



The Crustacean Society

Mysidacea from Shallow Waters in the Vicinity of Carrie Bow Cay, Belize, Central America, with Descriptions of Two New Species

Author(s): Richard F. Modlin

Source: *Journal of Crustacean Biology*, Vol. 7, No. 1 (Feb., 1987), pp. 106-121

Published by: [The Crustacean Society](#)

Stable URL: <http://www.jstor.org/stable/1548630>

Accessed: 19/10/2010 21:07

Your use of the JSTOR archive indicates your acceptance of JSTOR's Terms and Conditions of Use, available at <http://www.jstor.org/page/info/about/policies/terms.jsp>. JSTOR's Terms and Conditions of Use provides, in part, that unless you have obtained prior permission, you may not download an entire issue of a journal or multiple copies of articles, and you may use content in the JSTOR archive only for your personal, non-commercial use.

Please contact the publisher regarding any further use of this work. Publisher contact information may be obtained at <http://www.jstor.org/action/showPublisher?publisherCode=crustsoc>.

Each copy of any part of a JSTOR transmission must contain the same copyright notice that appears on the screen or printed page of such transmission.

JSTOR is a not-for-profit service that helps scholars, researchers, and students discover, use, and build upon a wide range of content in a trusted digital archive. We use information technology and tools to increase productivity and facilitate new forms of scholarship. For more information about JSTOR, please contact support@jstor.org.



The Crustacean Society is collaborating with JSTOR to digitize, preserve and extend access to *Journal of Crustacean Biology*.

<http://www.jstor.org>

MYSIDACEA FROM SHALLOW WATERS IN THE VICINITY OF CARRIE BOW CAY, BELIZE, CENTRAL AMERICA, WITH DESCRIPTIONS OF TWO NEW SPECIES

Richard F. Modlin

ABSTRACT

Sixteen species of Mysidacea occupy shallow-water habitats in the vicinity of Carrie Bow Cay, Belize. Geographic ranges of *Siriella mexicana*, *S. chierchiae*, *Amathimysis cheros*, *A. gibba*, *A. polita*, *Dioptromysis paucispinosa*, *Parvimysis bahamensis*, *Metamysidopsis* sp., *Mysidopsis velifera*, *Mysidium columbiae*, *M. integrum*, *Heteromysis actiniae*, *H. bermudensis*, and *H. mayana*, have been extended to include the waters off Belize, Central America. Descriptions of two new species, *Mysidopsis badius* and *Heteromysis tuberculospina*, are presented.

Information on peracaridean crustaceans in the waters around Carrie Bow Cay, Belize, Central America, is limited to the Amphipoda (Lewis and Kensley, 1982; Thomas, 1983; Thomas and Barnard, 1983a, b) and Isopoda (Kensley, 1982, 1984a, b). The Mysidacea in the shoal waters of Belize are unknown. The purpose of this paper is to provide information on the species composition, distribution, and ecology of the Mysidacea inhabiting the shallow waters in the vicinity of Carrie Bow Cay, Belize.

Carrie Bow Cay (16°48'N, 88°05'W) is a small, low coral-sand island (120 m long × 40 m wide) situated on the top of the Belizian barrier reef system about 20 km southeast of Dangriga. In addition to Carrie Bow Cay, the study area (Fig. 1) included the waters around a system of mangrove islands, the Blue Ground Range, located about 10 km southwest of Carrie Bow Cay and Twin Cays, a pair of mangrove islands, 2 km northwest of Carrie Bow Cay. A detailed description of the study area can be found in Rützler and Macintyre (1982).

MATERIALS AND METHODS

Habitats in the study area were sampled from 14–20 March 1985 using SCUBA or skin diving techniques. A dip net with an easily removable fine-mesh collecting bag (mesh size about 0.3 mm) was used to obtain specimens from various benthic and planktonic habitats. A sample was collected by passing the net over, around, or through the habitat. Once a sample was obtained the bag was closed with one hand and removed from its frame with the other. It was then securely tied and stowed in a diver's sac. The bag's code and information about the habitat sampled were recorded on a diver's slate. A new bag was then placed on the frame. This collecting technique allowed the sampling of individual habitats without the need to surface or leave the water. It also removed the need to carry a supply of collecting jars and vials in the water. Upon returning to shore, the contents of each bag were washed into a sample jar, stained with phloxine-B to facilitate sorting, and fixed for 12–24 h in a 10% solution of Formalin in sea water. Commensal and cryptic mysids were obtained from sponges, pieces of living and dead coral, anemones, and empty shells of *Strombus gigas*. These potential host/habitats were collected by hand while skin or SCUBA diving and individually bagged in situ in canvas collecting bags. At the field station the contents of each bag were emptied into a bucket of sea water, broken or cut into small pieces, and the pieces individually washed. The contents of the bucket were then filtered through a fine-mesh dip net (mesh size about 0.3 mm) and the residue was transferred to a specimen jar, stained in phloxine-B and fixed for 12–24 h before sorting. Once sorted all specimens were preserved in 70% ethyl alcohol.

Measurements of total length, the distance along the dorsal midline from the tip of the rostrum to the tip of the telson, of only those mysids that appeared intact were made with an ocular reticule calibrated to a stage micrometer.

Eggs and developing larvae were scraped from brood pouches to determine brood size and stage of

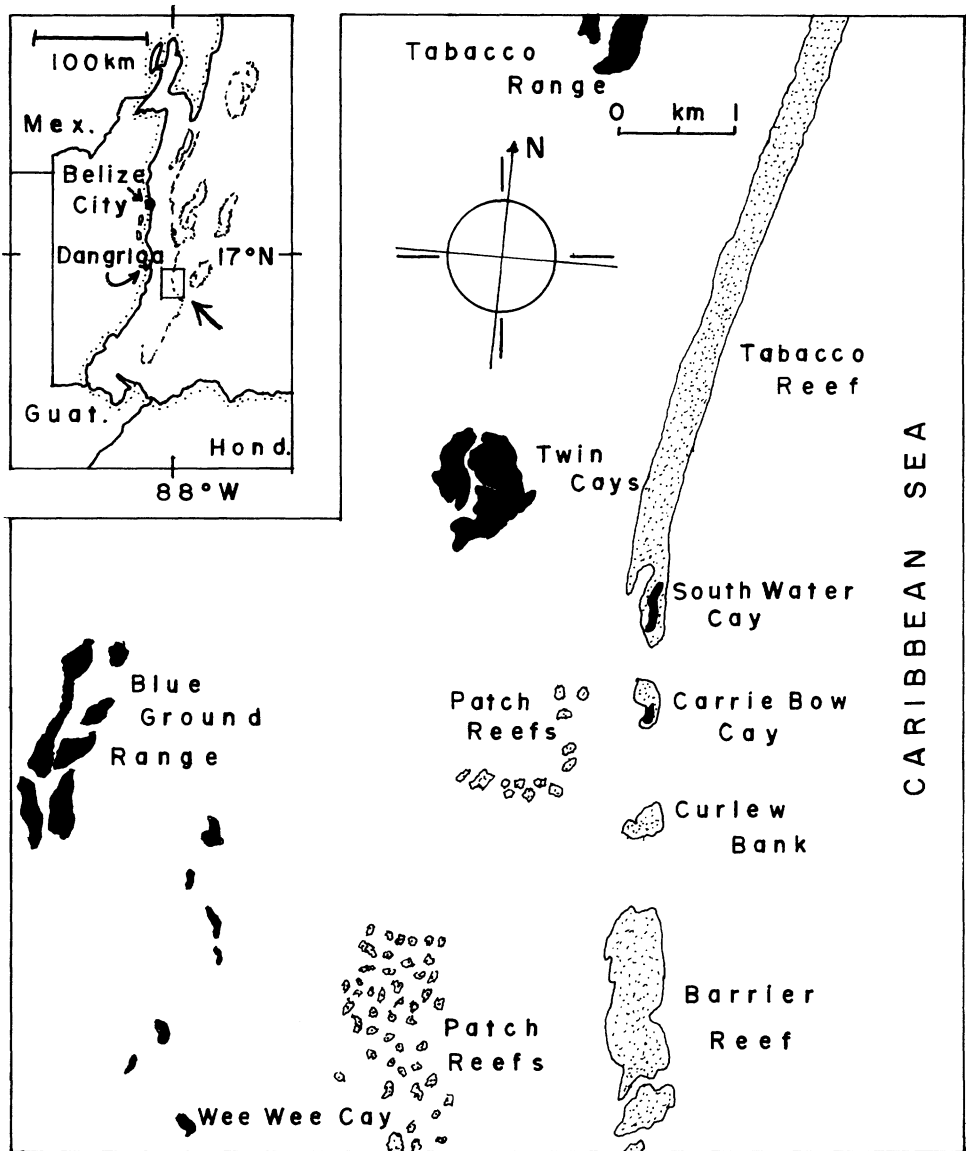


Fig. 1. Mysid collecting area in vicinity of Carrie Bow Cay, Belize, Central America. Arrow in inset indicates location of collecting area along the coastline of Belize.

development. Only gravid females with full pouches were used in these counts. Developmental stages were determined according to Modlin (1979, 1982).

Figures of new species were hand-drawn from observations through a phase contrast microscope. A calibrated grid was used to maintain the proper scale and symmetry. Papers used to identify the other species are listed in the synonymies to provide references to published descriptions. The entire collection, including the type specimens, reported in this paper has been deposited in the National Museum of Natural History, Smithsonian Institution, Washington, D.C. (USNM).

Sample numbers listed in the text provide the following information: month, day, and year, respectively, are the first six digits, and the next three characters are the station code. The station location, collecting technique, and a description of the habitat sampled are described below. All collecting stations are included to show the diversity of habitats sampled.

Station Code and Collection Information

A10. Back reef on south side of Carrie Bow Cay, skin diving, dip net passed through planktonic mysids swarming around corals, depth 1–2 m; B10. Location same as A10, skin diving, dip net, general collection in coral rubble, depth 1–2 m; C10. Location same as A10, skin diving, hand collection, empty queen conch shells, depth 1–2 m; A15. Back reef about 100 m north of Carrie Bow Cay, skin diving, dip net passed through algal turf growing on coral pavement, depth 0.1–1.0 m; B15. Location same as A15, skin diving, dip net passed through *Thalassia-Porites* community, depth 0.1–1.0 m; C15. Location same as A15, skin diving, hand collection, coral *Porites porites*, depth 0.1–1.0 m; E15. Location same as A15, skin diving, hand collection, sponge *Callyspongia vaginalis*, depth 1.0 m; G15. Location same as A15, skin diving, hand collection, empty queen conch shells, depth 0.1–1.0 m; A20. Patch reef system about 3 km southwest of Carrie Bow Cay, skin diving, hand collection, sea anemone *Bartholomea annulata*, depth 3.0 m; C20. Channel between mangrove cays in middle of Blue Ground Range (16°48'N, 88°09'W) about 8 km southwest of Carrie Bow Cay, skin diving, one sponge, *Iricinia*, removed from mangrove root, depth 0.5 m; D20. Location same as C20, skin diving, general collection with dip net passed around and along mangrove roots, depth 0.1–1.0 m; E20. Location same as C20, skin diving, dip net passed along sediment (fine organic silt) located on submerged portion of mangrove cay shoreline, and beneath and around mangrove roots, depth 0.1–1.5 m; F20. Location same as C20, collecting information same as D20; G20. Sandy bank on southern margin of Blue Ground Range (16°48'N, 88°09'W) about 8 km southwest of Carrie Bow Cay, skin diving, dip net passed through *Thalassia*-green algal bed, depth 1.0 m; H20. Location same as G20, skin diving, dip net passed along and through fine calcareous sand-organic silt shoal, depth 1.5 m; J20. Location same as A20, skin diving, collection by hand, sponge, *Iricinia*, depth 2.0 m; A25–D25. Inner forereef, high spur and groove region, of coral reef east of Carrie Bow Cay, SCUBA, dip net, general collections around base of hard and soft corals and in coral rubble, depth 5–8 m; E25. Location same as A25, SCUBA, hand collection, 2 specimens of *Callyspongia vaginalis*, depth 7 m; F25. End of boat pier on west side of Carrie Bow Cay, dip net from end of pier while using a night light to attract specimens, time of collection 2200–2300; A30. Back reef area south of Carrie Bow Cay, skin diving, collection by hand, empty queen conch shells, depth 1.0–2.0 m; B30. Location same as A30, skin diving, dip net passed through bed of *Thalassia*, depth 1.5 m; C30. Location same as A30, skin diving, dip net passed through algal turf growing over dead coral *Acropora palmata*, depth 1.0–1.5 m; A35. Back reef area about 500 m north of Carrie Bow Cay, skin diving, live *Porites porites* collected by hand, depth 1.0 m; B35. Location same as A35, skin diving, collection by hand, algal encrusted dead *Porites porites*, depth 1.0 m; C35. Patch reefs along northern edge of Carrie Bow Cut located about 1 km south of Carrie Bow Cay, SCUBA, collection by hand, empty queen conch shells, depth 5–6 m; D35. Location same as C35, SCUBA, collection by hand, 3 specimens of *Callyspongia vaginalis*, depth 6 m; E35. Location same as C35, SCUBA, collection by hand, 1 specimen of *Iricinia*, depth 5 m; F35. End of pier on west side of Carrie Bow Cay, dip net off end of pier while using a night light to attract specimens, time of collection 2200–2230; A40. Twin Cays, Sponge Harbor, located about 2.5 km northwest of Carrie Bow Cay, skin diving, dip net passed through mysids swarming between mangrove roots, depth 1.0 m; B40. Location same as A40, skin diving, collection by hand, clumps of the alga *Halimeda*, depth 1.0 m; C40. Lagoon due west of Carrie Bow Cay, skin diving, collection by hand, empty queen conch shells, depth 1.0–1.5 m; D40. Inner forereef slope, lower spur and groove region of coral reef, located east of South Water Cay, collection by hand, 2 specimens of sponge *Verongia fistularis*, depth 14 m; BK. Outer forereef slope, inner vertical wall of sand trough, poison, around hard and soft corals and sponges, depth 28.3 m, B. Kensley collector; AC. Outer forereef slope, specimens obtained from coral ledge, method of collection unknown, depth 38 m, A. Cohen collector, USNM No. 321390; KR. Twin Cays, in channel by Little Dipper, collection by hand, specimens of *Bartholomea annulata*, depth 1.0 m, W. Sterrer and K. Rützler collectors, USNM No. 300990; KR1. Twin Cays, entrance to Grouper Gardens, dip net through mysids swarming between mangrove roots, depth 1.0 m, K. Rützler collector, USNM No. 300990; and F65. Twin Cays, northeast shore of Twin Bays, dip net passed between mangrove roots at night, collecting time 2330, depth 0.5 m, F. Ferrari collector.

RESULTS

Siriella mexicana Brattegard, 1970

Siriella mexicana Brattegard 1970b, p. 117, figs. 3, 4.

Material Examined.—Sample number 031485B10, 1 juvenile; 031585A15, 1 juvenile; 031585B15, 1 juvenile; 031585G15, 2 juveniles; 031785F25, 1 juvenile; 031885B30, 1 juvenile; 102185F65, 16 ♂♂, 19 ♀♀ (12 ovigerous), 20 juveniles.

Geographic Distribution.—Coastal waters off Isla de Cozumel, Mexico (Brattegard, 1970b).

Ecological Notes.—Specimens ranged in size from 1.9–9.5 mm. During daylight hours, few juveniles were collected just behind the reef crest community near Carrie Bow Cay in algal turf, beds of *Thalassia*, coral rubble, and old conch shells located at depths from 0.1–2.0 m. One specimen was obtained in a plankton sample collected off the dock at about 2300. However, the 55 specimens collected in October 1985 were obtained from around mangrove roots, *Rhizophora mangle*, at about 2330. During the Smithsonian-Bredin Expeditions, specimens were obtained in a net towed at night from shore to about 60 m offshore (Brattegard, 1970b). *Siriella mexicana*, like its relative *S. chierchiae*, appears to be planktonic.

Siriella chierchiae Coifmann, 1937

Siriella chierchiae Coifmann, 1937, p. 3, fig. 1; W. M. Tattersall, 1951, p. 66, figs. 15, 16; Brattegard, 1970a, p. 2, fig. 1; 1970b, p. 116, fig. 2.

Siriella occidentalis W. M. Tattersall, 1937, p. 6, figs. 3, 4.

Material Examined.—Sample number 031685F20, 1 ♀, 8.5 mm.

Geographic Distribution.—Caribbean Sea, coastal waters of western Atlantic south to Brazil (Coifmann, 1937; Tattersall, 1951; Brattegard, 1970a, b, 1973, 1974a, b, 1975), off Key West, Florida (Tattersall, 1951), and Gulf of Mexico (Modlin, 1984).

Ecological Notes.—The specimen was collected at a station located in the Blue Ground Range. It was obtained from the water around the prop roots of the red mangrove, *Rhizophora mangle*, at a depth of about 0.1 m. This species is planktonic and undertakes diurnal vertical migrations (Brattegard, 1970a). It was collected at night from coastal waters (Brattegard, 1970a, b, 1973, 1974a, b) and from 160 km offshore (Modlin, 1984). During the day it was collected from various benthic substrates.

Amathimysis cherados Brattegard, 1974

Amathimysis cherados Brattegard, 1974a, p. 56, fig. 1A–D.

Material Examined.—Sample number 031685G20, 1 ♂; 031885B30, 4 ♂♂, 5 ♀♀ (2 ovigerous), 3 juveniles; 031885C30, 1 juvenile.

Geographic Distribution.—Caribbean coasts of Colombia (Brattegard, 1974a), Panama (Brattegard, 1974b), and Lesser Antilles (Brattegard, 1975).

Ecological Notes.—Specimens were obtained from beds of *Thalassia*, green algal-*Thalassia* communities, and from algal turf covering coral plates. Collection sites were at depths from 1.0–1.5 m. Total lengths ranged from 1.4–4.4 mm. Each ovigerous female carried 3 eggs.

The majority of specimens collected by Brattegard (1974a) were taken from beds of *Thalassia* or from sandy substrates that contained organic detritus and algae (Brattegard, 1974b).

Amathimysis gibba Brattegard, 1969

Amathimysis gibba Brattegard, 1969, p. 28, figs. 4, 5; 1974a, p. 52, fig. 1E, F.

Material Examined.—Sample number 031685G20, 1 ♂ (2.7 mm), 2 ♀♀ (2.6, 2.7); 031885B30, 1 ♀ (2.5).

Geographic Distribution.—Caribbean coasts of Colombia (Brattegard, 1973, 1974a), Panama (Brattegard, 1974b), Lesser Antilles (Brattegard, 1975), Puerto Rico (Brattegard, 1970b), southern Florida (Brattegard, 1969), and Gulf of Mexico (Modlin, 1984).

Systematic Note.—In their discussion of this species, Băcescu and Ortiz (1984)

treated the genus *Amathimysis* Brattegard (1969) as a subgenus of *Katerythrops* Holt and Tattersall (1905). Since Băcescu and Ortiz (1984) did not provide a rationale for this change, a more thorough study of this genus is necessary before the change can be established. All specimens of *Amathimysis* from Belize fit Brattegard's (1969) description.

Ecological Notes.—All specimens were collected in beds of *Thalassia* at depths from 1.0–1.5 m. Those collected in the southern Caribbean, Puerto Rico, and southern Florida were associated with either sandy substrates or sandy bottoms overgrown with *Thalassia* (Brattegard, 1969, 1970b, 1974a, b). Modlin (1984) obtained a specimen from a scaly soft coral taken at a depth of 26 m.

Amathimysis polita Brattegard, 1974

Amathimysis polita Brattegard, 1974a, p. 54, fig. 2.

Material Examined.—Sample number 031485B10, 2 ♂♂, 4 ♀♀ (none ovigerous), 4 juveniles; 031485C10, 0-0-1-0; 031585B15, 0-2-0-1; 031685D20, 0-2-0-0; 031685F20, 2-2-0-1; 031685G20, 0-4-0-1; 031785A25, 5-6-0-7; 031785B25, 0-0-0-1; 031785D25, 2-3-0-4; 031885B30, 1-0-0-0; 031985D35, 0-0-1-0; 120682BK, 0-1-0-1; 052376AC, 0-0-0-1. (Quartettes of numbers referring to males, females, ovigerous females, and juveniles, respectively.)

Geographic Distribution.—Caribbean coasts of Colombia and Panama (Brattegard, 1974a, b).

Ecological Notes.—Total length ranged from 1.2–3.6 mm. One of the ovigerous females carried 5 eggs and the other 6. The majority of specimens were obtained from coral reef habitats such as around the base of hard and soft corals, coral rubble, and old conch shells at depths from 5–38 m. Others were collected from between roots of the red mangrove, *Rhizophora mangle*, in beds of *Thalassia*, and from the sponge *Callyspongia vaginalis*. Brattegard (1974a, b) obtained specimens from sandy, silty soft bottom material at depths from 6–40 m.

Diopromysis paucispinosa Brattegard, 1969

Diopromysis paucispinosa Brattegard, 1969, p. 69, figs. 21, 22.

Material Examined.—Sample number 031485B10, 1 ♀ (3.5 mm); 031785D25, 1 ♀ (3.5); 031885C30, 1 ♂ (2.5); 031985A35, 1 ♂.

Geographic Distribution.—Bahama Islands (Brattegard, 1969).

Ecological Notes.—This species was collected from coral rubble, bases of hard corals, and algal turf covering dead *Acropora palmata*. It was also extracted from the surface of a colony of *Porites porites*. Depths of collections ranged from 2–8 m. Specimens collected by Brattegard (1969) came from sandy bottoms and from sand-algal bottoms at depths of 1–10 m.

Antromysis (Parvimysis) bahamensis (Brattegard, 1969)

Parvimysis bahamensis Brattegard, 1969, p. 74, figs. 23, 24; 1973, p. 46, fig. 19.

Material Examined.—Sample number 031685E20, 1 ♂ (2.5 mm), 5 ♀♀ (1.9–2.3), 1 juvenile (1.7); 120682BK, 2 ♀♀ (2.1, 2.3), 1 juvenile (1.7).

Geographic Distribution.—Bahama Islands (Brattegard, 1969), Puerto Rico (Brattegard, 1970b), coastal waters off Colombia (Brattegard, 1973, 1974a), Caribbean coast of Panama (Brattegard, 1974b), Lesser Antilles (Brattegard, 1975), and waters around the Florida Keys (Brattegard, 1973).

Systematic Note.—Bowman (1977) ranked the genus *Parvimysis* as a subgenus of *Antromysis*.

Ecological Notes.—Specimens were collected in the soft, organic silt beneath the roots of red mangrove trees, *Rhizophora mangle*, at the edges of mangrove cays in the Blue Ground Range; depth of collections was 1–3 m.

This species seems to congregate in fine soft sediments and sandy substrates, but has also been obtained in beds of *Thalassia* (Brattegard, 1969, 1973, 1974a, b, 1975).

Metamysidopsis sp.

Metamysidopsis spp., Brattegard, 1970b, key to known species in genus.

Material Examined.—Sample number 031885C30, 1 juvenile (1.9 mm).

Geographic Distribution.—Species of this genus are known only from American waters (W. M. Tattersall, 1951; Brattegard, 1970b).

Ecological Notes.—A single specimen in very poor condition was obtained from an algal mat that covered dead *Acropora palmata*.

Mysidopsis velifera Brattegard, 1973

Mysidopsis velifera Brattegard, 1973, p. 38, fig. 15.

Material Examined.—Sample number 031585A15, 1 ♂ (3.2 mm); 031785D25, 1 ♂ (3.0); 031885B30, 1 juvenile (1.3); 031885C30, 1 ♀ (3.6), 1 juvenile (1.8).

Geographic Distribution.—Caribbean coastal waters of Colombia, Panama (Brattegard, 1973, 1974a, b), and Lesser Antilles (Brattegard, 1975).

Ecological Notes.—Specimens were collected from near the base of hard and soft corals, algal turf, and beds of *Thalassia* at depths from 1.0–8.0 m. In the shallow waters of Colombia and Panama this species was obtained from beds of *Thalassia* and organically rich sandy sediments (Brattegard, 1973, 1974a, b).

Mysidopsis badius, new species

Figs. 2, 3

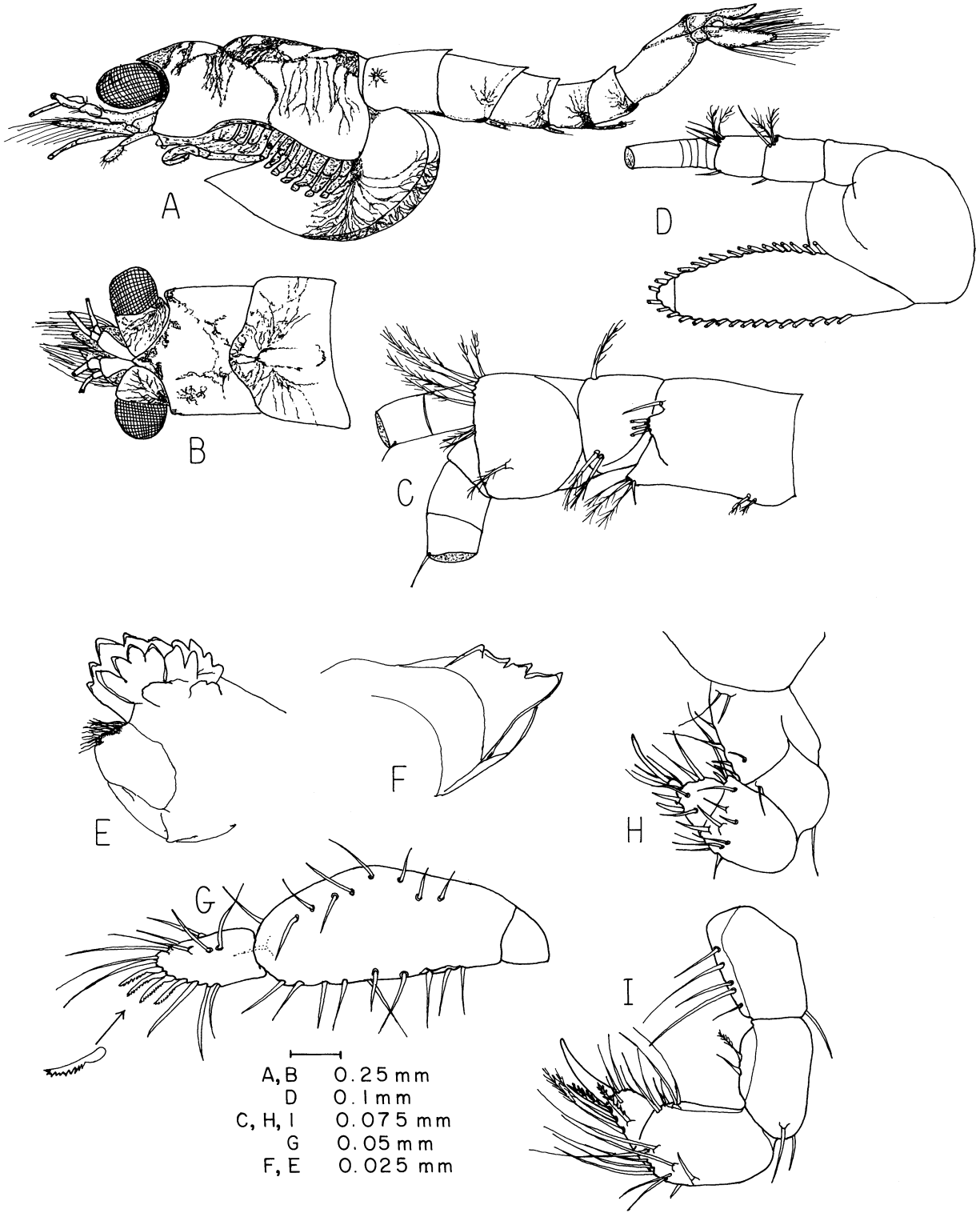
Type Material.—Sample number 031885B30, ♀ (4.0 mm), holotype, not dissected, USNM 228289; 1 ♀ (3.1 mm), 3 juveniles (1.3–2.2 mm), paratypes, not dissected, USNM 228290; 031685G20, ♂ (3.2 mm), paratype, dissected on 3 microscope slides, USNM 228290.

Material Examined.—Sample number 031685G20, 2 ♂♂ (3.1 mm), 3 ♀♀ (2.6–3.2) (none ovigerous), 4 juveniles (1.2–2.0); 031885B30, 3 ♀♀ (3.0–4.0), 3 juveniles (1.3–2.2).

Description.—Body (Fig. 2A) robust, beige to chestnut in color when observed alive and when preserved, diffused pigmentation on eyestalks, dorsal and lateral sides of carapace, ventral thoracic region, lateral and dorsal sides of abdominal segments and proximal region of telson, heavy pigmentation on proximal region of oostegites and near posterior margins of abdominal segments.

Carapace (Fig. 2A, B): anterior margin produced into short triangular rostrum, anterolateral margins angular, posterolateral margins rectangular, posterior margin slightly concave exposing thoracic segment 7 partially and 8 completely; cervical groove dividing anterior one-third from posterior two-thirds.

Antennular peduncle (Fig. 2C): segment 1 longer than 2 or 3, with ventral and lateral lobes distally each bearing 3 plumose setae and adjacent spine; segment 2 with 1 plumose seta medially, 2 plumose setae laterally; segment 3 with about 6 medial plumose setae, 2 plumose setae distally, ventrally stout plumose seta near distolateral margin; setation on male lobe conspicuous.



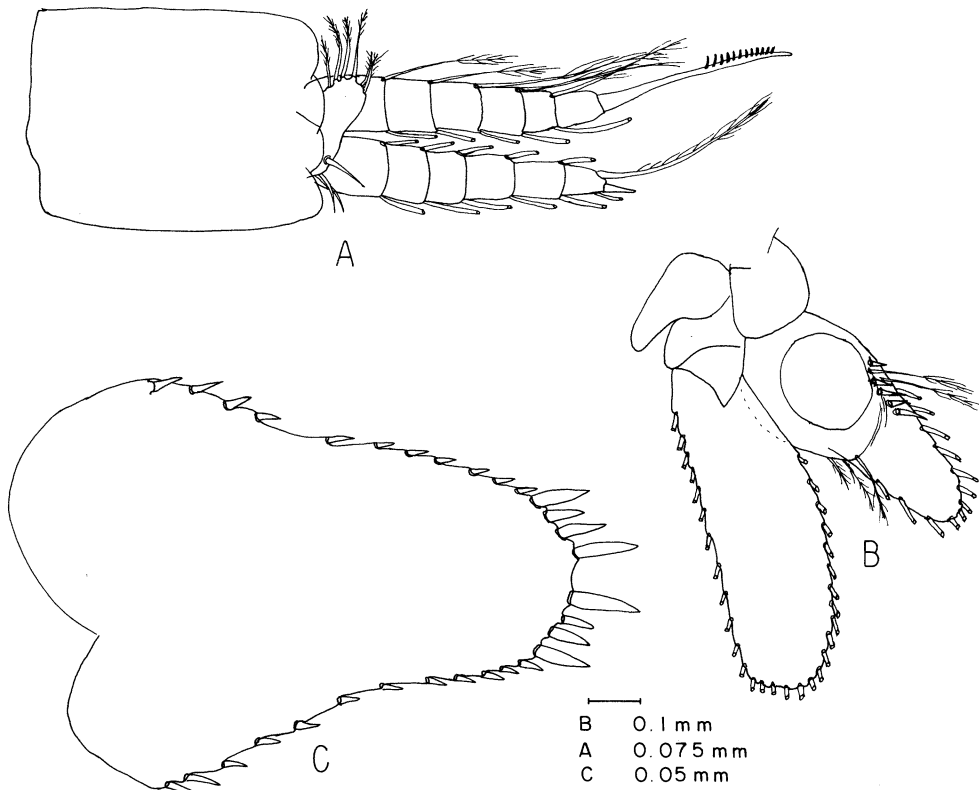


Fig. 3. *Mysidopsis badius*, new species: A, male pleopod 4; B, uropod; C, telson. A–C = male, 3.2 mm, paratype, USNM 228290.

Antenna (Fig. 2D): scale about 1.5 times longer than peduncle, bladelike, about 3 times longer than wide at widest point, outer margin slightly convex, tip rounded, inner margin strongly convex, setose all around, tip indistinctly articulate, about 0.09 times scale length; peduncle segment 1 without spines or setae; peduncle segment 2, 1.2 times longer than segment 3, with 2 plumose setae and 1 simple seta distomedially, short thin spine distolaterally; peduncle segment 3 with 2 plumose and 3 simple setae distomedially, short thin spine distolaterally.

Mandibles (Fig. 2E, F): without molar processes; left incisor with 6 pointed cusps, lacinia mobilis with 5 blunt and 4 pointed teeth; cutting edge of right incisor flat, lacinia mobilis with 4 low pointed cusps; palp (Fig. 2G) 3-segmented; segment 2, 2.5 times longer than 3, medial margin armed with 8 short naked setae, lateral margin with 10 naked setae; segment 3 with 3 long simple setae on lateral margin, about 8 on medial margin, 4 short serrated spines distolaterally.

Maxillule, maxilla, and labrum typical of genus.

←
Fig. 2. *Mysidopsis badius*, new species: A, whole animal; B, carapace; C, antennular peduncle; D, antennal peduncle and scale; E, left mandible; F, right mandible; G, mandibular palp; H, thoracic endopod 1; I, thoracic endopod 2. A, B = female, 4.0 mm, holotype, USNM 228289; C–I = female, 3.0 mm.

Thoracic leg 1 (Fig. 2H): endopod short and robust; distal margin of carpopropodus with about 5 slender spines and 6 simple setae; dactylus rounded, armed with about 5 spines and 4 setae, apex with robust claw slightly longer than dactylar segment.

Thoracic leg 2 (Fig. 2I): endopod with ischium, merus, and carpopropodus subequal in length; ischium with 1 short and 4 long simple setae medially, spine distolaterally; merus with 1 simple and 1 plumose seta medially, 2 spines distolaterally; lateral margin of carpopropodus with about 13 long simple setae and 2 slender spines, medial margin with 6 setae distally; dactylus about $0.4 \times$ length of carpopropodus, armed with 2 plumose setae, 4 simple setae, 2 robust pectinate spines and robust terminal claw.

Thoracic legs 3–8: typical of genus, carpopropodus 3-segmented, middle segment shortest.

Male pleopods: typical of genus, sympods subrectangular; pleopods 1–5, exopods 6-segmented; pleopods 2–5, endopods 6-segmented; endopod of pleopod 1 with 1 segment; exopod of fourth pleopod (Fig. 3A) terminating in long robust seta pectinate near distal end with about 12 small spinules. Female pleopod reduced to flat plates, fifth about 1.5 times longer than others.

Uropods (Fig. 3B): exopod about 1.4 times longer than endopod, lateral margin straight, medial margin slightly convex, setose all around; endopod with 5 stout spines along medial margin concentrated in area of statocyst, spines increasing in length distally.

Telson (Fig. 3C): entire, linguiform, lateral margins concave, each armed with 4 or 5 robust spines proximally, 7 short spines in midsection, distal margin with 2 long distolateral spines, 4 short spines, and 2 long apical spines separated by space.

Remarks. — *Mysidopsis badius* appears related to *M. robusta* (Brattegard, 1974a) and *M. eclipes* (Brattegard, 1969), but differs from both by having more intense body pigmentation. Spine arrangement and composition on the distal margin of the telson is different from that of *M. robusta*. *Mysidopsis badius* has 2 long distolateral spines, 4 short spines, and 2 long apical spines separated by a space rather than 2–4 short spines and 2 long apical spines. Exopods of male pleopods 1–5 and endopods of pleopods 2–5 are composed of 6 segments rather than 7 or 8. Endopod of male pleopod 1 has a single segment as in other species of *Mysidopsis*. There are 5 spines along the medial margin of the uropodal endopod concentrated near the statocyst. The endopod of the uropod of a mature *M. robusta* has 9 spines lining the proximal two-thirds of the medial margin. The antennal scale of *M. badius* is broader than that of *M. robusta* and its thoracic legs are not as heavily covered with setae.

Mysidopsis eclipes differs from *M. badius* by having a long curved barbed spine on the distal segment of the mandibular palp in addition to the 4 short serrated spines; 8 or 9 spines on the endopod of the uropod; and spines on the margins of the telson subequal in length and only 2 long apical spines that are not separated by a space.

Ecological Notes. — Specimens were collected exclusively in beds of *Thalassia* sampled in the shoal waters of the Blue Ground Range and on the west side of Carrie Bow Cay. Depth of collection was 0.1–1.0 m.

Etymology. — The specific name *badius*, Latin meaning brown or chestnut-colored, alludes to the color of the body of this species.

Mysidium columbiae (Zimmer, 1915)

Diamysis columbiae Zimmer, 1915, p. 172, figs. 23, 24; Brattegard, 1969, p. 86, fig. 27.

Material Examined.—Sample number 031485A10, 3 ♂♂, 2 ♀♀ (none ovigerous), 2 juveniles; 031485B10, 1-0-0-1; 031585A15, 0-1-0-0; 031685D20, 1-10-0-5; 031685F20, 1-4-0-45; 031885C30, 1-1-0-0; 032085A40, 11-3-32-5; 061383KR1, 2-1-15-0; 102185F65, 67-46-23-30.

Geographic Distribution.—This species is widespread throughout the Caribbean Sea and southern Gulf of Mexico (Zimmer, 1915; W. M. Tattersall, 1951; Goodbody, 1965; Emery, 1968; Brattegard, 1969, 1970b, 1973, 1974a, b, 1975; Băcescu and Ortiz, 1984).

Ecological Notes.—The greatest number of specimens occurred in collections made in water around the roots of red mangrove trees, *Rhizophora mangle*, growing along shorelines of Twin Cays and cays in the Blue Ground Range. Collections were made at depths from 1.0–1.5 m. Individuals were usually aggregated in planktonic swarms. Others were obtained from coral rubble and algal turf habitats located near the coral reef at Carrie Bow Cay. Total length ranged from 3.1–6.8 mm. Gravid females averaged 6.2 mm and carried 2–7 eggs or larvae.

Other investigators found this species swarming near corals (Emery, 1968; Brattegard, 1970b, 1973), mangroves (Goodbody, 1965; Brattegard, 1975), and around sandy and rubble habitats (Brattegard, 1969, 1974b), and in association with the urchin *Diadema antillarum* (see Brattegard, 1974a).

Mysidium integrum W. M. Tattersall, 1951

Mysidium integrum W. M. Tattersall, 1951, p. 223, fig. 96; Brattegard, 1969, p. 82, fig. 26.

Material Examined.—Sample number 031485A10, 14 ♂♂, 41 ♀♀ (1 ovigerous), 33 juveniles; 031485B10, 9-12-0-12; 031585A15, 0-2-0-0; 031785A25, 8-9-0-5; 031785B25, 19-15-0-3; 031785C25, 10-13-0-18; 031785D25, 0-0-0-12; 031885C30, 2-3-0-7.

Geographic Distribution.—Coastal areas throughout the Caribbean Sea (W. M. Tattersall, 1951; Brattegard 1970b, 1973, 1974a, b, 1975), Bahamian waters, and southern Florida (Emery, 1968; Brattegard, 1969), and Gulf of Mexico (W. M. Tattersall, 1951; Modlin, 1984).

Ecological Notes.—Individuals of *M. integrum* aggregate in swarms, but unlike *M. columbiae*, they appear to be more closely associated with coral features than mangroves. Specimens were observed in swarms at various sites in and around the reef. They were collected in coral rubble, algal turf, and in crevices and near the base of hard and soft corals. Depth of collections ranged from 1.0–8.0 m. Total length ranged from 1.5–5.0 mm. The single ovigerous female, 5.0 mm, carried 3 stage-I larvae.

At other locations in the Caribbean Sea this species was obtained from various coral reef habitats at depths from 1.0–30.0 m (Emery, 1968; Brattegard, 1969, 1970b, 1973, 1974a, b, 1975; Modlin, 1984).

Heteromysis actinia Clarke, 1955

Heteromysis actinia Clarke, 1955, p. 1, figs. 1–8; Brattegard, 1969, p. 96, figs. 31, 32.

Material Examined.—Sample number 120584KR, 3 ♂♂ (5.5–6.8 mm), 5 ♀♀ (6.2), (4 ovigerous) (6.5–7.5 mm), 2 juveniles (3.2, 3.5 mm).

Geographic Distribution.—Bahama Islands (Clarke, 1955; Brattegard, 1969), Lesser Antilles, Caribbean coast of Mexico and Panama (Brattegard 1970b, 1974b, 1975).

Ecological Notes.—This species was observed and collected by W. Sterrer and K.

Rützler in the channel between Twin Cays. Specimens were in association with the anemone *Bartholomea annulata*. Depth of collection was 1.0 m.

All collection records indicate that *H. actinae* is always collected in association with the sea anemone *Bartholomea annulata* (see Brattegard, 1969, 1970b, 1974b, 1975; personal observation). Experiments made by Clarke (1955) showed that this species has a strong commensal relationship with this sea anemone. Although commensal behaviors have been suggested for other species of *Heteromysis*, the evidence provided in support of commensalism is circumstantial and can not be used to justify such a contention.

Heteromysis bermudensis Sars, 1885

Heteromysis bermudensis Sars, 1885, p. 216, pl. 38, figs. 1–7; Clarke, 1955, p. 5, fig. 7; Brattegard, 1973, p. 51, fig. 20; Bowman, 1981, p. 458, fig. 1.

Material Examined.—Sample number 031585G15, 1 ♂, 3 ♀♀ (1 ovigerous), no juveniles; 031885A30, 1-0-1-0; 032085C40, 2-1-2-0.

Geographic Distribution.—Waters around Bermuda (Sars, 1885; Verrill, 1923; Clarke, 1955; Bowman, 1981) and Colombia (Brattegard, 1973). A subspecies *H. b. cesari* has been described from Cuba (Băcescu, 1968) and Saba Bank, Lesser Antilles (Brattegard, 1980).

Ecological Notes.—Total length of specimens ranged from 3.0–4.5 mm; ovigerous females (4.0–4.5 mm) carried 3 or 4 eggs or stage-I larvae. All specimens were obtained from empty queen conch shells, *Strombus gigas*, collected in the back reef area around Carrie Bow Cay. This species has been washed from a sponge and algae (Bowman, 1981) and from coral and shell rubble (Verrill, 1923; Clarke, 1955) in Bermuda and Bahama Islands, and from a sponge off Colombia (Brattegard, 1973).

Heteromysis mayana Brattegard, 1970

Heteromysis mayana Brattegard, 1970b, p. 140, figs. 12, 13.

Material Examined.—Sample number 031485C10, 0 ♂♂, 1 ♀ (none ovigerous), 0 juveniles; 031585G15, 0-0-0-2; 031685A20, 1-0-0-0; 031885A30, 4-3-0-1; 031985B35, 3-3-0-0; 031985C35, 1-0-0-0; 032085C40, 3-0-1-1.

Geographic Distribution.—Coastal areas of Quintana Roo, Mexico (Brattegard, 1970b), Colombia (Brattegard, 1973, 1974a), and tentatively from the Lesser Antilles (Brattegard, 1975).

Ecological Notes.—Total length ranged from 2.7–3.5 mm. Specimens were washed from pieces of dead *Porites porites* and empty shells of *Strombus gigas* that were collected in various back reef locations around Carrie Bow Cay. One individual was obtained in association with *Bartholomea annulata* collected in a patch reef system about 3 km southwest of Carrie Bow Cay. Brattegard (1970b, 1973, 1974a) reported this species from corals, coral rubble, beds of *Thalassia*, and a green sea anemone.

Heteromysis tuberculospina, new species

Figs. 4, 5

Type Material.—Sample number 031985C35, 1 ♂ (3.6 mm), holotype, not dissected, USNM 228287; 031985C35, 2 ♂♂ (4.5, 4.7 mm), 8 ♀♀ (2.7–4.8 mm) (1 ovigerous) (4.6 mm), 4 juveniles (1.7–2.5 mm), paratypes, not dissected, USNM 228288.

Material Examined.—Sample number 031685F20, 0 ♂♂, 1 ♀ (none ovigerous), 0 juveniles; 031685J20,



Fig. 4. *Heteromysis tuberculospina*, new species: A, carapace; B, antennular peduncle; C, antennular spine, male; D, antennular spine, female; E, antennal peduncle and scale; F, left mandible; G, right mandible; H, mandibular palp. A = male, 3.6 mm, holotype, USNM 228287; B, C, E = male, 4.7 mm; D, F-H = female, 3.9 mm.

0-1-0-0; 031785E25, 2-3-0-2; 031885A30, 1-0-0-0; 031985C35, 3-7-1-4; 031985D35, 7-11-4-13; 031985E35 0-1-0-0.

Description.—Body slender, typical of genus; color when alive beige with 2 red orange lateral stripes on dorsum of abdomen diffusing into thoracic region; anterodistal margin of eyestalk with small triangular tooth, cornea oval.

Carapace (Fig. 4A): with anterior margin forming triangular rostrum, lateral margins concave, anterolateral lobe angular, posterolateral lobe rounded, posterior margin concave exposing thoracic segment 8.

Antennule (Fig. 4B): length of peduncle segment 1 about equal to sum of lengths

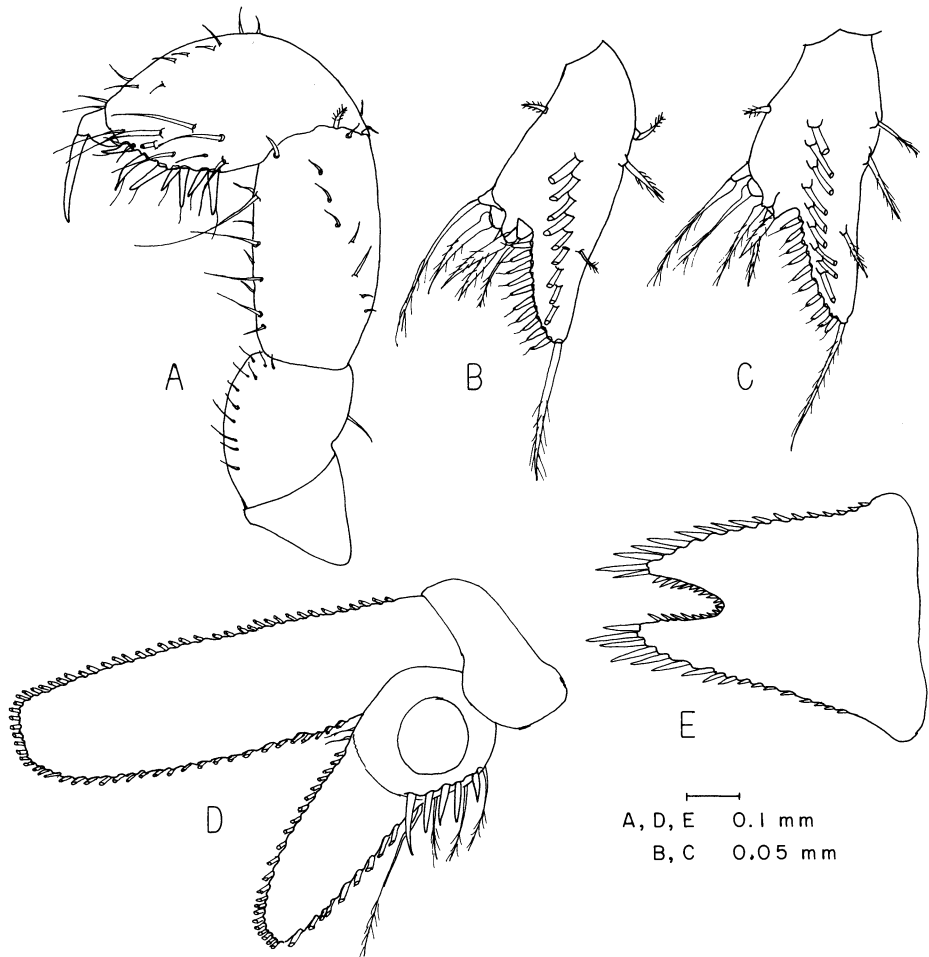


Fig. 5. *Heteromysis tuberculospina*, new species: A, thoracic endopod 3; B, male pleopod 3; C, male pleopod 4; D, uropod; E, telson. A–D = male, 4.7 mm; E = female, 3.9 mm.

of segments 2 and 3, with 2 plumose setae and 1 spine on anterodistal lobe; segment 2 with 3 plumose setae medially and clumps of minute setae covering distomedial lobe; segment 3 with robust flagellated spine distomedially possessing 3–5 tubercles distally (Fig. 4C, D), 3 plumose setae along medial margin, conspicuous male lobe ventrally, about 3 long simple setae on distal margin dorsally.

Antenna (Fig. 4E): peduncle about 1.4 times longer than scale; segment 1 small without spines or setae; segment 2 about 1.6 times longer than segment 3 and 2.7 times longer than segment 1, spine and 3 small setae on distomedial margin, 2 setae distolaterally; segment 3 with 4 naked setae distomedially and 2 distolateral setae; scale bladeliike, lateral margin straight, medial margin convex, apex articulate, tip about 0.1 times scale length, setose all around.

Mandibles (Fig. 4F, G): with well-developed incisors, laciniae mobiles, spine rows, and molar processes; palp (Fig. 4H) 3-segmented; segment 2 expanded, lateral margin with 15 simple setae, proximal half of medial margin with 7 simple setae; segment 3 lateral margin sinuous, distal half with about 12 robust pectinate

setae, long robust spine at apex directed medially with single row of short stiff setae along its length, 5 or 6 slender setae on medial side, medial margin convex.

Maxillules, maxillae, labrum, and thoracic legs 1 and 2 typical of genus.

Thoracic leg 3 (Fig. 5A): ischium with 11 or 12 small setae medially, merus with 9 simple setae medially with longest distally, small spine distomedially, small robust plumose seta distolaterally, row of about 9 small spines laterally; carpopropodus expanded, lateral and medial margins convex, medial margin with 7 robust flagellated spines arranged proximal to distal in 3 paired sets of subequal spines and 1 single spine distally about 0.5 times smaller than others, about 4 long and 4 short setae submarginally, about 12 short setae along lateral margin; dactylus small, rounded, terminating in long clawlike spine.

Thoracic leg 4: carpopropodus with 4 segments.

Thoracic legs 5–8: carpopropodus with 6 segments.

Pleopods (Fig. 5B, C): unsegmented; male pleopods 1, 2, and 5 not modified; 3 and 4 modified identically, each with 9 long robust plumose setae on anterior surface, 2 short robust plumose setae in proximal half of lateral margin, and 1 in distal half, long robust plumose seta in outer distal corner and 10 flagellated spines equal in length along distal margin, 5 plumose setae along distal margin of reduced pseudobranchial lobe, short plumose seta at about midlength along medial margin.

Uropods (Fig. 5D): exopod about 1.4 times longer than endopod, lateral margin straight, apex truncate, medial margin slightly convex, setose all around; endopod with lateral and medial margins concave, apex rounded, right endopod with 5 stout spines near medial margin in area of statocyst increasing in length distally, left endopod with 6 such spines, margins completely setose.

Telson (Fig. 5E): about 1.1 times longer than wide at base, outer margins completely spined each with 17 or 18 spines (apical spines included) increasing in length distally, outer apical spine longer than inner; cleft, depth about $0.3 \times$ length of telson, completely spined with 18–20 spines increasing slightly in length distally.

Remarks.—*Heteromysis tuberculospina* closely resembles *H. bredini*, but differs by having a tuberculate spine on the distomedial edge of segment 3 of the antennular peduncle, a terminal segment on the antennal scale 0.1 times as long as the length of the scale rather than 0.07 times, 7 flagellated spines on the medial margin of the carpopropodus of the third thoracic leg rather than 10, a 6-segmented carpopropodus on thoracic legs 5–8 rather than 7, a telson 1.1 times longer than wide at the base rather than 1.25 times, and 18–20 spines in the telsonal cleft rather than 31. Comparison of *H. tuberculospina* with *H. bredini* was made primarily with female specimens, since males of *H. bredini* have never been reported. Structural characteristics of males, except for the modification in pleopods 3 and 4, and the increased number of tubercles on the distomedial flagellated spine of the third segment of the antennular peduncle, are the same as those found in females.

Ecological Notes.—Total lengths of males ranged from 3.3–5.5 mm; females ranged from 2.7–5.2 mm and juveniles from 1.9–2.7 mm. Ovigerous females ranged from 4.6–5.6 mm and each carried 2 eggs or larvae. Specimens were obtained primarily from empty queen conch shells, *Strombus gigas*, and from the sponge *Callyspongia vaginalis* that were collected near Carrie Bow Cay. Collections were made at depths from 0.1–8.0 m. A single specimen was obtained from a general collection made around roots of the mangrove *Rhizophora mangle* at the Blue Ground Range, and from a sponge of the genus *Iricinia* collected in a patch reef system about 3 km southwest of Carrie Bow Cay.

Etymology. — Named for the tuberculate distal end of the flagellated spine located on the distomedial end of antennular peduncle segment 3. This particular spine on other heteromysids terminates in a sharply pointed or rounded tip. A slightly flared tuberculate tip has previously not been described in this genus. This spine is taxonomically important since its absence or presence separates the species of *Heteromysis* into two groups (Brattegard, 1970b; Modlin, 1984).

DISCUSSION

The coral and mangrove communities around Carrie Bow Cay, Belize, possess a rich and diverse mysid fauna. Of the 40 stations sampled, 75% produced mysids. Species diversity of this mysid assemblage is similar to that found in other Caribbean Sea locations where intensive and systematic collections have been made. Brattegard (1969, 1970a) collected 16 species in the waters around the Florida Keys and 15 species around the Bahama Islands. Modlin (1984) obtained 11 species from the Florida Middle Ground, the northernmost hermatypic coral reef system in the Gulf of Mexico. Sixteen species were collected in the shallow waters near Carrie Bow Cay. However, the mysid fauna in Belizian waters may be richer than this report indicates. Collecting efforts during this project were directed toward obtaining benthic, commensal, and cryptic mysids. Except for the *Mysidium* and *Siriella* species, no other planktonic mysids were collected. Since other planktonic genera have been reported from Caribbean locations, it is probable that they are also present in the water around Carrie Bow Cay.

ACKNOWLEDGEMENTS

I especially thank Dr. Klaus Rützler, coordinator of the Smithsonian's Coral Reef and Mangrove Ecosystems program, for making my collecting trip to Carrie Bow Cay, Belize, possible. In addition, I would like to acknowledge Mr. Michael Dardeau, Dauphin Island Sea Lab (DISL), Dauphin Island, Alabama, for his assistance in collecting specimens and Drs. Thomas E. Bowman, Brian Kensley, Klaus Rützler, and Frank Ferrari for allowing me to examine their collections of mysids from Carrie Bow Cay. The Marine Environmental Sciences Consortium, at the DISL, provided housing and laboratory facilities during part of this project. Laboratory and housing accommodations while on Carrie Bow Cay were generously provided by the Smithsonian Institution's Coral Reef and Mangrove Program, Belize, partly supported by the Exxon Foundation. This is contribution number 204 from the Caribbean Coral Reef Ecosystem Program, Smithsonian Institution, partly supported by the Exxon Corporation and contribution number 089 from the Marine Environmental Science Consortium, Dauphin Island Sea Lab, Alabama.

LITERATURE CITED

- Băcescu, M. 1968. *Heteromysini* nouveaux des eaux cubaines: Trois espèces nouvelles de *Heteromysis* et *Heteromysoides spongicola* n.g.n.sp.—*Revue Roumaine de Biologie, Zoologie* 13: 221–237.
- , and M. Ortiz. 1984. Contribution to the knowledge of the Mysidacea (Crustacea) of the Cuban insular shelf waters.—*Travaux du Muséum d'Histoire Naturelle Grigore Antipa* 24: 15–23.
- Bowman, T. E. 1977. A review of the genus *Antromysis* (Crustacea: Mysidacea), including new species from Jamaica and Oaxaca, Mexico, and a redescription and new records for *A. cenotensis*. — *In: J. R. Reddell, ed., Studies on the caves and cave fauna of the Yucatan Peninsula. Association for Mexican Cave Studies Bulletin* 6: 27–38.
- . 1981. First description of the male opossum shrimp, *Heteromysis bermudensis bermudensis* (Crustacea: Mysidacea).—*Proceedings of the Biological Society of Washington* 94: 458–461.
- Brattegard, T. 1969. Marine biological investigations in the Bahamas 10. Mysidacea from shallow water in the Bahamas and southern Florida. Part 1.—*Sarsia* 39: 17–106.
- . 1970a. Marine biological investigations in the Bahamas 11. Mysidacea from shallow water in the Bahamas and southern Florida. Part 2.—*Sarsia* 41: 1–35.
- . 1970b. Mysidacea from shallow water in the Caribbean Sea.—*Sarsia* 43: 111–154.
- . 1973. Mysidacea from shallow water on the Caribbean coast of Colombia.—*Sarsia* 54: 1–65.

- . 1974a. Additional Mysidacea from shallow water on the Caribbean coast of Colombia.—*Sarsia* 57: 47–86.
- . 1974b. Mysidacea from shallow water on the Caribbean coast of Panama.—*Sarsia* 57: 87–108.
- . 1975. Shallow-water Mysidacea from the Lesser Antilles and other Caribbean regions.—*Natuurwetenschappelijke Studiekkring voor Suriname en de Nederlandse Antillen* 83: 102–115.
- . 1980. *Platymysis facilis* gen. et sp. nov. (Crustacea: Mysidacea: Heteromysini) from the Saba Bank, Caribbean Sea.—*Sarsia* 65: 49–52.
- Clarke, W. D. 1955. A new species of the genus *Heteromysis* (Crustacea, Mysidacea) from the Bahama Islands, commensal with a sea-anemone.—*American Museum Novitates* 1716: 1–13.
- Coifmann, I. 1937. Misidacei raccolti dalla R. Corvetta "Vettor Pisani" negli anni 1882–85.—*Annuario dell'Istituto e Museo di Zoologico dell' Università di Napoli*, n. s. 7: 1–14.
- Emery, A. R. 1968. Preliminary observations on coral reef plankton.—*Limnology and Oceanography* 13: 293–303.
- Goodbody, I. 1965. Continuous breeding in populations of two tropical crustaceans, *Mysidium columbiae* (Zimmer) and *Emerita portoricensis* Schmidt.—*Ecology* 46: 195–197.
- Holt, E. W. L., and W. M. Tattersall. 1905. Schizopodous Crustacea from the north-east Atlantic slope.—*Reports of the Sea Inland Fisheries Ireland, 1902–1903, Part 2*: 99–152.
- Kensley, B. 1982. Anthuridae (Crustacea: Isopoda) of Carrie Bow Cay, Belize.—*In*: K. Rützler and I. G. Macintyre, eds., *The Atlantic barrier reef ecosystem at Carrie Bow Cay, Belize, I: Structure and communities*. *Smithsonian Contributions to the Marine Sciences* 12: 321–353.
- . 1984a. The role of isopod crustaceans in the reef crest community at Carrie Bow Cay, Belize.—*Marine Ecology* 5: 29–44.
- . 1984b. The Atlantic barrier reef ecosystem at Carrie Bow Cay, Belize, III: New marine Isopoda.—*Smithsonian Contributions to the Marine Sciences* 24: 1–81.
- Lewis, S. M., and B. Kensley. 1982. Notes on the ecology and behaviour of *Pseudamphithoides incurvaria* (Just) (Crustacea, Amphipoda, Amphithoidae).—*Journal of Natural History* 16: 267–274.
- Modlin, R. F. 1979. Development of *Mysis stenolepis* (Crustacea: Mysidacea).—*American Midland Naturalist* 101: 250–254.
- . 1982. Contributions to the ecology of the mysid crustaceans in the shallow waters of Dauphin Island, Alabama.—*Northeast Gulf Science* 5: 45–49.
- . 1984. Mysidacea from the Florida Middle Ground northeast Gulf of Mexico, with descriptions of three new species of *Heteromysis* and a key to the Heteromysini of the western Atlantic.—*Journal of Crustacean Biology* 4: 278–297.
- Rützler, K., and I. G. Macintyre (eds.). 1982. *The Atlantic barrier reef ecosystem at Carrie Bow Cay, Belize, I: Structure and communities*.—*Smithsonian Contributions to the Marine Sciences*, 12: i–xiv, 1–539.
- Sars, G. O. 1885. Report on the Schizopoda of H.M.S. *Challenger* during the years 1873–76.—*Report on the scientific results of the voyage of H.M.S. Challenger during the years 1873–1876, Zoology* 13: 1–255.
- Tattersall, W. M. 1937. New species of mysidacid crustaceans.—*Smithsonian Miscellaneous Collections* 96(26): 1–18.
- . 1951. A review of the Mysidacea of the United States National Museum.—*Bulletin of the United States National Museum* 201: 1–292.
- Thomas, J. D. 1983. *Curidia debrogania*, a new genus and species of amphipod (Crustacea: Ochelesidae) from the barrier reefs of Belize.—*Proceedings of the Biological Society of Washington* 96: 127–133.
- , and J. L. Barnard. 1983a. The Platyschnoplidae of America (Crustacea, Amphipoda).—*Smithsonian Contributions to Zoology* 375: 1–33.
- , and ———. 1983b. Transformation of the *Leucothoides* morph to the *Anamixis* morph (Amphipoda).—*Journal of Crustacean Biology* 3: 154–157.
- Verrill, A. E. 1923. Crustacea of Bermuda: Schizopoda, Cumacea, Stomatopoda, and Phyllocarida.—*Transactions of the Connecticut Academy of Arts and Sciences* 26: 181–211.
- Zimmer, C. 1915. Schizopoden des Hamburger naturhistorischen (zoologischen) Museums.—*Mitteilungen aus dem naturhistorischen Museum, Hamburg* 32: 202–216.

RECEIVED: 26 January 1986.

ACCEPTED: 28 March 1986.

Address: Department of Biological Sciences, The University of Alabama at Huntsville, Huntsville, Alabama 35899.