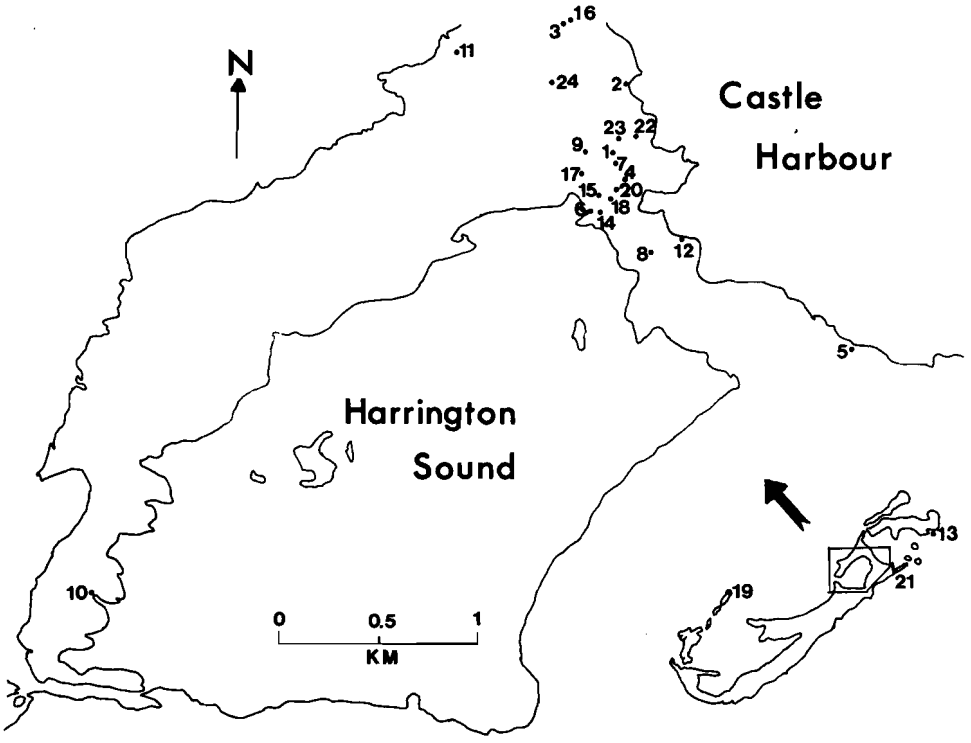


Figure 1. Locations of Bermuda caves from which Ostracoda were collected. (1) Bee Pit, (2) Castle Grotto, (3) Cathedral Cave, (4) Cherry Pit Cave, (5) Christie's Cave, (6) Cripplegate Cave, (7) Deep Blue Cave, (8) Emerald Sink, (9) Fern Sink, (10) Green Bay Cave, (11) Grenadier Pool, (12) Little River Cave, (13) Long Rock Sink, (14) Myrtle Bank Cave, (15) Palm Cave, (16) Prospero's Cave, (17) Roadside Cave, (18) Sailor's Choice Cave, (19) Small Fish Pond Cave, (20) Straw Market Cave, (21) Tucker's Town Cave, (22) Walsingham Cave, (23) Walsingham Sink Cave, (24) Wonderland Cave.

submerged passages accessible by cave diving. This cave system functions in tidal exchange between Castle Harbour and Harrington Sound. Deep Blue Cave is a segment of the Walsingham Cave System and contains one of the largest underwater cave chambers in Bermuda. The main entrance of this system, Walsingham Cave, consists of a pool at the base of a small cliff with extensive underwater passages leading back into total darkness. Emerald Sink, formed by a horseshoe-shaped collapse, has pools possessing tidal currents along three sides. Fern Sink is part of a relatively isolated cave system with large underwater collapse chambers and several air-filled rooms. Green Bay Cave, which is almost totally underwater, is the largest cave in Bermuda at over 2 km in length. The "Rat Trap" section of Green Bay Cave is a low area with moderate to strong tidal currents, located about 50 m into the cave from the main entrance on Harrington Sound. The "Desert" is an underwater room just past the "Rat Trap" with a broad expanse of deep silt covering the floor. The North Shore Passage of Green Bay is a long, nearly level, anastomosing tunnel at a depth of 17 m extending from Harrington Sound to out beneath the North Lagoon. Faunal diversity and biomass are the maximal at the "Rat Trap" and decrease with distance into the cave through the "Desert" to the North Shore Passage. Grenadier Pool consists of a 6 m deep water-filled sink with a section extending into partial darkness. Little River Cave is a tidal spring on Castle Harbour. Long Rock Sink is a partially sediment-filled collapse pool on a small islet off the east end of Bermuda. Prospero's Cave,

located only a few meters from Cathedral Cave, is at present used as an underground bar and discotheque. Roadside Cave is a small isolated cave located on the northern edge of the Walsingham area. Small Fish Pond Cave is a collapse sink at the old Naval Dockyard on Ireland Island. Tucker's Town Cave, on the Tucker's Town peninsula, contains a large underwater sand-floored chamber. Walsingham Sink Cave, located adjacent to and probably part of Walsingham Cave, has a soil slope extending down into the pool. Wonderland Cave, another former commercial cave, has a pool well isolated from the sea.

In addition to the caves, ostracode specimens were collected from Harrington Sound, a nearly enclosed inshore lagoon that still retains good connections with the sea. Salinity in Harrington Sound is at normal oceanic levels of about $36^0/00$.

PREVIOUS WORK

The Bermuda ostracode fauna is very poorly known and has never been monographed. The earliest records were by Brady (1880) for Challenger station 33 ("off Bermudas, 435 fathoms, mud, April 4, 1873"). Most of the eight species were misidentified and cannot be definitely identified today: *Pontocypris trigonella* Sars, 1866 (a species of *Propontocypris*); *Bairdia foveolata* (?) Brady, 1867 (a species of *Paranesidea*); *Cythere fungoides* Brady, 1866 (perhaps *Jugosocythereis pannosa*); *Cythere bermudae* Brady, 1880 (*Orionina bradyi* Van den Bold, 1963); *Xestoleberis curta* Brady, 1866 (a species of *Xestoleberis*); *Cytherella irregularis* Brady, 1880 (*Cytherelloidea irregularis*); *Cytherella pulchra* Brady, 1866 (a species of *Cytherella*); and *Asterope* sp. (a species of Cypridinoidea).

Van den Bold (1963a) described *Orionina bradyi*. Maddocks (1969a) reported *Glyptobairdia coronata* (Brady, 1870). Maddocks (1973) described *Saipanetta brooksi* and *Saipanetta* sp. 1. Maddocks (1974) reported *Macrocyprina* sp., *Triebelina* sp., *Bairdoppilata* sp., *Anchistrocheles* sp., *Hemicytherura bradyi* Van den Bold, 1963, *Jugosocythereis pannosa* (Brady, 1867), and *Paracytheridea tschoppi* Van den Bold, 1946. Maddocks (1976) described *Pussella danielopoli*, *Anchistrocheles barnharti*, and *Anchistrocheles hartmanni*. Maddocks & Kornicker (1985) reported *Cytherella lata* Brady, 1880, *Cytherelloidea irregularis*, *Saipanetta brooksi*, *Macrocyprina* sp., *Propontocypris* sp., *Triangulocypris laeva* (Puri, 1960), *Thalassocypria* sp., *Glyptobairdia coronata*, *Paranesidea* sp. (= *Paranesidea sterreri* n. sp. of this paper), *Cyprideis* sp. (= *Cyprideis edentata* Klie, 1939, of this paper), *Loxocorniculum* sp. (= *Loxoconcha oculocrista* Teeter, 1975, of this paper), *Orionina bradyi* Van den Bold, 1963, *Puriana rugipunctata* (Ulrich & Bassler, 1904), and *Xestoleberis* sp. Sket & Iliffe (1980) reported *Cypridopsis* sp. and *Cyclocypris* sp. from Freshwater Cave, which is the first record of freshwater Ostracoda, and reported *Bairdia* (s. l.) sp. n.?, *Polycope* sp., *Propontocypris* sp., and Myodocopida g. sp. from Walsingham Caves (identifications by Gerd Hartmann and R. F. Maddocks). This produces a total of 13 named species of Podocopida plus about 20 more indicated in open nomenclature, out of a fauna that exceeds 100 species (Maddocks, unpublished data and collections). For the Myodocopida, Kornicker (1981) reported four species of Myodocopina, and Deevey (1968) and Kornicker et al. (1976) described the pelagic ostracode fauna of the Sargasso Sea off Bermuda.

LIST OF CAVES COLLECTED AND SPECIES OCCURRENCES

Bee Pit, Hamilton Parish: 23 January 1984, specimens collected with a long-handled fine-mesh dip net from the underwater soil slope in 0 to 1 m water depths; 1 *Polycope* spp.

Cathedral Cave, Hamilton Parish: 15 February 1984, specimens collected while free diving with a fine-mesh hand net from bottom rocks and silt in 0 to 4 m water depths; 3 myodocopines.

Cherry Pit Cave, Hamilton Parish: 23 June 1982, specimens collected while free diving with a fine-mesh hand net from bottom rocks in 5 m water depth; 1 *Cytherella bermudensis*, 3 *Cytherella kornickeri*, 12 *Aponesidea iliffei*, 1 *Occultocythereis angusta*, 14 *Polycope* spp., 56 myodocopines. 12 January 1984, specimens collected using scuba with a fine-mesh hand net from bottom silt and gravel in 3 to 8 m water depths; 1 *Neonesidea omnivaga* (empty, 8 *Aponesidea iliffei* (empty), 22 *Polycope* spp., 19 myodocopines.

Christie's Cave, St. George's Parish: 24 September 1982, specimens collected using scuba with a fine-mesh hand net from bottom rocks and silt in 2 to 8 m water depths; 1 *Propontocypris* (*Ekpontocypris*) *lurida*, 3 *Polycope* spp., 1 myodocopine. 28 November 1983, specimens collected with a long-handled fine-mesh dip net from along the shore of the pool near the cave entrance in 1 m water depth; 9 *Callistocythere* sp.

Cripplegate Cave, Hamilton Parish: 21 October 1981, specimens collected from tidal currents flowing out of the cave with a 30 cm diameter plankton net; 1 *Aponesidea iliffei* (empty), 4 *Glyptobairdia coronata*, 1 myodocopine.

Deep Blue Cave, Hamilton Parish: 28 November 1981, specimens collected using scuba with a fine-mesh hand net from near silty bottom sediments of the underwater entrance chamber in 12 to 15 m water depths; 3 *Aponesidea iliffei* (empty), 15 *Havanardia keiji* (empty), 1 *Occultocythereis angusta*. 23 March 1982, specimens sorted from algae collected in 1 to 2 m water depths of the entrance pool; 5 *Paranesidea sterreri*, 3 *Dolerocypria bifurca*, 4 *Propontocypris* (*Ekpontocypris*) *lurida*, 2 *Propontocypris* (*Propontocypris*) sp. 2, 4 *Hemicytherura bradyi*, 1 *Cobanocythere* sp., 6 *Paradoxostoma* spp., 10 *Xestoleberis* spp., 3 *Polycope* spp., 1 myodocopine. 16 January 1984, specimens collected with a long-handled fine-mesh dip net from open water and from algal covered rocks in 0 to 2 m water depths; 1 *Dolerocypria bifurca*, 3 *Xestoleberis* spp. 20 February 1984, specimens collected with a long-handled fine-mesh dip net from the water column and soil slope in 0 to 1 m water depths; 1 *Callistocythere* sp., 2 *Polycope* spp., 5 myodocopines.

Emerald Sink, Hamilton Parish: 16 November 1983, specimens collected using scuba with a fine-mesh hand net from bottom silt on the entrance slope in 8 to 10 m water depths; 2 *Polycope* spp.

Fern Sink Cave, Hamilton Parish: 25 February 1982, specimens collected using scuba with a fine-mesh hand net from the fine bottom silt past the base of the underwater entrance slope in 18 m water depth; 52 *Havanardia keiji* (empty), 1 *Anchistrocheles hartmanni* (empty), 1 *Polycope* spp. (empty). 24 July 1984, specimens collected using scuba with a fine-mesh hand net from the ceiling and water column in 18 m water depth; 1 *Argilloecia* sp., 7 *Polycope* spp., 1 myodocopine. 24 July 1984, specimens collected using scuba with a fine-mesh hand net from bottom silt past the base of the entrance slope in 20 m water depth; 8 *Aponesidea iliffei* (empty), 25 *Havanardia keiji* (empty).

Green Bay Cave, Hamilton Parish: 5 September 1981, specimens taken from a lumpy yellow sponge collected using scuba in the area of the "Rat Trap" at 15 m water depth; 6 *Aponesidea iliffei*, 1 *Paranesidea bensoni* (empty), 1 *Glyptobairdia coronata*, 1 *Occultocythereis angusta*. 18 November 1981, specimens collected using scuba with a fine-mesh hand net from fine bottom silt in the Green Bay Passage just past the "Rat Trap" at 14 m water depth; 8 *Cytherella bermudensis*, 68 *Aponesidea iliffei* (empty), 1 *Havanardia keiji* (empty), 1 *Loxoconcha oculocrista* (empty), 6 *Polycope* spp. 9 January 1982, specimens collected using scuba with a fine-mesh hand net from bottom silt in the North Shore Passage near the terminal breakdown room at 17 m water depth; 7 *Aponesidea iliffei* (empty), 42 *Havanardia keiji* (empty), 3 *Candona* sp. (empty), 1 *Paradoxostoma* spp. 3 March 1982, specimens taken from hydroids attached to the diving line in the area of the "RAT Trap" at 16 m water depth; 1 *Neonesidea omnivaga*, 1 *Glyptobairdia coronata*, 13 *Paradoxostoma* spp. 28 November 1982, specimens collected using scuba with a fine-mesh hand net pulled through open water for several hundred meters in the North Shore Passage at 16 m water depth; 3 *Dolerocypria bifurca*. 13 March 1984, specimens collected using scuba with a fine-mesh hand net from detritus accumulating on the pycnocline located near the ceiling in the "Desert" at 12 m depth; 2 *Aponesidea iliffei*.

Grenadier Pool, Hamilton Parish: 21 November 1981, specimens collected using scuba with a fine-mesh hand net from fine bottom silt in 6 m water depth; 2 *Paranesidea sterreri*, 1 *Cyprideis edentata*, 1 *Xestoleberis* spp.

Harrington Sound: 1980-1981, specimens collected from this almost totally enclosed inshore water body by Michael Schweimanns (University of Kiel); 9 *Neonesidea omnivaga*, 4 *Aponesidea iliffei* (empty), 10 *Paranesidea sterreri*, 2 *Paranesidea bensoni* (empty), 1 *Glyptobairdia coronata* (empty), 2 *Havanardia keiji*, 21 *Heterocypris punctata*, 4 Paracypridinae spp., 3 *Jugosocythereis pannosa*, 31 myodocopines.

Little River Cave, Hamilton Parish: 22 June 1984, specimens collected with a fine-mesh hand net from 0 to 30 cm water depths; 4 *Cytherelloidea irregularis*, 1 *Paracypris crispa*, 44 *Neocaudites nevianii*, 2 *Xestoleberis* spp.

Long Rock Sink, St. George's Parish: 8 July 1984, specimens collected using scuba with a fine-mesh hand net from the steeply sloping bottom silt in 6 m water depth; 3 Cytheracea unidentifiable juveniles, 1 *Polycope* spp.

Myrtle Bank Cave, Hamilton Parish: 31 January 1982, specimens collected using scuba with a fine-mesh hand net from ceiling, walls and small ledges in the entrance pool at 7 m water depth and from bottom silt at 21 m water depth; 5 *Cytherella kornickeri*, 1 *Cytherelloidea irregularis*, 2 *Aponesidea iliffei* (empty), 3 Paracypridinae spp., 5 *Neocaudites nevianii*. 7 February 1982, specimens collected using scuba with a fine-mesh hand net from bottom silt in the passage leading to Palm Cave at 21 m water depth; 1 *Cytherella kornickeri* (empty), 1 myodocopine.

Palm Cave, Hamilton Parish: 20 January 1982, specimens collected using scuba with a fine-mesh hand net from bottom silt near the base of the entrance slope at 9 m water depth; 4 *Cytherella bermudensis*, 1 *Cytherella kornickeri*, 25 *Aponesidea iliffei* (empty), 3 *Neonesidea omnivaga* (empty), 1 *Paranesidea bensoni* (empty), 6 *Havanardia keiji* (empty), 1 *Propontocypris* (*Propontocypris*) sp. 1 (empty), 1 Paracypridinae spp. (empty), 2 *Xestoleberis* spp. (empty), 27 *Polycope* spp. 13 & 16 March 1982, specimens collected using scuba with a fine-mesh hand net from bottom silt in the underwater Palm Cave Room at 16 m water depth; 10 *Polycope* spp., 8 myodocopines. 29 January 1984, specimens collected using scuba with a fine-mesh hand net from silt covered rocks at the base of the entrance slope in 8 m water depth; 1 *Aponesidea iliffei*.

Prospero's Cave, Hamilton Parish: 5 February 1984, specimens collected with fine-mesh hand net from silt covered rocks in 3 to 4 m water depths; 2 *Havanardia keiji* (empty).

Roadside Cave, Hamilton Parish: 27 August 1982, specimens collected with a long-handled fine-mesh dip net from the water column and bare rock walls in 0 to 1.5 m water depths; 20 *Polycope* spp. 12 November 1982, specimens collected using scuba with a fine mesh hand net from bottom rocks at 4 to 8 m water depths; 4 *Propontocypris* (*Propontocypris*) sp. 1, 12 *Polycope* spp.

Sailor's Choice Cave, Hamilton Parish: 6 July 1982, specimens collected with long-handled fine-mesh dip net from the undercut sloping walls of the entrance pool in 0 to 1 m water depths; 5 *Polycope* spp. 6 July 1982, specimens collected while free diving with a fine mesh hand net from bottom rocks in 3 to 5 m water depths; 7 *Polycope* spp.

Small Fish Pond Cave, Sandys Parish: 15 November 1981, specimens collected using scuba with a fine-mesh hand net from detrital bottom sediments in 12 m water depth; 1 *Havanardia keiji*.

Straw Market Cave, Hamilton Parish: 12 January 1984, specimens collected using scuba with a fine-mesh hand net from gravelly sediment where currents come out of breakdown in 10 to 12 m water depths; 1 *Aponesidea iliffei*, 1 *Polycope* spp., 3 myocodopines.

Tucker's Town Cave, St. George's Parish: 11 February 1982, specimens collected using scuba with a fine-mesh hand net from woody material and bottom detritus at the base of the entrance slope in 15 m water depth; 11 *Propontocypris* (*Propontocypris*) *minacis*. 8 September 1982, specimens collected with a long-handled fine-mesh dip net from the sparsely algal-covered rear wall of the entrance pool in 0 to 2 m water depths; 7 *Polycope* spp. 8 September 1982, specimens collected with a long-handled fine-mesh dip net from the sand bottom of the entrance slope in 0 to 2 m water depths; 27 *Polycope* spp. 16 March 1984, specimens collected using scuba with a fine-mesh hand net from sand and rotting wooden planks at the base of the entrance slope in 16 to 18 m water depths; 5 *Polycope* spp.

Walsingham Cave, Hamilton Parish: 18 February 1982, specimens collected using scuba with a suction bottle and a fine-mesh hand net from the bottom silt and walls of the rear portion of the main entrance pool in 6 to 8 m water depths; 3 *Cytherella kornickeri*, 23 *Aponesidea iliffei*, 1 *Havanardia keiji* (empty), 1 *Propontocypris* (*Propontocypris*) sp. 1 (empty), 4 *Paracypris crispa*, 3 Paracypridinae

spp. (empty), 2 *Microcytherura* sp., 5 *Xestoleberis* spp., 15 *Polycope* spp., 4 myodocopines. 17 February 1984, specimens collected from silt-covered rocks of the main entrance pool in 0 to 3 m water depths; 1 *Aponesidea iliffei* (empty), 1 *Loxoconcha oculocrista*. 13 July 1984, specimens collected using scuba with a fine-mesh hand net from bottom silt in the main entrance room in 6 m water depth; 1 *Propontocypris* (*Ekpontocypris*) *lurida*, 6 *Dolerocypria bifurca*, 1 Pontocyprididae n. gen. n. sp., 5 *Xestoleberis* spp., 4 *Polycope* spp., 4 Cytheracea unidentifiable juveniles (empty).

Walsingham Sink Cave, Hamilton Parish: 7 February 1982, specimens collected by pumping approximately 5 m^3 of water from a depth of 5 m through a plexiglass cylinder containing a plankton net; 1 myodocopine. 18 February 1982, specimens collected using scuba with a fine-mesh hand net from the base of the entrance soil slope in 14 m water depth; 6 *Aponesidea iliffei* (empty), 22 *Havanardia keiji* (empty), 13 August 1982, specimens collected with a long-handled fine-mesh dip net from the water column, walls and ledges in 0 to 1.5 m water depths; 3 *Polycope* spp.

Wonderland Cave, Hamilton Parish: 25 July 1984, specimens collected using scuba with a fine-mesh hand net from gritty sediments covering rocks at rear of main pool in 12 m water depth; 1 *Havanardia keiji* (empty).

Mixed contents of broken vials: Castle Grotto, Hamilton Parish: 13 & 29 October 1981, specimens collected with a 30 cm diameter plankton net placed for 6 hours on both days in the northwest corner of the main pool on an out flowing tide; 29 October 1981, specimens collected with a long-handled fine-mesh dip net from bottom silt in 0.5 to 1.5 m water depths. Cripplegate Cave, Hamilton Parish: 9 October 1981, specimens collected with a 30 cm diameter plankton net placed in the cave entrance for 6 hours on an out-flowing tide. Emerald Sink, Hamilton Parish: 17 January 1982, specimens collected using scuba with a fine-mesh hand net from bottom silt and ledges at the entrance slope in 11 m water depth: 3 *Aponesidea iliffei* (empty), 2 *Neonesidea omnivaga*, 1 *Anchistrocheles hartmanni* (empty), 1 *Loxoconcha oculocrista*, 1 *Occultocythereis angusta*, 7 *Polycope* spp., 2 myodocopines.

ECOLOGY AND BIOGEOGRAPHY

The 52 samples from 24 caves have yielded at least 33 species (table II), not counting myodocopines. The average sample yielded only 2.1 species (2.9 including empty carapaces), which certainly does not reflect the true diversity of cave populations. This is an artifact of small sample size, and perhaps also of patchy distributions or strong microhabitat preferences, as may be seen by the fact that multiple samples from the same cave often contain different species. As might be expected, the larger caves and those that are part of cave-systems have produced more species, particularly Deep Blue Pool, Green Bay Cave, and Walsingham Cave. It is also obvious that the number of species increases with the number of samples collected from a particular cave and with the variety of microhabitats represented. Samples from bottom sediment have more specimens and species than those from rock walls, ceilings, or the water column. Figure 2 summarizes the species distributions.

The most abundant and ubiquitous taxon, with 212 specimens in 25 samples, is *Polycope* spp., which is the first record of Cladocopina on Bermuda. Cladocopina live in most marine environments, although the poorly calcified carapaces are rarely found as fossils. Although they are often said to be interstitial, Neale (1983) considered a benthic natatory habit more likely. In this study they were found living in 15 caves, including very isolated ones, through the entire range of surface salinities, sometimes the only species present. Because the majority of specimens were very young juveniles, and because no

TABLE II

List of ostracod species collected from Bermuda Caves.

1. *Cytherella bermudensis* Maddocks, n. sp.
2. *Cytherella kornickeri* Maddocks, n. sp.
3. *Cytherelloidea irregularis* (Brady, 1880)
4. *Neonesidea omnivaga* Maddocks, n. sp.
5. *Paranesidea sterreri* Maddocks, n. sp.
6. *Paranesidea bensoni* Teeter, 1975
7. *Aponesidea iliffei* Maddocks, n. gen., n. sp.
8. *Havanardia keiji* Maddocks, n. sp.
9. *Glyptobairdia coronata* (Brady, 1870)
10. *Anchistrocheles hartmanni* Maddocks, 1976
11. *Propontocypris* (*Propontocypris*) *minacis* Maddocks, n. sp.
12. *Propontocypris* (*Propontocypris*) sp. 1
13. *Propontocypris* (*Propontocypris*) sp. 2
14. *Propontocypris* (*Ekpontocypris*) *lurida* Maddocks, n. sp.
15. *Argilloecia* sp.
16. *Pontocyprididae* n. gen. n. sp.
17. *Heterocypris punctata* Keyser, 1975
18. *Candona* sp.
19. *Dolerocypria bifurca* Maddocks, n. sp.
20. *Paracypris crispa* Maddocks, n. sp.
21. *Paracypridinae* spp.
22. *Cyprideis edentata* Klie, 1939
23. *Hemicytherura bradyi* (Puri, 1960)
24. *Microcytherura* sp.
25. *Jugysocythereis pannosa* (Brady, 1869)
26. *Neocaudites nevianii* Puri, 1960
27. *Occultocythereis angusta* Van den Bold, 1963
28. *Callistocythere* sp.
29. *Loxoconcha oculocrista* Teeter, 1975
30. *Cobanocythere* sp.
31. *Paradoxostoma* sp.
32. *Xestoleberis* spp.
33. *Polycope* spp.
34. *Myodocopina* spp.

comparable sampling for live material has been conducted in open-water environments, it seems unlikely that *Polycope* is restricted to cave habitats.

Platycopina are represented by 30 specimens in 3 species, all of which also occur commonly in open-water habitats on Bermuda. Platycopina are burrowing filter-feeders, and in this study they were restricted to caves with silt or gravel sediment.

The 29 species of Podocopina are approximately equally distributed among the Bairdiacea (7 species and 390 individuals), Cypridacea (11 species and 81 individuals), and Cytheracea (11 species and 313 individuals), as is usual for reef-associated faunas. The diversity of Cytheracea is somewhat understated, however, both here and in most described faunas, because of the difficulties in collecting and studying the tiniest phytal and interstitial species, such as those here lumped in open nomenclature as *Paradoxostoma* spp., *Xestoleberis* spp., etc. The absence of Sigilliacea is not surprising, as the two Bermuda species of *Saipanetta* are very rare. The absence of Darwinulacea merely shows the lack of permanent freshwater bodies on Bermuda.

Bairdiacea are sediment-eating epibenthos. Unable to swim, they climb freely over all benthic surfaces. High diversity of Bairdiacea characterizes coralline faunas and those of other tropical habitats with coarse-grained sediments and abundant sessile invertebrates. Green Bay Cave yielded three living species of Bairdiacea, but no more than one was found in any other cave. Two species, *Neonesidea omnivaga* and *Paranesidea sterreri*, are also very common in open-water environments; in fact, they are the two most abundant species of Bairdiacea on Bermuda. Their presence in Green Bay Cave, Deep Blue Pool

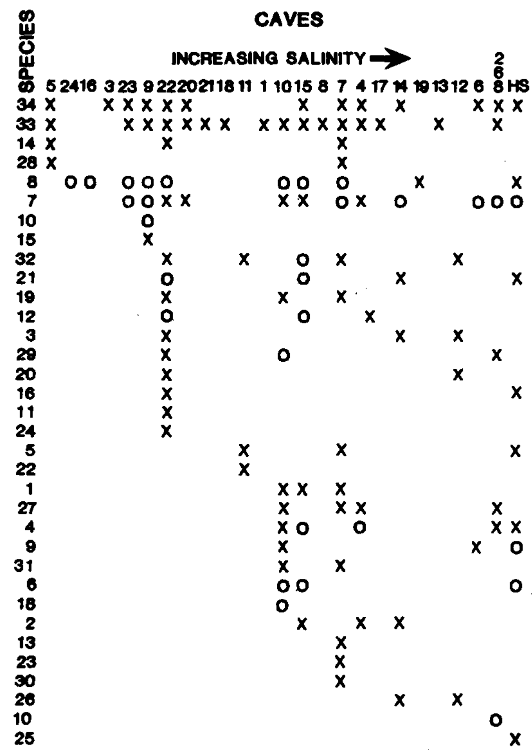


Fig. 2. Species distributions in Bermuda caves. The numbers along the top of the chart refer to the caves listed in fig. 1, arranged in order of increasing surface salinity from left to right. The numbers along the left-hand side refer to the species listed in Table II, listed in order of first occurrences along this salinity gradient. × refers to live or mixed live and empty specimens; O means that only empty specimens were found.

and Grenadier Pool shows open connection to the outside. *Glyptobairdia coronata*, which is known in reefal environments on the South Shore, was collected living on a sponge in Green Bay Cave and from outgoing tidal currents in Cripplegate Cave. Because of its massive carapace and normal bairdian appendage structure, it is highly unlikely that it can swim, so the occurrence in Cripplegate Cave demonstrates the effectiveness of transport and faunal exchange by tidal currents.

Two rare species, *Paranesidea bensoni* and *Anchistrocheles hartmanni*, were represented only by empty carapaces. In fact, three-quarters of all the empty-carapace occurrences were for species of Bairdiacea, probably because their carapaces are relatively large, well calcified, and robust. It is tempting, therefore, to speculate that these occurrences result from sediment transport by currents into the caves. However, the two most abundant species found empty in the caves, *Aponesidea iliffei* and *Havanardia keiji*, were also found living, and they are unknown or very rare in sediments collected in open-water en-

vironments. It seems likely that both species characteristically dwell in caves and cryptic habitats with low standing populations and low sedimentation rates, so that their empty carapaces are relatively abundant in the cave sediment. Some carapaces of *Havanardia keiji* were overgrown by the discoidal, tubular, coiled test of an agglutinate foraminifer, showing that they had been at the surface of the sediment for some time. Both species have an inflated carapace with flattened venter, and *Havanardia keiji* has ventrolateral keels; this shape might facilitate clinging tightly to an exposed rocky substrate in strong currents and thus make it easier to colonize the caves. Other species of both genera have been reported from open-water environments (not on Bermuda) with coarse sediment, low sedimentation rates, and abundant suspension-feeding invertebrates. All Bairdiacea are blind, and these species show no special morphologic features that can be attributed to subterranean life.

Cypridacea are represented by Pontocyprididae (6 species), Paracyprididae (3 species) and Cyprididae (2 species) but no Macrocyprididae. Species of *Propontocypris* are excellent swimmers associated with phytal and other shallow-water substrates. They are remarkably diverse in near-shore environments world-wide. The occurrence of *Propontocypris* (*Ekpontocypris*) *lurida* in Christie's Cave shows more tolerance for low salinity than had been previously recognized for this genus. The occurrence of *Argilloecia* in Fern Sink Cave belies the usual opinion that this genus is restricted to deeper water, and in fact three rare undescribed species occur also in sediments of the South Shore reefs. Many Cyprididae and Paracyprididae are euryhaline, and it is not surprising to find them well represented here. The most characteristic one, *Dolerocypria bifurca*, has not been seen in sediment samples outside the caves, perhaps because it is rather small and fragile. Its occurrence in a plankton tow in Green Bay Cave suggests good swimming ability, even though the so-called "swimming setae" are reduced. Maddocks (1968) questioned whether these setae actually function for swimming. *Dolerocypria bifurca* shows reddish-brown pigmentation of the epidermis in fresh material and has an eye-spot. *Paracypris crispa*, collected crawling on cave floors and walls, is also common in open-water environments.

Cytheracea, many with elaborately ornamented, well-calcified carapaces, are the dominant ostracodes in modern shallow-water environments including the reefs and lagoons of Bermuda. None can swim, but some can tolerate lowered salinity. *Loxoconcha*, *Xestoleberis*, and *Paradoxostoma* are strongly associated with plants; in the caves they occur mainly near the entrances. *Cobanocythere*, *Microcytherura*, *Xestoleberis*, and juveniles of many other genera are known to be interstitial in coralline sands. All of the species collected in the caves are also common on algae, coralline detritus, or sediments of the open-water environments outside. Many are also known from other Caribbean localities, perhaps because Cytheracea have been more thoroughly studied and are easier to identify than Bairdiacea and Cypridacea, or perhaps they are

more easily dispersed or genetically more conservative for some reason and thus are less likely to be endemic.

The majority of these podocopid species are well represented in sediment samples taken from Castle Harbour, Harrington Sound, North Lagoon, the reefs of the South Slope, and other open-water environments on the Bermuda platform. Their occurrence in the caves suggests open connections and life conditions not markedly different from those available in the coralline environments outside. A marked exception is *Aponesidea iliffei*, which has not yet been recognized outside the caves, although it is the most abundant podocopid species in these collections. Some others, notably *Havanardia keiji*, are very rare in open-water samples, chiefly from the South Shore and southern Castle Harbour, but are very abundant in the cave collections. Perhaps they prefer cryptic habitats in the porous coral and limestone masses and thus are underrepresented in sediments sampled by conventional techniques.

Nine species have been previously reported from the Bahamas, Florida, Belize, or other Caribbean localities: *Paranesidea bensoni*, *Glyptobairdia coronata*, *Heterocypris punctata*, *Cyprideis edentata*, *Hemicytherura bradyi*, *Jugosocythereis pannosa*, *Neocaudites nevianii*, *Occultocythereis angusta*, and *Loxoconcha oculocrista*. Twelve others, ten of which are described as new, are not represented in collections from other Caribbean localities and are apparently restricted to Bermuda: *Cytherella bermudensis*, *Cytherella kornickeri*, *Cytherelloidea irregularis*, *Aponesidea iliffei*, *Neonesidea omnivaga*, *Paranesidea sterreri*, *Havanardia keiji*, *Anchistrocheles hartmanni*, *Propontocypris* (*Propontocypris*) *minacis*, *Propontocypris* (*Ekpontocypris*) *lurida*, *Dolerocypria bifurca*, and *Paracypris crispa*. The remaining species, mostly rare or poorly preserved, are left in open nomenclature, and there is not sufficient evidence to evaluate their geographic distribution.

Four brackish- to freshwater species are included in this fauna. *Cyprideis edentata*, represented by a single specimen in Grenadier Pool, is extremely abundant in sediment samples from Mangrove Lake, which is known to have lowered salinity much of the year. A companion species in Mangrove Lake, *Thalassocypria* sp., has not turned up in the cave collections, but *Dolerocypria bifurca* may be related to species described from mangrove swamps and coastal lagoons of Florida and the Netherlands West Indies. The occurrence of living *Heterocypris punctata* in Harrington Sound indicates locally oligohaline conditions in that body, but whether it is temporally persistent remains to be seen. The occurrence of empty juvenile carapaces of *Candona* sp. in Green Bay Cave, similar in shape to subterranean species of southern Europe, is tantalizing but not sufficient to establish the permanence of a freshwater subterranean fauna. The earlier report (by Sket and Iliffe, 1980, in Freshwater Cave) of *Cypridopsis* sp. and *Cyclocypris* sp., which by such strategies as resting eggs and parthenogenesis are very successful colonizers of temporary ponds and streams worldwide, suggests that Bermuda might have a small, established freshwater ostracode fauna. These species belong to genera with broad geographic

distributions that are thought to be readily transported by migratory waterfowl. Additional sampling will be necessary to determine whether these are ephemeral occurrences or whether Bermuda supports a permanent freshwater fauna. Aldabra Atoll, with comparable size, climate, and geology, has been shown to support a freshwater to oligohaline ostracode fauna of 10 species (McKenzie, 1971).

In sum, the ostracode fauna of these caves is much like that of the lagoons and reefs in open-water environments on the Bermuda platform, which, in turn, has affinities with faunas of carbonate environments of the Bahamas, Florida, Belize, and other Caribbean localities. There is also a strong endemic component, with more than half of the named species being restricted to Bermuda though demonstrably related to other Caribbean species. Two species, *Paranesidea bensoni* and *Occultocythereis angusta*, show connections with Madeira and Ascension islands but are also known to be widely distributed around the Caribbean-Antillean region. None of these species can be shown by taxonomic affinity or morphologic peculiarity to be specialized for subterranean existence, and none show abyssal affinities. The few brackish- to freshwater species belong to genera that are ecologically tolerant and biogeographically widely dispersed.

ACKNOWLEDGMENTS

T. Iliffe collected the samples and described the habitats. R. F. Maddocks identified the species and is the sole author of the new taxa. The types have been deposited in the U. S. National Museum and additional specimens at the Bermuda Biological Station. The myodocopine ostracodes from these samples were referred to Dr. Louis S. Kornicker for identification, who will report on them separately.

This study was supported by National Science Foundation grant BSR-8215672 to T. Iliffe. We gratefully acknowledge the contributions of cave divers Paul Hobbs, Robert Power, and Mary van Soeren, who assisted with collections from the underwater caves, and Michael Schweimanns, who provided ostracode specimens from Harrington Sound. Cave diving equipment and techniques met standards set by the Cave Diving Section of the U. S. National Speleological Society. Additional subfossil material for some species was provided by shallow-water sediment samples collected from many reef and lagoonal environments on the Bermuda platform by John T. Barnhardt in 1962, by R. F. Maddocks in 1963, and by Warren Brooks in 1970, during the "Seminar on Organism-Sediment Interrelationships" at the Bermuda Biological Station, now in the collections of the Department of Geosciences, University of Houston. R. F. Maddocks thanks the Crustacean Society for funding her participation in the Bermuda Cave Symposium. This paper is a Contribution of the Bermuda Biological Station for Research.

SYSTEMATIC DESCRIPTIONS

Order PODOCOPIDA Sars, 1866

Suborder PLATYCOPINA Sars, 1866

Superfamily CYTHERELLACEA Sars, 1866

Family CYTHERELLIDAE Sars, 1866

Genus *Cytherella* Jones, 1849

Cytherella bermudensis Maddocks, n. sp. (figs. 3, 4A-I, 18A, B)

Material.—12 specimens in alcohol, including 1 male, 1 female, 4 juveniles, and 6 empty valves, and 55 subfossil specimens.

Types.—Holotype male USNM 216414, paratypes USNM 216415-216417.

Type locality.—Palm Cave, Bermuda.

Occurrence.—In Palm Cave, 20/I/82, 4 specimens. In Green Bay Cave, 18/XI/81, 8 specimens. In 15 sediment samples from Castle Harbour, North Lagoon, and the South Shore reefs, in shallow water, 55 subfossil specimens.

Derivation of name.—For the island of Bermuda.

Dimensions.—Male USNM 216414, RV L 0.74 mm, H 0.37 mm, LV L 0.73 mm, H 0.37 mm. Female USNM 216416, RV L 0.81 mm, H 0.43 mm, LV L 0.78 mm, H 0.40 mm.

Diagnosis.—Male carapace compressed, ovate-subquadrate in lateral view, with slight ventral indentation, gently sloping posterodorsal margin, and obliquely curved posterior margin; muscle-scar sulcus not well expressed; a short, straight, nearly vertical, posterior ridge is separated from the posterior margin by a smooth region. Female carapace similar in outline but proportionately higher; the inflated brood cavity is expressed externally as a distinct, vertically elongated, local swelling that does not reach to either the dorsal or ventral margin and is bounded posteriorly by the straight vertical ridge, which is slightly less distinct than in the male. A delicate micro-ornament of numerous, very tiny pits outlines a lacy network of ridges bounding polygonal fossae; the floors of these fossae are also densely pitted. Occasional oval fossae with smooth floors (unpitted) interrupt the pattern; in reflected light they appear darker than the polygonal fossae.

Male sixth limb with large, recurved, pediform palp. Anterodorsal edge of furca much thickened to form a solid, crescentic swelling; posterodorsal seta greatly enlarged, longer and thicker and the others, curving up and back. Hemipenis about twice as long as high, with sinuous outline, tapering distally to a downward-pointing, bulbous projection; copulatory tube long, curved in J-shape.

Remarks.—This species is externally quite similar to *Cytherella kornickeri*, with which it frequently occurs. It can be distinguished by its greater height to length ratio, the more inflated females, the pitted micro-ornament, oval spots, and soft-part characters.

Cytherella pandora Kornicker, 1963, a Bahamian species, has similar shape and micro-ornament, but only the females are said to have this micro-ornament (Kornicker, 1963). It also lacks the external vertical ridge, the

Fig. 3. *Cytherella bermudensis* Maddocks, n. sp. A-F, H-J, male USNM 216414; G, male USNM 216415. A, F, maxillule; B, hemipenis; C, sixth limb; D, furca; E, antennule; G, antenna; H, base of sixth limb; I, vibratory plate of fifth limb; J, fifth limb without vibratory plate. Magnifications: A, C, G, × 385; B, D-F, H-J, × 155.

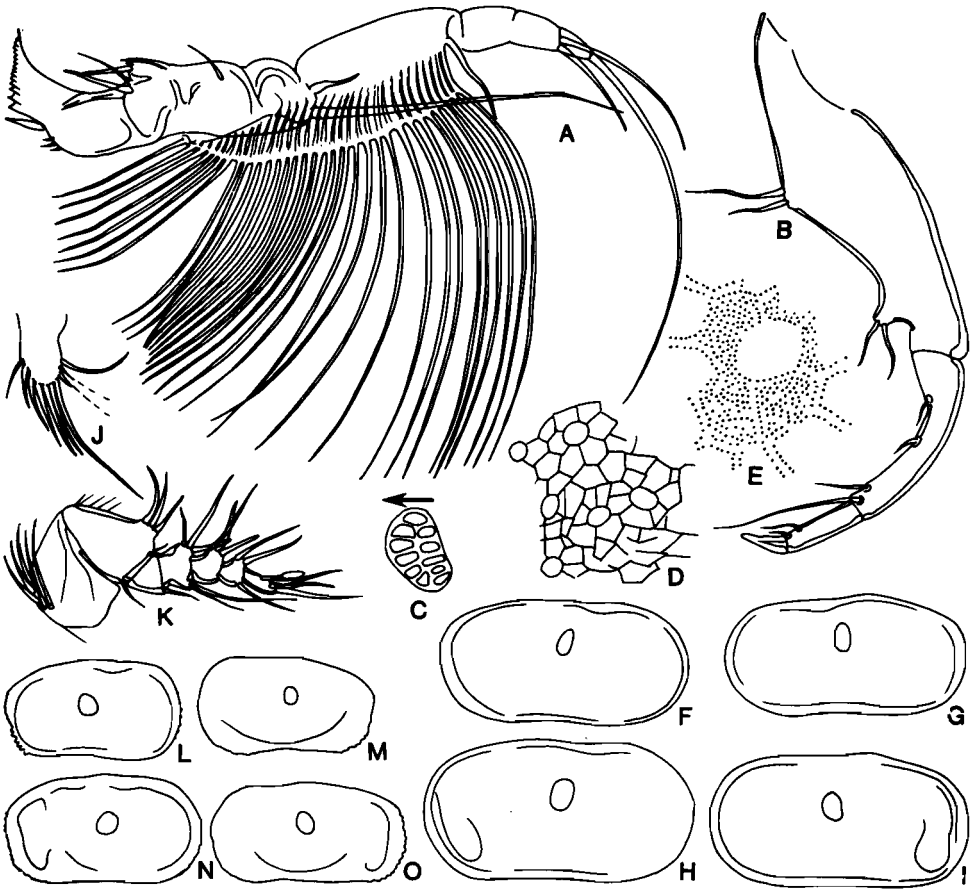


Fig. 4. A-I, *Cytherella bermudensis* Maddocks, n. sp. A, male USNM 216415; B, C, F, G, male USNM 216414; D, E, H, I, female (?) USNM 216416. A, mandible; B, palp of fifth limb; C, left exterior adductor muscle-scar pattern; D, carapace micro-ornament in posterolateral region, consisting of fine ridges and polygonal fossae with occasional oval fossae; E, same at higher magnification, showing that the polygonal fossae are finely pitted, and the ridges are outlined by lines of these pits, but the oval fossae are smooth; F, G, right and left valve exteriors of male; H, I, right and left valve exteriors of female. Magnifications; A, B, × 385; C, D, × 130; E, × 320; F-I, × 45. J-O, *Cytherelloidea irregularis* Brady. J, K, female USNM 216424; L, M, male (?) 2478W USNM 216425; N. O, female (?) 2479 USNM 216425. J, sixth limb; K, antennule; L, M, right and left valve exteriors of male (?); N, O, right and left valve exteriors of female (?). Magnifications: J, K, × 155; L-O, × 45.

female brood cavity is not externally demarcated, and the hemipenis is much longer and differently terminated. An undescribed species in the Florida Keys has similar micro-ornament but more elaborate posterior swelling and ridge. Another similar but undescribed species has been seen in collections from Belize.

Cytherella kornickeri Maddocks, n. sp. (figs. 5, 18C, D)

Material.—13 specimens in alcohol, including 4 males, 1 female, 7 juveniles, and 1 empty, and 18 subfossil specimens.

Types.—Holotype male USNM 216418, paratypes USNM 216419-216423.

Type locality.—Palm Cave, Bermuda.

Occurrence.—In Palm Cave, 20/I/82, 1 specimen. In Cherry Pit Cave, 23/VI/82, 3 specimens. In Myrtle Bank Cave, 31/I/82, 5 specimens; 7/II/82, 1 specimen. In Walsingham Cave, 18/II/82, 3 specimens. In 5 shallow-water sediment samples from Ferry Reach and Castle Harbour, 18 subfossil specimens.

Derivation of name.—For Louis S. Kornicker, who described Bahamian species of *Cytherella*.

Dimensions.—Male USNM 216415, RV L 0.71 mm, H 0.35 mm, LV L 0.70 mm, H 0.34 mm. Female USNM 216421, RV L 0.75 mm, H 0.41 mm, LV L 0.74 mm, H. 0.38 mm.

Diagnosis.—Male carapace compressed, ovate-subquadrate in lateral view, with shallow ventral indentation, gently sloping posterodorsal margin, obliquely truncate posterior margin and smoothly curving posterior region without any ridge. Female carapace larger, proportionately higher, rounded-subquadrate in lateral outline, without ventral indentation; posterior region gradually inflated, slightly expanded dorsally and ventrally to meet but not overhang the dorsal and ventral margins, not set off from medial region by any break in slope, bounded posteriorly by a distinct vertical ridge. Surface covered with a delicate, polygonal network of low, thin ridges, with the horizontal ridges more continuous than the vertical connecting ridges, the whole pattern very faint in reflected light; both the ridges and intervening polygonal fossae are smooth, without pits.

Anterodorsal edge of furca much thickened to form a solid crescentic swelling; posterodorsal seta greatly enlarged, longer and thicker than others, curving up and back. Hemipenis small, wedge-shaped, nearly equilateral-triangular, with short, thick, nearly straight copulatory tube; two small triangular lamellae project distally. The male sixth limb has no pediform palp and resembles that of the female.

Remarks.—This species is externally similar to *Cytherella bermudensis*, with which it often occurs, but it may be distinguished by its slightly more elongate males without a vertical posterior ridge, more inflated females without external demarcation of the brood chamber from the domicilium, the absence of pitted micro-ornament, and by soft-part characters.

The four males dissected show no trace of the palp of the sixth limb.

This species is similar in shape and reticulate micro-ornament to *Cytherella arostrata* Kornicker, 1963, a Bahamian species, but differs by greater proportional height, the posterior ridge of the female, the absence of two separate egg-depressions in each brood cavity, absence of an external demarcation of the brood cavity from the adjacent domicilium, and soft-part characters. *Platella muelleri* Puri, 1960, may have similar micro-ornament, but the original descrip-

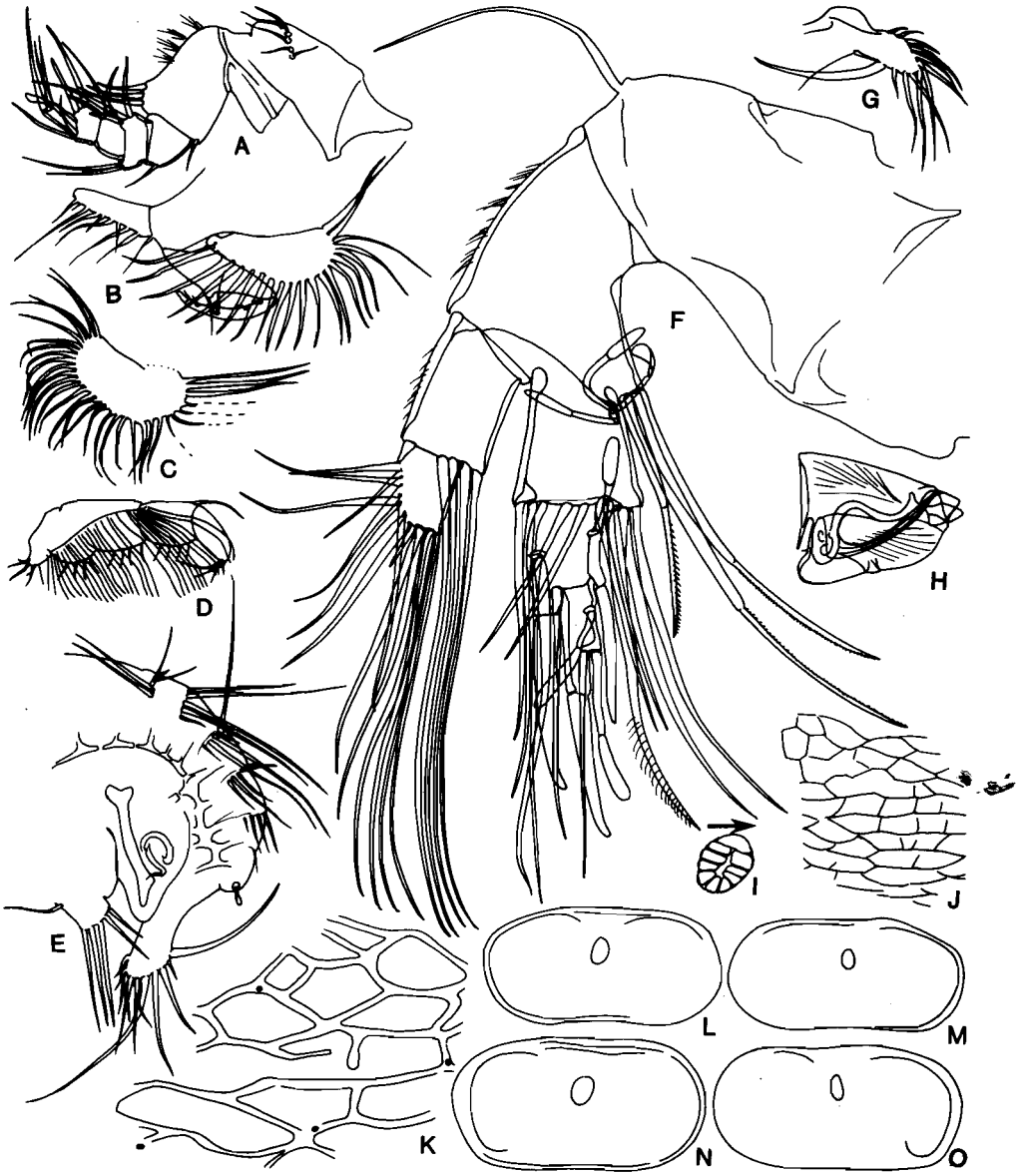


Fig. 5 *Cytherella kornickeri* Maddocks, n. sp. A, F-M, male USNM 216418; B-D, male USNM 216419; E, female 2468F USNM 216419.; N, O, female 2476 A USNM 216420, antennule; B, fifth limb; C, vibratory plate of maxillule; D, maxillule without vibratory plate; E, posterior region of female body with sixth limb, genital lobe, furca, postabdominal sensory (?) bristle, dorsal setae, and vestigial segmentation (?); F, antenna; G, furca; H, hemipenis; I, right exterior adductor muscle-scar pattern; J, K, carapace micro-ornament of thin ridges, smooth polygonal fossae, and small simple normal pore canals; L, M, right and left valve exteriors of male; N, O, right and left valve exteriors of female. Magnifications: A-E, G, H, × 155; F, × 385; I, J, × 130; K, × 320; L-O, × 45.

tion appears to be based on juveniles and needs revision. Similar undescribed species occur elsewhere in the Caribbean.

Genus *Cytherelloidea* Alexander, 1929

Cytherelloidea irregularis (Brady, 1880) (figs. 14J-0, 18E, F)

Cytherella irregularis Brady, 1880: 178, pl. 43 fig. 3a-c; Puri & Hulings, 1976: 312, pl. 24 fig. 10.

Material.—5 specimens in alcohol, including 3 females and 2 juveniles, and 150 subfossil specimens, USNM 216423-216425.

Occurrence.—In Little River Cave, 22/VI/82, 3 specimens. In Myrtle Bank Cave, 31/I/82, 1 specimen. In 16 shallow-water sediment samples from Castle Harbour, North Lagoon, South Shore and the South Reef, 150 subfossil specimens.

Dimensions.—Male USNM 216425, RV L 0.53 mm, RV H 0.30 mm, LV L 0.53 mm, H 0.29 mm. Female USNM 216425, RV L 0.58 mm, H 0.33 mm, LV L 0.58 mm, H 0.30 mm.

Distribution.—Brady described this species from Challenger Station 33 off Bermudas, depth 435 fathoms.

Diagnosis.—Male left valve oblong-subquadrate in lateral view with greatest height near anterior, tapering posteriorly, with distinct ventral indentation and angulate dorsal margin, obliquely truncate posterior margin. A thick smooth ridge parallels the anterior margin and is connected with it by about 10 cross-bars that separate deep marginal pits. A thick vertical ridge with numerous tubercles and denticles occupies the compressed posterior region and is separated from the swollen lateral surface by an abrupt constriction. A deep muscle-scar pit and weak anterodorsal and posterodorsal sulci are located dorsally. The undulating lateral surface rises to indistinct nodose swellings just above the muscle-scar pit, posterodorsally and posteroventrally. It is covered with a dense network of small irregular pits, aligned so as to define a reticulate pattern. Right valve similar but with more oblique posterior margin, anterior ridge lower, without cross-bars or marginal pits, set farther from anterior margin, and covered by faint reticulate pattern. Female valves similar, larger, proportionately higher, with two posterior egg-cavities expressed externally as swellings, separated from each other and from the adjacent lateral surface by depressions that are bridged by narrow ridges rising from the ornament.

Remarks.—The densely pitted-reticulate micro-ornament and the absence of all but marginal ridges separate this species from most other Caribbean species. No other species of *Cytherelloidea* is known on Bermuda.

Suborder PODOCOPINA Sars, 1866

Superfamily BAIRDIACEA Sars, 1888

Family BAIRDIIDAE Sars, 1888

Genus *Neonesidea* Maddocks, 1969

Neonesidea omnivaga Maddocks, n. sp. (fig. 6)

Material.—15 specimens in alcohol, including 9 females, 2 juveniles, and 4 empty valves, and 50 subfossil specimens.
Types.—Holotype female USNM 216426, paratypes USNM 216427-216431.
Type locality.—Harrington Sound.
Occurrence.—In Harrington Sound, 9 specimens. In Cherry Pit Cave, 12/I/84, 1 specimen. In Green Bay Cave, 4/III/82, 1 specimen. In Palm Cave, 20/I/82, 3 specimens. In mixed contents of broken vials, 2 specimens. In reef and lagoon sediments of North Lagoon, Harrington Sound, Castle Harbour, and the South Shore, 50 specimens.
Derivation of name.—Latin *omnivagus*, roving everywhere.

Dimensions.—Female USNM 216428, RV L 0.54 mm, H 0.29 mm, LV L 0.54 mm, H 0.31 mm.

Diagnosis.—Female carapace smooth, translucent white with amber setae and small, elongate, central opaque spot but no other opaque spots; greatest thickness located at about one-third length and about one-third length, just anteroventral to muscle-scar pattern, carapace tapering continuously from there in all directions; adductor muscle scars grouped into four elongate scars; left valve with angulate, five-sided lateral outline, weak ventral indentation, only moderately extended caudal extremity, with a few very tiny posteroventral marginal denticles; right valve smaller, more angulate, without marginal denticles. Appendage structure normal for the genus. Presumed males smaller and not as high, no soft parts available.

Remarks.—The species reported as *Neonesidea gerda* (Benson & Coleman, 1964) by Maddocks (1969d) from Florida and the Bahamas and as *Neonesidea longisetosa* (Brady, 1902) by Teeter (1975) in Belize are twice as large, have somewhat more rounded contours, and have additional anterior, posterior, and posterodorsal opaque spots; the thoracic legs of *N. gerda* have more elongate distal podomeres and claws. The species illustrated by Puri (1960) under the name *Bairdia crosskeyana* Brady, 1866, is similar in shape but larger and more elongate with a gently arched dorsal margin. Samples from the Florida keys yield similar specimens that are slightly larger than *N. omnivaga*, with a higher anterior angle, less distinct posterodorsal angle, and additional anterior and posterior opaque spots.

Genus *Paranesidea* Maddocks, 1969

Paranesidea sterreri Maddocks, n. sp. (figs. 17A-N, 18I, J)

Material.—21 specimens in alcohol and 187 subfossil specimens.
Types.—Holotype male USNM 216432, paratypes USNM 216433-216435.
Type locality.—Deep Blue Pool, Bermuda.

Fig. 6. *Neonesidea omnivaga* Maddocks, n. sp. A-H, female USNM 216426; I-K, female (?) USNM 216428. A, B, antenna; C, both furcae; D, sixth limb; E, seventh limb; F, mandible; G, maxillule; H, fifth limb; I-K, dorsal, right and left valve exteriors. Magnifications: A, ×385; B-H, ×155; I-K, ×70.

Occurrence.—In Deep Blue Pool, 23/III/82, 5 specimens. In Harrington Sound, 10 specimens. In Grenadier Pool, 21/XI/81, 2 specimens. In sediment and algal samples from Harrington Sound, Castle Harbour, Ferry Reach, North Lagoon, and South Shore reefs, 187 subfossil specimens and 4 specimens in alcohol.

Derivation of name.—For Dr. Wolfgang Sterrer, Director, Bermuda Biological Station.

Dimensions.—Male USNM 216434, RV L 0.79 mm, H 0.39 mm, LV L 0.67 mm, H 0.44 mm. Female USNM 216434, RV L 0.78 mm, H 0.44 mm, LV L 0.76 mm, H 0.49 mm.

Diagnosis.—Carapaces in alcohol translucent white, well-preserved subfossil carapaces clear with an elaborate opaque-white patch pattern, fresh carapaces with dark brown lining the interior except for a small, irregular clear spot in the anterodorsal region and sometimes a smaller clear spot posteromedially; exterior densely pitted with small, round punctae, spaced more widely than the diameter of these punctae; long brown external setae. Male left valve with rounded contours in lateral view, greatest height located at midlength, dorsal margin highly and broadly arched, ventral margin gently rounded, without angles, with small anteroventral and posteroventral marginal denticles; left valve angulate, upright, with anteroventral and posteroventral striate marginal frills; female larger and proportionately much higher.

Hemipenis with slender basal and middle lobes, distal lobe small, elongate-oblong, without heavily chitinized protuberances, swellings or setae; copulatory tube short, somewhat arched.

Remarks.—*Paranesidea harpago* (Kornicker, 1961), *Paranesidea gigacantha* (Kornicker, 1961), and *Paranesidea arostrata* (Kornicker, 1961), described from the Bahamas and Florida, have very different shapes, opaque patterns, and structure of hemipenes; *P. gigacantha* has a smooth exterior. *Paranesidea* sp. 1, reported by Maddocks (1974) from the Flower Gardens, Gulf of Mexico, is twice as large and completely smooth, with a different opaque pattern and hemipenis.

Paranesidea bensoni Teeter, 1975 (fig. 7 O)

Paranesidea bensoni Teeter, 1975: 417, fig. 3b-d, 4b.
Bairdia sp. cf. *B. bradyi* van den Bold (part), Benson & Coleman, 1963: 18, pl. 2 figs. 1-3, text-fig. 7.
Bairdia milne-edwardsi Brady, Puri, 1960: 131, pl. 6 figs. 14, 15.
Bairdia sp. C, Van den Bold, 1966: p. 55, pl. 2 fig. 5a, b.

Material.—4 empty valves in alcohol and 104 subfossil specimens, USNM 216460-216462.
Occurrence.—In Green Bay Cave, 5/IX/81, 1 specimen. In Harrington Sound, 2 specimens. In lagoon and reef sediment samples from North Lagoon, Ferry Reach, Castle Harbour, and south of Somerset, 105 specimens.

Distribution.—Teeter (1975) described the species from reef sediments of Belize. It is also known to occur in similar environments of Florida, Cuba, and the Bahamas.

Remarks.—A juvenile of a very similar species was described as *Bairdoppilata*? species 1 by Maddocks (1975) from intertidal algae on Ascension Island. The assignment to *Bairdoppilata* was based on soft-part characters, which are not yet known for *P. bensoni*. *P. bensoni* differs from the Ascension species in the

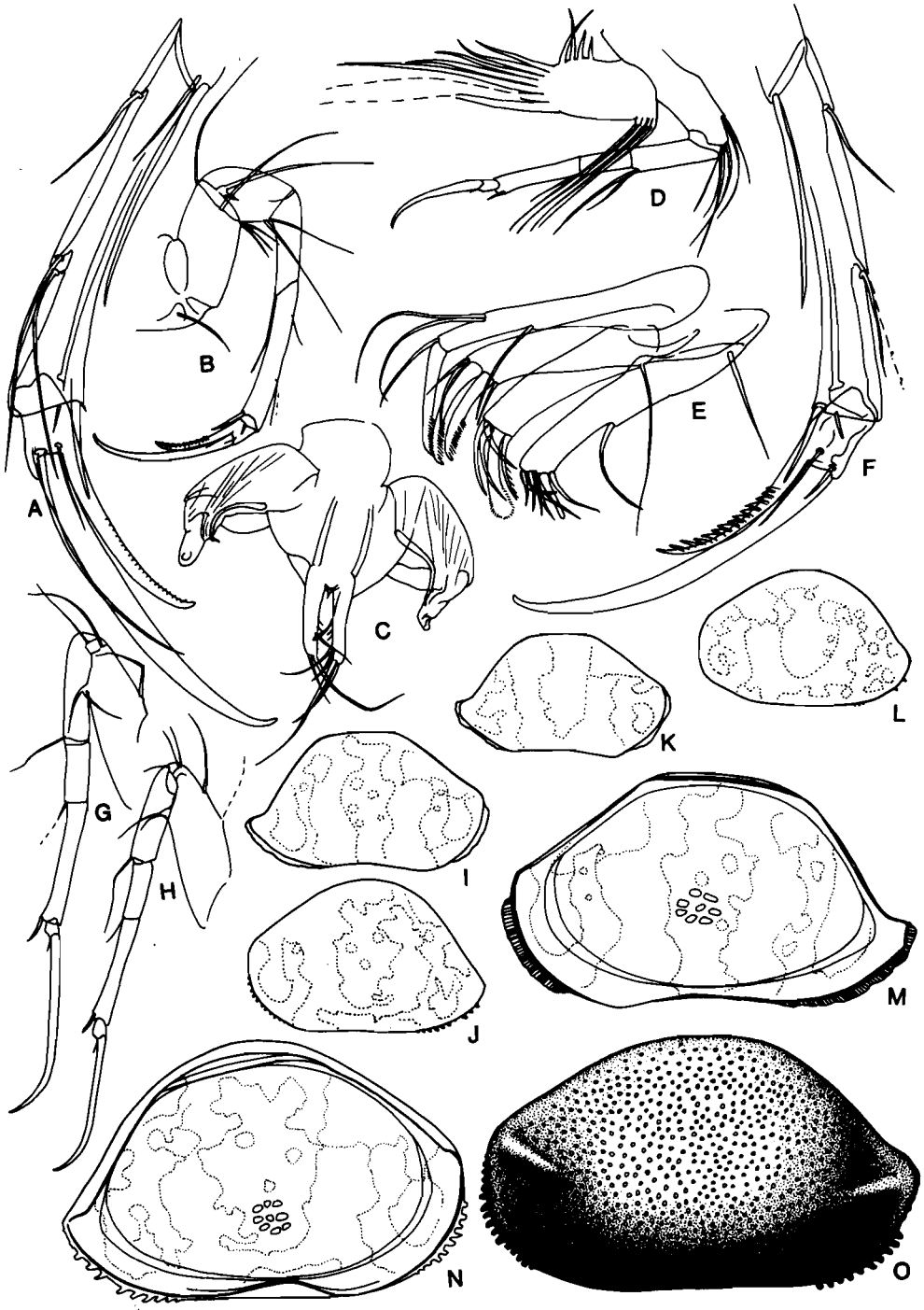


Fig. 7. A-N, *Paranesidea sterreri* Maddocks, n. sp. A, female USNM 216433; B-H, male USNM 216432; I, J, M, N, female 953F USNM 216434; K, L, male 952M USNM 216434. A, B, F, antenna; C, hemipenes and furcae; D, fifth limb; E, maxillule; G, seventh limb; H, sixth limb; I, J, female right and left valve exteriors; K, L, male right and left valve exteriors; M, N, female right and left valve interiors. Magnifications: A, E, F, ×385; B-D, G, H, ×155; I-L, ×89; M, N, ×70. O, *Paranasidea bensoni* Teeter, male (?) USNM 216460, left valve exterior, ×70.

following characters: "adult carapace very much larger and thicker-walled; left valve outline more rounded, with more arched dorsal margin, without ventral indentation; individual pits smaller and shallower, with more smooth area between pits, punctate texture of surface only slightly more pronounced than in typical *Paranesidea*; left valve with both anterior and posterior margins denticulate; calcified inner lamella very thick-walled, with shallow vestibules and prominent selvage" (Maddocks, 1975: 63). The juveniles have similar shape to the adult but are nearly smooth and lack the anterior and posterior ridges. Neither adults nor juveniles have accessory bairdoppilatan dentition. The compressed shape, thickened and ridged ornament, and uniform opaque white color show that it does not belong to *Paranesidea* in the strict sense. It is very likely that both the Ascension and the Bermuda-Caribbean species should eventually be moved to *Glyptobairdia* or to a new genus, but this must await the study of soft-part characters and perhaps additional species.

Genus *Aponesidea* Maddocks, new genus

Type species.—*Aponesidea iliffei* Maddocks, n. sp.

Other species included.—*Bairdia problematica* Hartmann, 1974, described from the coast of Angola, may belong to this genus, but the soft parts are unknown.

Derivation of name.—Greek *apo*, away from, at a distance from, plus *Nesidea* Costa, 1847.

Diagnosis.—The following diagnosis is based only on *Aponesidea iliffei* and may need revision after other species become known.

Carapace of typically bairdian shape but laterally inflated and ventrally flattened, smooth, with anteroventral and posteroventral marginal denticles on the left valve, marginal frills on the right valve. Fused claw of antenna coarsely serrate, with only 5-6 barbs that decrease rapidly in size, nearly as strongly serrate in the female as in the male; anterodistal seta short in the male, long in the female; distal claw smooth and tapering to a slightly bent point in both sexes. Vibratory plate of fifth limb has two unfeathered setae segregated proximally in both sexes. Furca with seven setae, the second very long and feathered, the first, third, fourth, and fifth of intermediate length, and the sixth and seventh fairly short. Hemipenis massive, elaborate, with very long copulatory tube.

Remarks.—When *Neonesidea* and *Paranesidea* were proposed for two very large species-groups formerly subsumed in "*Bairdia*," Maddocks (1969a) warned that additional accommodation would eventually have to be made for other species both in new genera and by revision of established genera. In particular, a few species show affinities with both *Neonesidea* and *Paranesidea* but cannot be appropriately assigned to either. One such potential genus, which still awaits a name, includes *Bairdia serrata* Müller, 1894, *Bairdia roquebrunensis* Rome, 1942, "Genus Uncertain, species 1" of Maddocks (1969a), and *Bairdia subcircinata* Brady and Norman, 1889. *Aponesidea* is another such species but sufficiently distinctive in its own right to serve as the type of a separate genus, even though the scope of that genus cannot yet be exactly defined.

Externally, its carapace resembles that of *Neonesidea*, particularly the *Neonesidea schulzi* group, but it is somewhat more inflated and considerably more flattened ventrally than is usual except for species of the *Neonesidea dinochelata* group. The furca, the terminal lobe of the hemipenis, the dimorphic anterodistal antennal seta, and the vibratory plate of the fifth limb (though nondimorphic) agree fairly well with *Neonesidea*, but the marginal denticulation, muscle-scar pattern, antennal claws, and absence of opaque spot all are inappropriate for *Neonesidea*. The marginal denticles (left valve) and frills (right valve), the smooth antennal claw, and the serrate fused antennal claw (though nondimorphic) all agree fairly well with *Paranesidea*, but the furca, hemipenis, and smooth carapace without patch pattern clearly do not. Unique characters include the nondimorphic or weakly dimorphic fused antennal claw and vibratory plate of the fifth limb and the excessively long copulatory tube of the hemipenis. The muscle-scar pattern also is distinctive, with four scars closely spaced in a bythocyprid pattern that is elsewhere seen only in Bythocypridinae, Pussellinae, and *Havanardia*, quite distinct from the elongate paired wedges of *Neonesidea* or the eight (divided) equally spaced oval scars of *Paranesidea*. At very high magnification these scars are finely subdivided without consistent pattern; this is reminiscent of *Havanardia*, *Triebelina* and *Pterobairdia*.

The inflated, ventrally flattened carapace and the adductor scar pattern suggest a link with *Havanardia*, even though the prominent ala and punctate ornament are missing. Unfortunately, the soft parts are not known for any of the five living species of *Havanardia* discussed by Keij (1973, 1976). A proposed sixth species, *Havanardia keiji*, resembles *Aponesidea* in characters of the antenna, fifth limb, furca, and hemipenis. In fact, in both carapace and soft-part characters *Havanardia keiji* appears to be morphologically intermediate between the grotesquely alate *Havanardia* and ordinary bairdians. Although it could have been assigned to *Aponesidea*, it is here assigned to *Havanardia*, in spite of the small size of its ala, to emphasize the continuity of this morphoseries. By this interpretation, therefore, *Aponesidea* becomes an important link between the small, ordinary bairdians such as *Neonesidea* or *Paranesidea* with the punctate, alate, reef-specialized *Havanardia* and perhaps *Pterobairdia*.

Aponesidea iliffei Maddocks, n. sp. figs. 8, 9

Material.—177 specimens in alcohol, including 1 male, 4 females, 9 juveniles, and 163 empty valves.

Types.—Holotype male USNM 216436, paratypes USNM 216437-216440.

Type locality.—Cherry Pit Cave, Bermuda.

Occurrence.—In Cherry Pit Cave, 23/VI/82, 12 specimens; 12/I/84, 8 specimens. In Cripplegate Cave, 21/X/81, 1 specimen. In Deep Blue Cave, 28/XI/81, 3 specimens. In Fern Sink Cave, floor, 24/VII/84, 8 specimens. In Green Bay Cave, 18/XI/81, 68 specimens; 9/I/82, 7 specimens; 13/III/84, 2 specimens. In Harrington Sound, 4 specimens. In Myrtle Bank Cave, 31/I/82, 2 specimens. In Palm Cave, 20/I/82, 25 specimens; 29/I/84, 1 specimen. In Straw

Fig. 8. *Aponesidea iliffei* Maddocks, n. sp. A, C, E-L, male USNM 216436; B, D, female USNM 216437. A-C, antenna; D, fifth limb; E, vibratory plate of fifth limb; F, fifth limb without vibratory plate; G, brush-shaped organ plus gland (?); H, antennule; I-K, mandible. Magnifications: A, C-H, J, × 155; B, I, K, L, × 385.

Market Cave, 12/I/84, 1 specimen. In Walsingham Sink Cave, 18/II/82, 6 specimens. In Walsingham Cave, 18/II/82, 6 specimens; 17/II/84, 2 specimens. In mixed contents of broken vials, 3 specimens. No specimens of this species have yet been found in shallow-water lagoon and reef sediment samples from open-water environments on the Bermuda platform.

Derivation of name.—For Dr. Thomas M. Iliffe, who collected the specimens.

Dimensions.—Female USNM 216437, RV L 0.87 mm, H 0.45 mm, LV L 0.87 mm, H 0.47 mm. Male USNM 216436, LV L 0.96 mm, H 0.51 mm, RV not measurable.

Diagnosis.—Carapace medium-sized, entirely smooth, translucent white, without opaque patches or with at most a slightly less transparent, central, vertical band; shape typically bairdian but very inflated and ventrally flattened, greatest thickness located at about one-quarter height, greatest height at about one-third length; anterior and posterior margins of left valve denticulate, anterior and posterior margins of right valve with striate frills; numerous, small, simple normal pore canals but infrequent, fairly short external setae; hinge normal, without accessory dentition.

Antenna with third and fourth podomeres approximately equal in length; distal claw fairly short, smooth, tapering to slightly bent, blunt point in both sexes; anterodistal seta slender and short in male, slender and long in female; posterodistal fused claw distally thickened, coarsely serrate at the tip, with about six barbs tapering rapidly in size. Vibratory plate of fifth limb with two unfeathered setae segregated anteroventrally, close together, the second one shorter than the other in the male specimen (broken or pathological?), two other unfeathered setae widely spaced along the ventral edge of the plate. Furca with seven setae, the second very long and feathered, the first and third of moderate length, the fourth and fifth a little longer, and the sixth and seventh a little shorter. Hemipenes large, massive, with small, hemicircular basal lobe, very large, subquadrangular middle lobe, and fairly large, rounded-subtriangular distal lobe, of which a small region near the tip is papillate, plus an oblong accessory lamella with a terminal hook which overhangs the distal lobe; copulatory tube very long, curled at the base in a hemicircle that is as large as the hemipenis and extends beyond it by at least half its width, then diverted in a U-shape, then tapering rapidly to a flexible straight or crooked termination, which passes through the hook of the terminal lamella.

Remarks.—There is considerable variation in size among adults in the empty carapaces. The single male is larger than either of the dissected females, although there are not enough live specimens to be certain of this trend. This is the reverse of the normal dimorphism in Bairdiidae.

In external appearance this species is intermediate between and can readily be confused with *Neonesidea omnivaga* and *Havanardia keiji*, with which it commonly occurs, so that careful attention must be paid to degree of inflation, ventral flattening, and lateral outline. *Bairdia problematica* Hartmann is much more inflated and more elongate, with a straight dorsal margin.

Fig. 9. *Aponesidea iliffei* Maddocks, n. sp. A, C, D, male USNM 216436; B, E-H, female USNM 216438. A, both hemipenes and furcae; B, right exterior adductor muscle-scar pattern; C, seventh limb; D, sixth limb; E-H, dorsal, right and left valve exteriors. Magnifications: A, C, D, × 155; B, × 130; E-H, × 45.

Genus *Havanardia* Pokorny, 1968

Havanardia keiji Maddocks, n. sp. (figs. 10, 11, 18G, H)

Types.—Holotype male USNM 216441, paratypes USNM 216442-216445.

Type locality.—Harrington Sound, Bermuda.

Material.—One male and 163 empty carapaces in alcohol, 3 subfossil valves.

Occurrence.—In Harrington Sound, 1 specimen. In Deep Blue Cave, 28/XI/81, 15 specimens. In Fern Sink Cave, 25/II/82, 52 specimens; 24/VII/84, 25 specimens. In Green Bay Cave, 9/I/82, 42 specimens. In Palm Cave, 20/I/82, 6 specimens. In Prospero's Cave, 5/II/84, 2 specimens. In Small Fish Pond, 15/XI/81, 1 specimen. In Walsingham Cave, 18/II/82, 1 specimen. In Walsingham Sink Cave, 18/II/82, 22 specimens. In Wonderland Cave, 25/VII/84, 1 specimen. In reef sediments of Castle Harbour and the South Shore reef, 3 specimens.

Derivation of name.—For A. J. Keij, for his studies on *Havanardia* and *Triebelina*.

Dimensions.—Male USNM 216441, RV L 1.11 mm, H 0.61 mm, LV L 1.09 mm, H 0.66 mm.

Fig. 10. *Havanardia keiji* Maddocks, n. sp., all male USNM 216441. A, antennule; B, C, antenna; D-F, mandible; G, seventh limb; H, sixth limb; I, brush-shaped organ; J, K, maxillule. Magnifications: A, B, D, G-J, × 155; C, E, F, K, × 385.

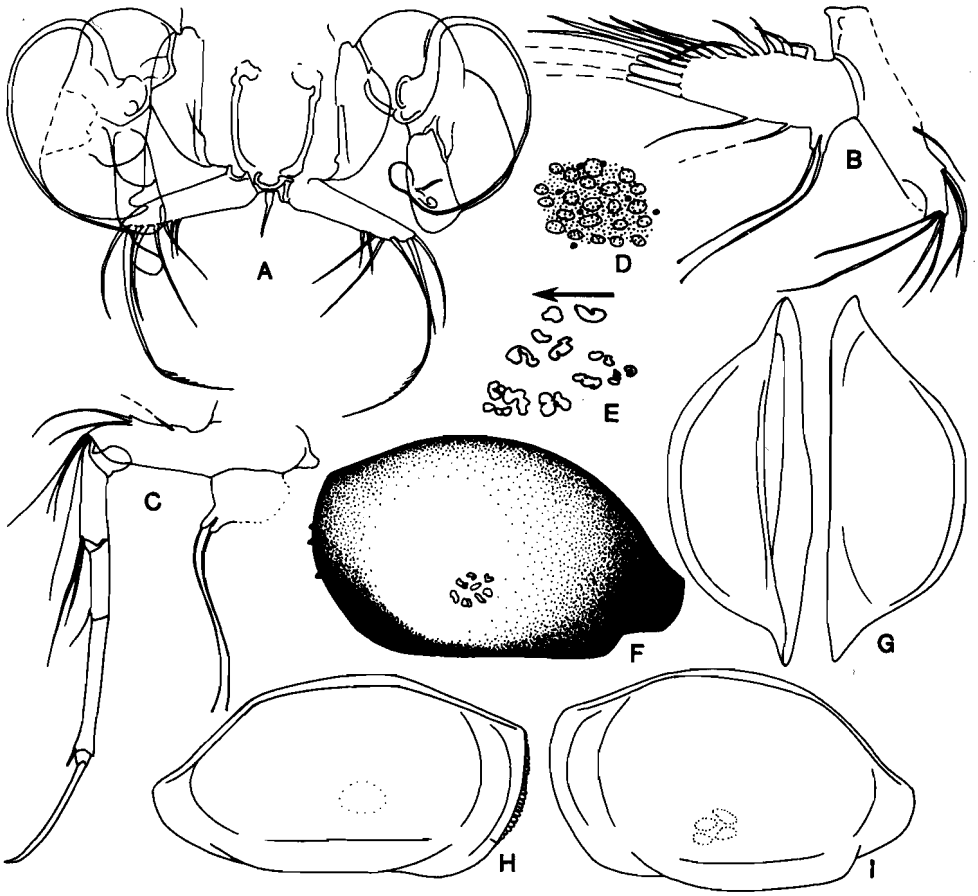


Fig. 11. *Havanardia keiji* Maddocks, n. sp. A-C, G-I, male USNM 216441; D, USNM 216442; E, F, instar-1 USNM 216443. A, both hemipenes and furcae; B, basal podomere and vibratory plate of fifth limb; C, fifth limb; D, carapace micro-ornament of shallow oval punctae, numerous very tiny pits, and small simple normal pore canals; E, left exterior adductor muscle-scar pattern; F, left valve exterior of instar-1 without distinct ala; G-I, dorsal, right and left valve exteriors of adult male with narrow ala. Magnifications: A-C, × 155; D, × 130; E, × 200; F, × 70; G-I, × 45.

Diagnosis.—Carapace medium-sized, only moderately robust, greatly inflated ventrolaterally, ventrally sharply flattened, with flat ventral surface set off from lateral surface by a narrow, diagonally sloping, ventrolateral ala; surface covered with numerous, shallow, oval punctae plus superimposed micro-ornament of densely spaced tiny pits. Left valve bairdian in lateral view, with obliquely truncate, denticulate anterior margin, greatest height located at about one-third length, broadly rounded dorsal margin sloping steeply to curved, truncate, short caudal process located below one-third height, nearly

straight ventral margin, overlapped in lateral view by posterior sweep of posteriorly sloping ala; right valve complementary, more angulate in outline, with narrow anterior marginal frill; valves marginally compressed and medially inflated in dorsal view, with greatest thickness at about one-third of length. Hinge normal bairdian, without accessory denticles; narrow anterior and posterior vestibules; adductor muscle-scar pattern located ventrally, just above ala, consisting of numerous, tiny, irregular spots grouped in four scars in the bythocyprid pattern.

Antenna with fourth and fifth podomeres of equal length, distal claw of male rather short, smoothly tapering to small bent point, without hook; anterodistal seta of male short; posterodistal fused claw of male distally serrate, with about six thick, long, comb-like barbs at its tip, remainder of claw smooth. Palp and first two masticatory processes of maxillule carying one to three enlarged, curved, clawlike setae, none widened or flattened into brush- or spatula-shape. Vibratory plate of male fifth limb has two featherless setae of equal length segregated anteriorly and proximally. Furca with seven setae, second long and feathered, first, third, fourth, and fifth of medium length, sixth and seventh quite short. Hemipenis large, compact, with crescentic basal lobe, hemicircular and inflated medial lobe, large, oblong distal lobe, and capped distally by an oblong lamella with a terminal hook-shaped opening like an old-fashioned bottle-opener; copulatory tube long, coiled in broad hemicircle that is nearly as large as the hemipenis and extends ventrally beyond it, terminating in a slender flexible tip that passes through the opening of the distal lamella.

Remarks.—This is the first species of *Havanardia* for which the soft parts have been described, but it may not be typical. The carapace and soft-part characters of this species show definite affinities with *Aponesidea*, differing primarily in the punctate and pitted ornament, the narrow ala, the masticatory processes of the maxillule, and the shorter copulatory tube. The overall shape, distal antennal claws and setae, and distal lamella of the hemipenes are remarkably similar. This species could equally well have been assigned to *Aponesidea.* It is here assigned to *Havanardia* to emphasize its morphologically intermediate character. Together with *Aponesidea* it serves to link the more ordinary bairdiids such as *Neonesidea* and *Paranesidea* with the more flamboyant species of *Havanardia* and perhaps *Pterobairdia.*

Unfortunately, only one adult male and no adult females were available for study, so that dimorphism cannot be reliably established. The empty carapaces show variation in size, and it is likely that females are overall larger than males.

This species differs distinctly from the previously known Caribbean and West African species of *Havanardia* by its much narrower ala, the straight, posteriorly sloping course of that ala, and the ventral position of its caudal process.

Genus *Glyptobairdia* Stephenson, 1946

Glyptobairdia coronata (Brady, 1870)

Bairdia coronata Brady, 1870: 243, pl. 32 fig. 9.
Triebelina coronata (Brady), Stephenson, 1947: 578; Key, 1954: 330, pl. 4 fig. 2; Puri, 1960: 131, pl. 6 figs. 1, 2; van Morkhoven, 1958, pl. 46 figs. 1-6; Rome, 1960: 1.
Bairdoppilata (*Glyptobairdia*) *coronata* (Brady), Maddocks, 1969a: 84, fig. 44a-g; Teeter, 1975: 42, figs. 3h, 4f.
Glyptobairdia coronata (Brady), Van den Bold, 1971: 336, pl. 3 fig. 6; Van den Bold, 1974: 33.
Glyptobairdia bermudezi Stephenson, 1946: 346, pl. 42 figs. 1-3.

Material.—7 specimens in alcohol and 71 subfossil specimens, USNM 216463-216465.
Occurrence.—In Cripplegate Cave, 21/X/81, 4 specimens. In Green Bay Cave, 5/IX/81, 1 specimen; 4/III/82, 1 specimen. In Harrington Sound, 1 specimen. In 17 sediment samples from reef and lagoon environments of the South Shore, South Reef, Castle Harbour, North Lagoon, Harrington Sound, and south of Somerset, 71 subfossil specimens.

Distribution.—This species has been reported from the Bahamas, the Florida keys, the Gulf of Paria, and Belize, always associated with the reef front.

Genus *Anchistrocheles* Brady & Norman, 1889

Anchistrocheles hartmanni Maddocks, 1976

Anchistrocheles hartmanni Maddocks, 1976: 204, pl. 1 figs. 12-16, pl. 2 figs. 4-6, pl. 3 figs. 13-16, pl. 4 figs. 1-15.

Material.—In Fern Sink Cave, 25/III/82, 1 specimen. In mixed contents of broken vials, 1 specimen, USNM 216466.

Distribution.—Maddocks (1976) described this species from living and subfossil specimens collected in coralline sand off St. David's Head and on the South Slope of Bermuda. It has not been seen in sediments from lagoonal environments.

Superfamily CYPRIDACEA Baird, 1845

Family PONTOCYPRIDIDAE Müller, 1894

Genus *Propontocypris* Sylvester-Bradley, 1947

Subgenus *Propontocypris* Sylvester-Bradley 1947

Propontocypris (Propontocypris) minacis Maddocks, n. sp. (fig. 12)

Material.—11 specimens in alcohol and 4 subfossil specimens.
Types.—Holotype male USNM 216446. paratypes USNM 216447.

Fig. 12. *Propontocypris minacis* Maddocks, n. sp. A, C-N, male USNM 216446; B, O-Q, female USNM 216447. A, mandible; B, female fifth limb; C, furca; D, antennule; E, F, male fifth limbs; G, antenna; H, sixth limb; I, seventh limb; J, Zenker's organ; K, hemipenis; L, maxillule; M, N, male right and left valve exteriors with testes; O, P, female right and left valve exteriors with ovaries; Q, right exterior muscle-scar pattern. Magnifications: A, G, L, × 385; B-F, H-K, × 155; M-P, × 45; Q, × 130.

Type locality.—Tucker's Town Cave, Bermuda.

Occurrence.—In Tucker's Town Cave, 11/II/82, 11 specimens. In sediment samples from Castle Harbour and the South Slope, 4 specimens.

Derivation of name.—Latin *minax, minacis*, jutting out, projecting, overhanging, for the structure of the hemipenes.

Dimensions.—Male USNM 216446, RV L 0.83 mm, H 0.35 mm, LV L 0.83 mm, H 0.35 mm. Female USNM 216447, RV L 0.83 mm, H 0.36 mm, LV L 0.82 mm, H 0.34 mm.

Diagnosis.—Carapace small, yellow, poorly calcified, smooth, with densely scattered normal pore canals and short exterior setae; valves nearly symmetrical, elongate-subtriangular in lateral view, with greatest height located at about one-quarter length at distinct anterodorsal angle, steeply sloping, nearly straight dorsal margin, indistinct posterodorsal angle, narrowly rounded posterior angle located ventrally, ventral margin straight, not posteriorly upswung, with weak or no ventral indentation; posterior and posterodorsal region of right valve edged with a continuous, serrate chitinous flange (not denticles); adductor muscle-scar pattern located dorsally, consisting of five elongate scars in pontocyprid arrangement; ovaries and testes carried posteriorly between valve lamellae.

Palps of male fifth limbs small, nearly symmetrical; basal podomere with small ventral peg, small ventral seta, fairly long dorsal seta; distal hook of moderate size, recurved through more than 90° on both legs, with prominent sensory (?) seta arising ventrally near inside of curve. Distal setae of seventh limb short, consisting of a short pectinate seta with about six hairlike barbs, a longer simple seta, and two shorter simple setae. Furca with six moderately long, curved setae, the distal ones only slightly thickened. Hemipenis small, elongate; basal part hemicircular with broadly rounded ventral margin; distally elongated, terminating in fingerlike projection plus overlying accessory lamellae; copulatory tube short, thick, irregularly wavy but not coiled, originating at about two-thirds length of basal part, reaching beyond and below distal projection to form scissor-like extension. Zenker's organ rather small, a simple narrow tube, hardly if at all inflated at the ends, drawn up in S-shape by the attached longitudinal muscles; vas deferens a narrow tube.

Remarks.—In spite of the very elongate carapace with straight venter, this species has few of the soft-part characters listed by Maddocks (1969b: 43, based largely on illustrations by Müller, 1894) as diagnostic of *Pontocypris*. Although the serrate posterior margin of the right valve and the slender, sigmoid Zenker's organ are hitherto known only in species of *Pontocypris*, the characters of the antennule, mandible, fifth limb, seventh limb, and furca are those of *Propontocypris* (*Propontocypris*). The hemipenis is unlike any previously described. The species appears to be morphologically intermediate between *Pontocypris* and *Propontocypris* (*Propontocypris*) but closer to the latter.

The very elongate carapace and unusual hemipenis easily distinguish this species from all named north European and Mediterranean species of *Pon-*

tocypris and *Propontocypris* (*Propontocypris*). Although species of these genera occur in the Caribbean and Gulf of Mexico, few have been named and none are known to be similar to this one.

Propontocypris (Propontocypris) sp. 1

Material.—6 empty juvenile carapaces in alcohol, USNM 216467.
Occurrence.—In Palm Cave, 20/I/82, 1 specimen. In Roadside Cave, 12/XI/82, 4 specimens. In Walsingham Cave, 18/II/82, 1 specimen.

Remarks.—These specimens are decalcified, fragmentary and juvenile, so that diagnostic characters cannot be observed.

Propontocypris (Propontocypris) sp. 2

Material.—2 females and 1 empty valve in alcohol, USNM 216468.
Occurrence.—In Deep Blue Pool, 23/III/82, 2 specimens. In sediment and *Cymopolia* from Ferry Reach, 1 specimen.

Remarks.—This species is similar to *P.* (*P.*) *minacis* but smaller, less elongate, and less acutely terminated posteriorly.

Subgenus *Ekpontocypris* Maddocks, 1969

Propontocypris (Ekpontocypris) lurida Maddocks, n. sp. (fig. 13)

Material.—6 specimens in alcohol and 26 subfossil specimens.
Types.—Holotype male USNM 216448, paratypes USNM 216449-216451.
Type locality.—Deep Blue Pool, Bermuda.
Occurrence.—In Deep Blue Pool, 23/III/82, 4 specimens. In Christie's Cave, 24/XI/82, 1 specimen. In Walsingham Cave, 13/VII/84, 1 specimen. In sediment samples from Ferry Reach, Castle Harbour, and North Lagoon, 26 specimens.
Derivation of name.—Latin *luridus*, pale yellow, for the color of the carapace.

Dimensions.—Male USNM 216448, RV L 0.57 mm, H 0.24 mm, LV L 0.53 mm, H 0.23 mm.

Diagnosis.—Carapace small, yellow, poorly calcified, flexible, with numerous simple normal pore canals and numerous, fairly long external setae; right valve elongate-ovate in lateral view with broadly arched dorsal margin, no distinct dorsal angle, greatest height located just ahead of midlength, anterior margin bluntly rounded, ventral margin sinuous with distinct ventral indentation, posterior margin broadly rounded; left valve distinctly smaller, with nearly straight ventral margin; carapace moderately inflated, greatest thickness located at about one-third height and midlength; adductor muscle-scar pattern located slightly dorsally, composed of five subquadrate scars in the usual arrangement for *Ekpontocypris*; deep anterior and posterior vestibules, numerous short radial pore canals. Ovaries and testes carried in posterior region of carapace between lamellae.

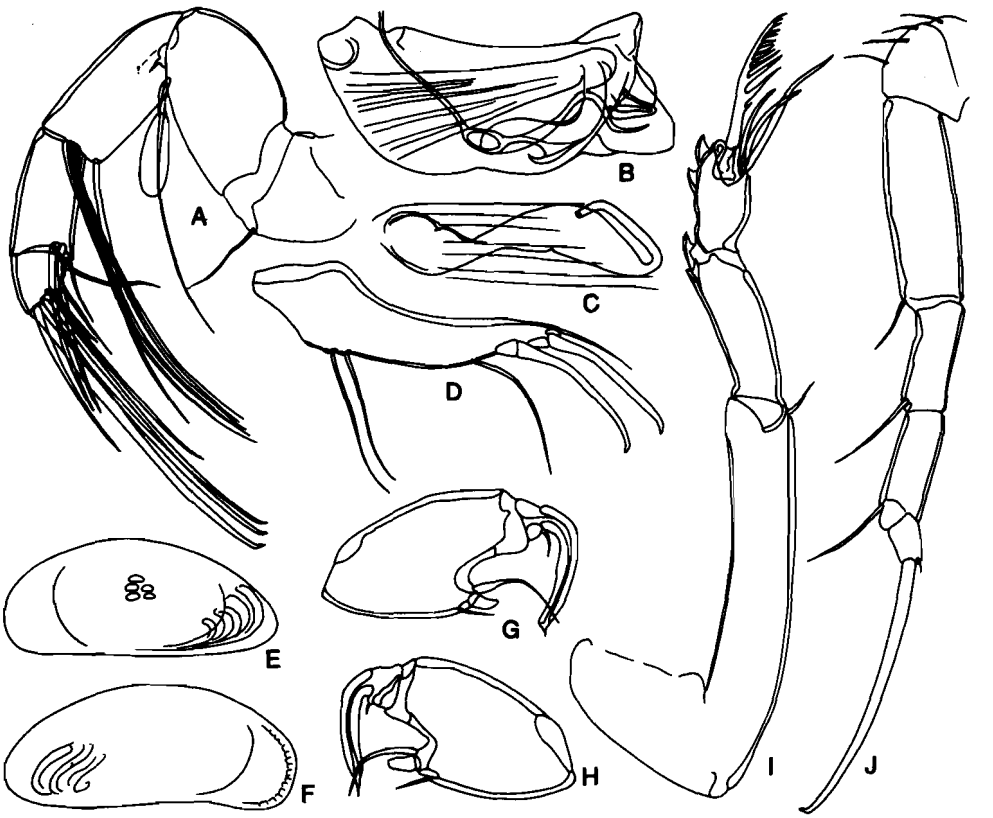


Fig. 13. *Propontocypris* (*Ekpontocypris*) *lurida* Maddocks, n. sp., all male USNM 216448. A, antenna; B, hemipenis; C, zenker's organ; D, furca; E, F, left and right valve exteriors with testes; G, H, male fifth limbs; I, seventh limb; J, sixth limb. Magnifications: A-D, G-J, × 385; E, F, × 70.

Palps of male fifth limb large, short, nearly symmetrical, with slender terminal hook bent through more than 90°, tiny sensory seta arising from base of hook; dorsodistal part of basal podomere elongated, ventral part bearing a small peg, a small ventral seta, and a long, thickened dorsal seta. Distal setae of seventh limb short, thick, consisting of a very short pectinate seta with about 12 thick barbs, the posterior barbs especially long and thick, a smooth seta nearly as long as pectinate seta, and 2 smooth setae that are only half as long. Furca with 6 long setae, the second and third enlarged to slender curved claws. Hemipenis elongate-subquadrate in outline with sinuous contours and flared, Y-shaped termination composed of dorsodistal and ventrodistal conical projections plus accessory lamellae; copulatory tube short, sinuous, arising ventrally before midlength, not reaching to end of organ, not coiled; vas deferens narrow. Zenker's organ a short tube expanded at the ends.

Remarks.—All characters agree with the diagnosis of *Ekpontocypris* given by

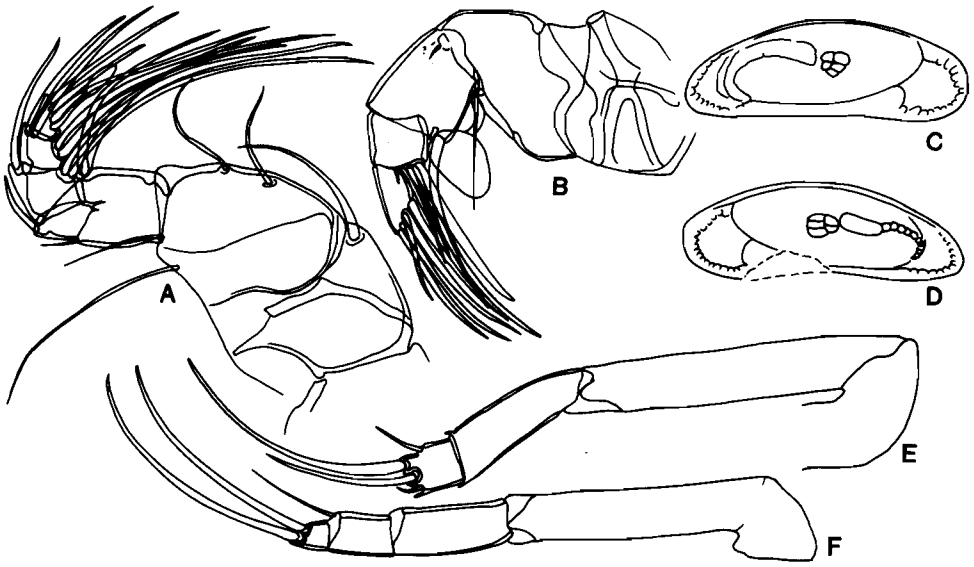


Fig. 14. *Argilloecia* sp., all female USNM 216469. A, antennule; B, antenna; C, D, right and left valve exteriors with ovaries; E, seventh limb; F, sixth limb. Magnifications: A, B, E, F, ×385; C, D, ×70.

Maddocks (1969b) except the narrow vas deferens and the conspicuous copulatory tube of the hemipenis. This species also differs from others of the subgenus (mostly described from the Indian Ocean, Australia and Japan) by having no seta longer than the pectinate seta on the seventh limb. None of the Caribbean or North American species have been sufficiently well described to be compared.

Genus *Argilloecia* Sars, 1866

Argilloecia sp. (fig. 14)

Material.—1 female in alcohol, USNM 216469.
Occurrence.—In Fern Sink, 24/VII/84, water column, 1 specimen.

Remarks.—The soft-part characters of this tiny specimen agree with those illustrated by Müller (1894) for Mediterranean species of *Argilloecia*. Although the genus is worldwide and highly diverse, very few other species have been well described, none from the Caribbean or North America. It is heterogeneous and probably needs revision. While some authors have considered *Argilloecia* to be restricted to deeper waters, up to three other undescribed species are also known from sediment samples on the South Slope of Bermuda, as well as in coralline environments elsewhere in the world.

New genus, new species (fig. 15)

Material.—1 female in alcohol, USNM 216470.
Occurrence.—In Walsingham Cave, 13/VII/84, 1 specimen.

Remarks.—The general shape, muscle-scar pattern, and enlarged zone of concrescence of this tiny specimen, as well as certain soft-part characters, are similar to those of *Argilloecia*. It differs from the typical species of that genus (*sensu* Maddocks, 1969b, and Müller, 1894) by having only one distal claw on the sixth limb, no long, thick, trailing seta at the posteroventral margin of each

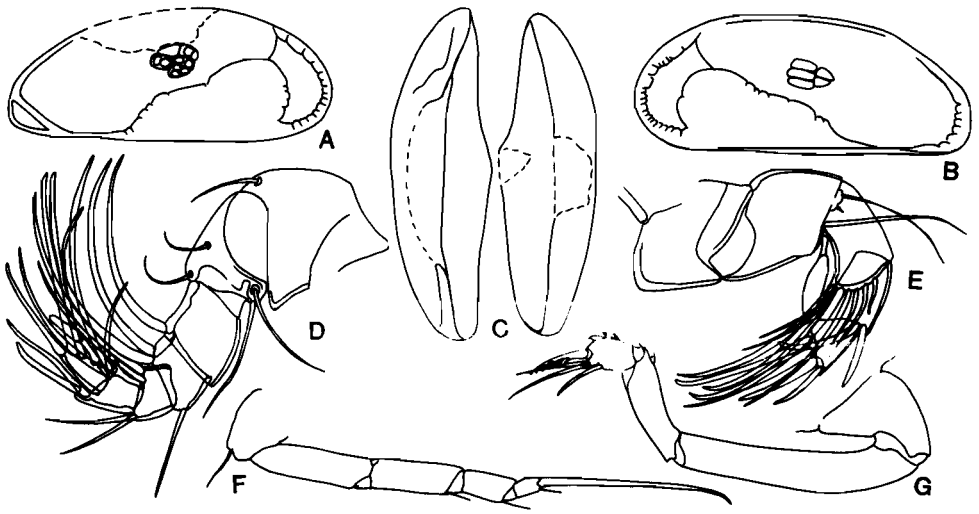


Fig. 15. Pontocyprididae n. gen., n. sp., all female USNM 216470. A, B, C, right, left and dorsal exteriors; D, antennule; E, antenna; F, sixth limb; G, seventh limb. Magnifications: A-C, × 120; D-G, × 385.

valve, and left-over-right valve overlap. Both *Argilloecia* and *Australoecia* (*sensu* McKenzie, 1967, 1981) have pronounced right valve overlap, and none of the established species of *Australoecia* have so irregular a line of concrescence. While both *Abyssocypris* and *Maddocksella* have left valve overlap, they differ in carapace size, shape, robustness, line of concrescence, muscle-scar pattern, and (in *A. atlantica* (Maddocks, 1977)) absence of a pectinate seta on the seventh limb. The general aspect is that of a small, specialized, perhaps interstitial, certainly deviant kind of *Argilloecia* s. 1. The irregular line of concrescence, shortened antennal "swimming setae," and shortened, simplified setal armament of the appendages may be secondary specializations for decreased size and interstitial life.

Family CYPRIDIDAE Baird, 1845

Subfamily CYPRINOTINAE Bronstein, 1947

Genus *Heterocypris* Claus, 1893

Heterocypris punctata Keyser, 1975 (fig. 17P, Q)

Heterocypris punctata Keyser, 1975: 275, text-fig. 13, pl. 22 figs. 10-11.

Material.—21 adult ovigerous females in alcohol, USNM 216471.
Occurrence.—In Harrington Sound, 21 specimens.

Remarks.—Keyser (1975) described this species living in mangrove environments of southwest Florida with salinity range 3-10‰, temperature 17-32°C, pH 7.4-9.0, on mud and detrital bottoms in quiet water. There are several other very similar species described from oligohaline and mesohaline environments of the Caribbean and Central and South America, which may be distinguished only by characters of the male limbs and genitalia. The absence of males in this sample might be due to chance, to seasonal occurrence of males, or to parthenogenesis. Species of *Heterocypris* are widely distributed in fresh-and brackish-water environments of Europe, the Americas, Africa, and Madagascar. McKenzie (1971) reported two species from permanent and temporary freshwater reservoirs and rockholes (salinity 0.6 to 10.5‰) on Aldabra Island in the Seychelles. Aldabra Atoll is much like Bermuda in size and porous limestone structure but higher in elevation, with an established freshwater ostracode fauna of 10 species (McKenzie, 1971).

Subfamily CANDONINAE Kaufmann, 1900

Genus *Candona* Baird, 1845

Candona sp. (figs. 17N, O)

Material.—3 juvenile empty carapaces in alcohol, USNM 216472.
Occurrence.—In Green Bay Cave, 9/I/82, 3 specimens.

Remarks.—Species of Candoninae are benthic inhabitants of permanent lakes and streams and are also well represented in subterranean faunas. Some species tolerate weakly brackish or alkaline waters and may be found in the upper reaches of estuaries or in alkaline lakes and springs. The subtrapezoidal shape, dorsally expanded left valve, and pronounced asymmetry of these Bermuda specimens are reminiscent of a group of Eurasian species, assigned to the genus *Pseudocandona*, which characterize freshwater subterranean habitats of

southern Europe and Lake Baikal (Danielopol, 1978), but the absence of living specimens and of adults raises doubts about the permanence of this population.

Family PARACYPRIDIDAE Sars, 1923

Subfamily THALASSOCYPRIDINAE Hartmann and Puri, 1974

Genus *Dolerocypria* Tressler, 1937

Dolerocypria bifurca Maddocks, n. sp. (fig. 16)

Material.—12 specimens in alcohol, including 2 males, 1 female, and 3 juveniles.
Types.—Holotype male USNM 216452, paratypes USNM 216453-216455.
Type locality.—Green Bay Cave, Bermuda.
Occurrence.—In Green Bay Cave, 28/XI/82, 3 specimens. In Deep Blue Pool, 23/III/82, 3 specimens. In Walsingham Cave, 12/VII/84, 6 specimens.
Derivation of name.—Latin *bifurcus*, two-forked, two-pronged, for the long pegs on the male fifth limb.

Diagnosis.—Carapace thin-walled, very compressed, fragile, translucent white showing reddish-brown epidermis and conspicuous eye underneath; carapace very elongate in lateral view, with greatest height located at about two-fifths length, smooth curving dorsal margin without distinct dorsal angle, narrowly rounded anterior and somewhat more pointed posterior margins, and gently indented, sinuous ventral margin; adductor muscle-scar pattern composed of six small subquadrate scars closely grouped in an anterior column of four and posterior column of two scars, appropriate for the subfamily; broad open vestibules, no radial pore canals visible; ovaries and testes housed between valve lamellae in posterior, testes extending forward to another coil in the anterior vestibule as well.

Antenna with five swimming setae that reach to tip of antennal claws. Palp of male fifth limb has two grotesquely elongated, flattened, stiff, ribbon-like setae that arise ventrally and proximally near its base, incompletely separated from the basal podomere and not movable, probably homologous with the "pegs" and "small setae" that occur on the ventrodistal edge of the basal podomere in other marine Cypridacea; distal hook plump, lobate, terminated by large, curved sensory (?) seta, moderately asymmetrical. Sixth limb slender with much reduced setae and slender distal claw. Seventh limb with long, recurved pectinate seta, enlarged and flattened near its tip, bearing about nine large barbs that taper distally, plus about four more tiny proximal barbs. Furca with two stout pectinate claws and a tiny anterodistal seta. Hemipenis roughly oblong, sinuous and lobate in outline, constricted near the base, bluntly truncate at the distal end. Zenker's organ small with five chitinous rosettes.

Remarks.—*Dolerocypria taalensis* Tressler, 1937, from the Philippines, has a slightly more acute posterior end, a larger comb on the pectinate seta of the

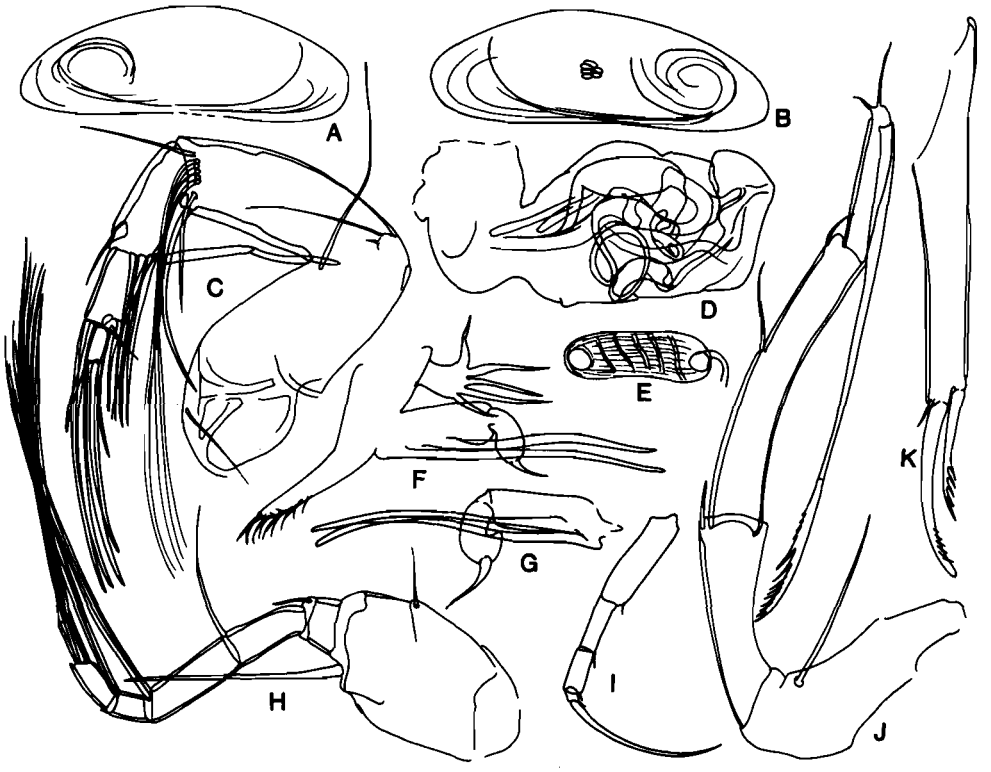


Fig. 16. *Dolerocypria bifurca* Maddocks, n. sp. A-E, H-J, male USNM 216452; F, G, K, male USNM 216453. A, B, right and left valve exteriors with testes; C, antenna; D, hemipenis; E, Zenker's organ; F, G, fifth limbs; H, antennule; I, sixth limb; J, seventh limb; K, furca. Magnifications: A, B, ×136; C, D, F-H, K, ×770; E, I, ×310.

seventh limb, with longer, more sharply tapering barbs, and a fourth, very tiny, dorsal seta on the furca; other diagnostic characters were not described. *Dolerocypria fastigata* Keyser, 1975, from the Florida Everglades, is much more elongate posteriorly with a more stretched-out adductor muscle-scar pattern, more robust sixth limb, no comb of barbs on the recurved seta of the seventh limb, a longer, more tapered distal claw on the furca, and a more compact, distally pointed hemipenis. *Dolerocypria inopinata* Klie, 1939, is nearly ovate, less elongate, with two small ventral setae on the palp of the male fifth limb, and with a lobate-subtriangular hemipenis. There are many discrepancies about such details in the descriptions of the known species of this genus, and the generic diagnosis needs revision.

Subfamily PARACYPRIDINAE Sars, 1923

Genus *Paracypris* Sars, 1866

Paracypris crispa Maddocks, n. sp. (fig. 17A-M)

Material.—5 specimens in alcohol and 72 subfossil specimens.
Types.—Holotype USNM 216456, paratypes USNM 216457-216459.
Type locality.—Walsingham Cave, Bermuda.
Occurrence.—In Little River Cave, 22/VI/82, 1 specimen. In Walsingham Cave, 18/II/82, 4 specimens. In sediment samples from lagoonal and reef environments of Castle Harbour, North Lagoon, Ferry Reach, Harrington Sound, and the South Slope, 72 subfossil specimens.
Derivation of name.—Latin *crispus*, having curly hair, for the branching radial pore canals.

Dimensions.—USNM 216456, RV L 0.74 mm, H 0.28 mm, LV L 0.75 mm, H 0.30 mm.

Diagnosis.—Carapace medium-sized, compressed, elongate with somewhat sinuous lateral outline, broadly rounded anterior margin, broadly arched dorsal margin without distinct dorsal or posterodorsal angle, tapering to pointed posterior margin, and sinuous, indented ventral margin; adductor muscle-scar pattern composed of six small, ovate-subquadrate scars arranged in an anterior column of four and posterior column of two scars, the top scar more elongate; line of concrescence irregular in the anterior, with complexly branching radial pore canals and broad zone of concrescence, open anterior and posterior vestibules.

Palp of male fifth limb very large, slender, without any pegs or setae on basal podomere, terminal part (homologous with hook of other cypridaceans) much reduced, distal sensory (?) seta enormously elongated and inflated, tapering to smooth point. Recurved seta of sixth limb short, reaching barely to end of second podomere, smooth; distal seta very long and clawlike, accompanied by a third small seta. Furca with two sturdy, barbed terminal claws, a very tiny anterodistal seta, and two very tiny hairlike setae immediately behind the claws. Hemipenis basally constricted, tapering anteriorly, with lobate distal outline. Zenker's organ with enlarged spherical bulb and six chitinous rosettes.

Remarks.—*Paracypris polita* Sars, from European waters, is acutely pointed posteriorly with more regularly branching radial pore canals and five long setae on furca. *Paracypris tenuis* Sars belongs to *Aglaiocypris* or a related genus. Many other fossil and living species have been assigned to *Paracypris* without description of soft parts. Other undescribed species also exist on the Atlantic shelf of North America and in coralline environments of the Caribbean and Indian Ocean. Thus clear-cut diagnoses of species and of the genus itself are not yet possible. This is the first description of a male in the genus.

PARACYPRIDINAE spp.

Material.—11 specimens in alcohol, USNM 216473.
Occurrence.—In Harrington Sound, 4 specimens. In Myrtle Bank Cave, 7/II/82, 3 specimens. In Palm Cave, 20/I/82, 1 specimen. In Walsingham Cave, 18/II/82, 3 specimens.

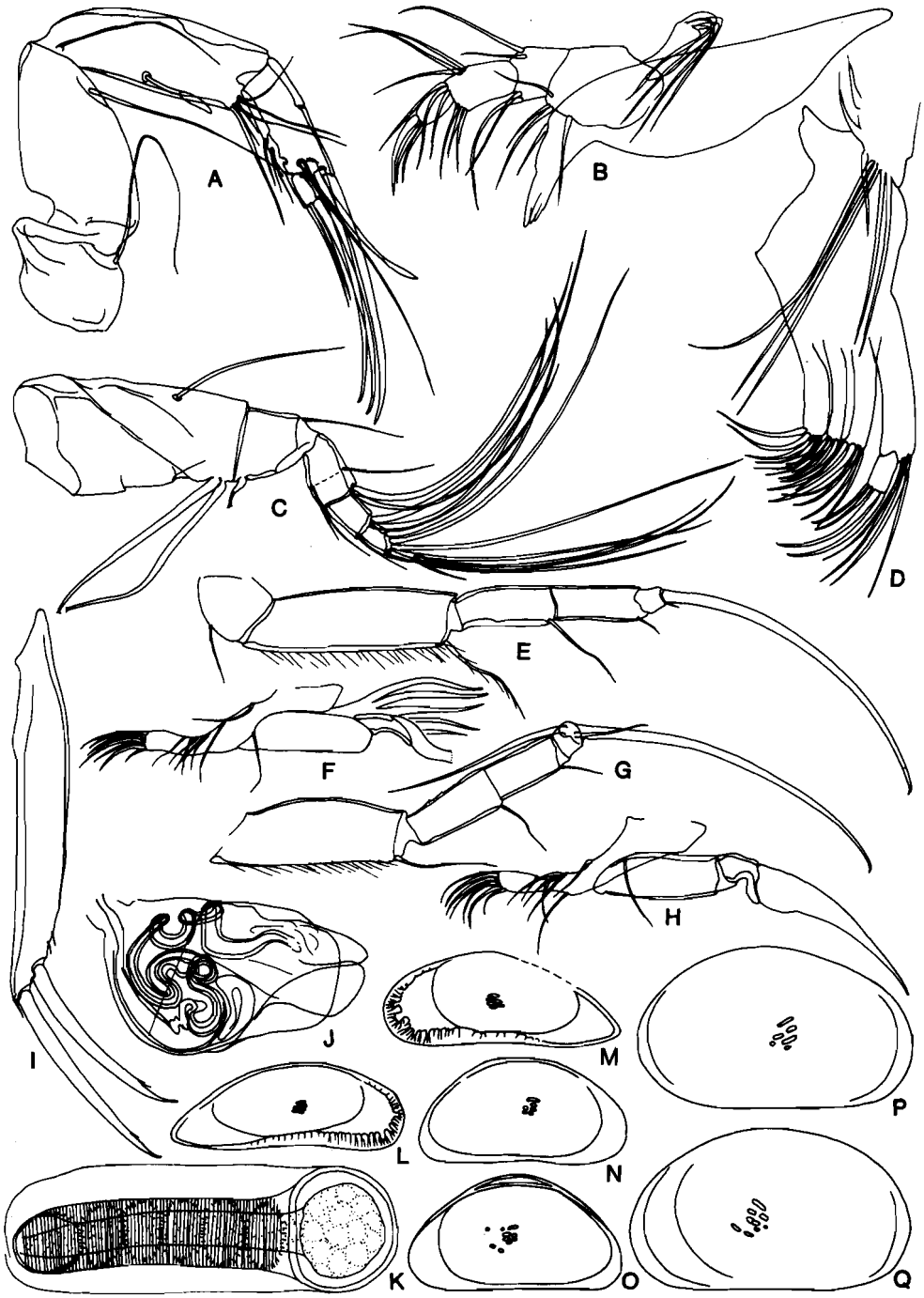


Fig. 17. A-M, *Paracypris crispa* Maddocks, n. sp. A-K, male USNM 216457; L, M, USNM 216456. A, antenna; B, mandible; C, antennule; D, maxilla; E, sixth limb; F, fifth limb, end of palp may be damaged; G, seventh limb; H, fifth limb; I, furca; J, hemipenis; K, Zenker's organ; L, M, right and left valve exteriors. Magnifications: A-C, F, H-K, ×320; D, ×495; E, G, ×245; L, M, ×45. N, O, *Candona* sp., instar USNM 216472, right and left valve exteriors, ×45. P, Q, *Heterocypris punctata* Keyser, female 2435F USNM 216471, right and left valve exteriors, ×26.

Remarks. — These specimens are juveniles, decalcified, or empty valves of *Aglaiocypris* or Thalassocypridinae, which cannot be identified with any of the large species that are common in lagoon and reef environments.

Superfamily CYTHERACEA Baird, 1850

Family CYTHERIDEIDAE Sars, 1825

Genus *Cyprideis* Jones, 1857

Cyprideis edentata Klie, 1939

Cyprideis edentata Klie, 1939: 11, figs. 9-15; Sandberg, 1964: 113, pl. 6 figs. 1-8, pl. 16 fig. 8, pl. 21 fig. 6a-d, pl. 22 fig. 6.

Material.—5 specimens in alcohol and many subfossil specimens, USNM 216474.
Occurrence.—In Grenadier Pool, 21/XI/81, 1 specimen. In Mangrove Lake, hundreds of specimens. In coralline sand in Castle Harbour, 7 subfossil specimens.

Distribution.—Klie (1939) described this species from saline coastal lagoons (25-87.7 g C1/1) in Aruba, Bonaire and Curaçao, Netherlands Antilles. Many species of *Cyprideis* are euryhaline and have broad geographic distributions though to result from passive dispersal by migratory waterfowl.

Family CYTHERURIDAE Müller, 1894

Genus *Hemicytherura* Elofson, 1941

Hemicytherura bradyi (Puri, 1960)

Kangarina bradyi Puri, 1960: 115, pl. 4 figs. 6, 7.
Hemicytherura bradyi (Puri), Teeter, 1975: 470, figs. 16i, 17m; Maddocks, 1974: 210, figs. 72-75; Baker & Hulings, 1966: 114, pl. 1 fig. 3.

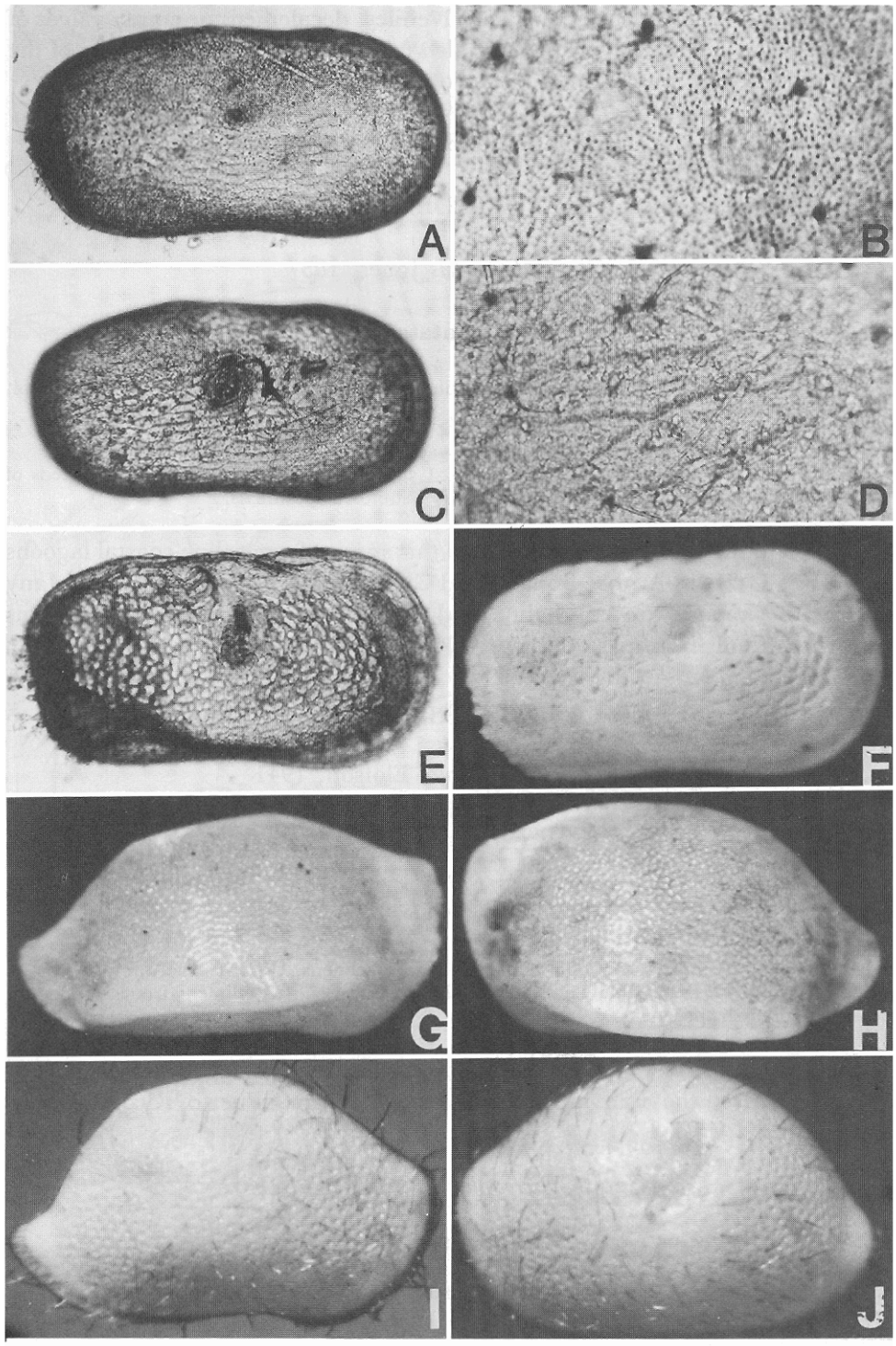
Material.—4 specimens in alcohol and 3 subfossil specimens, USNM 216475.
Occurrence.—In Deep Blue Pool, 23/III/82, 4 specimens. In sediment from Harrington Sound, 3 subfossil specimens.

Distribution.—The species is common in carbonate environments of Florida, Belize, the Bahamas, the Flower Gardens, Puerto Rico, and the Caribbean.

Genus *Microcytherura* Müller, 1894

Microcytherura sp.

Material.—2 specimens in alcohol and 9 subfossil specimens, USNM 216476.
Occurrence.—In Walsingham Cave, 18/II/82, 2 specimens. In sediment samples from Castle Harbour and North Lagoon, 9 specimens.


A
B
C
D
E
F
G
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I
J

Family HEMICYTHERIDAE Puri, 1953

Genus *Jugosocythereis* Puri, 1957

Jugosocythereis pannosa (Brady, 1869)

Cythere pannosa Brady, 1869; 154, pl. 19 figs. 1-2.
Jugosocythereis pannosa (Brady), Van den Bold, 1966: 47-48, pl. 1 fig. 11; Teeter, 1975: 449, fig. 11m, 12d; Maddocks, 1974: 210, pl. 5 figs. 1, 5, 6, 8, 9.

Material.—3 specimens in alcohol, hundreds of subfossil specimens, USNM 216477.
Occurrence.—In Harrington Sound, 3 specimens. In reef and lagoonal sediments from all over the Bermuda platform, hundreds of subfossil specimens.

Distribution.—The species is widely distributed and abundant in Bermuda, the Bahamas, the Florida Keys, the Flower Gardens, the Caribbean, and Belize.

Genus *Neocaudites* Puri, 1960

Neocaudites nevianii Puri, 1960

Neocaudites nevianii Puri, 1960: 127, pl. 1 figs. 13, 14, text-fig. 24a-c; Morales, 1966; 84, pl. 8 figs. 3a-c; Van den Bold, 1966; 55.
Neocaudites nevianii Puri?, Van den Bold, 1963b, pl. 8 fig. 3.
Neocaudites cf. *N. nevianii* Puri, Benda & Puri, 1962: 325, pl. 3 figs. 23, 24.
Rectotrachyleberis cf. *R. triplistriata* (Edwards), Puri, 1954; 264, pl. 11 figs. 1, 2.
Neocaudites triplistriatus (Edwards), Van den Bold, 1963b; 389, pl. 8 fig. 4.
Costa n. sp. 1, Puri & Hulings, 1957, fig. 11.

Material.—49 specimens in alcohol, 12 subfossil specimens, USNM 216478-216479.
Occurrence.—In Little River Cave, 22/VI/82, 44 specimens. In Myrtle Bank Cave, 31/I/82, 5 specimens. In shallow-water sediments from Castle Harbour, North Lagoon, Ferry Reach and Harrington Sound, 12 specimens.

Distribution.—This species is common in carbonate environments of Bermuda, Florida, the Bahamas, Mexico, Belize and the Caribbean.

Fig. 18. A, B, *Cytherella bermudensis* Maddocks, n. sp.; A, USNM 216414, right valve exterior, × 80; B, USNM 216416, detail of micro-ornament, × 400. C, D, *Cytherella kornickeri* Maddocks, n. sp. USNM 216418; C, right valve exterior, × 80; D, detail of micro-ornament, × 400. E, F, *Cytherelloidea irregularis* (Brady), USNM 216424, right valve exterior in transmitted and reflected light, × 100. G, H, *Havanardia keiji* Maddocks, n. sp., USNM 216442, right and left valve exteriors, × 55. I, J, *paranesidea sterreri* Maddocks, n. sp., USNM 216433, right and left valve exteriors, × 70.

Genus *Occultocythereis* Howe, 1951

Occultocythereis angusta Van den Bold, 1963

Cythereis deformis Brady, 1911; 597, pl. 20 figs. 7-8.
Occultocythereis angusta Van den Bold, 1963b, 391, pl. 9 fig. 1a-c, pl. 12 fig. 6; Van den Bold, 1966; 55; Teeter, 1975; 453, figs. 13f, g, 14a; Maddocks, 1974; 212, pl. 7 figs. 4-6.

Material.—4 specimens in alcohol and 64 subfossil specimens, USNM 216480.
Occurrence.—In Cherry Pit Cave, 23/VI/82, 1 specimen. In Deep Blue Cave, 28/XI/81, 1 specimen. In Green Bay Cave, 5/IX/81, 1 specimen. In mixed contents of broken vials, 1 specimen.

Distribution.—Described originally from Madeira, the species is common in carbonate environments of Bermuda, Panama, Belize, the Flower Gardens, and other Caribbean localities.

Family LEPTOCYTHERIDAE Hanai, 1957

Genus *Callistocythere* Ruggieri, 1953

Callistocythere sp.

Material.—10 specimens in alcohol and 3 subfossil specimens, USNM 216481.
Occurrence.—In Christie's Cave, 28/XI/83, 9 specimens. In Deep Blue Cave, 20/II/84, 1 specimen. In sediment samples from Ferry Point and Castle Harbour, 3 specimens.

Family LOXOCONCHIDAE Sars, 1925

Genus *Loxoconcha* Sars, 1866

Loxoconcha oculocrista Teeter, 1975

Loxoconcha oculocrista Teeter, 1975: 479, figs. 20d, 21a-c.
Loxocorniculum fischeri (Brady) (part), Benson & Coleman, 1963; 39, fig. 24.

Material.—3 specimens in alcohol, hundreds of subfossil specimens, USNM 216482.
Occurrence.—In Green Bay Cave, 18/XI/81, 1 specimen. In Walsingham Cave, 17/II/84, 1 specimen. In mixed contents of broken vials, 1 specimen. In reef and lagoonal sediments of the Bermuda platform, hundreds of subfossil specimens.

Distribution.—Teeter (1975) reported this species from Belize, Florida, and the Bahamas.

Family MICROCYTHERIDAE Klie, 1938

Genus *Cobanocythere* Hartmann, 1959

Cobanocythere sp.

Material.—One specimen in alcohol, USNM 216483.
Occurrence.—In Deep Blue Pool, 23/III/82, 1 specimen.

Family PARADOXOSTOMATIDAE Brady & Norman, 1889

Genus *Paradoxostoma* Fischer, 1855

Paradoxostoma spp.

Material.—20 specimens in alcohol, USNM 216484.
Occurrence.—In Deep Blue Pool, 23/III/82, 6 specimens. In: Green Bay Cave, 9/I/82, 1 specimen; 4/III/82, 13 specimens.

Family XESTOLEBERIDIDAE Sars, 1928

Genus *Xestoleberis* Sars, 1866

Xestoleberis spp.

Material.—25 specimens in alcohol, USNM 216485.
Occurrence.—In Deep Blue Pool, 23/III/82, 10 specimens. In Grenadier Pool, 21/XI/81, 1 specimen. In Little River Cave, 22/VI/82, 2 specimens. In Palm Cave, 20/I/82, 2 specimens. In Walsingham Cave, 18/II/82, 5 specimens; 12/VII/84, 5 specimens.

Order MYODOCOPIDA Sars, 1866

Suborder CLADOCOPINA Sars, 1866

Genus *Polycope* Sars, 1866

Polycope spp.

Material.—213 specimens in alcohol, USNM 216486.
Occurrence.—In Bee Pit Cave, 23/I/84, 1 specimen. In Cherry Pit Cave, 23/VI/82, 56 specimens; 12/I/84, 22 specimens. In Christie's Cave, 24/IX/82, 3 specimens. In Deep Blue Pool, 23/III/82, 3 specimens; 20/II/84, 2 specimens. In Emerald Sink Cave, 16/XI/83, 2 specimens. In Fern Sink Cave, 23/III/82, 1 specimen; 24/VII/84, 7 specimens. In Green Bay Cave, 18/XI/81, 6 specimens. In Long Rock Sink, 8/VI/84, 1 specimen. In Palm Cave, 20/I/82, 27 specimens; 13+16/III/82, 10 specimens. In Roadside Cave, 27/VIII/82, 20 specimens; 12/XI/82, 12 specimens. In Sailor's Choice Cave, 6/VII/82, from walls, 5 specimens; 6/VII/82, from rocks, 7 specimens. In Straw Market Cave, 12/I/84, 1 specimen. In Tucker's Town Cave, 8/IX/82, from walls, 7 specimens; 8/IX/82, sand bottom, 27 specimens; 16/III/84, 5 specimens. In Walsingham Cave, 13/VI/82, 3 specimens; 18/II/82, 15 specimens; 13/VII/84, 4 specimens; in Walsingham Sink Cave, 13/VIII/82, 3 *Polycope* spp. In mixed contents of broken vials, 7 specimens.

Remarks.—Two species may be included in this material. One is very small, completely smooth, and translucent white in color; the other is large, with serrate anteroventral margin, and amber in color. The great majority of specimens are exceedingly tiny juveniles.

LITERATURE CITED

BACESCU, M., 1980. Apseudes bermudeus n. sp. from caves around the Bermuda Islands. Acta Adriat., **21**: 401-407.

BAKER, J. H. & N. C. HULINGS, 1966. Recent marine ostracod assemblages of Puerto Rico. Publ. Inst. Mar. Sci. Texas, **11**: 108-125.

BENDA, W. K. & H. S. PURI, 1962. The distribution of Foraminifera and Ostracoda off the Gulf Coast of the Cape Romano area, Florida. Gulf Coast Ass. geol. Soc. Trans. **12**: 303-341.

BENSON, R. H. & G. L. COLEMAN II, 1963. Recent marine ostracodes from the eastern Gulf of Mexico. Univ. Kansas paleont. Contr. Arthropoda, Article 2: 1-52.

BOLD, W. A. VAN DEN, 1963a. The ostracode genus Orionina and its allies. J. Paleont. **37**: 33-50.

——, 1963b. Upper Miocene and Pliocene Ostracoda of Trinidad. Micropaleontology, **9**: 361-424.

——, 1966. Ostracoda from Colon Harbour, Panama. Carib. J. Sci., **6**: 43-64.

——, 1971. Ostracoda of the Coastal Group of formations of Jamaica. Gulf Coast Ass. geol. Soc. **21**: 325-348.

——, 1974. Ornate Bairdiidae in the Caribbean. Geoscience and Man, **6**: 29-40.

BOWMAN, T. E. & T. M. ILIFFE, 1983. Bermudalana aruboides, a new genus and species of troglobitic Isopoda (Cirolanidae) from marine caves on Bermuda. Proc. biol. Soc. Wash., **96** (2): 291-300.

BRADY G. S., 1867-1871. Ostracoda. In: De Folin, ed. Les Fonds de la Mer, **1**, **2**.

——, 1880. Report on the Ostracoda dredged by H. M. S. Challenger during the years 1873-1876. Rept. Voy. Challenger, (Zool.) **1** (3): 1-184.

——, 1911. Notes on marine Ostracoda from Madeira. Proc. Zool. Soc. London, **1911** (2): 595-601.

BRETZ, J. H., 1960. Bermuda: A partially drowned, late mature, Pleistocene karst. Bull. geol. Soc. Am., **71**: 1729-1754.

DANIELOPOL, DAN L., 1978. Über Herkunft und Morphologie der Süsswasser-hypogäischen Candoninae (Crustacea, Ostracoda). Sitz. ber. Öst. Akad. Wiss., (Mathem.-naturw. Kl.) (I) **187** (1-5): 1-161.

DEEVEY, GEORGIANA B., 1968. Pelagic ostracods of the Sargasso Sea off Bermuda: Descriptions of species, seasonal and vertical distribution. Peabody Mus. nat. Hist. (Yale Univ.), **26**: 1-125.

HART, C. W., JR. & R. B. MANNING, 1981. The cavernicolous caridean shrimps of Bermuda (Alpheidae, Hippolytidae, and Atyidae). J. Crust. Biol., **1** (3): 441-456.

ILIFFE, T. M., 1981. The submarine caves of Bermuda. In: Proc. Eighth int. Congr. Speleol., Bowling Green, KY, U. S. A.: 161-163.

ILIFFE, T. M., C. W. HART, JR. & R. B. MANNING, 1983. Biogeography and the caves of Bermuda. Nature, **302** (5904): 141-142.

KARAMAN, G. S., 1980a. Cocoharpinia iliffei, new genus and species from Bermuda, with remarks to other genera and species (Fam. Phoxocephalidae). Stud. Mar. (Kotor), **9-10**: 149-175.

——, 1980b. Revision of genus Idunella Sars with description of new species, I. sketi, n. sp. (Fam. Liljeborgiidae) (Contribution to the knowledge of the Amphipoda 102). Acta Adriat., **21** (2): 409-435.

KEIJ, A. J., 1973. Recent West African Havanardia species (Ostracoda). Proc. kon. Ned. Akad. Wet., Amsterdam, (B) **76** (4): 316-328.

——, 1976. Note on Havanardia and Triebelina species (Ostracoda). Proc. kon. Ned. Akad. Wet., Amsterdam, (B) **79** (1): 36-44.

KEY, J., 1954. Ostracoda. In: Tj. VAN ANDEL & H. POSTMA, Recent Sediments of the Gulf of Paria, Reports of the Orinoco Shelf Expedition, 1, Verhand. kon. Ned. Akad. Wet., Amsterdam, Afd. Natuurk., (1) **20** (5): 218-245.

KEYSER, DIETMAR, 1975. Ostracoden aus den Mangrovegebieten von Südwest-Florida. Abh. Verh. naturwiss. Ver. Hamburg, (n.F.) **18/19**: 255-290.

KLIE, WALTER, 1939. Ostracoden aus den marinen Salinen von Bonaire, Curaçao und Aruba. Capita zool., **8** (4^2): 1-19.

KORNICKER, LOUIS S., 1963. Ecology and classification of Bahamian Cytherellidae (Ostracoda). Micropaleontology, **9** (1): 61-70.

——, 1981. Benthic marine Cypridinoidea from Bermuda (Ostracoda). Smiths. Contr. Zool, **331**: 1-15.

KORNICKER, LOUIS S., SHELDON WIRSING & MAURA MCMANUS, 1976. Biological studies of the Bermuda ocean acre: planktonic Ostracoda. Smiths. Contr. Zool., **223**: 1-34.

LAND, L. S., F. T. MACKENZIE & S. J. GOULD, 1967. Pleistocene history of Bermuda. Bull. geol. Soc. Am., **78**: 993-1006.

MADDOCKS, ROSALIE F., 1968. Commensal and free-living species of Pontocypria Müller, 1894 (Ostracoda, Pontocyprididae) from the Indian and Southern oceans. Crustaceana, **15** (2): 121-136.

——, 1969a. Revision of recent Bairdiidae (Ostracoda). U. S. natn. Mus. Bull., **295**: 1-126.

——, 1969b. Recent ostracodes of the Family Pontocyprididae chiefly from the Indian Ocean. Smiths. Contr. Zool., **7**: 1-56.

——, 1973. Zenker's organ and a new species of Saipanetta (Ostracoda). Micropaleontology, **19** (2): 193-208.

——, 1974. Ostracodes. In: 200-229. THOMAS J. BRIGHT & LINDA HAITHCOCK PEQUEGNAT, eds., Biota of the West Flower Garden Bank, (Gulf Publishing Co., Houston).

——, 1975. Recent Bairdiidae (Ostracoda) from Ascension Island. Crustaceana, **28** (1) 53-65.

——, 1976. Pussellinae are interstitial Bairdiidae (Ostracoda). Micropaleontology, **22** (2): 194-214.

——, 1977. Anatomy of Australoecia (Pontocyprididae, Ostracoda). Micropaleontology, **23** (2): 206-215.

MADDOCKS, ROSALIE F., & LOUIS S. KORNICKER, 1985. Class Ostracoda (Mussel Shrimps), in: Wolfgang Sterrer, ed., Marine Fauna and Flora of Bermuda. John Wiley & Sons, Inc.

MCKENZIE, K. G., 1967. Recent Ostracoda from Port Phillip Bay, Victoria. Proc. roy. Soc. Victoria, **80** (1): 61-106.

——, 1971. Entomostraca of Aldabra, with special reference to the genus Heterocypris (Crustacea, Ostracoda). Phil. Trans. roy. Soc. Lond., (B) **260**: 257-297.

——, 1981. Chapman's "Mallee Bores" and "Sorrento Bore" Ostracoda in the National Museum of Victoria, with the description of Maddocksella new genus. Proc. roy. Soc. Victoria, **93**: 105-107.

MORALES, GUSTAVO A., 1966. Ecology, distribution and taxonomy of recent Ostracoda of the Laguna de Terminos, Campeche, Mexico. Bol. Univ. nac. autonoma Mexico, Inst. Geol., **81**: 1-103.

MORKHOVEN, F. P. C. M. VAN, 1958. On the validity of the ostracod genera Glyptobairdia and Bairdoppilata. J. Paleont., **32**: 366-368.

MÜLLER, G. W., 1894. Die Ostracoden des Golfes von Neapel und der angrenzenden Meeres Abschnitte. Monogr. Fauna Flora Golf. Neapel, **21**: 1-404.

NEALE, JOHN W., 1983. Geological history of the Cladocopina. In; R. F. MADDOCKS, ed., Applications of Ostracoda (University of Houston, Department of Geosciences). 612-622.

PURI, H. S., 1954. Contribution to the study of the Miocene of the Florida Panhandle, 3, Ostracoda. Florida geol. Survey Bull., **36**: 216-345.

——, 1960. Recent Ostracoda from the west coast of Florida. Trans. Gulf Coast Ass. geol. Soc., **10**: 107-149.

PURI, H. S., & N. C. HULINGS, 1957. Recent ostracode facies from Panama City to Florida Bay area. Trans. Gulf Coast Ass. geol. Soc., **7**: 167-190.

—— & ——, 1976. Designation of lectotypes of some ostracods from the Challenger Expedition. Bull. Brit. Mus. (nat. Hist.) **29** (5): 249-315.

ROME, DOM REMACLE, 1960. Note sur Triebelina coronata (Brady) et sa position systématique. Bull. Inst. roy. Sci. nat. Belg., **36**: 1-14.

SANDBERG, P. A., 1964. The ostracod genus Cyprideis in the Americas. Stockholm Contr. Geol., **12**: 1-178.

SKET, B., 1979. Atlantasellus cavernicolus n. sp. (Isopoda Asellota, Atlantasellidae n. fam.) from Bermuda. Biol. Vestn. (Ljubljana), **27** (2): 175-183.

SKET, B. & T. M. ILIFFE, 1980. Cave fauna of Bermuda. Int. Revue ges. Hydrobiol., **65** (6): 871-882.

STEPHENSON, M. B., 1946. Glyptobairdia, a new genus of Ostracoda. J. Paleont., **20**: 345-347.

——, 1947. Notes on the ostracode genus Triebelina. J. Paleont., **21**: 577-579.

STERRER, W. & T. M. ILIFFE, 1982. Mesonerilla prospera, a new archiannelid from marine caves in Bermuda. Proc. biol. Soc. Wash., **95** (3): 509-514.

TEETER, J. W., 1975. Distribution of Holocene marine Ostracoda from Belize. in: KENNETH F. WANTLAND & WALTER C. PUSEY III, eds., Belize Shelf—Carbonate Sediments, Clastic Sediments, and Ecology, Am. Ass. Petrol. Geol., Stud. Geol., **2**: 400-499.

YEATMAN, H. C., 1980 Miostephos leamingtonensis, a new species of copepod from Bermuda. J. Tenn. Acad. Sci., **55** (1): 20-21.

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