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PSEUDOTHELPHUSA MEXICANA, A NEW FRESHWATER CRAB FROM THE STATE OF GUERRERO, MEXICO (BRACHYURA: PSEUDOTHELPHUSIDAE)

Fernando Alvarez-Noguera

Abstract.—A new species of freshwater crab, *Pseudothelphusa mexicana,* from La Jolla Cave, in the State of Guerrero, Mexico, is described. It does not exhibit any external morphological modification for a troglobitic habitat. Its affinity with *Pseudothelphusa granatensis* is discussed.

In July 1983, and January and February 1984, 11 specimens (5 ♀, 6 ♂) of a previously undescribed freshwater crab were collected in La Jolla Cave, in the State of Guerrero, Mexico. They were captured in an isolated area in complete darkness 120 m from the cave's entrance after a 20 m vertical drop; this seems to restrict the distribution of the species to the deeper part of the cave. The presence of pseudothelphusid crabs in caves has already been reported. The genus *Typhlopseudothelphusa,* distributed from the south of Mexico to northern Guatemala, includes the only three species of truly troglobitic American pseudothelphusids (Hobbs et al. 1977, Rodriguez 1982). *Typhlopseudothelphusa mocinoi* does not have pigmentation on either the carapace or the appendages, and the ocular peduncle lacks visual elements (Rioja 1952). Like the species described herein, *Tehuana complanata* (Rodriguez 1982), reported from a cave in the State of Veracruz, exhibits no obvious adaptations to the cave environment (Rodriguez and Smalley 1969, Hobbs et al. 1977).

Pseudothelphusa mexicana,
new species
Fig. 1

Description.—Front of carapace without defined superior border, but limited by epigastric lobes. Inferior frontal border well marked and smooth. Slightly arched median groove reaching mesogastric region visible in frontal view. Carapace convex, with smooth surface and small papillae regularly distributed. Cervical groove deep and curved, reaching anterolateral margin of carapace. Cardiac and metabranchial regions with shallow grooves. Anterolateral margin bearing small denticles from cervical groove to epibranchial region, number varying from 16 to 24. Margin between ocular orbit and cervical groove sinuous and without denticles. Ventral surface of carapace smooth except on pterygostomian region, which bears cylindrical setae. Ratio ischium/exopod of third maxilliped varying from 0.7 to 0.87, average 0.8. Chelipeds unequal, right chelae larger; dactyl and propodus curved inward. Fingers of major chelae in male gaping. Ocular peduncle and cornea well developed, carapace with brown pigmentation, walking legs and chelipeds similar to those of epigean species.

Gonopod description.—In a caudal view the lateral process (fig. 24 in Rodriguez and Smalley 1969) changes to a caudal position at ⅔ of the length of the gonopod. Apex exhibiting well developed lateral lobe possessing 3 acute projections laterally oriented. Outer margin of mesial process curved and serrate, ending in rounded tip at about same level as projections of lateral lobe. Straight inner margin projecting toward median front portion of the apical cavity, without joining lateral lobe. Superior lobe re-

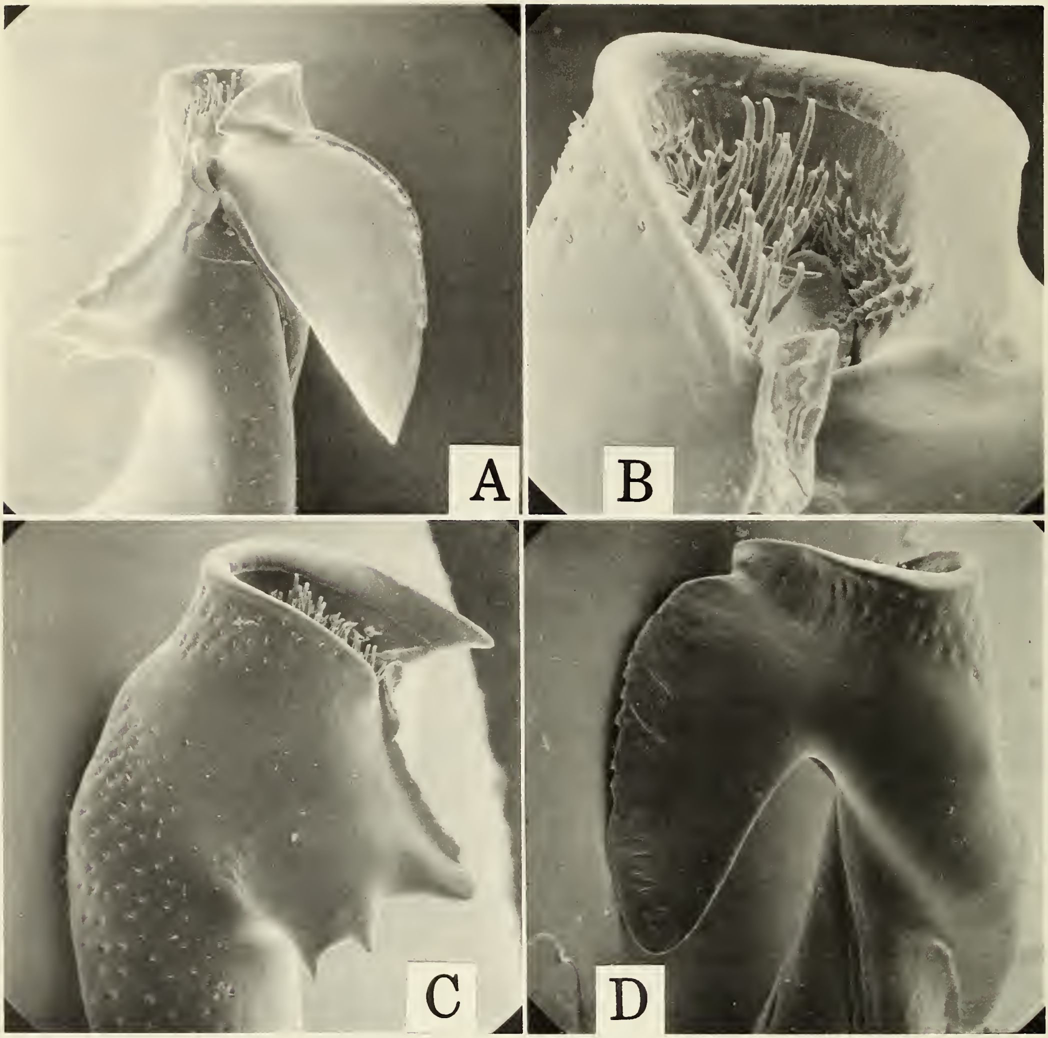

Fig. 1. *Pseudothelphusa mexicana,* holotype, left gonopod: A, Apical part, cephalic view, B, Detail of apex, cephalic; C, Lateral lobe; D, Mesial process.

duced to acute denticle as in *P. granatensis.* Apex of gonopod with oval cavity opening anteriorly and bearing 26 terminal pore setae. Internal border of cavity thicker than external one.

The terminology employed for the gonopod description is taken from Smalley (1964), and Smalley and Adkison (1984).

Type.—The holotypic male is deposited in the Carcinologic Collection, Instituto de Biologia, UNAM (Catalog No. EM 3604).

Type locality.—La Jolla Cave, State of Guerrero, Mexico (18°35′N, 99°34′W), 5 km northeast from Taxco by Highway 95, at an altitude of 1800 m. This cave was formed by chemical dissolution and always carries water in its deeper parts.

Relationships.—As stated by Rodriguez (1982), few external morphological characteristics within the pseudothelphusids have taxonomic value. The gonopod, however, provides the most important differentiation characters. The gonopod of *P. granatensis* (Rodriguez and Smalley 1969),

Table 1.—Measurements of width and length of carapace and fronto-orbital width, in mm.

Males			Females		
C.W.	C.L.	F.W.	C.W.	C.L.	F.W.
37.5*	23.1	21.8	29.5	18.2	17.1
21.0	12.9	13.2	36.0	21.8	21.1
26.6	17.0	16.3	33.0	19.7	19.0
24.0	13.3	14.3	36.2	21.4	21.2
27.2	16.3	17.0	36.0	22.0	20.5
33.2	19.4	19.4			

* Holotypic male.

a crab which seems to be closely related to *P. mexicana,* has the following features: a) a well developed mesial process that ends in a rounded tip, b) a reduced lateral lobe with an upward projection that closes the apical cavity, and c) the exterior border of the cavity is higher than the inner one (fig. 16 in Rodriguez and Smalley 1969). In *P. mexicana* the mesial process is similar in shape and position but shorter; the lateral lobe emerges from the same region forming a blade which ends in three sharp tips; and the apical cavity is opened in the median front portion due to the separation between the lateral lobe and the superior lobe.

Acknowledgments

I wish to thank Dr. Rodriguez for his valuable help, and Dr. Soto for his comments on the manuscript. I also thank Jose Luis Villalobos for allowing me to examine the type specimens of *P. granatensis,* and Yolanda Hornelas for the micrographs.

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AMPHIPODS OF THE FAMILY AMPELISCIDAE (GAMMARIDEA). VI. *AMPELISCA MACRODONTA,* A NEW SPECIES FROM THE FALKLAND ISLANDS

Gary D. Goeke

Abstract.—An unusual new ampeliscid amphipod, *Ampelisca macrodonta,* is described from the Falkland Islands. It is characterized by a series of small spines on the posterior margin of the basis of pereopod 7 and a very large tooth on the posterior corner of epimeral plate 3. The proposed new marine amphipod was collected in 3–9 meters of water over mud and broken shell bottoms.

Ampelisca macrodonta, new species
Figs. 1, 2

Material examined.—HOLOTYPE (16.2 mm), USNM 216638, 23 Feb 1927, 3–9 m, Port Stanley, Falkland Islands, boat dredge over mud and broken shell bottom, coll. W. L. Schmitt; PARATYPE (9.2 mm), USNM 216639, 2 Apr 1927, Teal Inlet, East Falkland Islands, coll. W. L. Schmitt.

Diagnosis.—Moderate sized, lower front margin of head deeply excavate, head 2½ body segments long, with 2 pairs of corneal lenses. Antenna I extending beyond end of antenna II peduncular segment 5; peduncular segments ratio 100:150:70, first segment tumid, antenna I flagellum with 13 segments, setae moderate in length. Antenna II peduncular segments 4 and 5 length ratio 100:60, flagellum ⅔ body length, with 20 segments, setae moderate in length. Mandible heavily sclerotized, 11 rakers, left with 4 teeth on lacinia mobilis, 6 teeth on incisor, palp segment 2 slightly curved, heavily setose, palp segment 3 ¾ length of segment 2 with 5 scattered and 3 apical setae. Maxilla 2, upper lip, and lower lip without diagnostic features. Maxilliped inner plate with 2 setal spines and 2 chisel-shaped spines distally and submarginal row of plumose setae; outer plate with 13 chisel-shaped spines and 3 distal plumose setae; palp normal. Maxilla 1 inner plate with 2 apical setae; outer plate with 11 distal spines; palp with 6 distal spines and 11 distal facial setal spines. Coxa 1 with well developed posteroventral notch, coxa 2 with slit, coxae 3 and 4 without slit or notch. All gills saclike. Pereopod 1 heavily setose with small dactyl. Pereopod 2 heavily setose, with elongate carpus. Pereopods 3 and 4 very similar but with 4 slightly more massive. Merus of pereopod 3 with setae of posterior margin on distal ½ only; pereopod 4 with margin entirely setose; dactyli of pereopods 3 and 4 longer than combined length of propodus and carpus on respective leg. Pereopod 5, anterior margin of basis rounded, posterior margin weakly biolobate; carpus with 4 anterior spines, posterior submarginal spinules in clusters of 2, 3, and 4, cluster of posterodistal marginal spines; propodus with 2 posterior and 3 distal spines, dactyl with 6 accessory teeth. Pereopod 6, anterior margin of basis bare proximally, 8 distal spines, posterior margin bare; anterior margin of carpus with 6 spines and with anterodistal and posterodistal clusters of spines, 4 sets of submarginal spinules in groups of 1, 2, 4, and 5, propodus with 10 antero- and 3 posteromarginal spines, dactyl with 9 accessory teeth. Pereopod 7, basis inflated, posterodistal margin with small spines, anterior margin slightly concave, ischium short with anterodistal spine, merus with posterodistal setae, antero- and posterodistal margins acuminate, carpus anterodistally acuminate with spine, posterodistally with 3 spines, propodus inflated, dactyl acuminate

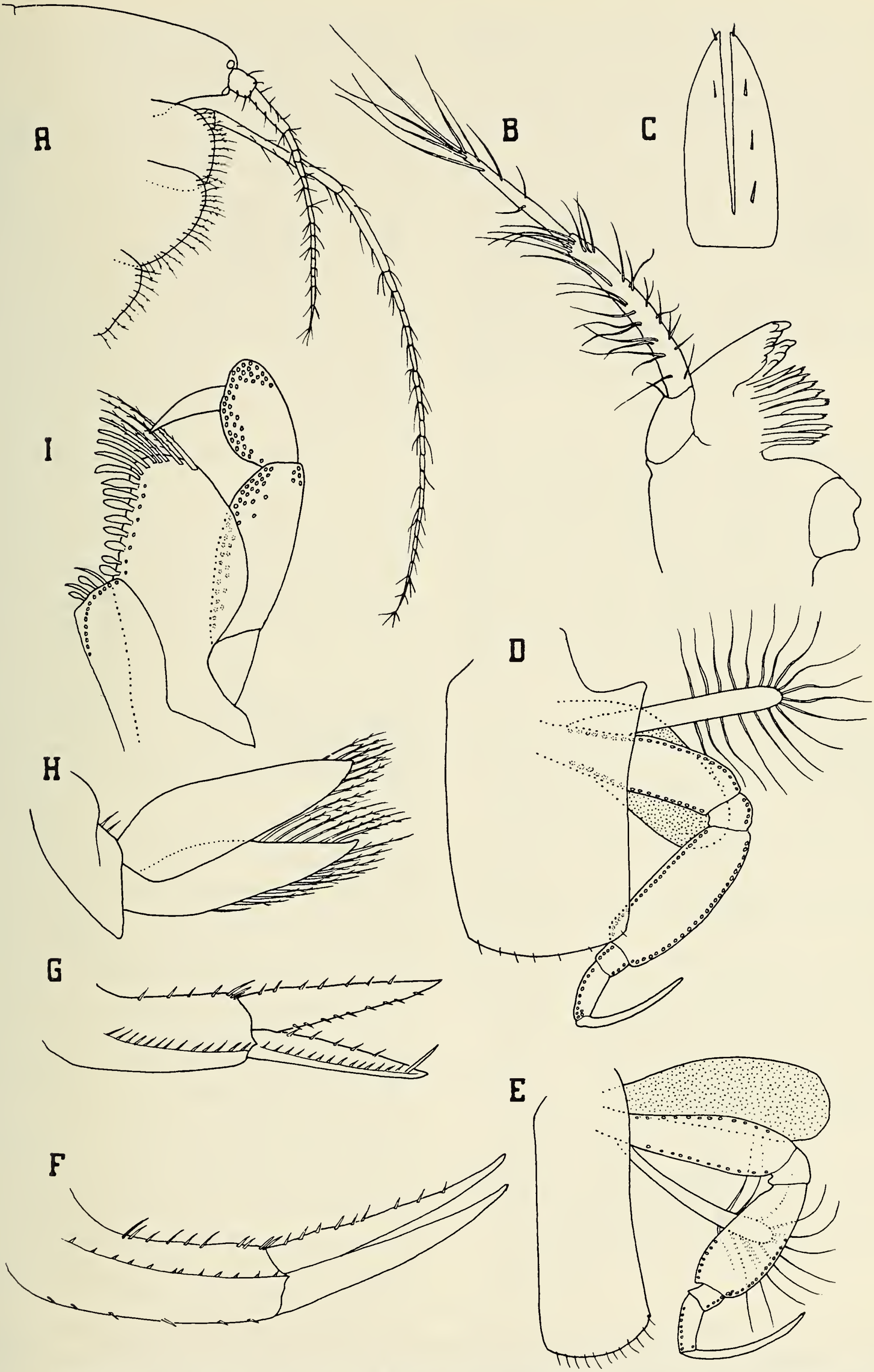

Fig. 1. *Ampelisca macrodonta,* new species: A, Head; B, Left mandible; C, Telson; D, Pereopod 4; E, Pereopod 3; F, Uropod 1; G, Uropod 2; H, Uropod 3; I, Maxilliped.

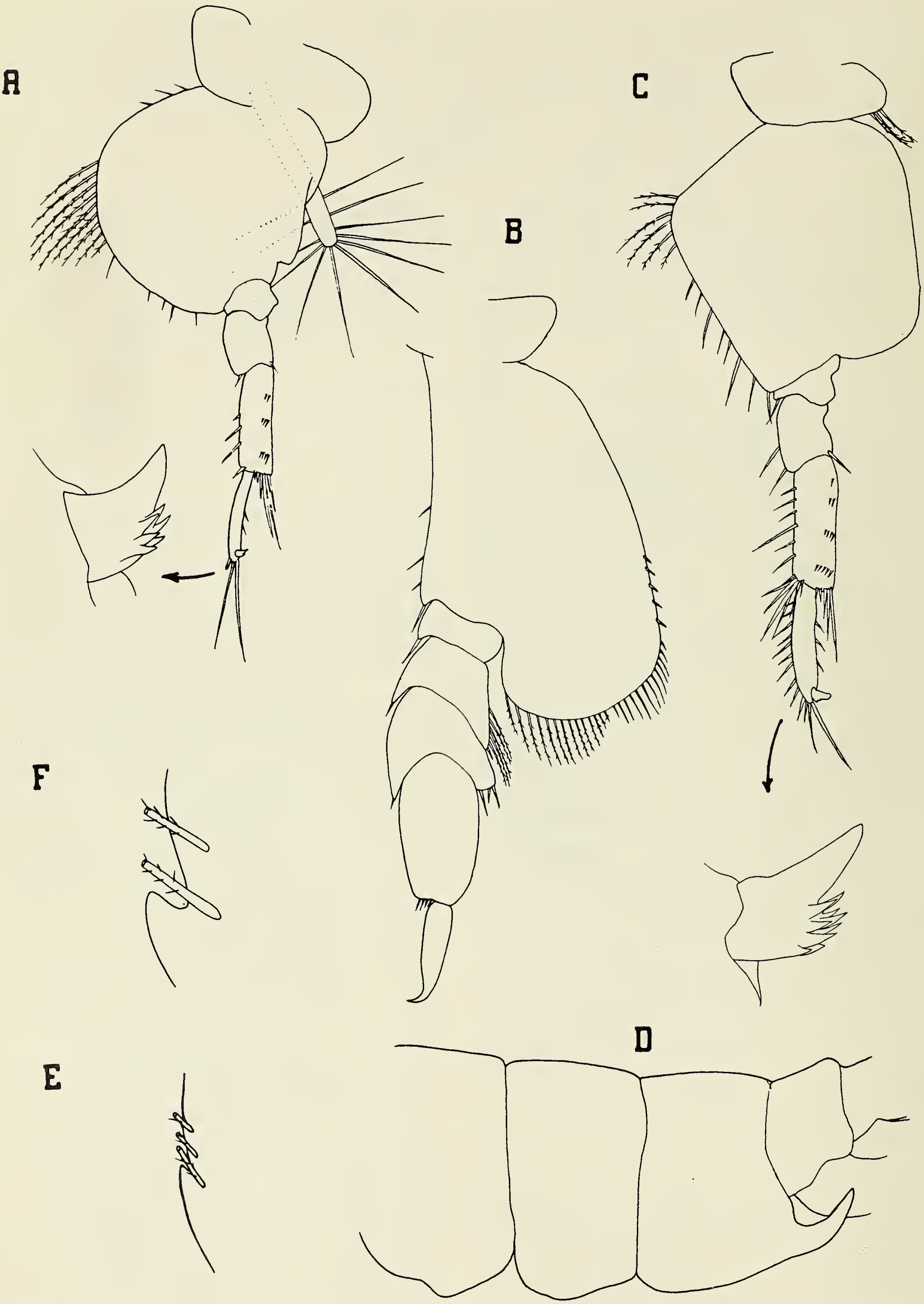

Fig. 2. *Ampelisca macrodonta,* new species: A, Pereopod 5 and detail of dactyl; B, Pereopod 7; C, Pereopod 6 and detail of dactyl; D, Lateral view of pleosome and urosome; E, Detail of slit or notch of coxa 2; F, Coxa 1.

with apex curved anteriad. Epimeron 1 rounded, ventral margin slightly sinuous with plumose setae; epimeron 2 rounded with ventral plumose setae; epimeron 3 with rounded anterior margin, very strong tooth at posteroventral corner, posterior margin slightly sinuous above tooth. Uropod 1 equal to uropod 2 in length, peduncle spinose, lower margin with facial spinules, outer ramus without dorsal spines but with ventrolateral spinules, inner ramus spinose. Uropod 2 peduncle and rami distally heavily spinose, outer ramus with long distal spine. Uropod 3 rami acuminate with plumose marginal setae. Telson cleft for more than ⅘ length with few dorsal setal spines.

Male.—Unknown.

Variation.—Little variability is evident in the pair of specimens collected from the Falkland Islands. Differences noted in the setation and number of flagellar articles of the antennae are minor and due to differences in maturity.

Etymology.—The specific name *macrodonta,* derived from the Greek "makros" (large) and "odous" (stem odont-) (tooth), refers to the very large tooth of the 3rd epimeral plate.

Remarks.—Ampelisca macrodonta is described from an area where seven species of *Ampelisca* have been recognized. Four of these seven species known from the extreme southern reaches of South America and Antarctica possess characteristics of the seventh leg similar to *A. macrodonta. Ampelisca barnardi* Nicholls, 1938, *A. hemicryptops* K. H. Barnard, 1930, *A. richardsoni* Karaman, 1975, and *A. statensis* K. H. Barnard, 1932, differ from *A. macrodonta* by the notch in the anterior margin of segment 4 of pereopod 7 (absent in *A. macrodonta*) and the small size of the posterior process of epimeral plate 3 (very large in *A. macrodonta*). *Ampelisca macrodonta* may be separated from *A. bouvieri* Chevreux, 1913, *A. composita* Schellenberg, 1931, and *A. anversensis* Karaman, 1975, by the deeply concave lower margin of the head and broader outer ramus of uropod 3 of *A. macrodonta.*

An interesting aspect of *A. macrodonta* is the presence of small spines on the posterodistal margin of the basis of pereopod 7. This author is aware of only two additional species which possess this feature. This pair of undescribed species has been found in the western Atlantic and the Gulf of Mexico and differs from *A. macrodonta* by a stronger superior lobe and much weaker posteroventral tooth on the third epimeral plate (Goeke, unpublished data).

Acknowledgments

The author would like to express his gratitude to the staff of the National Museum of Natural History for their kindness and help during a recent visit to Washington. Thanks are also extended to Richard W. Heard, Jr., Gulf Coast Research Laboratory, for his support and for a critical reading of the manuscript.

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NEOTROPICAL MONOGENEA. 10. *OMOTHECIUM,* NEW GENUS (DACTYLOGYRIDAE: ANCYROCEPHALINAE) AND TWO NEW SPECIES FROM THE PIRANAMBU, *PINIRAMPUS PIRINAMPU* (SPIX), (SILURIFORMES), IN BRAZIL

D. C. Kritsky, V. E. Thatcher, and W. A. Boeger

Abstract.—*Omothecium,* new genus (Dactylogyridae: Ancyrocephalinae) is proposed for two new species (*O. pinirampi* [type] and *O. luckyi*) collected from the gills of the piranambu, *Pinirampus pirinampu* (Spix), from Janauacá Lake near Manaus, Amazonas, Brazil. The new genus is characterized by its species having a sinistral nonsclerotized vagina opening anteriorly near the level of the copulatory complex, tandem gonads (testis postovarian), unmodified anchors and bars, undilated hook shanks, and a clockwise coiled cirral tube arising acutely from the cirral base.

Among monogeneans collected from Brazil during the past decade, two species of Ancyrocephalinae were discovered on the gills of the piranambu, *Pinirampus pirinampu* (Spix), Siluriformes, and were originally considered members of *Urocleidoides* sensu Mizelle, Kritsky, and Crane (1968). The revision of *Urocleidoides* by Kritsky, Thatcher, and Boeger (1986) has precluded these from the restricted genus. However, common morphologic features of the two species now justify the proposal of the new genus *Omothecium.*

The host was collected from Janauacá Lake near Manaus, Amazonas, Brazil, on 25 April 1984. Methods of host and parasite collection, preparation of helminths for study, measurement, and numbering of haptoral hook pairs are as described by Kritsky, Thatcher, and Boeger (1986). Measurements are in micrometers; averages are followed by ranges in parentheses. Measurements of the cirrus include 1) the diameter of the proximal ring of the coil, depicted on the respective drawings as the interval between the solid straight lines, and 2) an approximation of total length of the cirrus obtained by using a Minerva curvimeter on camera lucida drawings. Type specimens are deposited in the collections of the Instituto Nacional de Pesquisas da Amazônia (INPA), the U.S. National Museum Helminthological Collection (USNM), and the University of Nebraska State Museum (HWML) as indicated below.

Omothecium, new genus

Diagnosis.—Dactylogyridae, Ancyrocephalinae. Body divisible into cephalic region, trunk, peduncle, and haptor. Tegument thin, smooth. Head organs, cephalic lobes present; cephalic glands unicellular, comprising 2 bilateral groups posterolateral to pharynx. Eyes present. Mouth subterminal, midventral; pharynx muscular, glandular; esophagus present; intestinal caeca 2, confluent posterior to testis, lacking diverticula. Gonads tandem, intercaecal; testis postovarian. Vas deferens looping left intestinal crus; seminal vesicle a dilation of vas deferens; prostatic reservoir not observed. Cirrus comprising an ovate base from which coiled tube originates at acute angle, rings clockwise (Kritsky, Boeger, and Thatcher 1985). Accessory piece not articulated to cirrus, a fleshy rod serving as cirrus guide. Common genital pore midventral, at level of intestinal bifurcation. Oviduct short;

uterus delicate; seminal receptacle lying near anterior end of ovary; vagina weakly sclerotized, sinistral, opening anteriorly near level of copulatory complex. Vitellaria well developed, coextensive with gut. Haptor armed with dorsal and ventral pairs of unmodified anchors, ventral and dorsal bars, 7 pairs of hooks with ancyrocephaline distribution (Mizelle 1936); hooks with undilated shanks. Parasites of gills of siluriform fishes.

Type species, host, and locality.—Omothecium pinirampi, n. sp. from *Pinirampus pirinampu* (Spix), Pimelodidae, Janauacá Lake near Manaus, Amazonas, Brazil.

Other species.—Omothecium luckyi, n. sp. from *Pinirampus pirinampu* (Spix), Pimelodidae, Janauacá Lake, near Manaus, Amazonas, Brazil.

Etymology.—The generic name is from Greek (ōmos = shoulder + thēkē = case) and refers to the anterior position of the vaginal opening.

Remarks.—Omothecium is characterized by species possessing 1) a sinistral nonsclerotized vagina opening anteriorly near the level of the copulatory complex, 2) tandem gonads (testis postovarian), 3) unmodified anchors and bars, 4) undilated hook shanks, and 5) a clockwise cirrus tube arising from an acute angle from the cirrus base. *Omothecium* resembles *Cosmetocleithrum* Kritsky, Thatcher, and Boeger, 1986, by having species with tandem testes, unmodified anchors, and a sinistral vagina. The new genus differs from *Cosmetocleithrum* by lacking submedian posterior projections of the dorsal bar (present in *Cosmetocleithrum*), by having the vagina opening anteriorly on the left side (sinistral at level of ootype in *Cosmetocleithrum*), and by the nature of the copulatory complex.

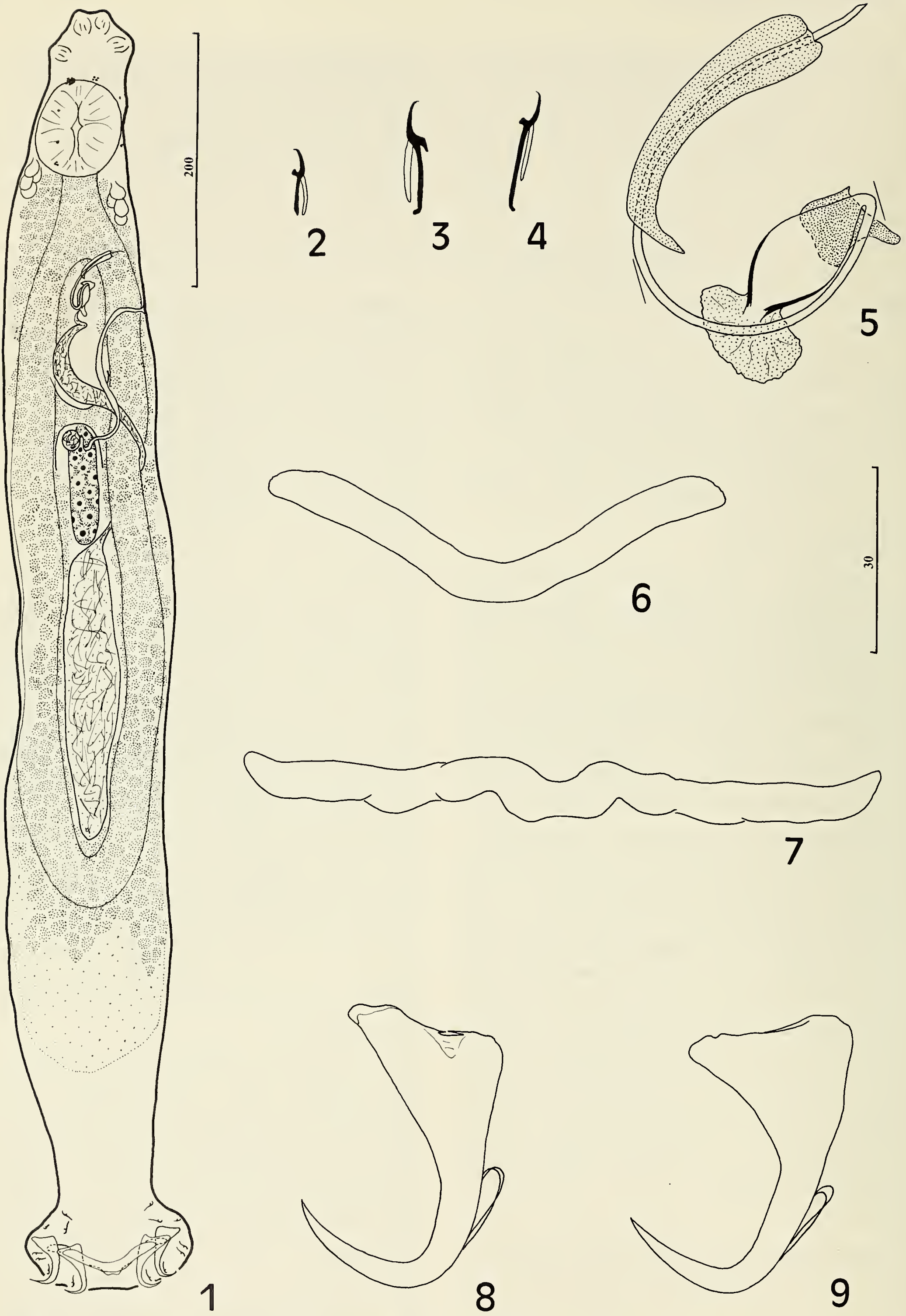
Omothecium pinirampi, new species
Figs. 1–9

Type specimens.—Holotype, INPA PA282-1; paratypes, USNM 78798, HWML 22972.

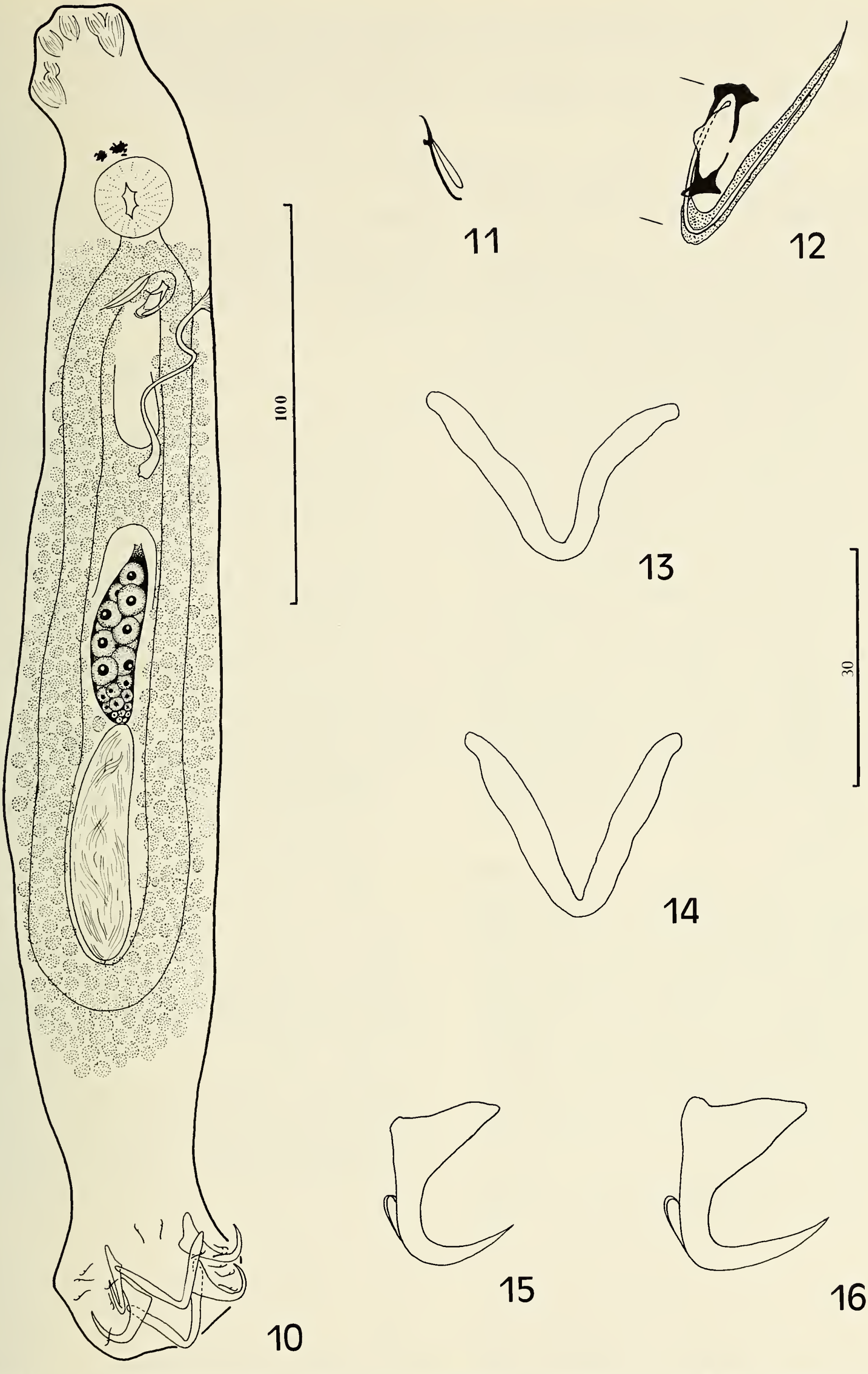
Description (based on 5 specimens).—Body fusiform, elongate with large glandular area posterior to limit of vitellaria; cephalic margin comprising 2 terminal, 2 bilateral cephalic lobes; 4 head organs, well developed; each group of cephalic glands comprising relatively few cells. Usually 2 eyes, submedial at anterior pharyngeal margin, frequently closely appressed giving appearance of single eye; eye granules small, subspherical; accessory granules distributed in cephalic and anterior trunk regions. Pharynx subspherical; esophagus short. Peduncle moderately elongate; haptor hexagonal. Anchors similar, each with poorly developed roots, large base, straight shaft, slightly curved point. Ventral bar shaped as expanded V; dorsal bar usually W-shaped, frequently flattened. Hook distribution ancyrocephaline, except members of hook pair 1 are situated submarginally on each side of the haptor. Hooks comprising 3 morphologic types; hook pairs 1, 3, 4, 7 with delicate point and shaft, slightly depressed thumb, elongate straight shank; pair 2 similar to previous pairs except shank length significantly reduced, erect thumb; pair 5, 6 with rapidly tapered shaft, strongly depressed thumb; FH loop shank length (pair 2), ⅘ shank length (pairs 5, 6), ⅔ shank length (remaining pairs). Cirrus comprising enlarged fusiform base with proximal flare, tube of about one complete ring. Accessory piece a cirrus guide, spathulate. Gonads bacilliform. Seminal vesicle a coiled dilation of vas deferens.

Measurements.—Body 952 (924–1004) long; greatest width 155 (129–189) near midlength. Greatest pharynx diameter 74 (68–78). Haptor 90 (73–112) long, 154 (122–185) wide. Ventral anchor 44 (41–47), base width 24 (20–27); dorsal anchor 41 (37–45), base width 26 (22–30). Ventral bar 44 (41–47); dorsal bar 36–37. Hook pair 2–9 (7–11), all others 16 (12–20). Cirrus 155–156 long, ring diameter 44 (41–47); accessory piece 36 (30–44). Testis 191 (143–240) × 54 (41–67); ovary 68 (53–82) × 37 (31–43).

Remarks.—Omothecium pinirampi is the



Figs. 1–9. *Omothecium pinirampi*: 1, Ventral view of holotype; 2, Hook pair 2; 3, Hook (pairs 5, 6); 4, Hook (pairs 1, 3, 4, 7); 5, Copulatory complex; 6, Ventral bar; 7, Dorsal bar; 8, Ventral anchor; 9, Dorsal anchor. All drawings are at the same scale (30 micrometers) except Fig. 1 (200 micrometers).



Figs. 10–16. *Omothecium luckyi*: 10, Holotype (ventral view); 11, Hook; 12, Copulatory complex; 13, Ventral bar; 14, Dorsal bar; 15, Ventral anchor; 16, Dorsal anchor. All figures are drawn to the 30-micrometer scale except Fig. 10 (100 micrometers).

type species for the genus and is named for its host.

Omothecium luckyi, new species

Figs. 10–16

Type specimens.—Holotype, INPA PA283-1; paratypes, USNM 78795, HWML 22973.

Description (based on 3 specimens).—Body fusiform; cephalic margin comprising 2 terminal, 2 bilateral poorly-developed cephalic lobes; head organs 4, poorly developed; cephalic glands inconspicuous. Eyes 2, closely associated, frequently appearing as single submedian eye at level of anterior pharyngeal margin; eye granules small, irregular to subspherical; accessory granules absent. Pharynx spherical; esophagus short. Peduncle broad, elongate; haptor subhexagonal. Anchors similar, each with poorly developed roots, large base, short straight shaft, slightly curved point. Bars similar, V-shaped. Hooks similar, each with fine point and shaft, erect thumb, delicate shank; FH loop $\frac{9}{10}$ shank length. Cirral base ovate with tissue flaps at each end, tube comprising a coil of less than one ring; accessory piece simple, serving as cirrus guide. Gonads subovate.

Measurements.—Body 375 (334–397) long, greatest width 54 (51–55) near midlength. Pharyngeal diameter 22 (19–27). Haptor 50 (49–52) long, 54 (50–58) wide. Ventral anchor 19–20, base width 15–16; dorsal anchor 22 (20–23), base width 14–15. Ventral bar 29 (27–30); dorsal bar 24 (23–26). Hook (all pairs) 10–11. Cirrus 72–73 long, ring diameter 20–21; accessory piece 22–23.

Remarks.—This species differs from *O. pinirampi* by 1) possessing smaller sclerotized haptoral structures, 2) the morphology of the dorsal bars (usually W-shaped in *O. pinirampi*; V-shaped in *O. luckyi*), and 3) the absence of different types of hooks in *O. luckyi*. *Omothecium luckyi* is named in honor of Dr. Z. Lucky, Faculty of Science, Brno, Czechoslovakia, who has greatly supported our studies on Neotropical Monogenea by providing specimens of his species collected from aquarium fishes in Czechoslovakia.

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HOST AND ELEVATIONAL SPECIFICITY OF PARASITIC BEETLES (*AMBLYOPINUS* SOLSKY) (COLEOPTERA: STAPHYLINIDAE) IN PANAMA

Robert M. Timm and James S. Ashe

Abstract.—The literature on staphylinid beetles of the tribe Amblyopinini, all of which are parasitic on Neotropical or Australian mammals, has provided few specifics on the natural history and host relationships of these beetles. We provide the first comprehensive data on host relationships and elevational range for a community of amblyopinines and their potential hosts. Mammals collected from eight separate localities along an elevational transect ranging from 900 to 1856 m were examined for parasitic beetles of the genus *Amblyopinus.* At these localities, mammals collected include a diverse array of marsupials, edentates, insectivores, bats, rodents, and lagomorphs. Among these potential hosts, parasitic beetles were limited to a subset of the cricetine rodents. Amblyopinines were collected from only two species of rodents at two localities with elevations of 1425–1525 m and 1800–1825 m. *Amblyopinus emarginatus* Seevers was collected at both localities, where it was found on a single species of host, *Oryzomys albigularis.* In contrast, *A. tiptoni* Barrera was collected only at the higher elevation on *Reithrodontomys creper.* These data, as well as reanalysis of literature records, are consistent with the interpretation that these beetles are much more host restricted than has been previously recognized. Additionally, while these beetles appear to be tracking specific species of hosts, they are restricted to that subset of the hosts' range above 1000 m. This implies that factors other than host range are of considerable importance to the distribution and ecology of these beetles.

Staphylinid beetles of the tribe Amblyopinini have most often been collected from the fur of mammals. They are thought to be parasitic, although there is little information available on the natural history of this tribe.

There are five genera in the tribe Amblyopinini, four of which are restricted to the Neotropical region, *Amblyopinus* Solsky, *Amblyopinodes* Seevers, *Edrabius* Fauvel, and *Megamblyopinus* Seevers, and a single genus, *Myotyphlus* Fauvel, which occurs in Australia and Tasmania (Seevers 1955). Members of the Amblyopinini are primarily found at high elevations and are seldom reported on mammals collected below 1000 meters elevation. All four Neotropical genera are found in South America; members of only one genus, *Amblyopinus,* are found in Central America and Mexico. Thirty-four species of *Amblyopinus* currently are recognized, most being known by only a few specimens with little biological data available. Five species of *Amblyopinus* are known from Central America and Mexico (*A. bolivari* Seevers and *A. isabellae* Barrera from Mexico, *A. schmidti* Seevers from Guatemala, *A. tiptoni* Barrera from Costa Rica and Panama, and *A. emarginatus* Seevers from Panama, Colombia, and Venezuela).

The most common hosts are cricetine rodents, although a wide range of hosts has been reported and includes marsupials; caviomorph, myomorph, and sciuromorph rodents; a sloth; and bats. Of the Panamanian amblyopinines, *A. tiptoni* has been collected most commonly on *Peromyscus nudipes* (Barrera 1966a, b), though it has also been reported on *Reithrodontomys creper* (Barrera 1966a, Vaughan 1982). In contrast, *A. emarginatus* has been reported from a wide array of hosts, though most commonly from species of *Oryzomys* (Barrera and Machado-Allison 1968, Machado-Allison and Barrera 1972).

The purpose of this paper is to report new data available for two species of *Amblyopinus* in Panama, *A. emarginatus* and *A. tiptoni.* We are now able to provide detailed information on host and elevational specificity of these species. Additionally, we examined specimens previously reported from Panama and provide a reevaluation of this material.

Materials and Methods

From 15 May through 10 July 1980, Ronald H. Pine and Robert J. Izor collected small mammals and their ectoparasites in the Cerro Colorado region of western Panama. Mammals were collected at eight localities ranging from 900 to 1856 m (see Pine and Handley, in prep.). Localities where *Amblyopinus* was encountered include (Fig. 1): Panama, Chiriquí-Bocas del Toro boundary, Cerro Bollo, 3.5 km E of Escopeta, 1800–1856 m (subsequently referred to as the "Cerro Bollo" locality). Originally cloud forest and elfin woodland, considerable forest remains, though some clearing has been undertaken for surveying purposes. Traps were set along pre-existing paths and paths cut through the forest for the trapline.

Species of small mammals taken at Cerro Bollo (numbers collected in parentheses) include: Talamancan small-eared shrew, *Cryptotis gracilis* (1); blackish small-eared shrew, *Cryptotis nigrescens* (15); *Cryptotis* sp. (1); Tomes' rice rat, *Oryzomys albigularis* (14); cloud forest pygmy rice rat, *Oryzomys vegetus* (3); Chiriquí harvest mouse, *Reithrodontomys creper* (33); Mexican harvest mouse, *Reithrodontomys mexicanus* (2); and Chiriquí brown mouse, *Scotinomys xerampelinus* (9) (Pine and Handley, in prep.).

Bocas del Toro, 25 km NNE of San Felix, 1425–1525 m (subsequently referred to as the "San Felix" locality). This area is cloud forest, except where disturbed. Trapping took place along a recently cut trail and a small stream, the Quebrada Alicia.

Species of small mammals taken at this locality (numbers collected in parentheses) include: opossum, *Didelphis marsupialis* (1); South American mouse-opossum, *Marmosa robinsoni* (2); blackish small-eared shrew, *Cryptotis nigrescens* (5); Tomes' rice rat, *Oryzomys albigularis* (50); cloud forest pygmy rice rat, *Oryzomys vegetus* (2); naked-footed deer mouse, *Peromyscus nudipes* (15); and Mexican harvest mouse, *Reithrodontomys mexicanus* (9) (Pine and Handley, in prep.).

Other species of terrestrial small mammals collected at lower elevations (900, 1275–1325, and 1400–1425 m) include: water opossum, *Chironectes minimus*; two-toed sloth, *Choloepus hoffmanni*; forest rabbit, *Sylvilagus brasiliensis*; Harris' rice rat, *Oryzomys aphrastus*; pygmy rice rat, *Oryzomys fulvescens*; yellow deer mouse, *Peromyscus flavidus*; and hispid cotton rat, *Sigmodon hispidus.* Additionally, 19 species of bats were collected throughout the elevational range (Pine and Handley, in prep.). None of these other mammals were parasitized by *Amblyopinus,* nor were any *Amblyopinus* found below 1425 m elevation.

An attempt was made to collect every beetle encountered, although a small number escaped. The actual number that escaped is uncertain, but represents only a very small percentage of those captured. None of the beetles which escaped were from hosts or elevations which differ from those reported here (R. Izor and R. Pine, pers. comm.). Thus, these data provide an informative representation of beetle distributions among available hosts and elevational range at these localities.

The mammals collected are deposited at the U.S. National Museum of Natural History in Washington; beetles at the Field Museum of Natural History.

Results

Staphylinids of the genus *Amblyopinus* were collected at two localities in Panama, the San Felix locality and the Cerro Bollo locality. Two species of *Amblyopinus* were collected. *Amblyopinus emarginatus* was obtained at both localities, although it was common at only 1425–1525 m. *Amblyopinus tiptoni* was obtained at only 1800–1856 m. These two localities are separated by a distance of less than 3 km.

Amblyopinus emarginatus Seevers

Amblyopinus emarginatus was taken from a single host species, Tomes' rice rat *Oryzomys albigularis,* from two elevational ranges (1425–1525 m and 1800–1856 m). It was collected from ten hosts; nine from the lower elevational range (total of 29 beetles) and one from the higher (1 beetle). In the lower elevational range (1425–1525 m) 50 *O. albigularis* were trapped, 35 males and 15 females. Of these, 9 had beetles (Table 1), 8 males and 1 female. At the higher elevation (1800–1856 m) 14 *O. albigularis* were trapped, 10 males and 4 females. Only 1 male had specimens of *A. emarginatus* (Table 1). At the San Felix locality, beetles were taken between 22 May and 11 June 1980; at the Cerro Bollo locality, the single *A. emarginatus* was taken on 7 July 1980.

Specimens of *A. emarginatus* from these localities were compared with the holotype of *A. emarginatus* from Colombia in the collection of the Field Museum of Natural History and found to be well within the expected range of variation in structural features for this species. The specimens of *A. emarginatus* from western Panama are isolated from the other populations of this species in the highlands of Columbia and Venezuela by about 900 km of the Panamanian and northwestern Colombian lowlands.

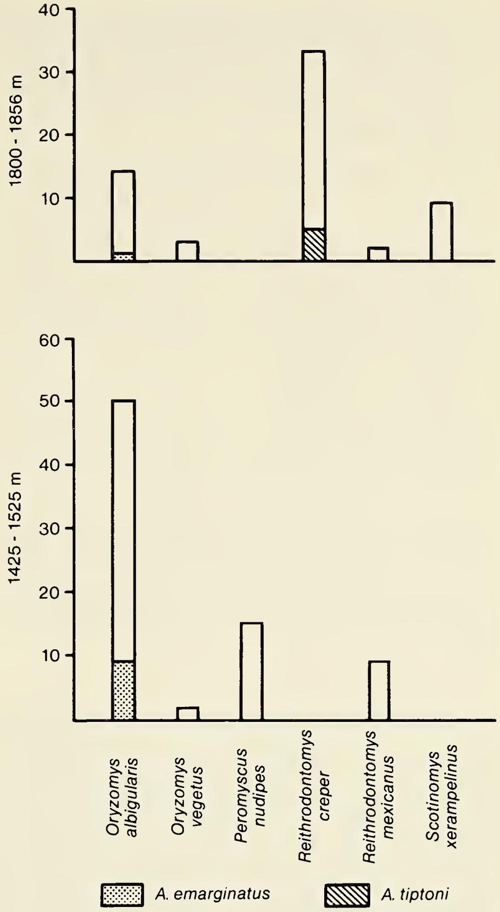

Fig. 1. Numbers of individuals of mammal species captured (total bar) and corresponding numbers from which specimens of *Amblyopinus emarginatus* Seevers and *Amblyopinus tiptoni* Barrera were collected from two localities (Cerro Bollo, 3.5 km E of Escopeta, 1800–1856 m; and Bocas del Toro, 25 km NNE San Felix, 1425–1525 m) along an elevational transect in Panama. We follow Pine (pers. comm.) in recognizing *Oryzomys vegetus* as distinct from *O. fulvescens.*

Amblyopinus tiptoni Barrera

Amblyopinus tiptoni was found on only one species of host, the Chiriquí harvest mouse, *Reithrodontomys creper,* at only one

Table 1.—Numbers of specimens of *Amblyopinus emarginatus* collected at two localities in western Panama [Cerro Bollo, 3.5 km E of Escopeta (="Cerro Bollo" locality); Bocas del Toro, 25 km NNE of San Felix (="San Felix" locality)] from individual specimens of *Oryzomys albigularis.*

Host Catalog No.*	Locality	No. beetles		
		Males	Females	Total
541126	San Felix	—	2	2
541127	San Felix	5	5	10
541131	San Felix	1	2	3
541135	San Felix	1	1	2
541136	San Felix	—	1	1
541141	San Felix	1	2	3
541142	San Felix	3	1	4
541354	San Felix	2	—	2
541373	San Felix	—	2	2
541356	Cerro Bollo	—	1	1
Totals		13	17	30

* Host Catalog No. refers to the catalog number of mammal specimens housed at the Smithsonian Institution.

Table 2.—Numbers of specimens of *Amblyopinus tiptoni* collected at one locality in western Panama [Cerro Bollo, 3.5 km E of Escopeta (="Cerro Bollo" locality)] from individual specimens of *Reithrodontomys creper.*

Host Catalog No.*	Locality	No. beetles		
		Males	Females	Total
541206	Cerro Bollo	1	2	3
541212	Cerro Bollo	1	—	1
541220	Cerro Bollo	—	1	1
541225	Cerro Bollo	1	—	1
541227	Cerro Bollo	1	—	1
Totals		4	3	7

* Host Catalog No. refers to the catalog numbers of mammal specimens housed at the Smithsonian Institution.

elevation range, 1800–1856 m. This was the only locality trapped at this high an elevation, and the only locality where *R. creper* was obtained. *Amblyopinus emarginatus* was also taken here, but is represented by only a single individual. Sixteen males and 16 females of *R. creper* were trapped, including all age categories. A total of seven specimens of *A. tiptoni* were found on 5 of these (Table 2), 2 males and 3 females. *Amblyopinus tiptoni* was collected between 15 and 22 June 1980.

Discussion

a) Host specificity.—In this study 38 species of small mammals were collected and surveyed for parasitic arthropods over an eight week period in western Panama. This included 19 terrestrial species and 19 species of bats. Of these potential hosts, *Amblyopinus emarginatus* was found only on *Oryzomys albigularis* and was present only at the two localities (and elevations) where *O. albigularis* was trapped. *Amblyopinus tiptoni* was found only on a single species of host, *Reithrodontomys creper,* at the single locality and elevational range where *R. creper* was trapped.

Several thousand specimens of mammals were collected from throughout Panama as part of the zoonoses surveys by the Gorgas Memorial Laboratory and the "Ectoparasites of Panama" surveys during the 1950's and 1960's. Most of the 201 species of native terrestrial mammals listed by Handley (1966) from Panama have been examined for ectoparasites. During these surveys, only three specimens of *Amblyopinus emarginatus* were obtained, all from a single locality at 1525 m in Bocas del Toro Province. Two species of hosts were reported, *Oryzomys albigularis* and *Peromyscus nudipes.*

Elsewhere, *A. emarginatus* has been collected on a number of occasions from the highlands of Colombia and Venezuela. Throughout the range of *A. emarginatus,* it has been reported from a variety of mammals including: *Oryzomys albigularis, O. caliginosus, O. alfaroi, O. concolor, O. devius, Akodon urichi, Peromyscus flavidus, Rhipidomys venustus, Thomasomys fuscatus, T. laniger,* and *T.* sp.; as well as from *Didelphis marsupialis, Marmosa dryas, Bradypus infuscatus, Myotis nigricans,* and *Vampyrops oratus* (Seevers 1955; Macha-

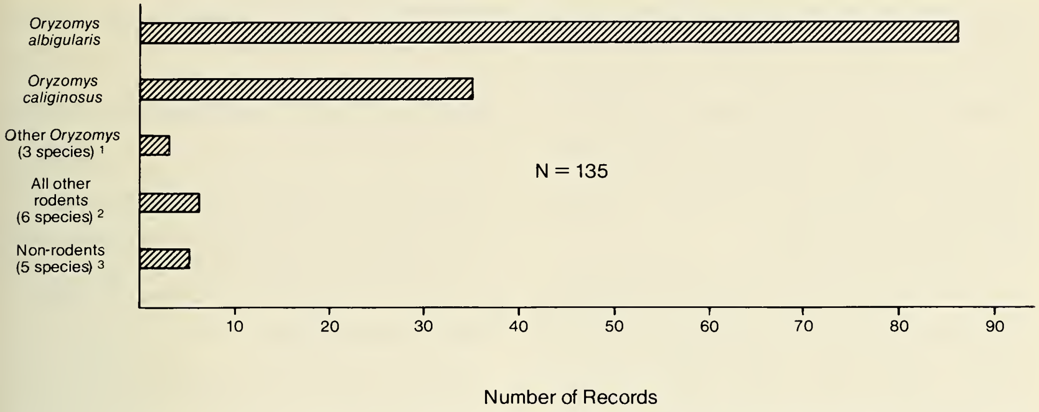

Fig. 2. Numbers of host individuals from which *Amblyopinus emarginatus* Seevers has been recorded, compiled from literature citations (Seevers 1955; Machado-Allison and Barrera 1964, 1972; Barrera 1966a, b; Barrera and Machado-Allison 1968).

[1] *O. alfaroi, O. concolor, O. devius* (*O. devius* is often considered conspecific with *O. albigularis*).

[2] *Akodon urichi, Peromyscus flavidus, Rhipidomys venustus, Thomasomys fuscatus, T. laniger,* and *Thomasomys* sp.

[3] *Didelphis marsupialis, Marmosa dryas, Bradypus infuscatus, Myotis nigricans,* and *Vampyrops oratus* (these records must be considered suspect).

do-Allison and Barrera 1964, 1972; Barrera 1966a; Barrera and Machado-Allison 1968). The last five of these, which include all reports from marsupials, the sloth, and bats, represent single records and should be considered suspect. The records from the two bats were even suspected to be contaminations in the original report by Machado-Allison and Barrera (1972). Among literature records of *A. emarginatus* (n = 135) (Fig. 2), most reports have been from species of *Oryzomys* (124; 91.9%), and the large majority of these have been either from *O. albigularis* (n = 86; 69.4%) or *O. caliginosus* (n = 35; 28.2%). All other host records represent single reports. This strongly suggests that species of *Oryzomys* represent the primary hosts of *A. emarginatus.*

Most records of *A. emarginatus* from *Oryzomys* are from *O. albigularis,* and indeed it has been reported from this host throughout the known range of the beetle. However, at one locality in Colombia, *A. emarginatus* was commonly reported from *O. caliginosus* (Barrera and Machado-Allison 1968). Interestingly, *O. albigularis* was also abundant at this locality and frequently parasitized by *A. emarginatus.*

These data, as well as results reported in this paper, provide considerable evidence that *A. emarginatus* is host specific on species of *Oryzomys,* primarily *O. albigularis.* In this study, it was found to be restricted to *O. albigularis,* though a variety of other rodent species, which could have served as hosts, were present in sympatry with *O. albigularis.* Thus, we conclude that *A. emarginatus* is much more host specific than literature reports suggest.

In contrast to the large number of records for *A. emarginatus, A. tiptoni* has been reported only three times in the literature, once from Panama and twice from a single locality in Costa Rica. In the original species description of specimens from Chiriquí Province in Panama, Barrera (1966a:284) reported "long series" of *A. tiptoni* from *Peromyscus nudipes* from several localities. However, he also noted "unique material" from *Reithrodontomys creper.* The other reports of *A. tiptoni* in the literature are from Cerro de la Muerte in Costa Rica where five specimens were reported from *Peromyscus nudipes* by Barrera (1966b), and several specimens were recorded from a single individual of *R. creper* by Vaughan (1982). In addition, we have collected *A. tiptoni* from several specimens of *Peromyscus nudipes* at Monteverde (Puntarenas Prov.) in Costa Rica (unpublished data).

The results reported here suggest that *A. tiptoni* is limited in host range to *R. creper* at the localities sampled, though relatively few specimens were collected. It was collected at only one locality and elevation range (1800–1856 m). No specimens of *P. nudipes* were found at this locality; however, *P. nudipes* was abundant at the locality where *A. emarginatus* was most common. Though this is the host of *A. tiptoni* most often reported in the literature, and the elevation is within the range known for this beetle, no beetles were found on this host.

b) Elevational zonation and host distribution.—In this study *Oryzomys albigularis* was taken at elevations above 1425 m, *Reithrodontomys creper* above 1800 m, and *Peromyscus nudipes* from 1250 to 1500 m.

In a survey of mammals from Panama, Handley (1966) reported that *Oryzomys albigularis* was an uncommon, terrestrial species found in fog forest at high elevations in both extreme eastern and western Panama. He found it at elevations ranging from 1220 to 2380 m. He reported *Reithrodontomys creper* to be abundant at high elevations in western Panama; it is primarily a terrestrial species that is found in fog forests and openings. He found it at elevations ranging from 2075 to 3175 m. *Peromyscus nudipes* was a common terrestrial species in evergreen forest. It was found at elevations ranging from 730 to 2380 m.

Oryzomys albigularis and *O. caliginosus* are widespread species in southern Central America and northern South America and are found over a range of elevations. However, *O. albigularis* is most common at higher elevations (above 1200 m), while *O. caliginosus* is most common at lower elevations (below 1000 m) to sea level (Gardner 1983, Handley 1966). *Amblyopinus emarginatus* has been collected on these hosts only at elevations above 1050 m. Herein, we found *A. emarginatus* common only at 1425–1525 m elevation, and rare at 1800–1856 m elevation. Several collections were made at localities ranging from 900 to 1425 m elevation. Neither *O. albigularis* nor *A. emarginatus* were found at these lower elevations, though two other species of *Oryzomys* were present.

It is interesting that *A. emarginatus* has not been found on *O. caliginosus* in Costa Rica or Panama where *O. caliginosus* is common at lower elevations. The only report of *A. emarginatus* from *O. caliginosus* is from a single locality in Colombia where *O. albigularis* and *O. caliginosus* were sympatric at higher elevations (above 1600 m) (Barrera and Machado-Allison 1968). The occurrence of *A. emarginatus* only on *O. albigularis* in Panama (and perhaps elsewhere) may primarily be a result of the higher elevation preference of this species of *Oryzomys*. This implies that *A. emarginatus* is restricted to higher elevations, though suitable hosts occur over a much broader elevational range.

Handley (1966) reported that *Peromyscus nudipes* was common in Panama between 730 and 2380 m. However, *A. tiptoni* was collected from this species only between 1525 and 2075 m (Barrera 1966a). Barrera (1966a) reported that *A. tiptoni* was common on *P. nudipes* from numerous localities within the 1525 to 2075 m elevational range during the months of January and February. In addition, *A. tiptoni* has been collected at 3335 m from *P. nudipes* at Cerro de la Muerte in Costa Rica (Barrera 1966b) as well as at 1600 m at Monteverde (Timm, unpublished data).

In comparison, *Reithrodontomys creper* is limited to higher elevations (2075–3350 m) in the mountain systems of northwestern Panama and central Costa Rica (Hooper 1952, Handley 1966, Hall 1981). Literature reports of *A. tiptoni* from *R. creper* have been from elevations of 3200 m in Panama

(Barrera 1966a) and 3200 m in Costa Rica (Vaughan 1982). Our data indicate that *A. tiptoni* occurs on *R. creper* in Panama as low as 1800–1856 m, the lowest elevation at which this species of mammal was collected.

It is notable that 15 specimens of *P. nudipes* were collected at 25 km NNE of San Felix (1425–1525 m). This is within the elevational range from which *A. tiptoni* has been previously reported to occur on *P. nudipes*. However, no specimens of *Amblyopinus* were found on *P. nudipes* at this locality.

Conclusions

Historically, the literature on staphylinid beetles of the tribe Amblyopinini, all of which are parasitic on Neotropical mammals, has provided few specifics on the natural history and host relationships of these beetles. Our studies provide the first comprehensive data on host relationships and elevational range for a community of these beetles and potential hosts. In Central America the mammal community includes a diverse array of marsupials, edentates, insectivores, bats, primates, rodents, and carnivores. Among these potential hosts, parasitic beetles are limited to a subset of the cricetine rodents. Within a given community of cricetines, beetles appear to be restricted to one or a very few species. Specifically, our data are consistent with the interpretation that these beetles are much more host restricted than has been previously recognized.

In the communities studied, *Amblyopinus emarginatus* is host specific on *Oryzomys albigularis*. In addition, our reanalysis of distribution of *A. emarginatus* among hosts from throughout its known range provides considerable evidence of host specificity for mammals of the genus *Oryzomys* in general and *O. albigularis* in particular. The number of host records for *A. emarginatus* far exceeds those for any other amblyopinine. Therefore, though published host data for many species are confusing and inconclusive (see for examples, Seevers 1955, Machado-Allison and Barrera 1972) our analysis of data for *A. emarginatus* provides a robust confirmation of a previously unexpected level of host specificity.

Data presented herein indicate that *Amblyopinus tiptoni* is restricted to *Reithrodontomys creper.* However, host specificity for this beetle throughout its range is less well documented. This uncertainty is partially a result of lack of comprehensive collections. Additionally, it has been reported from two species of cricetine rodents, *Peromyscus nudipes* and *R. creper.* In most instances, it has been restricted to one host locally. Considerable additional study is required to clarify host relationships of this beetle.

Additionally, our data show that while beetles of the genus *Amblyopinus* appear to be tracking specific hosts, they are restricted to that subset of the hosts' range above 1000 m. Few other groups of parasites show this restricted distributional pattern in relation to host elevational range. Wenzel and Tipton (1966) also noted that *Amblyopinus tiptoni,* as well as several other species of ectoparasites, are restricted to only a subset of their hosts' range, and suggested that these groups were primarily temperate in distribution. This implies that factors other than host range are of considerable importance to the distribution and ecology of some ectoparasites. Though factors responsible for this aspect of amblyopinine distributions are not obvious, possible candidates include temperature-humidity relationships, annual and seasonal climatic variation, and vegetational communities. This characteristic of amblyopinine ecology seems to be one of the most curious features of these beetles and merits further attention.

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THE DISTRIBUTION AND FOOD HABITS OF *NEPHTYS BUCERA* EHLERS, 1868, (POLYCHAETA: NEPHTYIDAE) IN THE SURF ZONE OF A SANDY BEACH

John J. McDermott

Abstract.—*Nephtys bucera* was more abundant below mean low water (MLW) than above, in the surf zone of an exposed sandy beach along the southern coast of New Jersey. Food items found in the digestive tracts of 111 *N. bucera,* collected over several years, were identified and counted. One hundred preserved worms ranged in length from 51 to 166 mm, wet weight from 70 to 3400 mg, and dry weight from 13 to 506 mg. Juvenile wedge clams, *Donax variabilis,* were the most common and abundant prey, occurring in 65.5% of worms with food and accounting for 81.3% of all food items. Clams, all young-of-the-year, were consumed whole and digested in their valves; they ranged in shell length from 1.1 to 6.4 mm ($\bar{x}$ 2.47 ± 0.82). The spionid polychaete, *Scolelepis squamata,* was next in dietary importance (incidence 32.3%, abundance 10.1%). This potentially important prey species dominates the intertidal area above MLW for all except three winter months, and thus there is usually little spatial overlap with *Nephtys.* The crustaceans *Amphiporeia virginiana* and *Emerita talpoida* appeared to be incidental prey. Thus *N. bucera* is an opportunistic carnivore (there was no evidence of deposit feeding) influencing the population dynamics of several surf-dwelling invertebrates. *Nephtys bucera* itself is a minor prey item for at least one species of juvenile fish inhabiting the surf zone, viz., the northern kingfish *Menticirrhus saxatilis.*

Nephtys bucera, a relatively large sand-dwelling polychaete, is distributed from the Gulf of Saint Lawrence to South Carolina, and in the Gulf of Mexico from Florida to Mississippi (Verrill 1873; Hartman 1945, 1951; Carpenter 1956; Sanders 1958; Pettibone 1963; Croker 1970, 1977; Wass 1972; Day 1973[1]; Gardiner 1975; Kinner and Maurer 1978; Zingmark 1978; Croker and Hatfield 1980; Garlo 1980). It is found from the intertidal zone to a depth of about 200 m (Pettibone 1963, Day 1973, Zingmark 1978), primarily in sand containing little organic matter, and has been reported in concentrations ranging from 10 to 419 worms/m^2 (Carpenter 1956, Sanders 1958, Kinner and Maurer 1978).

Clark (1962) reviewed the scanty literature on the genus and pointed out that, with few exceptions, all species were carnivorous. In apparently the only published information on the food habits of *N. bucera,* Croker (1977) listed it as an omnivore, but gave no evidence for such a designation. The purpose of the present study was to determine the types of prey consumed by *N. bucera,* to relate this information to potential prey in its habitat, and to discuss its role in the food web of the surf zone.

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[1] Perkins (1980) examined all of the specimens from the coast of North Carolina identified as *N. bucera* by Day (1973), and found that 17 specimens were *N. bucera,* 43 *N. simoni* (a new species) and 13 may have been the young of *N. picta.*

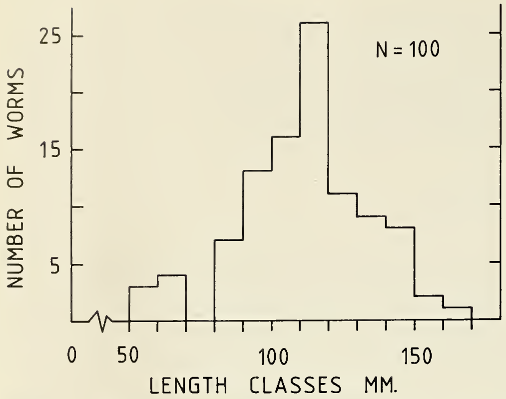

Fig. 1. The length-frequency distribution of 10 mm size classes of *Nephtys bucera* (preserved) from the surf zone at Seven Mile Beach, Avalon, New Jersey.

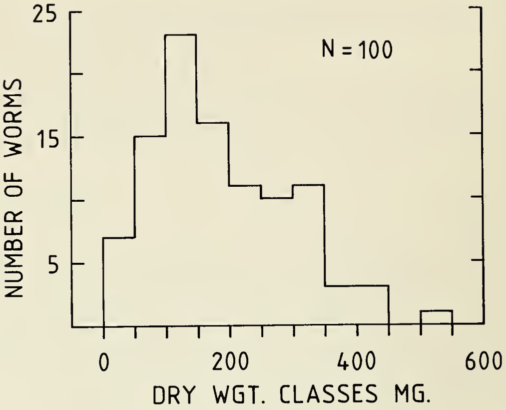

Fig. 2. The dry weight-frequency distribution of 50 mg size classes of *Nephtys bucera* (preserved).

Materials and Methods

Worms were collected in the surf of an exposed sandy beach at Avalon, New Jersey (39°04′43″N, 74°44′05″W) from 1977–1985. This was the site of an extended study (1977–1979) dealing with interactions of the benthos and nekton (McDermott 1983). The spatial distribution of *Nephtys* was determined from the analyses of 704 benthic cores (each 20 cm deep and 46 cm^2) taken along transects run perpendicular to the shore from above mean high water (MHW) to 50 m seaward of mean low water (MLW). Few of the worms collected in these cores were used for food analyses because most were damaged.

The majority of worms used for food determinations were collected during spring ebb tides by turning over the exposed sediments with a long-handled spade. Digging was usually done in a 20 m wide region (parallel to the shore) below MLW, where worms were more abundant than inshore of this mark. Worms were placed immediately into capped tubes containing ~15% sea water formalin. This isolation was to insure recovery of any food regurgitated from the gut, but no evidence of regurgitation was subsequently found.

The following determinations were made on each worm prior to examination: total length to the nearest mm, width of the prostomium (posterior to base of antennae) to the nearest 0.1 mm, and damp weight to the nearest 10 mg. Dry weight and ash-free dry weight (AFDW) to the nearest mg, were determined after examination.

Contents of the entire digestive tract of each worm were examined with the aid of a dissecting microscope, and prey species were identified and counted. Shell lengths of one prey item, *Donax variabilis,* were measured to the nearest 0.1 mm with a calibrated ocular micrometer.

Results

Eleven of the 111 *N. bucera* used for food analyses were slightly damaged and were not measured or weighed. The remaining worms ranged in length from 51 to 166 mm ($\bar{x}$ 110.9 mm ± 22.7) (Fig. 1), in wet weight from 70 to 3400 mg ($\bar{x}$ 1167.1 mg ± 696.3), and in dry weight from 13 to 506 mg ($\bar{x}$ 187.2 mg ± 108.1) (Fig. 2). The mean AFDW/dry weight ratio for 49 worms collected in the fall of 1980 and 1983 was 0.832 ± 0.051. Regression equations and correlation coefficients for various relationships follow:

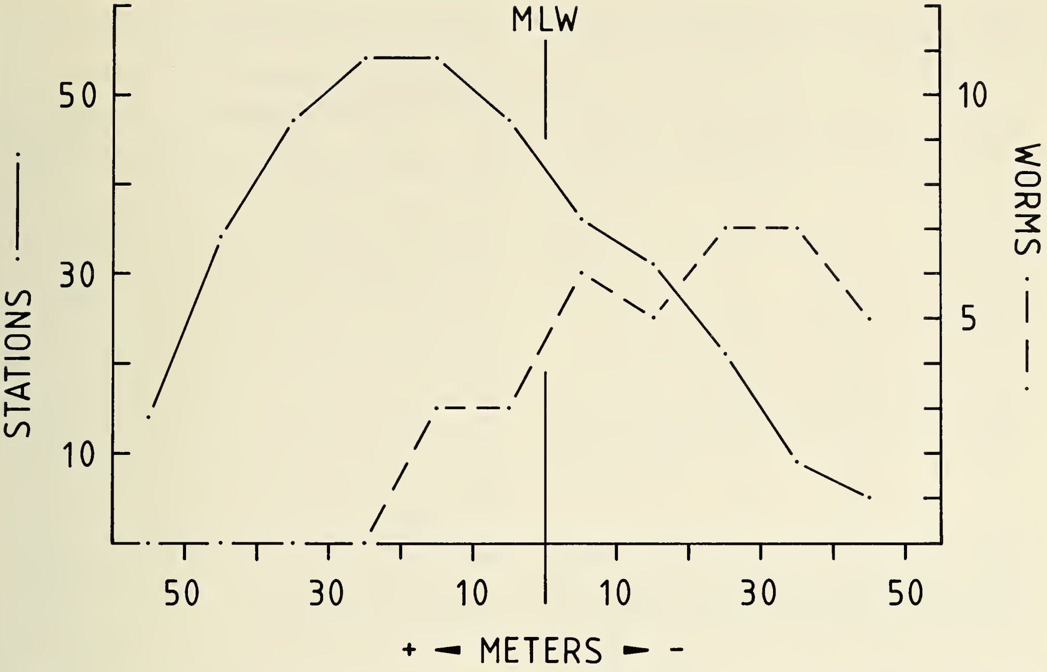

Fig. 3. The distribution of *Nephtys bucera* at Seven Mile Beach, Avalon, New Jersey, in relation to the mean low water mark (MLW), based on 704 cores (each 20 cm deep, 46 cm^2) taken from 1977–1979 at 250 stations above and 102 stations below MLW, plotted in 10 m intervals. The zone occupied by the dominant polychaete *Scolelepis squamata* is located approximately between 10 and 30 m above MLW, during all but three winter months.

dry wt (Y) vs. wet wt
$Y = 9.3500 + (0.1525)X$ $R = 0.98$
dry wt (Y) vs. length
$\log Y = -3.8882 + (2.9832)X$ $R = 0.92$
wet wt (Y) vs. length
$\log Y = -3.6389 + (3.2469)X$ $R = 0.93$
AFDW (Y) vs. dry wt
$Y = 0.3726 + (0.8295)X$ $R = 0.99$
pro. w (Y) vs. length*
$Y = 0.1747 + (0.0127)X$ $R = 0.91$

* prostomium width of 90 worms (72 from those examined for food and 18 juvenile worms from the benthic cores).

Core samples revealed that small juvenile worms occurred in the surf zone during the summer months (June to the middle of September), when the water temperatures exceeded 15°C. These juveniles (15 of 23 were measurable) ranged in length from 5.5 to 42.0 mm ($\bar{x} = 19.0$ mm ± 11.3; 10 worms were below 20 mm), and in dry weight from 0.1 to 15.7 mg ($\bar{x}$ 2.3 mg ± 4.3). They are not included in Figs. 1 and 2, and their gut contents were not analyzed.

Six *N. bucera* were collected in 500 cores taken above MLW, and 30 were recovered from 204 cores below MLW (Fig. 3). The ratios of worms to cores were 0.012 and 0.147, respectively, approximating 2.5 worms/m^2 inshore and 32 worms/m^2 offshore of MLW. Thus *N. bucera* is considerably more abundant below the MLW mark, only slightly overlapping the narrow (20 m wide band) *Scolelepis* zone, which is found in the mid-intertidal region for most of the year. During the winter months (particularly January through March), however, when the *Scolelepis* population moves to

Table 1.—Incidence and total numbers of food items in the digestive tracts of *Nephtys bucera* collected in the surf zone of Seven Mile Beach, Avalon, New Jersey.

Date of collection	Number of worms		Incidence of food items					Unidentified crustacean fragments
	Examined	With food	*Scolelepis*	*Donax*	*Amphiporeia*	Amphipod fragments	*Emerita*	
13-5-78	1	0						
24-7-78	1	1	1					
14-10-78	3	3		2	1			1
28-10-78	5	4		1	2	2		
7-7-79	3	3	3					
16-10-79	3	1						1
27-3-80	7	2	2					
12-10-80	7	7		7			4	
22-11-80	19	16	8	13	2	1		
9-9-83	5	4	2	2				
5-11-83	24	18	13	4	1			
3-6-85	33	31		30	8	1		
Totals	111	90	29	59	14	4	4	2
Numbers of each item			34*	278	18	4*	5	2*

* Where no anterior ends were found, fragments were calculated as one individual.

the lower intertidal and subtidal region (McDermott 1983), there may be more overlap of the populations. This assumes that *Nephtys* does not migrate also.

Donax variabilis was the most common and most abundant prey species found in the digestive tracts of 111 worms examined from 1978 to 1985 (Table 1). These clams occurred in 65.6% of worms with food, amounted to 81.3% of all food items, and were ingested by worms from all size classes. The small spionid polychaete *Scolelepis squamata* was next in importance, while the two crustaceans, *Amphiporeia virginiana* and *Emerita talpoida,* appeared to be incidental prey. The mole crabs belonged to the 1980 year-class (carapace lengths: 3.5, 4.0, 4.5 and 5.1 mm). Most of the amphipod fragments were probably from *Amphiporeia.* Eleven additional damaged worms were also examined, and in these *Donax* was dominant over *Scolelepis* and *Emerita.* Sand was not often found in the digestive tracts of *Nephtys,* but when found it was usually in small amounts in the rectum.

Clams are consumed whole, i.e., the shells are not crushed by the two conical pharyngeal jaws of the worm during ingestion. Broken shells were found sporadically, but this was attributed to damage caused during dissection. The clams were all young-of-the-year, ranging in shell length from 1.1 to 6.4 mm ($\bar{x}$ = 2.47 mm ± 0.82). The length frequency distribution of all undamaged clams recovered from *Nephtys* appears in Fig. 4. Clams were usually oriented with their long axes parallel to the gut of the worm, thus the longest clam (6.4 mm) required a buccal opening equal only to its height (4 mm). This clam was one of two recovered from one of the longest worms in the collection (149 mm long, 441 mg dry wt). Up to 18 clams were found in a single worm (a specimen 118 mm long, 243 mg dry wt), and they ranged in length from 1.9 to 3.2 mm ($\bar{x}$ = 2.38 ± 0.33). Nine of these clams were packed into a swollen part of the gut just posterior to the muscular pharynx.

Most of the clams recovered were in the 1.5 to 2.9 mm category (Fig. 4), and practically all of the larger clams were from the 22-11-80 collection (2.8 to 6.4 mm long, $\bar{x}$ 4.41 mm ± 0.85, n = 30). Worms in this collection were not significantly larger than those from other collections, indicating that worms collected at other times would have been capable of ingesting larger clams had they been available.

Clams are digested within their shells, the two valves usually remaining attached by the ligament even after complete digestion of the tissues. Some tightly closed clams with little or no digestion were found in the lower gut. Whether some clams escape digestion and are redeposited alive back into the sediments with the feces, is a question that must be left to laboratory experimentation. K. Fauchald's (Smithsonian Institution, pers. comm.) observations on several species of nephtyids, suggest that following digestion bivalve shells of the size reported here are probably regurgitated because the anal openings of these worms are too small to allow passage in the normal manner.

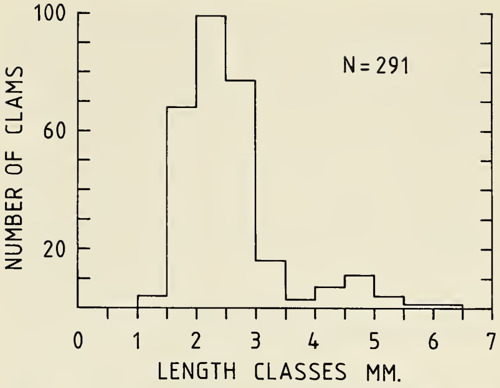

Fig. 4. The length-frequency of 0.5 mm size classes of *Donax variabilis* removed from the digestive tracts of *Nephtys bucera.*

Discussion

Nephtys bucera appears to be an opportunistic carnivore, feeding on the invertebrates most available to them in the surf. It was found previously that *Scolelepis, Donax, Amphiporeia* and *Emerita* are the dominant benthic species in this particular habitat along the coast of New Jersey (McDermott 1983).

The virtual lack of significant amounts of sand in the digestive tracts of *N. bucera,* with or without macrofauna, certainly obviates any contention that this species is a deposit feeder. Sanders' (1956, 1960) observation that *N. incisa* is a non-selective detritus feeder was viewed by Clark (1962) as a condition probably peculiar to the species, and perhaps related to the unusually high concentrations of the worm in the offshore waters of Long Island Sound and Buzzards Bay, Massachusetts. Sanders' (1960) contention that it would not be feasible for the worm to be primarily a predaceous feeder because of its dominance in the soft-bottom community of Buzzards Bay, might be reevaluated in light of what appears to be a great diversity and relative abundance of potential prey species tabulated for the area. Suspension feeding was recently suggested for the same species by Davis (1979).

Clark (1962) noted that the European species, *N. cirrosa* and *N. hombergi,* while usually not packed with food, fed mainly on a variety of polychaetes. Never were their digestive tracts filled with sand. Warwick and Price (1975) also concluded that *N. hombergi* was a carnivore, but their evidence was meager, and they were concerned that no other suitable macrofaunal animals of a lower trophic level were available in the Lynher Estuary (England) to maintain the large population of *Nephtys.* Ockelmann and Muus (1978) determined that *Nephtys* spp. from Danish waters fed on foraminiferans, small molluscs (including the small montacutid bivalve *Mysella bidentata*) and smaller polychaetes. *Nephtys caeca, N. hombergi* and *N. longosetosa* all occurred in their study areas, but the food of each was not specified. Brown (1964) considered *N. capensis* to be an impartial feeder that "draws the line only at plant material," but he gave no substantiating data. Srinivasa Rao and Rama Sarma (1978) concluded that *N. oligobranchia* from the east coast of India feeds primarily on polychaetes. In their recent review of food and feeding in polychaetes, Fauchald and Jumars (1979) concluded that nephtyids are predominantly carnivores, but they admitted that there is a scarcity of information on the subject.

Ockelmann and Muus (1978) observed that the shells of *Mysella bidentata* are crushed by the pharyngeal jaws of European *Nephtys* spp. This did not appear to be the case with *Donax* ingested by *N. bucera.* Possible differences in feeding behavior and size of the jaws among nephtyids and the physical properties of bivalve shells, may be related to how small bivalves are handled by these predators.

Although *Donax* was the dominant food item of *N. bucera,* further more intensive seasonal observations from field collections, as well as laboratory experiments, are necessary in order to determine if it has a preference for this clam. It may be suggested that as the population of *Scolelepis* moves offshore in the winter it becomes a more important food source in the diet of *N. bucera,* but the sporadic nature of my sampling does not lend itself to a seasonal analysis. It appears likely that other species of haustoriid amphipods, belonging to the same subfamily as *Amphiporeia* (Pontoporeiinae) and to the subfamily Haustoriinae, and known to exist in relatively small numbers in the *Nephtys* region (McDermott 1983), would be suitable prey.

Nephtys' role in the food web of the shallow surf zone is that of a predator, influencing (to an undetermined extent) the population dynamics of *Donax, Scolelepis* and various benthic crustaceans. All of the latter have been shown to be important prey for a variety of fishes that inhabit the surf zone (McDermott 1983). *Nephtys,* in turn, serves as occasional food for juvenile northern kingfish (*Menticirrhus saxatilis*); single specimens were found in the stomachs of four of the 159 fish examined. The kingfish feeds predominantly on *Scolelepis,* which makes up over 80% of its diet in the surf (McDermott 1983). *Nephtys* was not observed in the stomach contents of 236 juvenile spot (*Leiostomus xanthurus*), also a member of the Sciaenidae, or in other species of fishes examined from the same environment.

Further, more detailed studies on the life history of *N. bucera* will require improved sampling techniques. The methods used in the present study are not adequate for obtaining sufficient numbers of worms. Two devices, a suction corer and a scoop dredge, specifically developed recently for use in the surf zone by Fleischack et al. (1985) may hold promise for obtaining adequate samples of *Nephtys* and other invertebrates living in this turbulent region.

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TWO NEW SPECIES OF *PETTIBONEIA* (POLYCHAETA: DORVILLEIDAE) PRIMARILY FROM THE GULF OF MEXICO

Paul S. Wolf

Abstract.—Two new species of the genus *Pettiboneia* Orensanz, 1973, are described, *P. duofurca* from the east and west coasts of Florida, Alabama, and Texas, and *P. blakei* from the east coast of Florida.

The genus *Pettiboneia* Orensanz, 1973, is currently known for three species: *P. sanmatiensis* Orensanz, 1973 (redescribed by Blake 1979), *P. urciensis* Campoy and San Martin, 1980, and *P. australiensis* Westheide and von Nordheim, 1985. *Pettiboneia sanmatiensis* is recorded from Argentina, its type locality, and from California and British Columbia (Blake 1979:1137); *P. urciensis* is described from the Mediterranean; and *P. australiensis* is described from Australia. Wolf (1984) identified two potentially new species of *Pettiboneia* from the Gulf of Mexico; these are described below.

The bulk of the material examined for this study was collected as part of a U.S. Bureau of Land Management (now Minerals Management Service) Outer Continental Shelf baseline study conducted during 1975–1981. MAFLA stations were those designated within the Mississippi–Alabama–Florida portion of the program; SOFLA stations were those located off southwest Florida; STOCS stations were located off the Texas coast (see Uebelacker and Johnson (1984). The remaining material was collected under the auspices of the Environmental Protection Agency (EPA) during contracts issued to Battelle, Columbus Laboratories (EPA/Bat stations); to Science Applications International Corp. through JRB Associates, McLean, Virginia (SAI stations); and under a contract issued by the U.S. Army Corps of Engineers to Barry A. Vittor & Associates, Inc. (COE station).

The type material and some additional specimens are deposited in the National Museum of Natural History, Smithsonian Institution (USNM). Other specimens are in the laboratory museum of Barry A. Vittor & Associates, Inc., Mobile, Alabama.

Figure Abbreviations

an	antenna	nuO	nuchal organ
br	branchia	pa	palp
noto	notopodium	vC	ventral cirrus

Pettiboneia Orensanz, 1973

Type species.—*Pettiboneia sanmatiensis* Orensanz, 1973.

Diagnosis.—Maxillae in 8–14 rows, each row composed of free denticles only; some maxillary rows with rasping denticles; base plates absent. Denticle rows not fused posteriorly. Maxillary carriers absent. Prostomium with well-developed, biarticulate palps; antennae digitiform, simple, shorter than palps. Notopodia present anteriorly, long, with internal acicula, without distal article; absent posteriorly. Branchiae present or absent. Supraacicular setae simple with long tapered forms and furcate setae; subacicular setae include compound falcigers and occasionally inferior simple setae.

Remarks.—Armstrong and Jumars (1978) described *Protodorvillea pugettensis* and *P. dibranchiata,* both of which probably belong in *Pettiboneia* primarily because of their jaw morphology (Blake, pers. comm.); however, both species are described as having maxillary carriers. Thus, their inclusion within *Pettiboneia* would necessitate expansion of the generic diagnosis to include species with maxillary carriers.

Pettiboneia duofurca, new species
Figs. 1, 2

Pettiboneia sp. A.—Wolf, 1984:44–47, fig. 44-1, 44-2a-j.

Material examined.—FLORIDA, off Palm Beach: EPA/Bat Sta 5-2, Nov 1984, 26°46.0′N, 79°58.9′W, 118 m, medium coarse sand, 1 Paratype (USNM 98931).—Off Port Everglades: EPA/Bat Sta Dive 1, Nov 1984, 26°07.7′N, 80°05.0′W, 17 m, sand, 1 Paratype (USNM 98932).—Off Tampa Bay: MAFLA Sta 2209I, Jun 1976, 27°52′30.5″N, 83°33′59.0″W, 34 m, clayey-sandy silt, 1 specimen (USNM 89597); SAI Sta A-13-1, 15 May 1982, 82°59.0′N, 27°36.5′W, 49 m, medium fine sand, 1 specimen; SAI Sta A-13-3, same date and location, 49 m, coarse sand with gravel, 1 specimen.—Northwest: MAFLA Sta 2422C, Jun 1976, 29°30′N, 84°27′W, 24 m, medium fine sand, 2 specimens including 1 ovigerous female; MAFLA Sta 2424B, Jul 1976, 20°13′00.7″N, 85°00′01.4″W, 27 m, medium sand, 4 specimens (USNM 89557); MAFLA Sta 2424C, same date and location, 3 specimens; MAFLA Sta 2424E, same date and location, 1 specimen (USNM 89596); MAFLA Sta 2424H, same date and location, 1 specimen.—Off Panama City: MAFLA Sta 2528H, Aug 1977, 29°54′58.6″N, 86°04′58.5″W, 37 m, coarse sand, 2 specimens (USNM 89594–5); SAI Sta 10-1, Nov 1983, 30°08′07″N, 85°45′39″W, 17.7 m, fine to medium sand with shell, 1 Paratype (USNM 98933).—ALABAMA, off Mobile Bay: COE Sta 695-6, 1 Apr 1981, 30°01.5′N, 87°54.27′W, 22.4 m, sand, 1 specimen.—TEXAS, off Matagorda: SAI Sta 1-3, Nov 1983, 28°15.33′N, 96°11.91′W, 9.3 m, sand and gravel, 1 specimen.—Off Padre Island: STOCS Sta III/4-1, no date, 26°58′N, 97°20′W, 15 m, sand, 1 specimen.—Off Port Isabel: STOCS Sta IV/4-1, Fall 1976, 26°10′N, 97°08′W, 15 m, sand, 2 specimens (USNM 89556, 89593).—Off Brownsville: SAI Sta 8-3, Nov 1983, 26°03.28′N, 97°04.15′W, 16.9 m, sand, Holotype (USNM 98930).

Description.—Length to 4.3 mm, width to 0.2 mm. Largest specimen incomplete with 45 setigers. Prostomium conical, broadly rounded anteriorly (Fig. 1a), with 1 pair of small eyes, when present. Antennae smooth, digitiform, about ⅔ length of palps. Palps biarticulate. Single pair of large nuchal organs present dorsolaterally at postectal corners of prostomium. Additional ciliated areas present on prostomium, palps, and laterally on each tentacular ring (Fig. 1a).

Notopodia present on setigers 2–8 or 9, with internal acicula, without distal article (Fig. 1b). Notopodia absent posteriorly (Fig. 1c). Branchiae present on dorsal edge of neuropodia from setigers 3–5 or 8, or absent entirely. Parapodia without well-developed pre- or postsetal lobes (Fig. 1b, c).

Supraacicular setae including simple serrate setae tapering to fine tips, and furcate setae. Furcate setae of anterior few setigers small, with tines slightly unequal in length, with spines present below short tine (Fig. 1d); thereafter tines long, slightly unequal in length, with or without spines below short tine (Fig. 1e, f). Furcate setae of juveniles pseudocompound, with tines unequal in length and with numerous spines below short tine (Fig. 1g, h). Subacicular setae compound, with long to short blades having unidentate tips (Fig. 1i, j); blade length ratio approximately 4.4–5.1:1. Far posterior parapodia with inferior simple setae (Fig. 1k).

Pygidium with 4 anal cirri, 2 very long, filiform dorsal ones and pair of shorter, club-shaped ventral ones (Fig. 2a).

Maxillae in 12 rows (Fig. 2b), each row composed of separate denticles, each denticle wider than long. Row 1 with 6–7 broad,

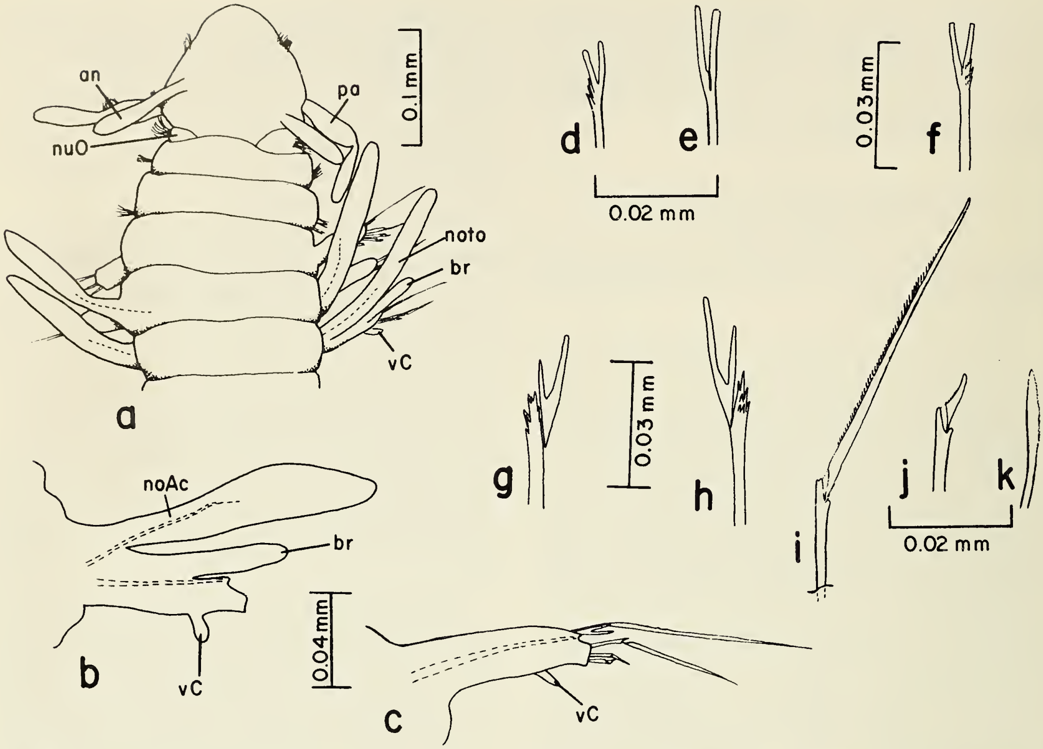

Fig. 1. *Pettiboneia duofurca*: a, Anterior end, dorsal view; b, Anterior parapodium, posterior view; c, Posterior parapodium, posterior view; d, Furcate seta from anterior setiger of adult; e, Same, from posterior setiger; f, Same, spinous form; g, Pseudocompound furcate seta from anterior setiger of juvenile; h, Same, from posterior setiger of juvenile; i, Superior subacicular falciger; j, Inferior subacicular falciger; k, Inferior simple seta. (Figs. a–e, i–k from Wolf 1984:fig. 44-2a–h.)

rounded, poorly chitinized, clear, rasp-like denticles, each denticle with numerous minute teeth. Row II with about 13–15 squared, flattened denticles, each denticle with one large tooth and several smaller ones. All denticles of Row II heavily sclerotized and dark brown in color. Rows III–VI with poorly sclerotized, clear, rounded, rasp-like denticles, each denticle with numerous teeth. Mandibles each with anterior portions rounded, scalloped along inner edge. Each mandible strongly concave medially along outer edge, and with widely divergent posterior portions (Fig. 2c).

Remarks.—Reexamination of material shows that rows I and II of Wolf (1984) were labelled and described in reverse order. It also appears that in most specimens examined, row I is not as long as row II, but this feature is difficult to determine due to the small size and/or the condition of the worms. Indeed, row I may be analogous to maxillary carriers of other dorvilleid genera, thereby further distinguishing *P. duofurca* from other species of the genus. If maxillary carriers are present, this may be cause to remove *P. duofurca* to a new genus; however, I have elected not to do this since other diagnostic characters indicate *P. duofurca* is best kept within *Pettiboneia* for the present.

Among the material examined, one complete juvenile specimen was found that measures 2.06 mm in length for 28 setigers. It differed from the adult worms in having pseudocompound furcate setae (Fig. 1g, h)

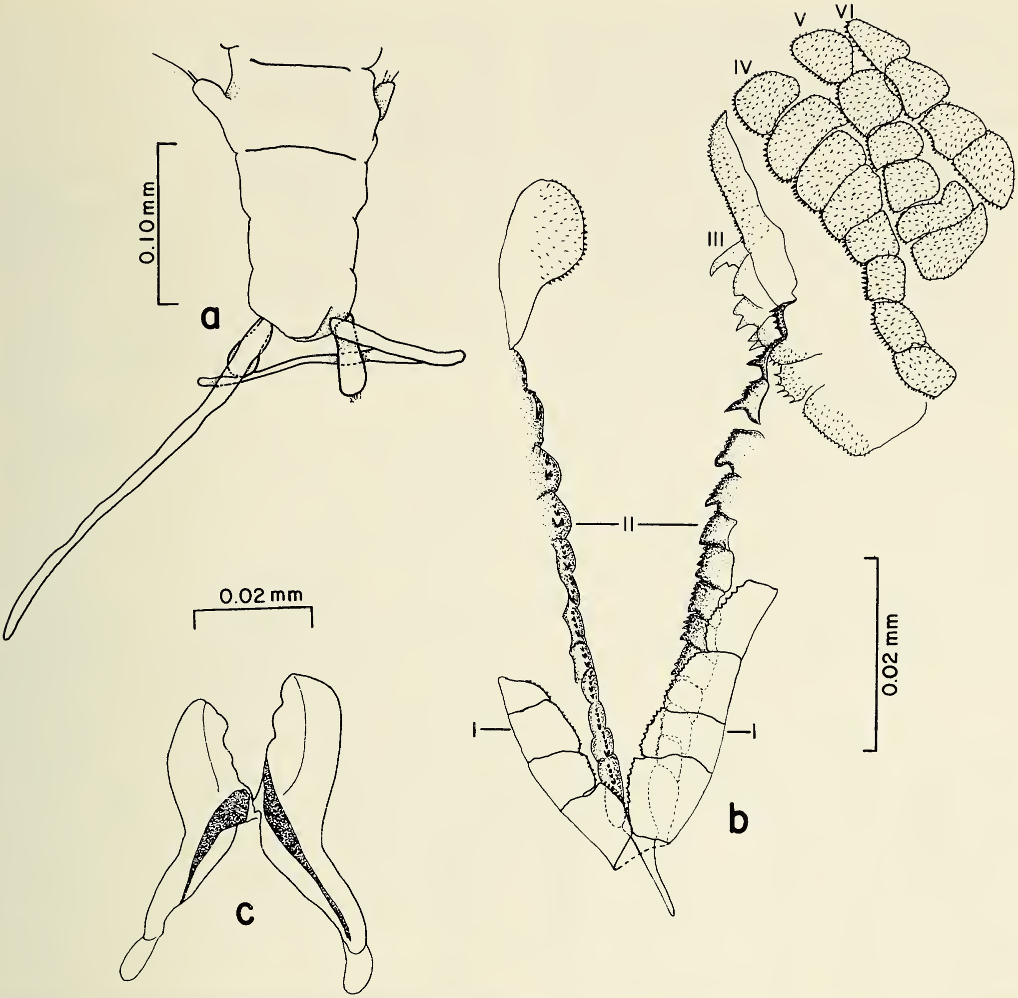

Fig. 2. *Pettiboneia duofurca*: a, Posterior end, dorsal view; b, Maxillae, dorsal view (left side not completely shown); c, Mandibles, dorsal view. (Fig. c from Wolf 1984:fig. 44-2j.)

and in having dorsal cirri present on both parapodia of setiger 3 only. The mandibles and maxillae are identical to those of the adult although an entirely new set of each was developing within the juvenile specimen.

One gravid female was also found. It contained 1–2 eggs per setiger from setiger 11. The largest egg measured about 80 μm in diameter.

Pettiboneia duofurca is similar to *P. blakei,* described below, in having only 12 maxillary rows instead of 14 as in *P. sanmatiensis* or eight rows as in *P. australiensis* and *P. urciensis. Pettiboneia duofurca* differs from *P. blakei* in having denticles of all maxillary rows wider than long rather than longer than wide; in having smaller, more numerous rasp-like teeth on each denticle rather than fewer, more prominent teeth; in having narrow, widely flaring mandibles instead of broad, slightly divergent mandibles; in having two types of furcate setae instead of one; and in having branchiae in some specimens.

Etymology.—The species name is taken

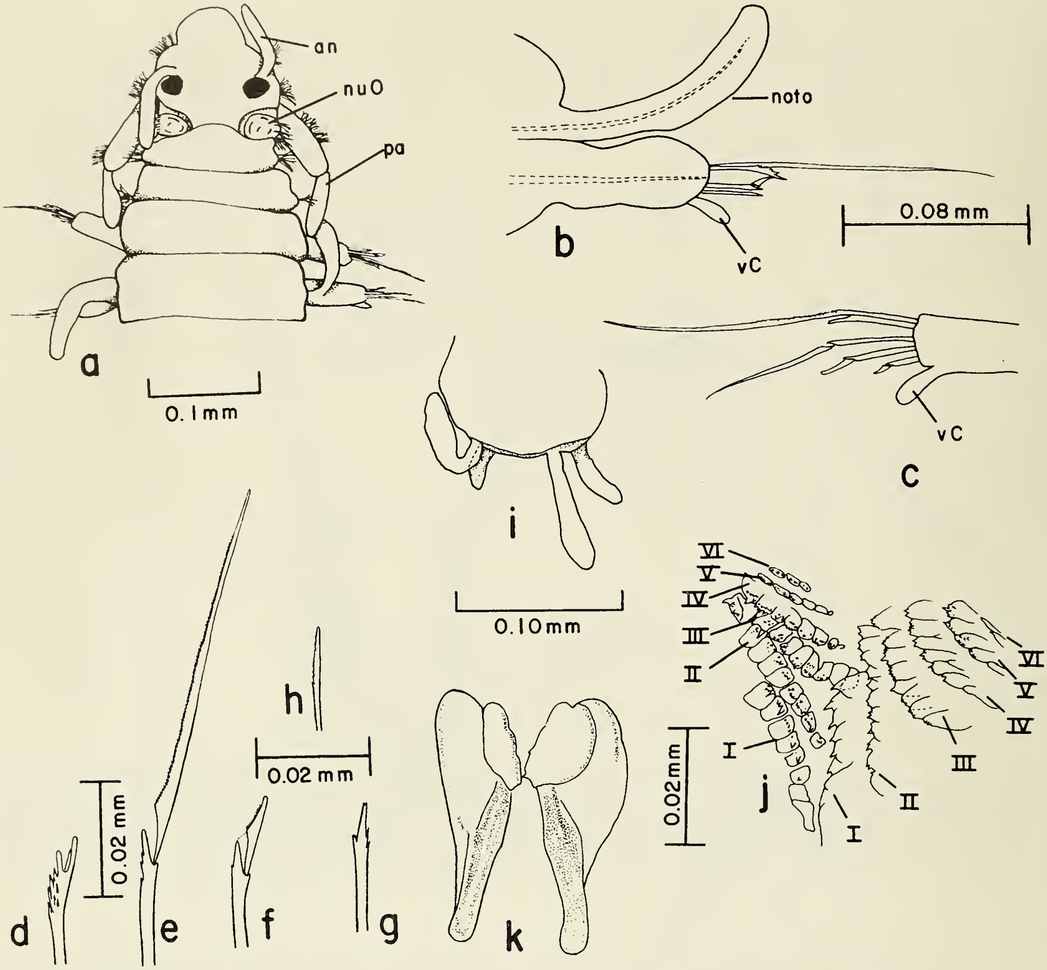

Fig. 3. *Pettiboneia blakei*: a, Anterior end, dorsal view; b, Anterior parapodium, posterior view; c, Posterior parapodium, posterior view; d, Furcate seta; e, Superior subacicular falciger; f, Inferior subacicular falciger; g, Setal shaft, edge-on view; h, Inferior simple seta; i, Pygidium, dorsal view; j, Maxillae, dorsal view; k, Mandibles, dorsal view. (Figs. a–h, j, k, from Wolf 1984:fig. 44-4a–j.)

from the Latin *duo,* two, and *furca,* fork, referring to the two types of furcate setae present along the body.

Distribution.—East and west coasts of Florida to Texas, 9.3–118 m.

Pettiboneia blakei, new species
Fig. 3

Pettiboneia sp. B.—Wolf, 1984:44–49, fig. 44-3, 44-4a–j.

Material examined.—FLORIDA, southwest: SOFLA Sta 20A, May 1981, 25°17.34′N, 82°09.73′W, 22 m, coarse sand, 1 specimen: MAFLA Sta 2211F, Nov 1977, 27°56′29.5″N, 83°52′59.5″W, 43 m, coarse sand, 2 specimens.—Off Tampa Bay: EPA/Bat Sta 1111-III-OLD 3-10, Dec 1984, 27°29′N, 83°04.5′W, 22.6 m, sand, 1 Paratype (USNM 98937); EPA/Bat Sta 1111-III-5-1, Dec 1984, 27°28.7′N, 83°06.5′W, 24.7 m, sand, 1 Paratype (USNM 98935); EPA/Bat Sta 1111-III-5-3, same data, 1 Paratype (USNM 98936); EPA/Bat Sta

1111-III-5-10, same data, Holotype (USNM 98934).—West coast: MAFLA Sta 2315A, Jul 1976, 28°33′59.1″N, 84°20′09.1″W, 38 m, silty-fine sand, 1 specimen; MAFLA Sta 2316C, Nov 1977, 28°42′00.3″N, 84°20′00.7″W, 35 m, silty-fine sand, 1 specimen.—Off Cape San Blas: MAFLA Sta 2854G, Aug 1977, 29°24′00.1″N, 85°42′02.0″W, 42 m, medium fine sand, 1 specimen.—Off Panama City: MAFLA Sta 2528J, Aug 1977, 29°54′58.6″N, 86°04′58.5″W, 37 m, coarse sand, 1 specimen.

Description.—Length to 8.5 mm, width to 0.58 mm. Largest specimen complete with 114 setigers. Prostomium (Fig. 3a) rounded anteriorly, expanded in ocular region, with single pair of large eyes at antennal bases. Antennae smooth, digitiform, about ½ length of palps. Palps distinctly biarticulate. Single pair of large, ciliated nuchal organs located at dorsal postectal corners of prostomium. Additional prominent ciliated areas present on prostomium, palps, and laterally on both peristomial rings (Fig. 3a).

Notopodia present on setigers 2–12 to 24 (Fig. 3b), with internal acicula, without distal article. Branchiae absent. Notopodia absent posteriorly (Fig. 3c). Neuropodia without pre- and postsetal lobes.

Supraacicular setae include long, simple, serrate setae tapering to fine tips; and furcate setae with blunt-tipped tines, slightly unequal in length, about 4 rows of spines below short tine (Fig. 3d). Subacicular setae compound, unidentate, with long to short serrate blades (Fig. 3e, f); apical tips of setal shafts bifid when viewed edge-on (Fig. 3g). Inferior simple setae present on far posterior parapodia (Fig. 3h).

Pygidium rounded with 2 pairs of filiform, subterminal anal cirri, dorsal cirri about twice as long as ventral ones (Fig. 3i).

Maxillae arranged in 12 rows (Fig. 3j) each row composed entirely of free denticles. Each denticle longer than wide, with 1 main tooth and several smaller teeth. Maxillary carriers absent. Rows I–IV each with 6–8 denticles; row V with 5–6 denticles; row VI with 2–4 denticles. Each mandible broad anteriorly, scalloped along inner edge, then tapering abruptly posteriorly and becoming slightly divergent (Fig. 3k).

Remarks.—One paratype (USNM 98936) is a gravid female with numerous eggs present in each setiger from about setiger 26. The largest eggs measured 65–70 μm in diameter.

Pettiboneia blakei is most similar to *P. duofurca,* described above, but differs in several respects (see "REMARKS" for *P. duofurca*).

Etymology.—The species is named in honor of Dr. James Blake, Battelle New England Marine Research Laboratory, Duxbury, Massachusetts, for his numerous contributions to polychaete taxonomy including those dealing with the Dorvilleidae.

Distribution.—East coast of Florida, 22–43 m.

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I wish to thank Dr. Kristian Fauchald, Smithsonian Institution, Washington, D.C.; and Dr. Barry A. Vittor and Ms. Linda Sierke, Barry A. Vittor & Associates, Inc., for their reviews of the manuscript.

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Barry A. Vittor & Associates, Inc., 8100 Cottage Hill Rd., Mobile, Alabama 36609.

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100(1), 1987, pp. 35–39

DROMIOPSIS KIMBERLYAE, A NEW LATE CRETACEOUS CRAB FROM THE PIERRE SHALE OF SOUTH DAKOTA

Gale A. Bishop

Abstract.—Two specimens of an undescribed Cretaceous crab were collected from the Heart Tail Ranch in the lower Pierre Shale, Butte County, South Dakota. The specimens are assigned to *Dromiopsis kimberlyae* n. sp., the second North American species of *Dromiopsis* and the first from the Cretaceous of North America. *Dromiopsis kimberlyae* joins seven previously described decapod taxa as a rare faunal element in the Heart Tail Ranch Decapod Assemblage.

Recollecting of the Heart Tail Ranch Decapod Assemblage, Butte County, South Dakota, on 23 June 1985, resulted in discovery of the left side of the carapace of an undescribed fossil crab (Fig. 2A, B) (by Kimberly Dawn Bishop). During subsequent collecting on 31 July 1985, I found a second specimen of this crab, a complete carapace with a partly extended abdomen (Fig. 2C–I). Both specimens are preserved in apatite concretions typical of the Heart Tail Ranch Decapod Assemblage (Bishop 1985). This assemblage now consists of eight decapod species represented by about 900 specimens. The Heart Tail Ranch Decapod Assemblage is from the Gammon Ferruginous Member of the Pierre Shale and is Early Campanian in age (see geologic map and stratigraphic diagrams in Bishop 1985, figs. 1 and 2).

Systematic Paleontology
Class Crustacea
Order Decapoda
Family Dynomenidae Ortmann, 1892
Dromiopsis Reuss, 1859

Diagnosis.—Carapace pentagonal, convex, front forming large triangular lobe, lateral margins tuberculate (to smooth), transverse grooves strong (emended after Glaessner 1969:R488).

Range.—*Dromiopsis* is Late Cretaceous to Paleocene in age, ranging from the Cenomanian through the Paleocene. Most taxa are from Belgium, Sweden, Denmark, and Germany (Förster 1975). One species, *Dromiopsis americana* Roberts, 1956, was described from the Paleocene of New Jersey.

Dromiopsis kimberlyae, new species
Figs. 1, 2

Diagnosis.—Carapace nearly circular, arched longitudinally and transversely; front downturned and triangular; anterolateral margin keeled, not tuberculate; transverse grooves strong, medial groove becoming obsolete posteriorly on intestinal region.

Types.—The holotype (SDSM 10184) and paratype (SDSM 10185) are deposited in the collections of the Museum of Geology, South Dakota School of Mines, Rapid City, South Dakota 57701.

Occurrence, preservation, and sample size.—Two specimens preserved in apatite concretions were collected in the SW ¼, Sec. 16, T11N, R2E, Butte County, South Dakota from the Heart Tail Ranch Assemblage (Bishop 1985). This fauna is from the zone of *Baculites* sp. (smooth), early form and is mid-early Campanian in age. The holotype is a complete carapace steinkern with a par-

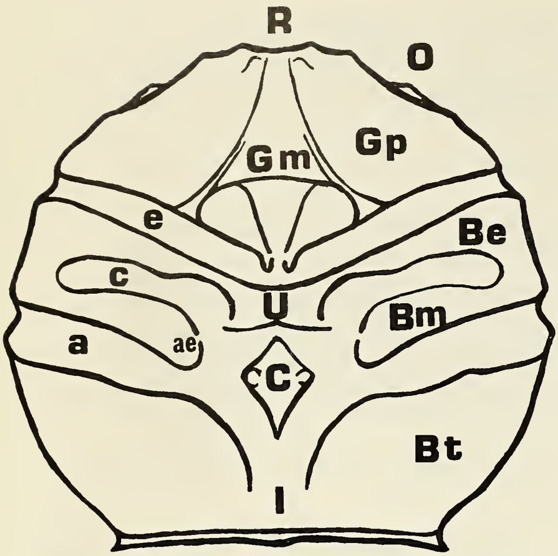

Fig. 1. Line drawings of carapace of *Dromiopsis kimberlyae* showing carapace regions and grooves. Carapace grooves are: e, cervical; c, postcervical; a, brachialcardiac, and ae, position of attachment of the *attractor epimeralis* muscle. Carapace regions are: R, rostrum; O, orbit; Gm, mesogastric; Gp, protogastric (with epigastric boss near rostrum); U, urogastric; C, cardiac; I, intestinal; and B, the branchial regions, Be, epibranchial, Bm, mesobranchial, and Bt, metabranchial.

tially extended, but reflexed, abdomen. The paratype is the left third of a carapace steinkern. *Dromiopsis kimberlyae* is the eighth decapod species to be described from the Heart Tail Ranch Assemblage and the specimens represent specimens number 855 and 856 collected from the Heart Tail Ranch.

Description.—Carapace pentagonal-circular, slightly wider than long (19.1 mm long, 19.8 mm wide), strongly arched transversely, arched longitudinally. Rostrum strongly downturned, triangular with medial sulcus running onto tip causing upturned rim to form a "bifid," blunt tip. Orbits large (59% of carapace width), divided, forming slight concavities on anterolateral margin, rims slightly raised, lower edge with suborbital spine. Anterolateral margins slightly concave around orbits then curving into a nearly circular arc, widest at crab's midpoint, then forming posterolateral margins until their junction with concave posterior margin. Anterolateral dorsal shield edge strongly reflexed and keeled from orbit to cervical furrow, from cervical furrow to branchiocardiac furrow, and for short distance immediately behind branchiocardiac furrow, breaking up into a few parallel elongate tubercles. Posterior margin raised into ridge bordered by marginal furrow. Carapace strongly differentiated by 3 more or less transverse grooves. Cervical groove deep, relatively straight and oblique. Branchiocardiac groove almost as deep, nearly transverse from dorsal shield edge to medial ridge where it bifurcates to encircle cardiac region. Between cervical and branchiocardiac furrows a shorter, third transverse groove, "post-cervical furrow," arising just anterior of cardiac region and running subparallel to other 2 transverse grooves, becoming obsolete before reaching dorsal shield edge. Cephalic arch (area anterior to cervical furrow) moderately differentiated into medial metagastric region, and protogastric-hepatic-epigastric region by indistinct groove running obliquely inward from cervical furrow then swinging forward to form triangular anterior tongue of mesogastric region. Posterior of mesogastric region separated into 2 low, lateral bosses by shallow medial furrow; each boss asymmetrical, steep behind where roughened by mold of muscle insertion areas terminating in pair of small, spinelike insertion points. Epigastric regions raised into small, circular, epigastric bosses. Scapular arch (area posterior to cervical groove) differentiated into sagittal ridge and branchial regions by more or less continuous longitudinal groove. Sagittal ridge consisting of (anterior to posterior) urogastric region ("Gastrical gruben" and urogastric regions of Förster 1975), diamond-shaped cardiac region with transversely-paired tubercles, and poorly differentiated intestinal region. Branchial regions subdivided into anterior epibranchial, me-

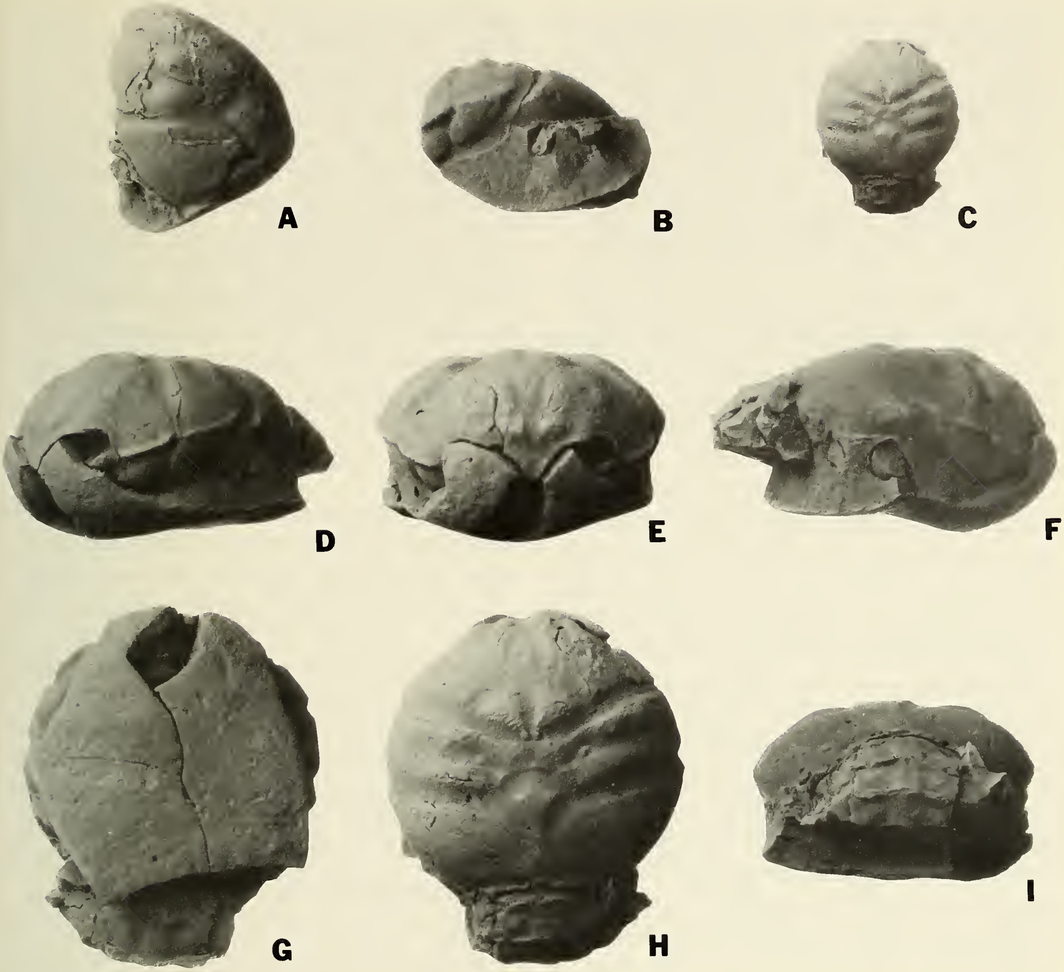

Fig. 2. Photographs of *Dromiopsis kimberlyae*: A–B, Dorsal and left lateral view of paratype (SDSM 10184), ×2.0; C–I, holotype specimen (SDSM 10185) seen in: C, Dorsal view, ×1.0; D, Left oblique; E, Anterior; F, Right lateral; G, Ventral; H, Dorsal; and I, Posterior views (D–I, ×2.0).

dial mesobranchial, and posterior metabranchial regions. Major muscle insertion points lie on posteriors of mesogastric bosses, on posterior edge of cervical furrow, and in small, paired oval areas in "postcervical furrow" (Fig. 2H). Both cervical and branchiocardiac furrow continue onto reflexed pterygostomial region separating it into an anterior part (subhepatic), medial part (anterior subbranchial), and posterior part (posterior subbranchial). Abdomen subtilely grooved longitudinally, with low, laterally placed pleural bosses paired across each somite. Appendages only preserved in cross section.

Etymology.—Dromiopsis kimberlyae is named in honor of its discoverer, Kimberly Dawn Bishop.

Comparison.—Dromiopsis kimberlyae can be distinguished from all congenors by its keeled, non-tuberculate anterolateral margin. *Dromiopsis kimberlyae* is much smoother, more circular, and has a carapace less divided by grooves than *D. rugosa*

(Schlotheim 1820) and its associates (*D.* cf. *rugosa* of Förster 1975). *Dromiopsis kimberlyae* is not as coarsely ornamented as is *D. gigas* Forir, 1887, nor does it have as prominent a transverse, raised urogastric region. *Dromiopsis kimberlyae* is more circular in dorsal view, has a proportionally broader posterior margin, less rounded anterolateral margins and much deeper carapace grooves than *D. elegans* Reuss, 1859. *Dromiopsis kimberlyae* is most similar to *D. laevior* Reuss, 1859, and the closely related (Förster 1975:290) form *D. depressa* Segerberg, 1900, in circular carapace shape, carapace proportions, and carapace smoothness. *Dromiopsis kimberlyae* differs from *D. depressa* by being much more circular, proportionally shorter, by having a much more highly grooved carapace, and by possessing a complete, incised cervical furrow. *Dromiopsis kimberlyae* is more circular than *D. laevior,* has deeper, more pronounced, more complete carapace grooves, retains a prominent, but incomplete, "postcervical" furrow where *D. laevior* does not, possesses tuberculate epigastric spines where *D. laevior* does not, and possesses transversely paired spinules on the cardiac region where *D. laevior* is smooth. *Dromiopsis kimberlyae* differs significantly from *D. americana* Roberts, 1956, by being more circular, having its carapace more fully differentiated by generally deeper, almost complete grooves (except perhaps the branchiocardiac furrow so prominently depicted by Roberts 1956: fig. 2), by possessing the keeled, rather than tuberculate, anterolateral margin, and by possessing the "postcervical" groove completely lacking in *D. americana. Dromiopsis pulchella* Secretan, 1964 (Pl. 19, fig. 7, text-figs. 99–100) bears little resemblance to congenors in *Dromiopsis* and may represent a new genus-level taxon.

Remarks.—Dromiopsis kimberlyae is the second species of *Dromiopsis* described from North America and is the only *Dromiopsis* from the Cretaceous of North America. Its scarcity in the Heart Tail Ranch Assemblage (~0.2% of the decapods) is in agreement with its European record (Förster 1975: 289) which consists of five species represented by approximately 12 specimens, many of which are only claws associated with fragmentary carapaces. *Dromiopsis kimberlyae* generally fits into the phyletic scheme envisioned by Roberts (1956:8), forcing the divergence of the *D. rugosa* stock from the *D. kimberlyae-D. elegans-D. laevior-D. americana* stock further back in time to at least the mid-early Campanian.

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NEW SUBSPECIES OF *DRYOCOPUS JAVENSIS* (AVES: PICIDAE) AND *FICEDULA HYPERYTHRA* (AVES: MUSCICAPIDAE) FROM THE PHILIPPINES

Robert S. Kennedy

Abstract.—Austin L. Rand prepared descriptions and named two new subspecies of Philippine birds that were never published. After examining specimens of the proposed subspecies and comparing them with closely allied forms, I concur with Rand's descriptions and here formally propose recognition of the two subspecies: *Dryocopus javensis cebuensis,* n. subsp. (Cebu); and *Ficedula hyperythra matutumensis,* n. subsp. (Mt. Matutum, Mindanao).

At the end of his tenure as Chief Curator of Zoology at the Field Museum of Natural History, Austin L. Rand prepared two papers on Philippine birds that were never published. The first manuscript, "The Thicket Flycatcher *Muscicapa hyperythra* of Mindanao," later referred to by Rand (1970 ms) as completed in 1969, contained the description of a new subspecies of the Thicket Flycatcher, which is now usually called the Snowy-browed Flycatcher and placed in the genus *Ficedula.* The second manuscript, entitled "An Annotated List of Philippine Birds" and completed in 1970, was of book length and was the culmination of his more than two decades of work with Philippine birds. It contained the description of a new subspecies of White-bellied Woodpecker (*Dryocopus javensis*).

During the course of my research on Philippine birds, J. T. Marshall, Jr., with the approval of G. E. Watson, kindly provided a copy of each of the Rand manuscripts which are on microfilm in the Division of Birds at the National Museum of Natural History. After discovering the unpublished descriptions, I examined specimens of the proposed subspecies, compared them to other nearby populations and concluded that Rand's diagnoses were accurate but incomplete and that the two subspecies are indeed valid.

Here I formally describe the two subspecies discovered and named by Rand by presenting his diagnoses verbatim and by adding the results of my own comparative work.

Dryocopus javensis: White-bellied Woodpecker

Bourns and Worcester (1894), McGregor (1907, 1909), Hachisuka (1934) and Delacour and Mayr (1946) reported the occurrence of the White-bellied Woodpecker on Cebu. Recently, however, Parkes (1960), duPont (1971), and Short (1982) failed to mention the Cebu population of this woodpecker in their discussions or treatment of the Philippine subspecies.

Hachisuka (1934) placed the Cebu birds in *D. j. confusus* of Luzon, but this was questioned by Delacour and Mayr (1946). As noted earlier, Rand (1970 ms) examined the Cebu birds and found that they represent an undescribed subspecies to be known as:

Dryocopus javensis cebuensis, new subspecies

Holotype.—USNM 315188, adult male, 22 Jun 1892, Pandai, Cebu Island, Philippines, D. C. Worcester and F. S. Bourns (collectors' no. 511 from Menage Expedition).

Subspecific characters.—"Most like *D. j. multilunatus* of Mindanao in having an all black back, a moderate amount of white streaking in chin, upper throat and side of head; a scant amount of narrow pale edgings on breast feathers, and bill that is mostly black but with some yellowish or black horn in the lower mandible.

"Differs from *D. j. multilunatus* in the shorter bill [*cebuensis*—(3) 46.5 ± 0.64, range 46.0–47.2: *multilunatus*—(22) 54.4 ± 2.77, range 49.0–59.1] and the shorter wing [*cebuensis*—(3) 195.7 ± 2.08, range 194–198: *multilunatus* —(22) 209.9 ± 8.30, range 197–229]." (Rand 1970 ms).

Similar to *D. j. suluensis* of the Sulu Archipelago in most plumage characters including the presence of a concealed white patch in the lower back or rump and in being of equal size (*suluensis*: bill (15) 47.6 ± 1.63, range 44.9–51.7: wing (15) 193.7 ± 5.15, range 186–203). Differs from *suluensis* in having buffy edgings to some of the breast feathers and in having narrow buffy tips (in two of the three specimens) to the outer primaries; some specimens of *suluensis* have, at most, a tiny buffy spot near the tip of one or more primaries.

Dryocopus j. confusus of Luzon differs from *D. j. cebuensis* in being larger (*confusus*: bill (6) 198.7 ± 1.21, range 197–200: bill (6) 51.9 ± 2.36, range 48.0–54.8), in lacking the buffy edgings to the breast feathers, and in having a black bill, a mostly white throat and the black plumage characters a deeper black.

Range.—Known only from Cebu Island, Philippines, where it has not been seen by local and visiting naturalists for several decades.

Etymology.—Rand named this form for the island it inhabited.

Remarks.—"It is interesting that *cebuensis,* most similar to Mindanao *multilunatus* [and to *suluensis*] and less so to Luzon *confusus,* is nearly surrounded by islands of more different forms: the white-backed *philippinus* of Negros, Masbate, etc., and the black-backed birds with heavily patterned throat and breast, *pectoralis* of Samar–Leyte–Bohol." (Rand 1970 ms).

Of the three known specimens of *cebuensis,* one (USNM 357282) is a mounted bird that was previously on display. The red of its malar mark and the top of its head are much duller and darker than the other two specimens. Its bill has been painted, and the tip of one primary, although sooty black, looks as if it may have been buffy at one time, like the outer primaries of the other two specimens. All of these plumage characters seem to have resulted from exposure to light and to soot while it was on display.

In comparisons of *cebuensis* with *suluensis,* I noted that *cebuensis* has a concealed white patch in the lower back; thus, Rand's mention of an all black back is incorrect. However, some specimens of *multilunatus* have a concealed white patch on the back as well. Parkes (1960) mentions one Basilan specimen with some white on the back and I found a concealed white patch on the lower back of at least three Basilan specimens (USNM).

The differences or similarities in plumage characters noted in the description section above are valid for both sexes. Rand did not treat each sex separately presumably because of the few specimens of *D. j. cebuensis* available for comparison.

Specimens examined.—*Dryocopus j. cebuensis*: 2 ♂, 1 ♀ (USNM). *D. j. confusus*: 3 ♂, 3 ♀ (DMNH). *D. j. multilunatus*: Basilan—3 ♂, 2 ♀ (USNM); Dinagat—1 ♂ (DMNH); Mindanao—2 ♂, 2 ♀ (DMNH), 5 ♂, 6 ♀, 1? (USNM). *D. j. suluensis*: 5 ♂, 6 ♀ (DMNH); 3 ♂, 1 ♀ (USNM).

Ficedula hyperythra: Snowy-browed Flycatcher

As noted by Rand (1969 ms), the written history of *F. hyperythra* on Mindanao is short yet more forms (four subspecies including the one described here) of this species inhabit that island than of any other species (except *Phylloscopus trivirgatus*) with a similar range. Such divergence has come about through the isolation of populations of this species in the higher elevations (above 1000 m) of the mountains of Mindanao that have served as habitat islands for the different forms.

The first subspecies discovered was *F. h. montigena* (Mearns 1905) from Mt. Apo, which has since been recorded on nearby Mt. McKinley and on Mt. Katanglad in central Mindanao (Ripley and Rabor 1961), and from the Piagayungan Mts. of Lanao del Sur Province (USNM 580519–580524). It is the only previously described race in the Philippines in which the plumage of the male closely resembles that of the female both in the color of the upperparts and in the rufous colored tail. In 1957, D. Rabor obtained specimens of a second subspecies from Mt. Malindang in the Zamboanga Peninsula that Rand and Rabor (1957) named *F. h. malindangensis.* This form is more closely allied to *F. h. nigrorum* of Negros and shows the sexual dimorphism (including males with gray tails and females with rufous tails) typical of most races of this species.

More recently, J. duPont discovered a third subspecies at Daggayan in Misamis Oriental Province in northern Mindanao, named *F. h. daggayana* by Meyer de Schauensee and duPont (1962). The male of *daggayana* has a dark tail similar to that of *malindangensis* even though the chestnut-tailed *montigena* from Mt. Katanglad and the Piagayungan Mts. occurs between the two populations. A fourth subspecies, a chestnut-tailed form, recognized and named by Rand may be known as:

Ficedula hyperythra matutumensis, new subspecies

Holotype.—FMNH 275254, adult male, 23 Jan 1964, Tucay E-el, Mt. Matutum, 3300 to 3500 ft, Tupi, South Cotabato Province, Mindanao Island, Philippines, D.S. Rabor (collector's no. 39568).

Subspecific characters.—"Like *montigena* in having tail and outer edges of remiges dark red brown in both sexes but differs in having the rufous of the underparts much deeper and more extensive, extending from chin to flanks and undertail coverts; male differs further in having the back more slaty with hardly a trace of olive brown posteriorly. Female differs further in having crown and foreback slaty gray with an olive brown wash on lower back and rump only." (Rand 1969 ms).

Similar to *montigena,* sex for sex, in length of tail and culmen but averages smaller than *montigena,* sex for sex, in wing chord (*matutumensis*—♂ (8) 60.3 ± 0.53, range 59.2–61.0; ♀ (7) 57.1 ± 1.29, range 54.9–58.2: *montigena*—♂ (7) 62.0 ± 1.31, range 60.4–64.5; ♀ (7) 58.8 ± 1.30, range 56.6–60.7) and in tarsus length (*matutumensis*—♂ (8) 17.3 ± 0.24, range 17.0–17.7; ♀ (5) 16.5 ± 0.58, range 15.6–17.0: *montigena*—♂ (6) 18.4 ± 0.26, range 18.1–18.7; ♀ (7) 17.9 ± 0.60, range 17.0–18.7).

"Like *daggayana* with underparts deeply and extensively colored from chin to undertail coverts. Male differing in having tail and edges of wing quills red brown as in female; side of head blacker; with little or no olive brown tinge on lower back; female differing also in having back with little or no olive brown, and in having spot in front of eye and eye ring rusty." (Rand 1970 ms).

Measurements.—Culmen ♂ (8) 13.0 ± 0.26, range 12.5–13.3; ♀ (7) 13.0 ± 0.12, range 12.8–13.1. Tail ♂ (8) 45.0 ± 1.35, range 43.3–47.1; ♀ (7) 40.8 ± 1.18, range 39.8–42.2. See above for other measurements. Weight ♂ (5) 10.1 ± 0.50 g, range 9.7–10.9 g; ♀ (2) 9.33 ± 0.11 g, range 9.25–9.40 g; 1 ♀ with "ripe egg" in the oviduct 12.3 g (collected 21 June 1966).

Range.—Known only from above 1000 m on Mt. Matutum, South Cotabato Province, Mindanao Island, Philippines.

Etymology.—Rand named this form for the mountain it inhabits.

Remarks.—After examining more specimens than Rand had seen, I concluded that the best character distinguishing *matutu-*

mensis from *montigena* is the absence or near absence of the olive brown tinge on the lower back of male *matutumensis* and the restriction of this color in females to the lower back. The more extensive and deeper rufous of the underparts is a general character of *matutumensis* but is shared by some specimens (particularly DMNH 36738 and USNM 580521) of *montigena.*

Differences between males of *matutumensis* and *daggayana* are as Rand described except for the alleged blacker sides of the head, which does not hold for all specimens of *matutumensis.* Females of *matutumensis* do have less olive brown in the back but the spot in front of the eye and the eye ring are rusty in both forms.

Specimens examined.—Ficedula h. daggayana: 1 ♂ (type), 1 ♀ (DMNH). *F. h. matutumensis*: 3 ♂ (AMNH); 3 ♂, 3 ♀ (FMNH); 7 ♂, 5 ♀ (USNM). *F. h. montigena*: 1 ♂; 1 ♀ (AMNH); 3 ♂, 1 ♀ (DMNH); 3 ♂, 3 ♀ (FMNH); 4 ♂, 6 ♀ (USNM).

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THE SUBGENERA OF THE CRAWFISH GENUS *ORCONECTES* (DECAPODA: CAMBARIDAE)

J. F. Fitzpatrick, Jr.

Abstract.—The genus *Orconectes,* the last major cambarid genus to be reevaluated following the major increase in species recognized in recent years, is divided into 10 subgenera. Besides the nominate subgenus, *Faxonius* Ortmann, 1905, is resurrected and the new names *Billecambarus, Buannulifictus, Crockerinus, Gremicambarus, Hespericambarus, Procericambarus, Rhoadesius,* and *Tragulicambarus* proposed. Each is diagnosed and the type species illustrated; six species-groups are recognized in *Crockerinus,* four in *Procericambarus,* and two each in *Buannulifictus, Gremicambarus* and *Hespericambarus,* with *Billecambarus* and *Tragulicambarus* being monotypic. The divisions are justified with a phylogenetic discussion of morphological, geographical, and to a lesser extent, temporal considerations.

In recent years all of the major genera in the Cambaridae, except *Orconectes,* have been reevaluated. The tremendous increase in the number of recognized species has almost mandated that the members of the larger genera be grouped into natural associations at levels lower than genus, assemblages which have been formally recognized as subgenera and/or "Sections." Hobbs (1969) began the current reassessments with a study of *Cambarus* in which he recognized several subgenera, erected the genus *Fallicambarus* for one divergent group of species and recognized the validity of *Hobbseus,* proposed by Fitzpatrick and Payne (1968). Hobbs then turned his attention to *Procambarus* and identified a number of subgeneric groupings within it (1972). *Fallicambarus* likewise was discovered to consist of two subgeneric-level assemblages (Hobbs 1973). Recently, Fitzpatrick proposed subgenera for the monogeneric Cambarellinae (1983). Also recent is a series of events beginning with Hobbs' (1981) discovery of a new group, *Distocambarus,* which was first proposed as a subgenus of *Procambarus,* soon elevated to generic rank (Hobbs and Carlson 1983), and then divided into two subgenera (Hobbs 1983).

Associated with these major revisions, the past two decades have seen miscellaneous reassignments of species groups, principally by the elevation of subgenera to genera (Fitzpatrick 1963, Bouchard 1972). Also a new subgenus was proposed to receive a disjunct species, newly-discovered, and assignable to *Cambarus* (Bouchard and Hobbs 1976), and the similarly erected genus *Bouchardina* Hobbs, 1977, was offered.

For 25 years I have been studying the members of the genus *Orconectes,* second only to *Procambarus* in the number of described species assigned to it. The species have been assembled into "Groups" and the latter into "Sections," but they are essentially the same divisions proposed by Ortmann (1905) and modified by Creaser (1934). The number of species assigned to this genus has nearly doubled since then, but there has been no comprehensive review of the interspecific relationships or an attempt to reorganize the species into groupings which reflect this added knowledge. There are still several taxa which are known to exist but await formal description; likewise uncertain are the precise limits of variation in many species (most recently noted by Cooper and Hobbs 1980:1–2). Only two small groups of the genus have been studied in detail (Fitzpatrick 1967, Hobbs and Barr 1972). Nonetheless, certain clearly related groups seem obvious, and in comparing them some phylogenetic trends are suggested.

The nomenclatorial history of *Orconectes* is relatively straightforward. First proposed for troglobitic animals and established upon characteristics which are essentially adaptations to the spelean environment, the genus was inadequately defined (Cope 1872). Most of the early writers followed Faxon's (1885) lead in rejecting the genus. In 1905, Ortmann offered a scheme of classification for North American (=Cambaridae) crawfishes in which he proposed several subgenera, one of which was *Faxonius* with *Astacus limosus* Rafinesque, 1817, the second species known from North America, the type species. Faxon (1914) vigorously rejected this system, but in the interim Fowler (1912) accepted *Faxonius* as a subgeneric name and designated *Orconectes inermis* Cope, 1872, as the type species of *Orconectes* Cope, 1872. In 1933, Creaser accepted *Faxonius,* elevated it to generic level, and proposed a new subgenus, *Faxonella,* to receive the quite divergent *Cambarus clypeatus* Hay, 1899.

In a major reorganization, Hobbs (1942) argued cogently and persuasively for the recognition of Ortmann's (1905) subgenera, but as genera, with the exceptions that *Faxonius,* as a subjective junior synonym, be replaced by *Orconectes.* Since then *Orconectes* has been accepted according to his definition with one notable exception. Creaser (1962) rejected many of Hobbs' arguments and proposed different generic assignments. Of interest here is only that *Orconectes* (sensu Hobbs) was divided into three equivalent "generic patterns": *Faxonius, Faxonella,* and *Orconectes* (s. s.). To the latter he assigned *Cambarus lancifer* Hagen, 1870, *Orconectes inermis* Cope, 1872, and *Astacus pellucidus* Tellkampf, 1844 "(with subspecies—if they are subspecies)" (1962:3); *Faxonella* contained *Cambarus clypeatus* and, presumably, *Orconectes* (*Faxonella*) *beyeri* Penn, 1950. In general his system was rejected in favor of Hobbs' with the exception that Fitzpatrick's (1963) formal elevation of *Faxonella* to generic status is commonly accepted. No other major changes in nomenclature have been suggested.

The synonymies at most levels in the present paper have been kept to a minimum for brevity's sake. The reader is referred to Hobbs' extensive synonymies (1974b) if more detailed information is required.

Taxonomic Characters in *Orconectes*

As is the case with most crawfishes, certain of the obvious external morphological features, useful for the recognition of species, are readily modified to adapt to the environmental conditions in which the animal lives. Such features are difficult to use in establishing intergroup relationships except in the broadest sense. On the other hand, structures associated with amplexus are less susceptible to environmental modification. In *Orconectes,* however, even these cannot be easily analyzed. For example, in the Propinquus Group, studied in detail by Fitzpatrick (1967), a number of interspecific "hybrids" are reported in the literature (Crocker 1957, Crocker and Barr 1968). But Fitzpatrick (1967) strongly implied that natural hybridization was a rare occurrence. Recently, Capelli and Capelli (1980) and Smith (1981b) reported "hybrids" between species that I propose should be assigned to separate subgenera (!) below.

I have no reason to question the veracity of the reports of any of the workers mentioned above. Yet I remain firmly convinced that no extensive interspecific hybridization occurs in *Orconectes* or any other crawfish genus. It is very difficult to conceive of a species retaining its identity without reproductive isolation. Too many data exist not to believe that there are many, many species of crawfishes in North America. Smith himself (1981b), as he offers an explanation of events leading to the possible origins of his specimens, acknowledges that the occurrence of his apparent hybrids is probably a transient one and related to the quite artificial situation of an introduction of members of an alien population of a previously allopatric species. When such events occur, I would expect responses not unlike the well documented one in *Bufo* (e.g., Blair 1941, Cory and Manion 1955). Possibly the most revealing facts related to hybridization are in the experimental data gathered by Tierney and Dunham (1984) which seem to indicate that inability to recognize a conspecific mate exists principally in species which, because of allopatry, lack a stimulus to develop isolating chemical cues; *naturally* sympatric populations are probably more accurate in mate selection. Berrill (1985) assembled data from laboratory-induced interspecific matings between *O. propinquus* and *O. rusticus,* two species in competition as the latter is expanding its range, which demonstrated that such crossings reduced significantly the reproductive success in both species (or more specifically, from a natural standpoint, in individuals unable to identify their own species), similar indeed to the *Bufo* situation.

Equally, statistics fail to provide clear indication of relationships. Structures associated with amplexus in crawfishes are very variable and extensive overlaps occur in meristic and morphometric data (Fitzpatrick 1967; Chambers et al. 1979, 1980; Tierney 1982). Sometimes sophisticated statistical methodology is overtly misleading. For example, when a local population of *O. propinquus* (Girard) was subjected to discriminant analysis of morphology, it seemed to consist of two distinct morphological groups; pleopod morphology was among the highest discriminant functions (Fitzpatrick and Pickett 1980). Shortly thereafter, Smith (1981a) extended the examination to a larger—geographically and numerically—data base and determined that the proposed separation of forms was not justified.

Despite these difficulties, it is still possible to discern certain morphological associations which enable the recognition of species groups. In first form males, the first pleopods are straight or curved with respect to the long axis of the appendage. One may determine the proportions of the terminal elements with respect to each other and to the appendage as a whole; the elements can range from subsetiform to stout and bladelike. In females, the degree of sculpture of the annulus ventralis can be described in generalities that lead to groupings compatible with those based on pleopod morphology. Although no longer are groupings recognized that are based upon such characters as the areola, the spinose ornamentation of the cephalothorax and the structure of the cheliped, they, too, often exhibit a similarity compatible with groupings based on structures associated with amplexus. Using these, a natural system of classification can be established.

Notes on the *Orconectes* Annulus

The seminal receptacle of the Cambaridae is a potentially very useful tool for the taxonomist. Despite this, it has received little attention. Without the artistic skills of Hobbs, our knowledge would be little advanced beyond the level of the early part of the century (Andrews 1906a, b). Perhaps the most comprehensive collation of annulus morphology is in Hobbs' checklist (1974b), but all of his species descriptions and many of his reviews contain realistic, detailed representations of the structure. Only one study of variation in *any* species has been made: for *O. propinquus* (Tierney 1982); and very few descriptive terms have been established for features of the annulus. Hobbs (1981: 10, fig. 4b) provided a labelled figure and a brief verbal discourse on its anatomy. Fitzpatrick (1983) added some observations especially pertinent to the pendulent annulus as found in the Cambarellinae. To discuss *Orconectes,* however, requires the addition of some terminology.

Hobbs' figure (1981:fig. 4b) is essentially that of a procambarid, not undesirable as most consider that the family arose from a procambaridlike ancestor. But in most *Orconectes* there are prominent tubercular or lobular elevations associated with the cephalolateral surfaces (the *cephalolateral prominences*). These may be united–to varying degrees–along the cephalomedian margin, or they may be separated by a depression of varying development which I propose to call the *trough.* I interpret the *fossa,* as illustrated by Hobbs (1981), to be the fundus of a pit formed by a deep ingression of the *sinus.* In many *Orconectes* there is a conspicuous transverse subovate depression, located caudal to the cephalolateral prominences but cephalic to the higher caudal margins and not traversing the entire width of the annulus. I suggest that this depression be called the *sulcus.* The relationships of the sinus and fossa to this sulcus seem to be significant. One need only to refer to Tierney's (1982) difficulties in the application of the word "groove" to appreciate the need for the introduction of such terminology.

Generic and Subgeneric Diagnoses of *Orconectes*

Family Cambaridae Hobbs, 1942
Subfamily Cambaridae Hobbs, 1942
Genus *Orconectes* Cope, 1872

Diagnosis.—"Antenna never with conspicuous fringe on mesial border. Third maxilliped with teeth on mesial margin of ischium. Mesial margin of palm of chela usually with row of less than 12 tubercles; lateral margin of fixed finger never bearing row of spiniform tubercles; opposable margin of dactyl seldom with prominent excision. Areola broad to obliterated at midlength. Ischium of third, rarely third and fourth, pereiopod with hook. Coxa of fourth pereiopod of male lacking caudomesial boss except in troglobitic members. First pleopod of first form male almost always symmetrical, never deeply withdrawn between bases of pereiopods nor concealed by dense setal mat extending from ventrolateral margins of sternum, and contiguous basally; terminal elements (usually 2, occasionally 3 in troglobitic members) highly variable in length and disposition—divergent, straight, or curved caudodistically or caudally; central projection never abruptly curved caudally at base nor forming arc of more than 90 degrees. Female with annulus ventralis immovable or slightly movable in troglobitic species; first pleopod usually present. Branchial formula 17 + ep." (Hobbs 1974a: 14–15).

Billecambarus, new subgenus
Figs. 1, 14a

Diagnosis.—(Based on first form male and female.) Body and eyes pigmented, latter well developed. Rostrum with small marginal spines, median carina absent. Cervical spines much reduced or absent; areola about 9.5 times longer than wide with 1 or 2 punctations across narrowest part, and constituting about 34–35% of total length of carapace; cephaloventral surface of carapace with small squamous tubercles; devoid of spines or tubercles in hepatic region. First pleopod of male ending in 2 terminal elements, elements short (about 15% total length of pleopod), subparallel, both curved caudodistally from base so that apices directed at angle of nearly 90° to main axis of basal portion of pleopod; mesial process slender; distal fourth of pleopod inclined caudodistally at angle of about 30°; shoulder on cephalic surface of pleopod just proximal to aforementioned inclination not strongly developed or sharply angular. Inner margin of palm of chela about 28.5% of length of outer margin; opposable margins of immovable finger and dactyl with prominent

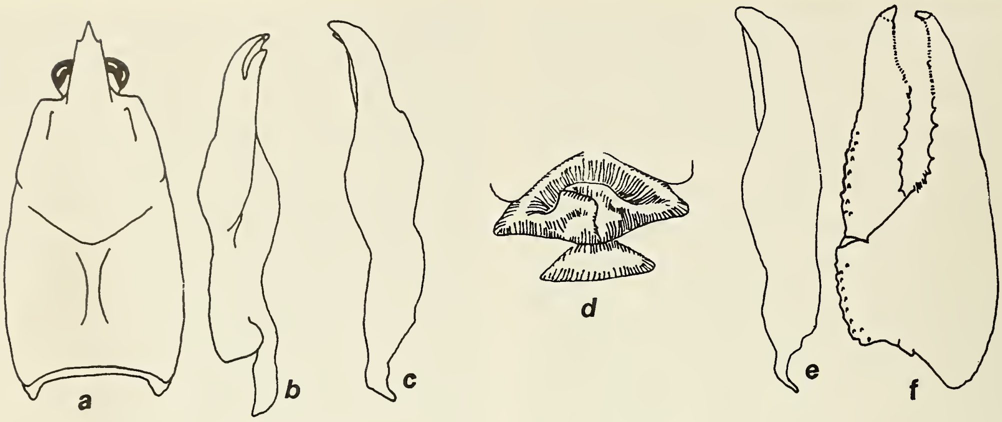

Figure 1

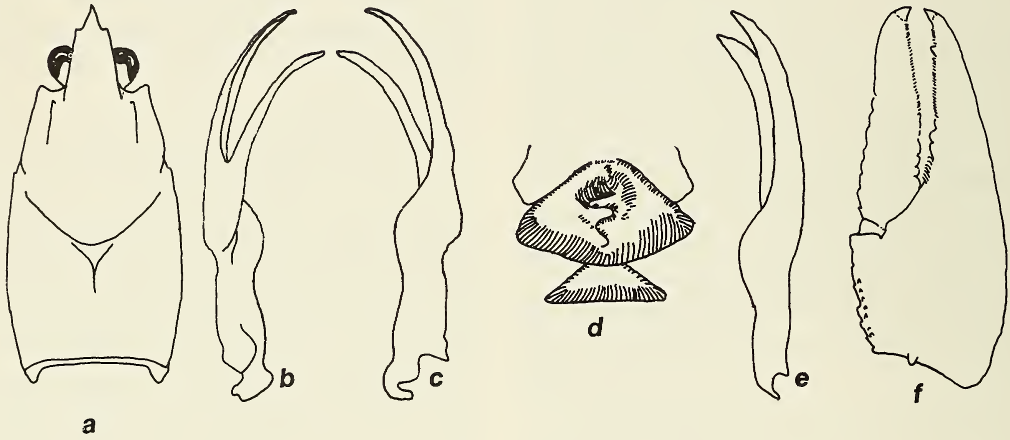

Figure 2

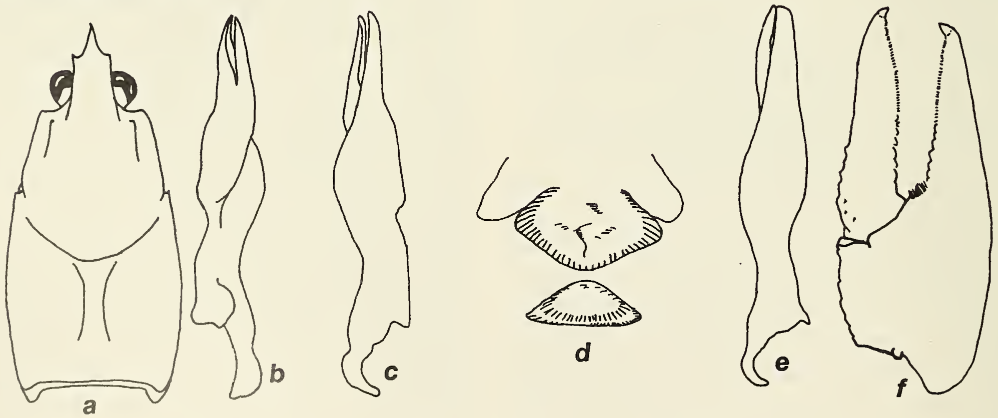

Figure 3

subequal tubercles in basal half; tuft of setae at base of immovable finger, if present, quite weakly developed. Annulus ventralis of female immovable, firmly attached to preceding sclerite, widest near midlength and only slightly more than twice as wide as long; cephalolateral prominences tuberculiform and narrow; sulcus deep and arching through 80% of cephalic half of annulus; fossa not conspicuous with sinus traversing deep depression inclined at angle of about 20° to transverse axis about midpoint of annulus, then turning sharply caudally following shallower depression to caudal margin.

Type species.—*Cambarus Harrisonii* Faxon, 1884:130.

List of species.—Monotypic, *Orconectes* (*Billecambarus*) *harrisonii* (Faxon, 1884: 130).

Gender.—Masculine.

Etymology.—*Bille* (German = axe) plus the generic name, *Cambarus,* because the first pleopod of the male reminds me of a bill-hook used in pruning plants.

Buannulifictus, new subgenus
Figs. 2, 13b

Diagnosis.—(Based on first form male and female.) Body and eyes pigmented, latter well developed. Rostrum with marginal spines, lacking median carina. Cervical spines if present reduced; areola obliterated, linear, or with room for no more than 2 punctations in narrowest part, constituting 31–36% total length of carapace; cephaloventral surface of carapace with small squamous tubercles; devoid of spines or tubercles in hepatic region. First pleopod of male ending in 2 terminal elements of subequal length (except in *O. m. meeki*), moderately long (36–45% total length of pleopod), and both curved caudodistally throughout length (except in *O. m. meeki*), mesial process subsetiform; cephalic margin of pleopod lacking shoulder. Inner margin of hand 28–31% of length of outer margin; opposable margin of immovable finger with prominent (except in *O. palmeri creolanus*), subequal tubercles in basal half; opposable margin of dactyl with prominent (except in *O. p. palmeri, O. p. creolanus,* and *O. hobbsi*), subequal tubercles; tuft of setae at base of immovable finger not well developed but present in most specimens of *O. palmeri* subspp. Annulus ventralis of female immovable, firmly attached to preceding sclerite, widest caudal to midlength and about as wide as long; cephalolateral prominences lobiform and weakly developed in most specimens; sulcus when obvious sharply constricted laterally but obvious central depression always present; trough usually present but not deep or conspicuous; sinus originating in fossa set at acute angle to longitudinal axis of annulus and winding sinuously caudad but lost before reaching caudal margin.

Type species.—*Cambarus Palmeri* Faxon, 1884:124.

List of species.—Palmeri Group (areola linear or obliterated; central projection more than 40% of total length of pleopod):

Orconectes (*Buannulifictus*) *denae* Reimer and Jester, 1975:124.
O. (*B.*) *hobbsi* Penn, 1950:381.
O. (*B.*) *palmeri palmeri* (Faxon, 1884:124).
O. (*B.*) *palmeri creolanus* (Creaser, 1933: 16).

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Figs. 1–3. Type species of *Orconectes* subgenera (all not to same scale): 1, *Orconectes* (*Billecambarus*) *harrisoni*; 2, *O.* (*Buannulifictus*) *palmeri palmeri*; 3, *O.* (*Crockerinus*) *sanbornii sanbornii.* a, Dorsal view of carapace; b, Mesial view of first pleopod of first form male; c, Lateral view of first pleopod of first form male; d, Annulus ventralis of female; e, Lateral view of first pleopod of second form male; f, Dorsal view of chela of first form male.

O. (*B.*) *palmeri longimanus* (Faxon, 1898: 655).

Meeki Group (areola with room for at least one punctation across narrowest part; central projection less than 40% of total length of pleopod):

Orconectes (*Buannulifictus*) *meeki meeki* (Faxon, 1898:657).

O. (*B.*) *meeki brevis* Williams, 1952:348.

Gender.—Masculine.

Etymology.—*Bu*- (L., =large, prefix) + *annulus* (L., =ring) + *fictus* (L., =form), an allusion to the large annulus ventralis characteristic of members of this subgenus.

Crockerinus, new subgenus
Figs. 3, 13a

Description.—(Based on first form male and female.) Body and eyes pigmented, latter well developed. Rostrum with marginal spines, median carina present or absent. Cervical spines usually present and moderately well developed; areola 4–10 times longer than wide with room for more than 2 punctations in narrowest part, constituting 29–36% total length of carapace; cephaloventral surface of carapace with small squamous tubercles, devoid of spines or tubercles in hepatic region. First pleopod of male ending in 2 terminal elements of subequal length or with mesial process slightly shorter, moderately long (29–36% of total length of pleopod), subparallel (except in *O. shoupi*); basal half of both elements subparallel to main axis of pleopod, distal half continuing subparallel to axis or curved caudodistally about 45°; mesial process subsetiform; cephalic margin of pleopod with or without shoulder. Inner margin of hand 29–36% length of outer margin; opposable margins of both fingers with or without prominent tubercles in basal half, tubercles always subequal in size; small tuft of setae at base of immovable finger present or absent. Annulus ventralis of female immovable, firmly attached to preceding sclerite, widest at or slightly cephalic to midlength and 1.6–2.1 times wider than long; cephalolateral prominences lobiform or tuberculiform, moderately or well developed; sulcus varying from shallow and obscure to well developed (not developed in *O. bisectus, O. shoupi,* and *O. tricuspis*); trough present and well developed to absent; fossa when present small but deep (linear in *O. illinoiensis*), located near midpoint of annulus, sinus usually moving sharply laterally and then recurving to near midline before progressing sinuously caudad but lost before reaching caudal margin (except in *O. erichsonianus*).

Type species.—*Cambarus Sanbornii* Faxon, 1884:128.

List of species.—Sanbornii Group (central projection 24–29% total length of pleopod, distal half straight—except extreme tip often arced caudally—and subparallel to mesial process; lacking distinct gap between bases of fingers; opposable margin of fixed finger usually with one tubercle larger than rest; annulus 1.4–1.7 times wider than long, moderately developed cephalolateral prominences oriented at distinct angle to transverse axis, trough obscure, and sinus originating near midpoint of annulus and with distinctly laterally oriented section in anterior half):

Orconectes (*Crockerinus*) *obscurus* (Hagen, 1870:69).

O. (*C.*) *sanbornii sanbornii* (Faxon, 1884: 128).

O. (*C.*) *sanbornii erismophorus* Hobbs and Fitzpatrick, 1962:208.

O. (*C.*) *stannardi* Page, 1985:564.

O. (*C.*) *virginiensis* Hobbs, 1951:122.

Marchandi Group (central projection 28–29% total length of pleopod, distal half straight or curved caudodistally—*marchandi*—and subparallel to mesial process; lacking distinct gap between bases of fingers; opposable margin of fixed finger usually with one tubercle larger than rest; annulus 1.5–1.6 times wider than long, well developed cephalolateral prominences oriented at distinct angle to transverse axis, trough well developed, and sinus originating near midpoint of annulus and lacking distinctly laterally oriented section in anterior half):

Orconectes (*Crockerinus*) *eupunctus* Williams, 1952:330.
O. (*C.*) *marchandi* Hobbs, 1948b:140.

Propinquus Group (central projection 30–35% total length of pleopod, distal half straight—except extreme tip sometimes arced caudally—and subparallel to mesial process; lacking—except in *jeffersoni*—distinct gap between bases of fingers; opposable margin of fixed finger without one tubercle larger than rest; annulus 1.7–1.9 times wider than long, weakly to moderately developed cephalolateral prominences oriented at distinct angle to transverse axis, trough weakly or only moderately developed, and sinus originating near to or just lateral to midpoint of annulus and distinctly laterally oriented section in anterior half):

Orconectes (*Crockerinus*) *erichsonianus* (Faxon, 1898:659).
O. (*C.*) *jeffersoni* Rhoades, 1944:123.
O. (*C.*) *propinquus* (Girard, 1852:88).

Rafinesquei Group (central projection 21–29% total length of pleopod, distal half straight—except extreme tip often arced caudally—and subparallel to mesial process; lacking distinct gap between bases of fingers; opposable margin of fixed finger with or without one tubercle larger than rest; annulus 1.6–1.8 times wider than long, cephalolateral prominences lobiform or broadly tuberculiform and always well developed, oriented—often as much as 90°—at distinct angle to transverse axis, trough distinct and usually moderately deep, and sinus may or may not originate in deep fossa near or slightly lateral to midpoint of annulus before following undulant longitudinal route not quite to caudal margin, sinus with—except in *bisectus*—distinctly laterally oriented section in anterior half):

Orconectes (*Crockerinus*) *bisectus* Rhoades, 1944:129.
O. (*C.*) *illinoiensis* Brown, 1956:163.
O. (*C.*) *rafinesquei* Rhoades, 1944:116.
O. (*C.*) *tricuspis* Rhoades, 1944:117.

Shoupi Group (central projection about 21% total length of pleopod, straight, subparallel to mesial process in basal half but distal half of latter curved caudodistally at angle of about 45° and not subsetiform; distinct gap between bases of finger about as wide as width of base of dactyl; opposable margin of fixed finger without one tubercle larger than rest; annulus about 2.4 times wider than long, well developed tuberculiform cephalolateral prominences oriented subparallel to transverse axis and occupying much of cephalic half of annulus, trough narrow but distinct, sinus originating on midline in cephalic third of annulus, arcing caudolaterally to point caudolateral to middle of annulus, recurving to midpoint before turning sharply caudadally to proceed in substraight line almost to caudal margin):

Orconectes (*Crockerinus*) *shoupi* Hobbs, 1948a:14.

Gender.—Masculine.

Etymology.—Named in honor of Denton W. Crocker in recognition of his lifelong study of many of the species assigned to this subgenus.

Subgenus *Faxonius* Ortmann, 1905:97
Figs. 4, 15a

Faxonius (subgeneric name): Ortmann, 1905 (part).—Fowler, 1912 (part).
Faxonius (generic name): Creaser, 1933 (part); 1962 (part).
[For a fuller synonymy and explanation see Hobbs 1942:339, 350–352; 1974a:14; 1974b:26.]

Diagnosis.—(Based on first form male and female.) Body and eyes pigmented, latter well developed. Rostrum with marginal spines, median carina absent. Cervical spines well developed (except in *O. indi-*

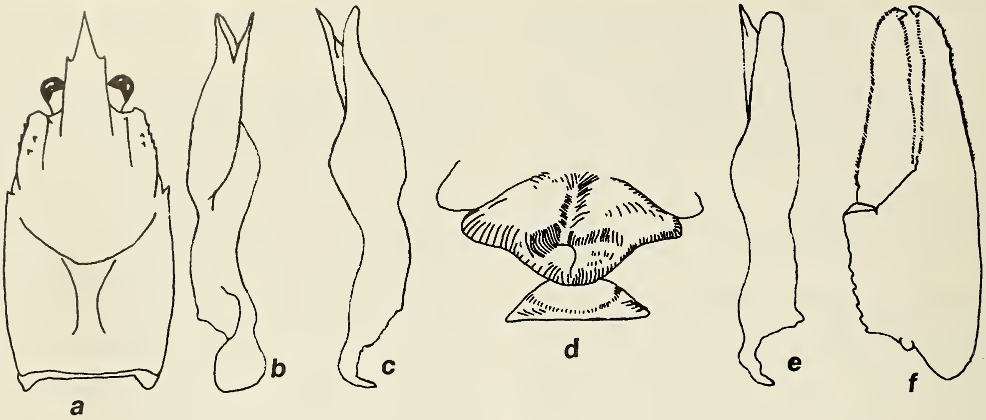

Figure 4

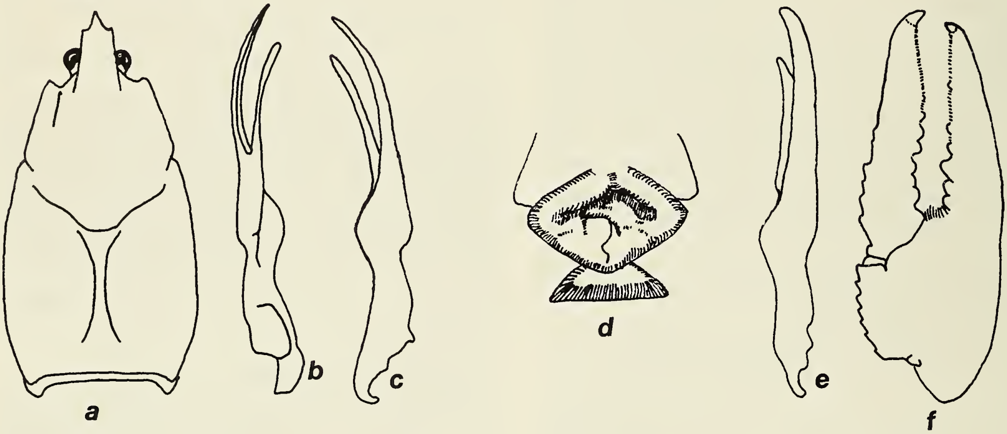

Figure 5

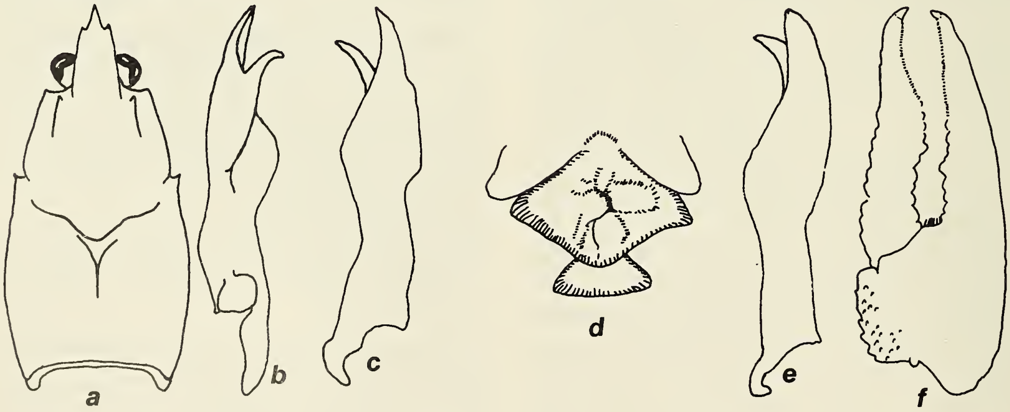

Figure 6

anensis); areola 6.0–8.0 times longer than wide with room for more than 2 punctations in narrowest part, and constituting 31–33% total length of carapace; cephaloventral surface of carapace with small squamous or spinose tubercles, hepatic region with (in *O. limosus*) or without spines. First pleopod of male ending in 2 terminal elements of subequal length, short (less than 20% total length of pleopod), straight but divergent at angle of about 20°, neither (except central projection in *O. wrighti*) subparallel to main axis of pleopod; mesial process slender and tapering apically but not subsetiform; distal half of pleopod (except in *O. wrighti*) slightly inclined caudodistally; cephalic margin of pleopod lacking shoulder. Inner margin of hand 33–40% length of outer margin; opposable margins of fingers lacking prominent tubercles in basal half, setose margins obscuring small tubercles; tuft of setae at base of immovable finger lacking. Annulus ventralis of female immovable, firmly attached to preceding sclerite, widest near midlength and 1.9–2.1 times wider than long; cephalolateral prominences tuberculiform and well developed, occupying much of cephalolateral half of annulus; sulcus arising lateral to midline of annulus then moving to it before turning sharply caudally forming only very slightly undulant line disappearing before reaching caudal margin.

Type species.—Astacus limosus Rafinesque, 1817:42. Designated by Ortmann 1905: 97.

List of species.—

Orconectes (*Faxonius*) *indianensis* (Hay, 1896:494).
O. (*F.*) *limosus* (Rafinesque, 1817:42).
O. (*F.*) *wrighti* Hobbs, 1948c:85.

Gremicambarus, new subgenus
Figs. 5, 12

Diagnosis.—(Based on first form male and female.) Body and eyes pigmented, latter well developed. Rostrum with or without marginal spines, median carina absent (except in *O. alabamensis*). Cervical spines much reduced, absent, or only moderately well developed; areola obliterated, linear or to 3.5 times longer than wide with room for more than 2 punctations in narrowest part of wider areolae, constituting 25–40% total length of carapace; cephaloventral surface of carapace with small squamous tubercles; devoid of spines and tubercles in hepatic region. First pleopod of male ending in 2 terminal elements, elements moderately long to long (20–40% total length of pleopod), subparallel or divergent with central projection subparallel to main axis of pleopod through at least 90% length or curved caudodistally or inclined caudodistally; elements subequal in length with mesial process tapering evenly from base to tip or deflected sharply caudodistally (to 90°) in apical 15% with distal part subspatulate and cephalically excavated; cephalic surface of pleopod lacking shoulder. Inner margin of hand 25–43% length of outer margin; opposable margin of immovable finger with or without (*O. alabamensis, O. compressus, O. rhoadesi*) row of prominent tubercles in basal half and if present one markedly larger than rest; opposable margin of dactyl also with tubercles likewise disposed except one never markedly larger than rest; tuft of setae of varying degree of development present at base of immovable finger (except in *O. compressus* and *O. mississippiensis*). Annulus ventralis of female immovable, firmly attached to preceding sclerite, widest near

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Figs. 4–6. Type species of *Orconectes* subgenera (all not to same scale): 4, *Orconectes* (*Faxonius*) *limosus*; 5, *O.* (*Gremicambarus*) *virilis*; 6, *O.* (*Hespericambarus*) *difficilis*. a, Dorsal view of carapace; b, Mesial view of first pleopod of first form male; c, Lateral view of first pleopod of first form male; d, Annulus ventralis of female; e, Lateral view of first pleopod of second form male; f, Dorsal view of chela of first form male.

midlength (except caudal to midlength in *O. alabamensis*) and (except in *O. alabamensis* and *O. immunis*) length and width subequal; cephalolateral prominences well developed and occupying most of width of annulus; trough of varying width and depth but always clearly evident; sulcus deep, usually partially overhung along some of its width by caudal parts of cephalolateral prominences; fossa deep although sometimes obscured by overhang of cephalolateral prominences with sinus originating lateral to midline in cephalic half of annulus and moving transversely across midline where making U-shaped turn to midline and thence caudad for varying distance but never so far as caudal margin of annulus.

Type species.—*Cambarus virilis* Hagen, 1870:63.

List of species.—Virilis Group (central projection greater than 35% total length of pleopod and reaching coxa of first pleopod; mesial process subsetiform or tapering base to tip; caudal margin of annulus somewhat angular):

Orconectes (*Gremicambarus*) *causeyi* Jester, 1967:518.
O. (*G.*) *nais* (Faxon, 1885:140).
O. (*G.*) *virilis* (Hagen, 1870:63).

Alabamensis Group (central projection less than 35% total length of pleopod and reaching no farther anteriorly than coxa of second pleopod; mesial process apically subspatulate; caudal margin of annulus generally rounded):

Orconectes (*Gremicambarus*) *alabamensis* (Faxon, 1884:125).
O. (*G.*) *chickasawae* Cooper and Hobbs, 1980:29.
O. (*G.*) *compressus* (Faxon, 1884:127).
O. (*G.*) *cooperi* Cooper and Hobbs, 1980:17.
O. (*G.*) *etnieri* Bouchard and Bouchard, 1976b:459.
O. (*G.*) *holti* Cooper and Hobbs, 1980:23.
O. (*G.*) *immunis* (Hagen, 1970:71).
O. (*G.*) *mississippiensis* (Faxon, 1884:123).
O. (*G.*) *rhoadesi* Hobbs, 1949:19.
O. (*G.*) *validus* (Faxon, 1914:382).

Gender.—Masculine.

Etymology.—*Gremius* (Latin = middle, center) in combination with the generic name, *Cambarus,* an allusion to the dominance of this subgenus in the central part of North America.

Hespericambarus, new subgenus
Figs. 6, 16a

Diagnosis.—(Based on first form male and female.) Body and eyes pigmented, latter well developed. Rostrum with marginal spines, median carina absent. Cervical spines well developed; areola obliterated and constituting 31–33% total length of carapace; cephaloventral surface of carapace with small squamous tubercles; devoid of spines or tubercles in hepatic region (except small spines in *O. blacki*). First pleopod of male terminating in 2 elements, elements short (less than 20% total length of pleopod) and unequal in length (except in *O. blacki* and *O. maletae*), apices divergent with longer central projection subparallel to main axis of pleopod or deflected caudodistally to angle of 45°, mesial process deflected 30–90°; shoulder present on cephalic surface of pleopod only in *O. difficilis.* Inner margin of hand 24–31% length of outer margin; opposable margins of immovable finger and dactyl with prominent subequal tubercles in basal half (*O. difficilis* with one, centrally located, larger than rest on both fingers); tuft of setae small but obvious at base of immovable finger. Annulus ventralis of female immovable, firmly attached to preceding sclerite, widest at midlength or nearly so, about as wide as long; cephalolateral prominences lobiform or obscure with poorly defined trough visible only in *O. difficilis* and *O. hathawayi*; sulcus-like structure evident only in *O. maletae* and there caused by single cephalomedian prominence; fossa if present poorly defined and sinus describing simple undulant line in caudal half of annulus but not reaching caudal margin.

Type species.—*Cambarus difficilis* Faxon, 1898:656.

List of species.—Difficilis Group (mesial process sharply recurved and approaching subsetiform; central projection slender; anterior portion of sinus of annulus deeply incised):

Orconectes (*Hespericambarus*) *difficilis* (Faxon, 1898:656).
O. (*H.*) *maletae* Walls, 1972:456.

Hathawayi Group (mesial process broad and tapering from base to tip, not recurved more than 45°; central projection laterally compressed; sinus of annulus shallowly incised):

Orconectes (*Hespericambarus*) *blacki* Walls, 1972:454.
O. (*H.*) *hathawayi* Penn, 1952:1.
O. (*H.*) *perfectus* Walls, 1972:451.

Gender.—Masculine.

Etymology.—*Hesperius* (Latin = western) in combination with the generic name, *Cambarus,* referring to the generally western distribution of the members of this subgenus.

Subgenus *Orconectes* Cope, 1872:419
Figs. 7, 8, 16b

Orconectes: Cope, 1872.—Fowler, 1912.—Hobbs, 1942.—Creaser, 1962 (part).
Faxonius: Ortmann, 1905 (part) (subgeneric name).—Creaser, 1933 (part) (subgeneric name).
[For a fuller synonymy and explanation see Hobbs 1942:339, 350–352; 1974a:14; 1974b:26.]

Diagnosis.—(Based on first form male and female.) Albinistic; eyes reduced and without pigment. Rostrum with or without marginal spines; median carina absent. Cervical spines well developed to scarcely observable; areola 3.5–6.5 times longer than wide with room for more than 2 punctations across narrowest part, constituting 34–46% total length of carapace; cephaloventral surface of carapace usually with small spinose or squamous tubercles; hepatic region usually (except in *O. inermis testii*) with one to many spines of varying degrees of development. First pleopod of male ending in 2 or 3 very short (less than 10% total length of pleopod) terminal elements, caudal process if present always small and often vestigal; mesial process tapering from base to tip, divergent distally and usually subequal in length to central projection (but in *O. pellucidus* mesial process at least twice as long as central projection); central projection more or less subparallel to main axis of pleopod; rounded shoulder (often angular but always small in *O. australis packardi*) present in *O. australis* subspp. and *O. incomptus* but absent in *O. inermis* subspp. and *O. pellucidus.* Inner margin of hand 37–39% length of outer margin; opposable margin of immovable finger with at least one small tubercle in basal half, usually more and (except in some specimens of *O. pellucidus*) with one larger than rest; opposable margin of dactyl with 3–5 small tubercles in basal half but only *O. australis* subspp. with one larger than rest. Annulus ventralis of female slightly movable, always separated from preceding sclerite by nonsclerotized cuticle, widest at or slightly cephalic to midlength or with measurements subequal; cephalolateral prominences in strict sense absent but prominent longitudinal ridges along midline occupying cephalic two-thirds or more of annulus; ridges usually separated by narrow shallow median groove probably representing trough; sometimes shallow transverse depression associated with caudal margins of aforementioned ridges perhaps representing rudimentary sinus; fossa if present poorly developed and sinus usually arising anterior to it in caudal fourth of

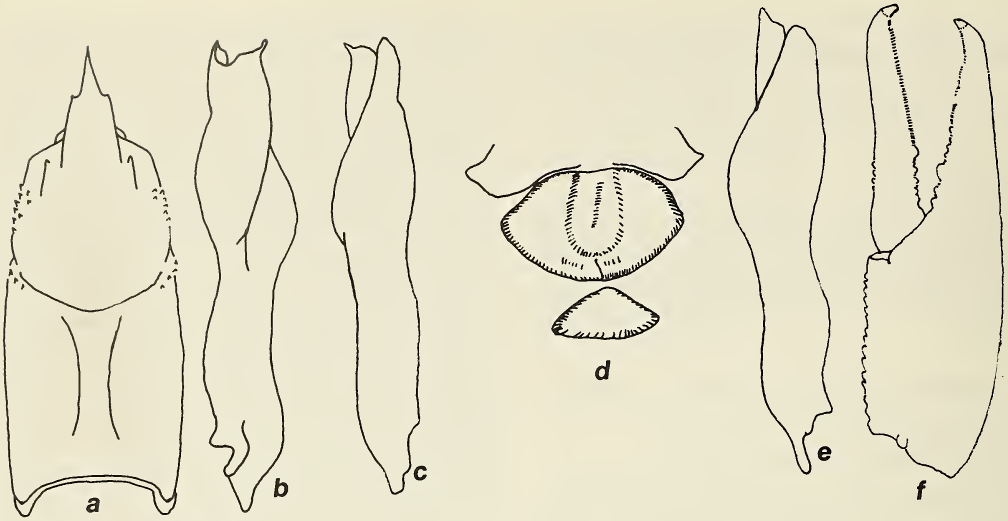

Figure 7

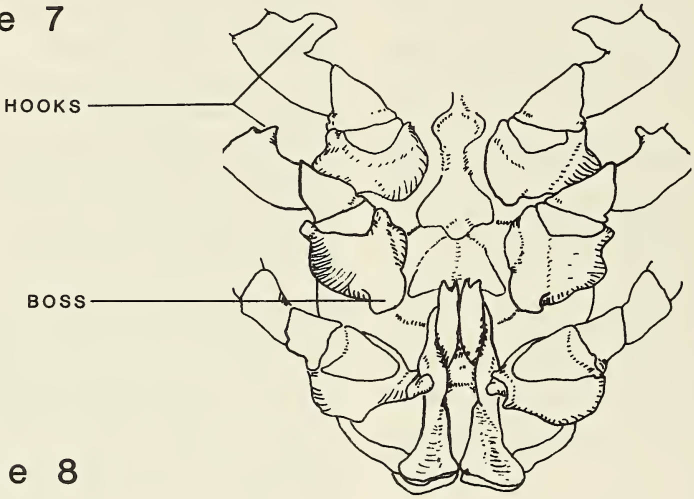

Figure 8

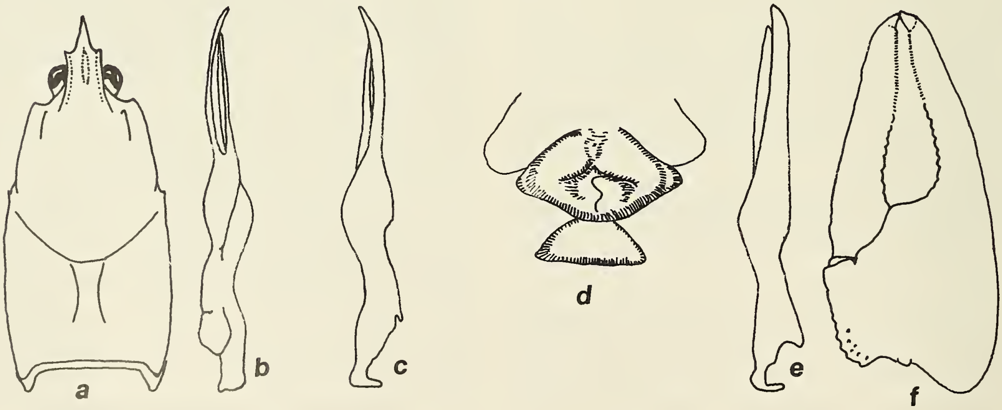

Figure 9

annulus near midline and arcing gently to or nearly to caudal margin.

Type species.—*Orconectes inermis* Cope, 1872:449; designated by Fowler 1912:339 as type-species of the genus *Orconectes*.

List of species.—

Orconectes (*Orconectes*) *australis australis* (Rhodes, 1941:142).

O. (*O.*) *australis packardi* Rhoades, 1944: 121.

O. (*O.*) *incomptus* Hobbs and Barr, 1972: 32.

O. (*O.*) *inermis inermis* Cope, 1872:449.

O. (*O.*) *inermis testii* (Hay, 1891:148).

O. (*O.*) *pellucidus* (Tellkampf, 1844:684).

Procericambarus, new subgenus
Figs. 9, 17

Diagnosis.—(Based on first form male and female.) Body and eyes pigmented, latter well developed. Rostrum with marginal spines or distinctly angular cephalic termini of margins so that bases of acumen clearly delimited; median carina present or absent. Cervical spines present and well developed to scarcely observable; areola 4.5–17.5 times longer than wide with room for at least 2 and usually more punctations across narrowest part, and constituting 29–37% total length of carapace; cephaloventral surface of carapace with small squamous tubercles; devoid of spines or tubercles in hepatic region. First pleopod of male ending in 2 terminal elements, elements long (34–55% total length of pleopod) and of subequal length or with central projection 10–20% longer than mesial process, subparallel or very slightly divergent (artifactual divergence in preserved specimens not uncommon); central projection subsetiform, straight and subparallel to main axis of pleopod or gently arced, apical 5–10% curved sharply caudodistally or distally so that apex directed nearly 90° to main axis of basal part of pleopod; mesial process subsetiform and apex rounded distally (except subspatulate and cephalically excavated in *O. nana* and *O. macrus*), usually subparallel to main axis of pleopod for most of length but distal 10–20% often arced cephalodistally; cephalic surface of pleopod with or without prominent sharply angled shoulder just proximal to base of central projection. Inner margin of hand 24–38% length of outer margin; opposable margin of immovable finger with prominent tubercles in basal half (except in *O. forceps* and *O. mirus*), only rarely (in *O. longidigitus* and *O. williamsi*) with one larger than remainder; opposable margin of dactyl with small or low scale-like tubercles (except prominent in *O. longidigitus, O. ozarkae,* and *O. williamsi,* and unequal in size), all subequal in size; tuft of setae if present at base of immovable finger poorly developed, prominent only in *O. ozarkae.* Annulus ventralis of female immovable, firmly attached to preceding sclerite, widest near midlength and distinctly wider than long if caudal overhang present in some species not considered; cephalolateral prominences large and lobiform (except reduced to low ridges in *O. quadruncus*); trough distinct and usually deep (except in *O. ozarkae, O. quadruncus* and some specimens of *O. longidigitus*); sulcus deep and obvious (shallow but usually distinct in *O. quadruncus*), cephalic parts often obscured by overhang of cephalolateral prominences; sinus arising in distinct deep fossa (fossa sometimes obscured by overhanging ceph-

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Figs. 7–9. Type species of *Orconectes* subgenera (all not to same scale): 7 and 8, *Orconectes* (*Orconectes*) *inermis inermis*; 8, ventral view of posterior thorax of first form male (redrawn from Hobbs and Barr 1972); 9, *O.* (*Procericambarus*) *forceps*. a, Dorsal view of carapace; b, Mesial view of first pleopod of first form male; c, Lateral view of first pleopod of first form male; d, Annulus ventralis of female; e, Lateral view of first pleopod of second form male; f, Dorsal view of chela of first form male.

alolateral prominences) in cephalic part of sulcus, curving sharply laterad, executing U-turn at midline, then extending sinuously caudad to disappear before reaching caudal margin.

Type species.—*Cambarus forceps* Faxon, 1884:133.

List of species.—Forceps Group (terminal elements of pleopod of unequal length, central projection 34–40% total length of pleopod, both elements subsetiform; cephalic shoulder present or absent; annulus about twice as wide as long, caudal margin rounded—except in *O. neglectus chaenodactylus*—and with overhanging cephalolateral prominences creating large sulcal cavity):

Orconectes (*Procericambarus*) *barrenensis* Rhoades, 1944:125.
O. (*P.*) *forceps* (Faxon, 1884:133).
O. (*P.*) *longidigitus* (Faxon, 1898:653).
O. (*P.*) *mirus* (Ortmann, 1931:81).
O. (*P.*) *neglectus neglectus* (Faxon, 1885: 142).
O. (*P.*) *neglectus chaenodactylus* Williams, 1952:344.
O. (*P.*) *placidus* (Hagen, 1870:65).
O. (*P.*) *rusticus* (Girard, 1852:88).

Hylas Group (terminal elements of pleopod of markedly unequal length, central projection 48–52% total length of pleopod and subsetiform, mesial process subsetiform or apex bluntly rounded or apex expanded and cephalically excavate; cephalic shoulder present; annulus about as long as wide or slightly longer than wide and with caudal margin produced into tongue-like projection which overhangs following sclerite);

Orconectes (*Procericambarus*) *acares* Fitzpatrick, 1965:87.
O. (*P.*) *hylas* (Faxon, 1890:632).
O. (*P.*) *leptogonopodus* Hobbs, 1948b:146.
O. (*P.*) *peruncus* (Creaser, 1931:7).
O. (*P.*) *punctimanus* (Creaser, 1933:1).

Quadruncus Group (terminal elements of pleopod subequal in length, central projection about 33% total length of pleopod and tapering from base to tip, mesial process spatulate and excavated cephalically in distal third with small spinose projection in distal fourth of caudal margin, both elements inclined caudally in distal half; cephalic shoulder absent; annulus about as wide as long with caudal margin projected into tongue-like protrusion which overhangs following sclerite, cephalolateral prominences and sulcus weakly developed):

Orconectes (*Procericambarus*) *quadruncus* (Creaser, 1933:10).

Spinosus Group (terminal elements of pleopod of unequal length, central projection 40–48% total length of pleopod, both elements subsetiform; cephalic shoulder present—absent only in *O. williamsi*; annulus at least as long as wide, caudal margin rounded and if projected only slightly overhanging following sclerite):

Orconectes (*Procericambarus*) *luteus* (Creaser, 1933:7).
O. (*P.*) *macrus* Williams, 1952:337.
O. (*P.*) *medius* (Faxon, 1884:121).
O. (*P.*) *menae* (Creaser, 1933:5).
O. (*P.*) *nana* Williams, 1952:333.
O. (*P.*) *ozarkae* Williams, 1952:339.
O. (*P.*) *putnami* (Faxon, 1884:131).
O. (*P.*) *saxatilis* Bouchard and Bouchard, 1976a:439.
O. (*P.*) *spinosus* (Bundy, 1877:175).
O. (*P.*) *transfuga* Fitzpatrick, 1966a.
O. (*P.*) *williamsi* Fitzpatrick, 1966b.

Gender.—Masculine.

Etymology.—*Procerus* (Latin = tall, thin) combined with the generic name, *Cambarus,* an allusion to the long, thin terminal elements characteristic of most members of this subgenus.

Rhoadesius, new subgenus

Figs. 10, 14b

Diagnosis.—(Based on first form male and female.) Body and eyes pigmented, latter well developed. Rostrum with marginal

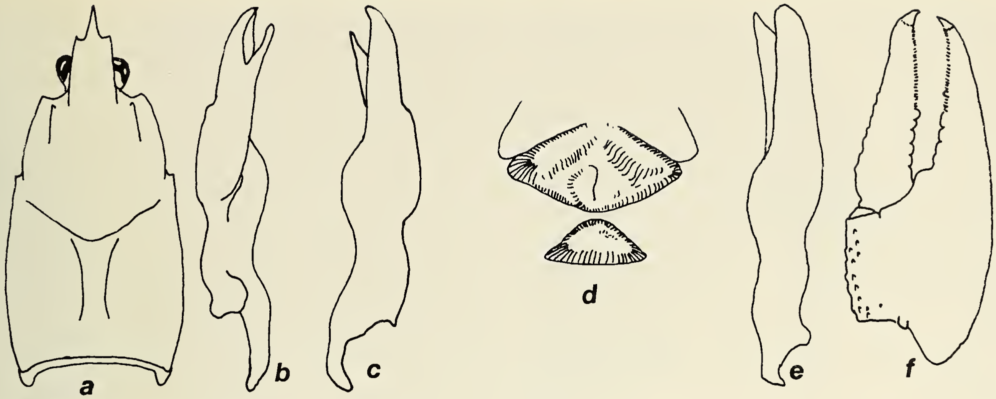


Figure 10

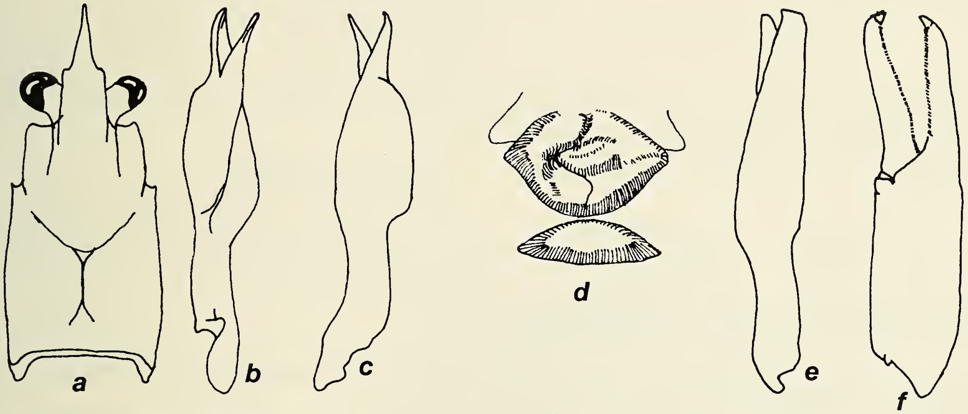


Figure 11

Figs. 10, 11. Type species of *Orconectes* subgenera (all not to same scale): 10, *Orconectes* (*Rhoadesius*) *sloanii*; 11, *O.* (*Tragulicambarus*) *lancifer.* a, Dorsal view of carapace; b, Mesial view of first pleopod of first form male; c, Lateral view of first pleopod of first form male; d, Annulus ventralis of female; e, Lateral view of first pleopod of second form male; f, Dorsal view of chela of first form male.

spines, median carina absent. Cervical spines well developed; areola 5.5–6.5 times longer than wide with 3–4 punctations across narrowest part, and constituting 32–34% total length of carapace; cephaloventral surface of carapace with small squamous tubercles; devoid of spines or tubercles in hepatic region. First pleopod of male ending in 2 short (less than 18% total length of pleopod) terminal elements of unequal length, elements subparallel (*O. sloanii*) or divergent (*O. kentuckiensis*), mesial process stout and tapering from base to tip; distal half of pleopod inclined caudodistally at angle of about 30° to main axis of basal portion; cephalic surface of pleopod with (*O. sloanii*) or without (*O. kentuckiensis*) shoulder. Inner margin of hand about 29% length of outer margin; opposable margin of immovable finger and dactyl with (*O. sloanii*) or without (*O. kentuckiensis*) prominent tubercles, never with one more strongly developed than others; tuft of setae at base of immovable finger, if present, never well developed. Annulus ventralis of female immovable, firmly attached to preceding sclerite; widest near midlength; cephalolateral prominences developed only in *O. sloanii* and trough not always clearly demonstrated; sulcus usually present but often not well defined; sinus arising near midpoint of annulus, in well defined fossa only in *O. kentuckiensis,* and following simple undulating path to be lost before reaching caudal margin.

Type species.—*Cambarus sloanii* Bundy, 1876:24.

List of species.—

Orconectes (*Rhoadesius*) *kentuckiensis* Rhoades, 1944:122.
O. (*R.*) *sloanii* (Bundy, 1876:24).

Gender.—Masculine.

Etymology.—Named in honor of the late Rendell Rhoades in recognition of his contributions to our knowledge of crawfishes.

Tragulicambarus, new subgenus
Figs. 11, 15b

Orconectes: Creaser, 1962:3 (part), 6 (Fig. 15), 7 (part).

Diagnosis.—Based on first form male and female.) Body and eyes pigmented, latter well developed. Rostrum lacking marginal spines but with sharply angular shoulders delimiting base of very long (about 50% of total length of rostrum) acumen, median carina absent. Cervical spines well developed; areola obliterated and constituting about 31% total length of carapace; cephalolateral surface of carapace with small squamous tubercles; devoid of spines or tubercles in hepatic region. First pleopod of male ending in 2 short (about 18% of total length of pleopod) terminal elements of subequal length; central projection subparallel to main axis of pleopod and laterally compressed into blade-like structure; mesial process stout, tapering from base to tip and divergent from central projection throughout length; cephalic surface of pleopod with well defined shoulder near base of central projection. Inner margin of hand about 45% length of outer margin; opposable margin of immovable finger and of dactyl without prominent tubercles; margins of fingers setose but tuft of setae at base of immovable finger lacking. Annulus ventralis of female immovable, firmly attached to preceding sclerite; widest near midlength and about as long as wide; cephalolateral prominences well developed and separated by well defined trough; sulcus deep but only unilaterally developed; sinus arising in distinct fossa in sulcus and lateral to midline of annulus, moving caudomesially in gentle arc to midline, there turning caudally to traverse slightly undulant path to intersect caudal margin.

Type species.—*Cambarus lancifer* Hagen, 1870:59.

List of species.—Monotypic, *Orconectes* (*Tragulicambarus*) *lancifer* (Hagen, 1870:59).

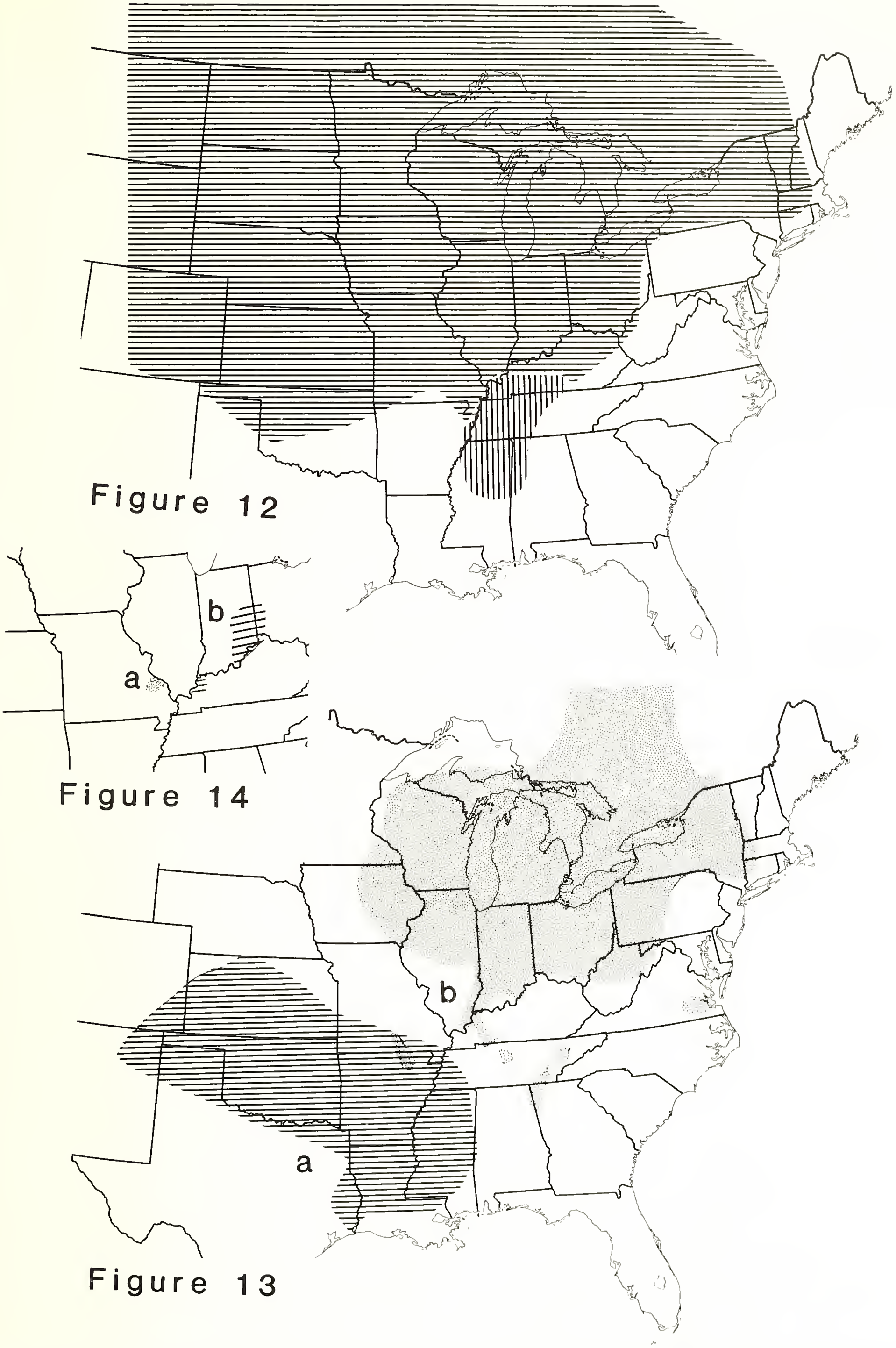
Gender.—Masculine.

Etymology.—*Tragula* (Latin = a javelin) combined with the generic name, *Cambarus,* a reference to the trivial name of the only species.

Phylogenetic Considerations
Fig. 18

As outlined above, the similarities of taxonomic characters in *Orconectes* make it difficult to apply cladistic techniques rigidly when considering phylogeny. Nevertheless, one can make some outgroup and ingroup comparisons to identify probable apomorphies and plesiomorphies. The latter comparisons are sometimes confusing, because ecological channelization has led to convergent emergences of certain characteristics.

Perhaps the clearest plesiomorphy is multiple terminal elements. Hobbs has convincingly argued for a procambarid-like ancestor for the family Cambaridae (1958, 1967, 1969, 1976, 1981; Hobbs and Barr 1960, 1972). Implicit in these discussions is an ancestral pleopod of four elements, from which certain lineages can be shown



Figs. 12–14. Distribution of *Orconectes* subgenera: 12, Subgenus *Gremicambarus* (horizontal rulings = contribution of *virilis-nais* complex; vertical rulings = other species of the subgenus); 13, Subgenera *Buannulifictus* and *Crockerinus* (a, horizontal rulings = *Buannulifictus*; b, stippling = *Crockerinus*); 14, Subgenera *Billecambarus* and *Rhoadesius* (a, stippling = *Billecambarus*; b, horizontal rulings = *Rhoadesius*).

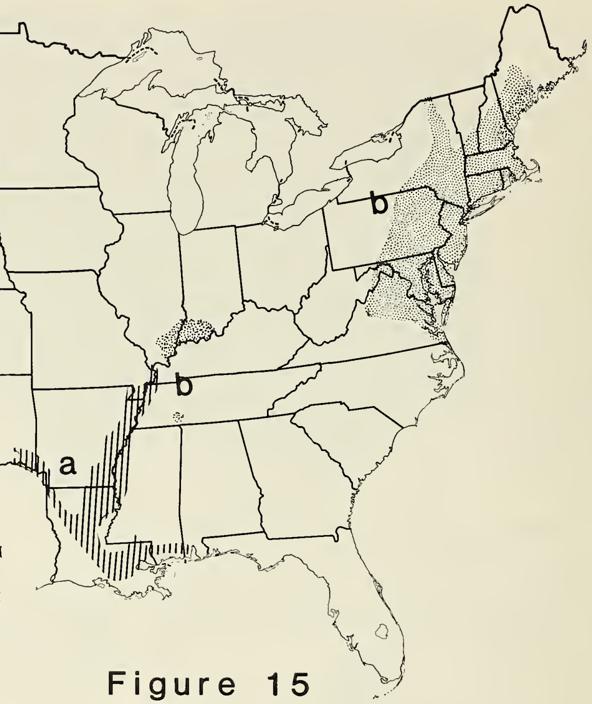


Figure 15

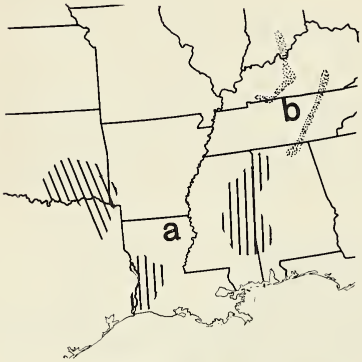


Figure 16

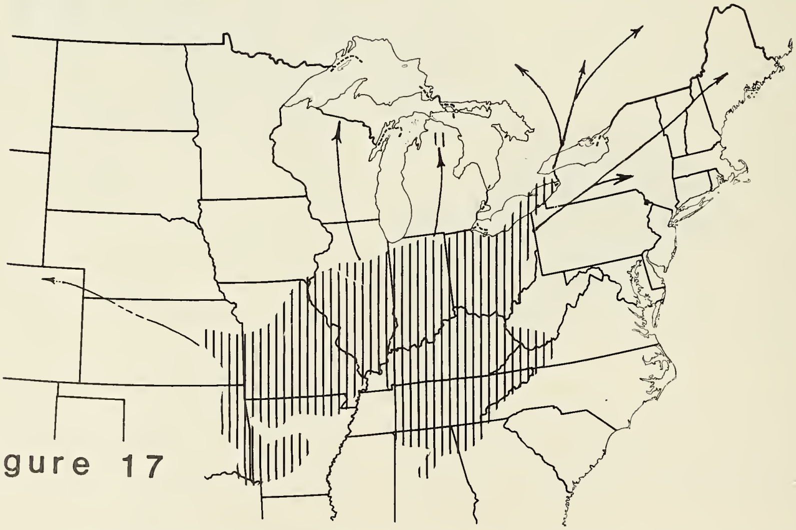


Figure 17

Figs. 15–17. Distribution of *Orconectes* subgenera: 15, Subgenera *Faxonius* and *Tragulicambarus* (a, vertical rulings = *Tragulicambarus*; b, stippling = *Faxonius*); 16, Subgenera *Hespericambarus* and *Orconectes* (a, vertical rulings = *Hespericambarus*; b, stippling = *Orconectes*); 17, Subgenus *Procericambarus* (arrows represent probable or actual introductions where large populations have been established, probably at the expense of native species).

to lose specific elements. Also, in general, these elements are fundamentally short in the plesiomorphic state.

Identification of the first clade.—The retention of short (comparatively) terminal elements by members of the subgenus *Orconectes* is the more primitive form. This conclusion is reinforced by the presence of a third element (the caudal process) in *O.* (*O.*) *australis australis* and in *O.* (*O.*) *incomptus* and the occasional presence of a vestigial caudal process in *O.* (*O.*) *australis packardi* (in some specimens even a vestigial cephalic process can be recognized: Hobbs and Barr 1972:31, fig. 8c, d). Hooks (sometimes rudimentary) on the fourth pereiopods of specimens of *O.* (*O.*) *australis* subspp., *O.* (*O.*) *inermis* subspp., and *O.* (*O.*) *pellucidus* further serve to place the subgenus close to the stem population from which the genus descended. (Only in rare specimens of other subgenera of *Orconectes* are hooks found on pereiopods other than the third.)

Other features attributed to the procambarid ancestor also present in the nominate subgenus include spinose ornamentation of the hepatic region of the carapace and along the cephalic part of the cervical groove, a short broad areola, and a movable (albeit slightly) annulus ventralis in the females. Equally significant is the presence of these apparently most primitive members of the genus in a geographical area which Hobbs (most recently, 1984) considers the center of diversity for the Cambaridae; members of the subgenus are troglobites in the karst along the southeastern edge of the Cumberland Plateau. Thus, by outgroup comparisons one is able to establish reasonably reliable plesiomorphic character states for the genus, identify the group retaining the greatest number of plesiomorphic states, and postulate probable lineages through which the several subgenera were established. Unfortunately, of these, only the terminal elements of the male pleopod and the annulus ventralis of the female are not subject to influence by the habitat. And the most striking feature of the annulus in the subgenus *Orconectes,* its motility, is lost in all other subgenera.

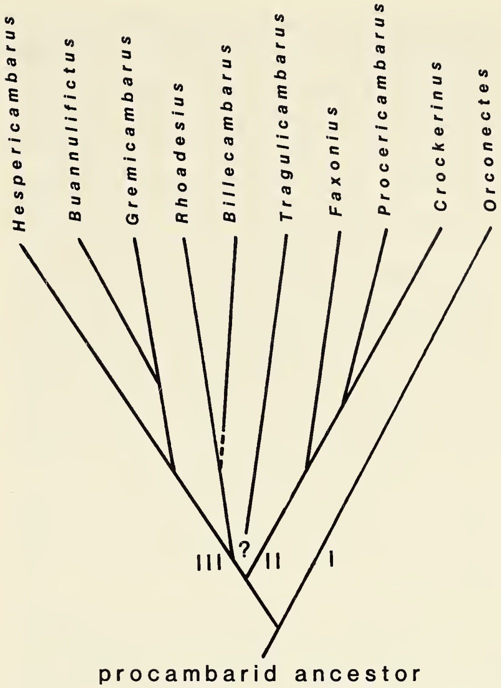


Fig. 18. Cladogram expressing proposed relationships of subgenera of *Orconectes.*

Enough plesiomorphies do exist, however, to permit evaluations of other character states in the members of the nominate subgenus and to compare them with members of *Procambarus* which Hobbs (1984) has indicated contain many familial plesiomorphies: the subgenera *Pennides* and *Ortmannicus* (particularly the Pictus Group). From these comparisons, one can project additional probable synapomorphies for the genus.

In those species with the greatest number of plesiomorphies (*O. australis* subspp. and *O. incomptus*) a shoulder is present at the cephalic base of the central projection. A similarly situated or somewhat proximally displaced irregularity (in varying degrees of development) can be found in some members of *Pennides* (*P. ablusus, P. lylei, P. natchitochae, P. versutus*) and some members of the Pictus Group (*P. enoplosternum,* *P. hirsutus, P. pictus*). Fitzpatrick (1967) postulated that the shoulder was plesiomorphic for members now assigned to the subgenus *Crockerinus,* which members likewise exhibit few character states which I consider apomorphic. Thus, a cephalic shoulder would seem to be plesiomorphic, but not its degree of development.

The annuli ventrales of members of *Pennides* and the Pictus Group of *Ortmannicus,* although not as simply constructed as the *Orconectes* in question, are nevertheless comparatively weakly sculptured as a group. Further, females of the genus *Cambaroides* (subfamily Cambaroidinae) have only a simple, unsculptured annular plate. It is not, therefore, excessive to consider more elaborate sculpturing of this structure to be apomorphic.

In *Orconectes* one can find no consistent pattern of cheliped development which can be used to establish lineages. This feature was extremely useful to Hobbs (1969) when he examined *Cambarus.* Equally, the carapaces of *Orconectes* species do not afford a means to evaluate apomorphic trends. In most carapace characteristics, the members of the genus are remarkably similar.

If one accepts the postulates I have offered, then some decisions about lineages can be made. In members of the subgenus *Orconectes* the annulus ventralis is movable, nearly planar and, significantly, lacking any structures which can be identified unequivocally as vestiges or precursors of a trough or sulcus. The central projection and mesial process are both short; the former is often flattened in the cephalocaudal plane and the mesial process is usually robust although tapering from base to tip. When compared with these character states and with members of other genera of the Cambaridae, long subsetiform elements, bladelike central projections, and spatulate, cephalically excavated mesial processes become the apomorphic condition.

The first recognizable apomorphies seem to be a firm commitment in the gonopod to only two terminal elements (the central projection and the mesial process), their elongation, and the introduction of orconectid (for lack of a better term) sculpturing to the annulus ventralis. Shortly after these specializations become established, in group II of my cladogram (that leading to *Crockerinus, Faxonius,* and *Procericambarus*), the main shaft of the pleopod became more cylindrical, principally through the reduction of the caudal expansion of that area situated caudolateral to the proximal opening of the sperm groove. At about the same time, development of both a trough and sulcus occurred on the annulus, and the mesial process of the male gonopod became subsetiform.

In group III there was no appreciable reduction of the caudal expansion of the gonopod, it remained rather prominent; the mesial process tended toward attenuation but was not subsetiform. In females, the trough and sulcus were probably very weakly developed and variable.

Trends leading to Faxonius.—Returning to group II, further developments can be recognized. The divergent apices of the terminal elements of the gonopod were retained by some, as were the plesiomorphic carapace spines (evidenced by their retention in *O. limosus*), and a clearly recognizable trough can be seen; only in *O. wrighti* is the sulcus obscure, but in all of them the cephalolateral prominences are easily identifiable, and the sinus arises in a barely recognizable fossa near the midwidth of the sulcus. The populations diversified into the members of the subgenus *Faxonius.*

Other populations of group II took another tack (leading to *Crockerinus* and *Procericambarus*). The central projection also approached a subsetiform state, and the straight elements moved into a subparallel relationship. A shoulder was probably present on the pleopod (Fitzpatrick 1967:167), and both trough and sulcus were clearly evident on the annulus.

Trends leading to Crockerinus.—Of these, those that developed into members of the subgenus *Crockerinus* retained a relatively low degree of relief on the surface of the annulus; the sinus arose from a moderately developed fossa which was located near the midline of the annulus in the cephalic portion of the sulcus. From there, the sinus usually extended laterad or caudolaterad before recurving sharply to the midline (the unique annulus of *O. bisectus* is an exception); and from there it followed a gently sinuous path nearly to the caudal margin, only rarely (in *O. erichsonianus* and *O. shoupi*) intersecting it. A fundamentally broadly spindled shape was retained throughout.

The male gonopods remained in a more conservative state. They were longer than the plesiomorphic condition found in members of the subgenus *Orconectes* and longer than in members of the subgenus *Faxonius* but somewhat shorter than the conditions found in members of the subgenus *Procericambarus.* Both the mesial process and central projection became less stout, but they remained subequal in length or nearly so. The central projection never reached a state of being subsetiform. The cephalic shoulder was lost in most populations, but individuals in many retained it, albeit usually in a reduced form.

Trends leading to Procericambarus.—In members of *Procericambarus* the annulus developed large, conspicuous cephalolateral prominences and a deep, distinct trough, often overhung in its cephalic parts by the cephalolateral prominences; in general, the annuli of members of *Procericambarus* are the most prominently sculptured in the genus. The strong tongue-like projection of the caudal margin of the annulus in members of the Hylas Group also represents an extreme for the genus. The terminal elements of the male gonopod became much elongated, especially the central projection. The tip of the elements reach the coxae of the second pereiopod when the abdomen is flexed, and in some species they reach as far as the mouthparts. Undoubtedly, in pleopods one can say that the most divergent state of the genus is reached. The subgenus seems to represent the most modified, with respect to structures used in amplexus, situation in the genus, and indeed its members may well be the most specialized members of the family in this respect.

Trends leading to Tragulicambarus.—Returning to the initial dichotomy of the two major groups, an enigma, *O. lancifer,* is encountered. In many ways it is unlike any other *Orconectes.* The acumen usually accounts for at least half of the total length of the rostrum, although I have seen many specimens in which the acumen approached more typical proportions. The hand is long and narrow, the inner margin of the palm being clearly longer than the dactyl. The central projection is laterally compressed and blade-like, a characteristic shared only with *O. bisectus.* But all of these, except the pleopod, probably represent specializations rather than significant apomorphies. The hand is very reminiscent of *Procambarus* (*Capillicambarus*) spp. and less so of *Faxonella* spp. All of these species inhabit roadside ditches or other such semipermanent standing waters. The hand would seem to be more indicative of habitat than ancestry. Never reaching the extreme of *lancifer,* the acumena of several apparently distantly related species of *Orconectes* can be quite long: *O.* (*O.*) *inermis, O.* (*C.*) *virginiensis, O.* (*P.*) *longidigitus.* Likewise, outgroup representatives sometimes have very long acumena: *Cambarellus* (*Cs.*) *prolixus, Procambarus* (*Ortmannicus*) *youngi, P.* (*Pennides*) *ablusus, P.* (*Pe.*) *lylei, P.* (*Pe.*) *lagniappe.* Such distribution discourages the use of the acumen to determine relationships.

If the general morphology of the pleopod of *lancifer* is compared with what I have taken to be the plesiomorphic condition, one notices that the reduction of the area caudolateral to the proximal opening of the sperm groove is not reduced to the degree found in members of *Crockerinus, Faxo-*

nius, and *Procericambarus.* In this respect, the pleopod is more like that of the lineage of group III of the major dichotomy than of group II. Similarly, the length of the cephalocaudal axis of the annulus is nearly equal to that of the transverse axis, again more like the condition obtaining in the group III stem. Discounting the apparently environmentally influenced features, *Tragulicambarus* seems to have arisen as a unique divergence from the group III stock, but its precise relationship remains unclear.

Less tenuous are the lineages of what I perceive to be the principal line of descent in the group III arm of the dichotomy. The greatest diameter of the gonopod remained located just distal to the proximal opening of the sperm groove, and there it retained close to twice the diameter at the base of the terminal elements. In the terminal elements, especially the mesial process, a marked tendency to have their apices oriented caudodistad or caudad developed. The length of the cephalocaudal axis of the annulus approached or slightly exceeded that of the transverse axis. The development of cephalolateral prominences encouraged the appearance of distinct troughs and sulci.

Trends leading to Hespericambarus.—The species which digressed least from the postulated ancestral type of group III are assigned to the subgenus *Hespericambarus.* In these animals, the terminal elements retained a relatively stout condition, were still relatively short and had minimal modification of their basic shape. The annuli were simple, and in none was the combination of a clearly defined trough and sulcus present. Only in *O. difficilis* (and possibly *O. maletae*) is a fossa present, and the sinus, although more conspicuous than that in the subgenus *Orconectes,* is not elaborate. Moreover, only in *O. difficilis* does the cephalocaudal elongation of the annulus become such that the structure can be described as subrhomboid. *Orconectes hathawayi* seems to be the extant species which can be described as "closer to the ancestral type." It has the straightest and shortest terminal elements in the subgenus; but also pertinent is the fact that many individuals bear spines (although most rather small) in the hepatic region of the carapace, their presence earlier herein considered a plesiomorphic character state.

As a final observation, I should comment on the nomenclature employed for members of this subgenus. Lacking contrary evidence, I would retain the nomenclatorial combinations proposed by Walls (1972), despite that fact that I cannot comprehend the intergradations of populations visualized by him. But for reasons implicit in my recognizing two "Groups" within the subgenus, I am listing each taxon as a distinct species and deferring determination of the precise limits of variations for the several populations until a later time.

Trends leading to Rhoadesius.—Probably closely related to but nonetheless distinct from *Hespericambarus* is the small group of crawfishes assigned to the subgenus *Rhoadesius.* These differ from members of the former principally in that the distal half of the pleopod is inclined caudally to the main axis of the appendage (as established by the basal part). The annuli are relatively simple, but in *O. kentuckiensis* a fossa is present, and in *O. sloanii* ridge-like cephalolateral prominences suggest a tendency to sulcus formation. Both species have a moderately broad areola in contrast to the obliterated one in members of *Hespericambarus,* yet this character is unreliable for determining relationships. Species, in any genus, which inhabit cool, tumbling waters tend to have a short, broad areola; in contrast, species living in sluggish, warm, standing waters and burrowers most likely will have a long and obliterated areola; species living in intermediate type habitats usually exhibit intermediate characteristics of this structure.

Trends leading to Billecambarus.—Perhaps the most confusing of the members of the genus is *O.* (*Billecambarus*) *harrisoni.*

In some respects the pleopod resembles that of members of *Rhoadesius,* but the short terminal elements are curved throughout their length to a degree that, coupled with caudal inclination of the distal half of the pleopod, the apices of both are directed due caudad. The annulus is unique in the genus. Only in *O.* (*R.*) *kentuckiensis* are the cephalolateral regions so undeveloped that the anterior half of the annulus is essentially a deep transverse excavation similar to the condition in *O.* (*Bi.*) *harrisoni.* In the latter, this transverse sulcus (?) is overhung caudally by a median projection of the more elevated caudal half; the sinus originates nearly on the cephalolateral margin and runs obliquely in a deep groove to the midline before turning caudally to move in a scarcely arched path to the caudal margin. The species seems to be a digressive, trans-Mississippi offshoot of *Rhoadesius.*

Trends leading to Gremicambarus.—In members of the subgenus *Gremicambarus* the central projection is straight in its basal part, although the distal parts of the pleopods are frequently inclined caudally with respect to the main axis of the basal half of the appendage. The mesial process is likewise usually straight basally. The proportions of the annulus approach those of *Crockerinus,* but the structures differ conspicuously from those of the latter in that well defined sulci are present and, except in *O.* (*G.*) *validus,* equally well defined troughs are also present. The sinus originates in a deep fossa, usually in the cephalolateral portion of the sulcus and extends laterally before recurving sharply to the midline; this produces a prominent, tongue-like, laterally oriented ridge which descends toward the lateral parts of the sinus, which latter is frequently partly obscured by an overhang of the cephalolateral prominence and/or lateral extension thereof. These are probably the most complexly organized annuli in the genus.

Further evidence of the digressive nature of the members of this subgenus can be found in the nearly subcylindrical main shaft of the pleopod. Members of the Alabamensis Group are extreme in having a spatulate mesial process with a conspicuous groove along the cephalic face. The hands, although usually not useful for determining relationships, help tie the species together into a cohesive group. In all (except *O. compressus* and *O. chickasawae*) a tuft of setae, of varying degrees of development, occurs at the base of the opposable margin of the fixed finger; in this respect they resemble members of *Crockerinus.* But, most unusual in the genus, fully half of the species have at least one tubercle on the opposable margin of the fixed finger which stands out from the rest in size. Another unusual characteristic occurs in the basal third of the opposable margin of the dactyl (absent only in *O. compressus, O. cooperi* and *O. rhoadesi*): a broad concavity with (except in *O. immunis*) more than one prominent tubercle, structured not unlike that seen in *Cambarus* (*Lacunicambarus*) spp.

Trends leading to Buannulifictus.—More divergent still are members of the subgenus *Buannulifictus.* Except in *O. meeki meeki,* the distal portion of the pleopod is inclined caudally with respect to the main axis of the proximal part of the pleopod, *and* the central projection is curved throughout its length, the apex (except in the same subspecies) directed more or less caudally. The subsetiform mesial process is likewise curved but also from its base takes a path divergent from that of the central projection, the apices of the terminal elements being at least twice as far apart as the bases.

One of the most significant changes in the annulus ventralis was an increase in the cephalocaudal axis. The development of the cephalolateral prominences was more toward a ridge-like oval than toward a circular hillock, a situation shared with *Gremicambarus.* Not surprisingly, the annuli are superficially similar in the two subgenera. But in *Buannulifictus* the lateral development of the prominences is more intrusive on the middle of the annulus, resulting in a sulcus which is more pit-like than ditch-like. At the same time, the mediocephalic incursions of the prominences render the trough poorly evidenced, at best. The sinus originates in a deep fossa near the caudal margin of the cephalolateral prominences, and its peregrinations are not dissimilar to those described for *Gremicambarus,* although a tongue-like ridge as described for the latter subgenus is clearly defined only in *O.* (*B.*) *palmeri palmeri.*

Except for *O.* (*B.*) *palmeri longimanus,* the dactyl concavity typical of *Gremicambarus* is absent, but a tuft of setae at the base of the fixed finger is present, albeit poorly developed, in all but the two subspecies of *O. meeki.* The opposable margins of the fingers usually have well developed tubercles, but no prominently large one is characteristically present. The two subgenera are bound by many commonalities, some of which are apparently synapomorphic. But an equal number of differences exist also. One is led to the conclusion that although their members are rather closely related, they constitute two distinct species groupings, here recognized as subgenera.

Geographic and Temporal Interpretations

In such speculations as have been presented in preceding paragraphs one invariably is led to postulate temporal assignments for proposed events. At the moment I am more prepared to examine geographic relationships than paleontologic ones. Hobbs and Barr (1972) offered explanations of the time and place of the origin of *Orconectes.* They also similarly addressed the early development and migration of the early isolates of the parental population. They accepted the pre-Miocene origin of the genus, located geographically at the southeastern rim of the Cumberland Plateau, proposed by Hobbs (1969), as well as his suggestion that the expansion was essentially westward. Their principal addition was to offer a "Tertiary" northward migration of early populations, some of which gained access to the Atlantic drainages and persisted as *O.* (*F.*) *limosus.* They also provided strong arguments that the genus descended from stream dwellers.

Fitzpatrick (1967) associated emergence of *Crockerinus* and *Procericambarus* with (by inference) the early Quarternary and envisioned subsequent speciation of the former as a result of conditions existing during Illinoian to post-Wisconsin times. His explanations were more compatible with Rhoades' (1962) proposals for events effecting the distribution of northern crawfishes than were those of Hobbs and Barr (1972). Indeed, they rejected outright Rhoades' mechanism to explain the distribution of *O. limosus.*

If I were inclined to disagree with any of the above, I could find no concrete data to refute Hobbs' and Barr's hypotheses. Recently, however, Fitzpatrick (1983) used new geologic information to speculate that a prominent pre-Pleistocene river drained the upper Tennessee into the Florida Parishes of Louisiana and argued that this river could account for the eastern distribution patterns of the Cambarellinae. He carried this proposal further (Fitzpatrick 1986), giving more details, in using such a drainage to account for many peculiarities of crawfish distribution in the eastern part of the Gulf Coastal Plain. In this scheme, the proposed "ancestral home" of *Orconectes* would be related to this river. It seems more than coincidental that the expansion of *Orconectes* is essentially west of this river and that of the early digressives of *Cambarus* (Hobbs 1969) is to the east.

If one uses this proposed river to localize the eastern boundary of the eastcentral margin of the Mississippi Embayment, one can begin to speculate about the dispersal routes (corridors in the sense of Hobbs 1969, 1984). One early group moved north through eastern Tennessee and West Virginia, possibly through the New River system, and gained access into what is now the upper Ohio drainage. From Hobbs' and Barr's (1972) timetable this would be definitely pre-Illinoian and probably Tertiary time. These populations became the members of *Faxonius.* Another "wave" of invasion, out of the same Cumberland source area followed, to diversify into today's *Crockerinus.* This more progressive descendent of the ancestral stock would have obliterated any extant epigean remnant of *Orconectes* (subgenus) and was able to bisect the range of *Faxonius* to leave the probably already isolated *limosus* precursors in the Atlantic drainages and compressing the remainder into three isolated populations near the periphery of a range that at once encompassed the area from the Appalachian divide to the eastcentral rim of the Mississippi embayment and south of the Teays system. By Fitzpatrick's (1967) reckoning this would have occurred before the Illinoian glaciation.

West of what is now the lower reaches of the Tennessee River another stock was establishing itself. This was the precursor of my proposed "Group III" (Fig. 18) lineage (*Billecambarus, Buannulifictus, Gremicambarus, Hespericambarus, Rhoadesius,* and *Tragulicambarus*). These crawfishes seem to have invaded the northern (lower) reaches of this drainage as several "waves"; possibly these are associated with the migrations of the ice sheets of the Pleistocene. One group, however, seems to have become established west of the Mississippi River comparatively early. Exactly how this was accomplished is highly problematical, but surely considerable opportunities exist and existed for animals not too demanding of the stream environment to cross as meanders of the mid-Mississippi channel occur. Apparently the ancestors of members of *Hespericambarus* settled in the Tertiary or early Quarternary streams of northwest Louisiana/Arkansas/Oklahoma and invaded the Quarternary lands as they became available. The present-day representatives east of the river are *O.* (*H.*) *perfectus* and populations very close to it. They, in turn, are almost indistinguishable from Louisiana's *O.* (*H.*) *hathawayi,* and I interpret them to be relatively recent immigrants into the Tombigbee drainage system.

Possibly coincident with these activities, another group was moving up (down by present directions) the streams into the Ohio basin. These diversified into the members of *Rhoadesius* and were more widespread than today. For whatever reason—climatic change, replacement by more efficient competitors, or both—the original range was bisected and remains today as two, essentially relict, allopatric areas.

Two monotypic, enigmataic subgenera attract our attention next. *Orconectes* (*Billecambarus*) *harrisoni* can be found only in a very restricted area just west of the Mississippi River flood plain in Missouri and between the latitudes of confluence of the Missouri and Ohio rivers with the Mississippi. As discussed above, its morphology is very difficult to interpret, but it seems to be most closely related to *Rhoadesius* and could represent a very disparate western isolate from that group of populations. *Orconectes* (*Tragulicambarus*) *lancifer* is likewise morphologically unique and even more difficult to associate with another group of species. That an almost perfect correlation of its distribution with Quarternary-Holocene deposits exists is inescapable, however, and one must therefore assume a comparatively late specialization enabling its almost unique (for *Orconectes*) invasion of the habitats—essentially lentic, often stagnant, or very sluggishly flowing and lacking firm substrates for much of their extent—associated with these regions.

Becoming fully established in the lower (i.e., southern) reaches of the eastern leg (i.e., upper) of the Tennessee River were the progenitors of *Procericambarus.* This may have taken place in Early Quarternary times. This stock seems to have consisted of vigorous competitors; indeed, *O.* (*P.*) *rusticus* is one of the most successful displacers at the present time (Crocker and Barr 1968; Capelli 1975, 1982; Berrill 1978; Capelli and Munjal 1982; Tierney and Dunham 1984). They eliminated *Crockerinus* from its ancestral home on the Cumberland Plateau, drove *O.* (*C.*) *erichsonianus* southward and pushed the second, northern assemblage hard as they invaded the Ohio system. They spread extensively, possibly along the Erigan system, going across the Mississippi to occupy the Missouri highlands and thence southward into the Ouachitas. They tumbled off the Highland Rim into the Nashville Basin to become firmly established in central Tennessee and Kentucky. How this was accomplished will probably always remain unknown. It may have resulted from an invasion down the slopes from the Cumberland Plateau; it may have been via a union of the two segments of the Tennessee River; or it may have been both. Until the approximate time of this fusion to form the present Tennessee River is determined, further speculation seems useless. Man has helped *O.* (*P.*) *rusticus* in its invasions, but much of the range represents its own vigorous and successful expansion into areas breaking free of ice cover.

The lower (southern) parts of the western (lower) leg of the Tennessee drainage saw the nearly simultaneous establishment of ancestors to *Gremicambarus.* Most species initially probably had difficulties expanding their range northward as they encountered the vigorous *Procericambarus* populations and were forced to content themselves with central Tennessee and the emerging lands which are now associated with the Tombigbee River drainage.

To the west and southwest of them *Buannulifictus* fauna was laying claim to most of Mississippi and the southern parts of the west bank of the river. Little conjecture can be made concerning this stock, for present drainage patterns in the critical areas do not well reflect the history of the region. There are extensive "drowned" drainages in northern Mississippi (Murphey and Grissinger 1981), and serious questions of the age and sources of deposits throughout the area have been raised (May 1981, Isphording 1983).

Becoming teleological, one could say that *Gremicambarus* "bided its time" and "worked to build a better mousetrap." By the retreat of the last ice sheet, two species of the subgenus were poised "to hold their own" as the north was exposed for colonization. Surely the subgenus dominates the crawfish fauna of the central part of North America. But an examination of the ranges of the members of the subgenus leaves no doubt that the overwhelming majority of the total range is ococupied by *O.* (*G.*) *immunis* and *O.* (*G.*) *virilis,* the latter exceeded in range only by *Procambarus* (*Ortmannicus*) *acutus* subspp. The several populations of *O.* (*G.*) *virilis, O.* (*G.*) *nais* and *O.* (*G.*) *causeyi* are morphologically nearly indistinguishable, although Pryor and Leone (1952) reported serological differences between *O. nais* and *O. virilis.* The latter has to be evaluated in light of Phillips' report of possible intergrade populations in southwestern Iowa (1980); this is one of the few studies in which a detailed examination for just such a situation has been reported. Regardless, the *Gremicambarus* invaders attempting to move out of Missouri River drainages into southern Missouri and Kansas-Oklahoma were stymied in their southern and southwestern migration by well-established *Buannulifictus* populations and in their westward and northern movements by intolerable or inaccessable habitats resulting from climatic conditions. Nevertheless, they constitute the most widespread subgenus of *Orconectes* and are obviously successful competitors.

In summary, analysis reveals a reasonably rational division of the genus *Orconectes* into 10 subgenera which seem to reflect historical events in the diversification of the genus. Adequate data determining precise relationships are lacking, but generalities implied by the proposed groupings are supported by the information at hand.

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CHONO ANGUSTIARUM, A NEW GENUS AND SPECIES OF ZOBRACHOIDAE (CRUSTACEA: AMPHIPODA) FROM MAGELLAN STRAIT, WITH A REVISION OF UROHAUSTORIIDAE

Janice Clark and J. L. Barnard

Abstract.—The new genus and species, *Chono angustiarum,* from Magellan Strait, has characters of both Zobrachoidae and Urohaustoriidae. The Zobrachoidae are redefined to include genera with well developed epimeron 1, in contrast to Urohaustoriidae containing genera with vestigial epimeron 1. The previously described Magellanic genera *Huarpe* and *Tonocote* also represent intergrades between the two families as originally described from Australia where they are very distinctive.

Chono angustiarum, a new genus and species of Zobrachoidae is described from Magellan Strait. This marine fossorial amphipod almost perfectly intergrades between the Urohaustoriidae and Zobrachoidae by combining a well developed epimeron 1 with a simple gnathopod 1. Overlaps between the two families, so distinct in Australian waters, have already been described in Magellan genera such as *Huarpe* Barnard and Clark (1982) and *Tonocote* Clark and Barnard (1986). We are not prepared for final fusion of the two families because the genera remain distinctive on the basis of epimeron 1. In our redefinition the Zobrachoidae retain the plesimorphic state of epimeron 1 in fully developed condition, whereas Urohaustoriidae have epimeron 1 vestigial or absent. The distinction remains strong. Structure of gnathopods is thereby discounted.

Methods of analysis follow Barnard and Drummond (1982). In the text, symbols "E" and "e" = large and small setae, "S" and "s" = large and small spines, "p" = penicillate seta, "R" = right sided appendage as contrasted to normal description based on left.

Discussion

When originally described from Australia (Barnard and Drummond 1982), the families Zobrachoidae (then three genera) and Urohaustoriidae (then six genera) were distinguished by the apomorphic characters of Urohaustoriidae as follows: simple gnathopod 1, strongly reduced coxa 2 in comparison to coxa 3, adze-shaped coxa 3 with large posteroventral projection, great reduction of epimeron 1, smallness of rostrum on head, small number of setae on inner plate of maxilla 1, more strongly extended incisor with reduced development of cusps, greatly reduced number of rakers, and generally the reduction in size of article 2 of outer ramus on uropod 3; to this could be added in retrospect the development of awns on the setae of the mandibular palp and the loss of lateral setae on the peduncle of uropod 2. Table 1 shows the overlaps between the old family extremes occurring in *Huarpe, Tonocote,* and *Chono.*

Characters of the table are stated in such a way that Zobrachoidae reflect (+) and Urohaustoridae (0). The intermediate genera are placed in transformational order re-

Table 1.—Characters of Zobrachoidae and Urohaustoriidae from Australia compared to transitional Magellanic genera. Intermediate genera are arranged in their closest affinities. Asterisks denote strongest anomalies in this particular arrangement.

Character	Urohaustoriidae	*Chono*	*Huarpe*	*Tonocote*	Zobrachoidae	
1	0	0	+	+	+	Coxa 3 not adze-shaped
2	0	0	+	+	+	Coxa 2 not very small
3	0	0	0	+	+	Rakers 4+
4	0	+*	0	+	+	Outer ramus uropod 3 elongate
5	0	0	0	+	+	Gnathopod 1 subchelate
6	0	0	+	0*	+	Setae of mandibular palp not awned
7	0	0	+	0*	+	Uropod 2 peduncle with many lateral setae
8	0	0	+	0*	+	Mandibular incisors not extended
9	0	0	0	+	+	Setae on inner plate of maxilla 1 4+
10	0	+*	0	+	+	Epimeron 1 well developed
11	0	0	0	+	+	Rostrum strong
12	0	0	+	0*	+	Antenna 1 with setal crescent

flecting their closer affinities and the strongest anomalies in the selected sequence are marked with asterisks (*). If one desired to place the intermediate genera into families, the families could be defined on any single character alternative or they could be divided by character groups 1-2, 3-5-9-11, 4-10, and 6-7-8-12. One would thus subjectively rank any single character state or group of states as more important than any other. The trends from (+) to (0) represent our opinion as to increasing apomorphy (0) and the immediate ancestor to this pool of 12 genera would reflect all (+), though a more remote ancestor might not; for example, the remotest ancestor of Amphipoda might have a simple gnathopod 1, no lateral setae on uropod 2, no rostrum, no antennal crescent, etc.

Besides the 12 characters of Table 1 we also selected 26 other character states often used for generic distinctions in this group but found those to vary within the original families described.

We continue to distinguish between the two families on the basis of epimeron 1 in Urohaustoriidae. The great reduction of epimeron 1 is extremely rare in amphipods; it occurs also in some freshwater amphipods, some ingolfiellids and some corophioids, all of which exhibit a trend for the body to become cylindrical in contrast to the dorsoventral flattening found in haustorioids. Of course, one may also suggest that pleonite 1 (epimeron 1) of urohaustorioids actually has become cylindrical as a functional adaptation to improve the motion of the pleon, increase the space for musculature, and decrease friction with the appendages of the thorax which overlie epimeron 1.

Relationships.—*Chono* differs from Australian Zobrachoidae in the poorly developed rostrum, poorly toothed mandibular incisors, low number (fewer than 4) or absence of rakers, fewer than 4 setae on the inner plate of maxilla 1, dominant coxa 3, and simple gnathopod 1.

Chono differs from Australian Urohaustoriidae in the elongate article 2 on the outer ramus of uropod 3, the well developed epimeron 1, and the lack of size or setational dominance by epimeron 2.

Chono differs from both *Huarpe* and *Tonocote* in the adze-shaped dominant coxa 3 and small coxa 2 relative to coxa 3. *Chono* differs from *Tonocote* also in the loss or low number of rakers; simple gnathopod 1, weak setation on maxilla 1 and weak rostrum. *Chono* differs from *Huarpe* also in the elongate article 2 on the outer ramus of uropod 3, unawned setae of the mandibular palp, lack of lateral setation on the peduncle of uropod 2, elongate incisors, well developed epimeron 1, and lack of setal cresent on article 1 of antenna 1.

The following new key distinguishes the 12 known genera of Urohaustoriidae and Zobrachoidae.

Key to the Genera of Urohaustoriidae and Zobrachoidae

1. Epimeron 1 well developed (Zobrachoidae) 2

– Epimeron 1 vestigial (Urohaustoriidae) 6

2. Antenna 1 of urothoe form, with article 3 elongate, more than twice as long as broad 3

– Antenna 1 of haustorius form, article 3 not elongate, less than twice as long as broad 4

3. Article 4 of antenna 2 narrow, epimeron 2 well developed, article 5 of pereopods 3–4 posteriorly spinose .... *Prantinus*

– Article 4 of antenna 2 broad, epimeron 2 reduced, article 5 of pereopods 3–4 posteriorly naked .. .. *Tonocote*

4. Coxa 3 dominant and adze-shaped, coxa 2 very small .... *Chono*

– Coxa 4 dominant, coxa 3 not adze-shaped, coxa 2 not very small .. 5

5. Telson elongate, rami of uropods 1–2 with many medial setae, no basoventral setae .... *Zobracho*

– Telson short, rami of uropods 1–2 lacking medial setae, bearing basoventral setae .... *Bumeralius*

6. Dactyl of pereopod 5 spinose ... 7

– Dactyl of pereopod 5 not spinose 9

7. Antennae bearing supernumerary oar-shaped setae, article 2 of pereopods 6–7 narrow or strongly tapering distally .... *Narunius*

– Antennae lacking supernumerary oar-shaped setae, article 2 of pereopods 6–7 fully expanded, not tapering distally 8

8. Coxa 3 large, coxa 4 small .... *Urohaustorius*

– Coxa 3 small, coxa 4 large .... *Gheegerus*

9. Coxae 1 and 2 of equal size, epimeron 2 about equal in size to epimeron 3, lacking setae ..... *Dirimus*

– Coxae 1 and 2 diverse, epimeron 2 either larger or more setose than epimeron 3 10

10. Gnathopod 2 subchelate, dactyls of pereopods 5–7 setose in female .... *Tottungus*

– Gnathopod 2 parachelate, dactyls of pereopods 5–7 not setose in female 11

11. Coxa 1 smaller than coxa 2, coxa 3 smaller than 4, not adze-shaped, inner rami or uropods 1–2 fully developed, peduncle of uropod 2 with lateral row of setae .... *Huarpe*

– Coxa 1 larger than coxa 2, coxa 3 larger than 4, adze-shaped, inner rami of uropods 1–2 reduced or absent, peduncle of uropod 2 lacking lateral row of setae .... *Tuldarus*

Master Legend

Capital letters as follows refer to parts; lower case letters to left of capital letters refer to specimens noted in legends; lower case letters to right of capitals refer to adjectival modifications in list below: A, antenna; C, coxa; D, dactyl; F, accessory flagellum; G, gnathopod; H, head; I, inner plate or ramus; J, incisor; K, pleopod; L, labium; M, mandible; O, outer plate or ramus; P, pereopod; Q, seta; R, uropod; S, maxilliped; T, telson; U, labrum; V, palp; W, pleon; X, maxilla; Y, oostegite; Z, gill; d, dorsal; f, few setae removed; r, right; s, setae removed; t, left.

Chono, new genus

Diagnosis.—Rostrum weak. Peduncle of antenna 1 short, stout, articles 2 and 3 of peduncle progressively shortened, weakly geniculate; primary flagellum elongate, accessory flagellum less than half as long as primary flagellum. Antenna 2 of haustorius form, article 4 expanded, article 5 small, articles 4–5 with facial armaments, article 4 with long ventral setae and subventral clusters of bifid setae. Aesthetascs simple. Mandibular incisors with long stem, thin, untoothed; right and left laciniae mobiles weakly diverse; no rakers; molar broad and bulky, not strongly extended, with weak triturative surface and weak accessory chopper; setae of palp article 3 awned. Mandibular lobes of lower lip well developed. Inner plate of maxilla 1 small, slightly broadened, poorly setose, outer plate with 9 spines (some specimens with 6, 7, or 8), palp short, uniarticulate, palpar setae attached weakly in 2 sets. Inner plate of maxilla 2 feeble, with sparsely developed weakly submarginal oblique row of setae. Baler lobes present on maxillipeds, absent on maxillae. Outer plate of maxilliped with spines; palp article 2 expanded, article 3 elongate, dactyl clavate, 2-setose.

Coxae 1–2 together small, similar, subrectangular, coxae 3–4 together larger, coxa 2 larger than coxa 1, most of coxa 2 hidden by coxa 3; latter larger than coxa 4, adze-shaped and extended posteroventrally; coxae 2–6 with simple gills; oostegites 4 pairs, slender.

Gnathopods small, similar, gnathopod 1 simple, gnathopod 2 barely subchelate (debatable), carpus elongate, propodus weakly like a mitellid barnacle. Dactyls of pereopods 3–7 distinct, large, dactyls lacking setae and spines. Article 2 of pereopods 5–7 expanded, pereopod 5 of haustorius form; distal article of pereopods 6–7 not underslung, only moderately widened, pereopods 6–7 otherwise similar, not dominating pereopod 5.

Peduncle of pleopods wider than long, pleopod 3 smallest, inner rami moderately shorter than outer. Epimeron 1 distinctly developed; epimeron 3 dominant in size and setation. Urosomites scarcely produced and poorly setose ventrally. Inner ramus of uropods 1–2 absent, outer ramus linguiform, poorly setose marginally, each with 1 apical seta; peduncle of uropod 1 strongly setose laterally, of uropod 2 generally lacking long setae laterally. Uropod 3 of ordinary form, outer ramus dominant and biarticulate, article 2 with 2 large apical setae. Telson short, broader than long, deeply cleft.

Description.—Eyes indistinct or poorly visible. Dorsolateral surface of article 1 on antenna 1 with longitudinal row of setae; article 2 densely setose dorsolaterally, groups distinguishable, article 3 poorly setose. Article 3 of antenna 2 short, poorly setose; flagellum much longer than article 4 of peduncle.

Right lacinia mobilis small, slender, apically bifid, weakly bifid basally; left larger, broad, weakly bifid basally; article 3 of mandibular palp slightly shorter than article 2. Lower lip without cone on each outer lobe. Inner plate of maxilla 1 with 2 apicomedial setae; some spines on outer plate bifid. Inner plate of maxilliped with 2 stout apical spines. Coxae 1–2 poorly setose, gill 2 dominant, gills 5–6 tiny. Gnathopod 2 lacking surficial button combs.

Pereopods 3–4 lacking extensive secondary facial rows of spines on article 5.

Uropods 1–2 lacking huge dorsal setae on peduncles; peduncle of uropod 1 with bundle of ventral setae, on uropod 2 weakly setose medially; rami lacking basoventral setae.

Type species.—*Chono angustiarum* Clark and Barnard, new species.

Composition.—Unique.

Etymology.—Named for a tribe of South American Indians. Gender masculine.

Chono angustiarum, new species
Figs. 1–6

Diagnosis.—With the characters of the genus; unique features being loss of rakers, loss of surficial combs on gnathopod 2, weak mandibular lobes on lower lip outer lobes; single apical seta on uropods 1–2 rami; broad inner plate of maxilla 1 (2 apicomedial setae).

Description of female "y," 1.87 mm (illustrated).—Head about 0.7 times as long as wide (1.4 times as wide as long), rostrum about 5 percent as long as remainder of head, one setule at apex of lateral lobe. Primary flagellum of antenna 1 with 7 articles, formula of long aesthetascs = 0-0-0-1-1-1-1; accessory flagellum 3-articulate. Dorsal facial formula on article 1 of antenna 1 = 3 setae, 1 spine; on article 4 of antenna 2 in 3 sets of 4, 2, and 12, long spines dominant, on article 5 = 8 (all in transverse apical set); article 3 with 2 setae; flagellum with 5 articles. Spine formula on right and left mandibular palp article 3 = 4-1-2-1. Inner plate of maxilla 1 with 2 short apicomedial setae; outer plate with 9 spines. Inner plate of maxilla 2 with 4 facial setae. Inner plate of maxilliped with 1 medial and 2 apical setae; palp article 2 with 8 setae in facial row, article 3 lacking facial setae; basal articles of maxilliped broadened and with weakly developed baler lobe bearing 1 seta.

Coxae 1 and 2 subrectangular, coxa 1 smaller than coxa 2, both bearing 1 anterior setule; coxa 3 with 3 long and 1 medium posteroventral setae, and 2 ventral setules anterior to elongate setae; coxa 4 with 2 long and 1 short ventral setae and 5 medium to short posterior setae.

Gnathopods 1–2 with setal brushes on distal apex of articles 2 and 3. Setal and spine formula on pereopod 3 = 4, 2, 2-0, 3 + 1 + 2; pereopod 4 = 4, 2, 2-0, 3 + 1 + 2; article 2 of pereopods 5–6 with one mediofacial seta.

Peduncular spine formulas of pleopods 1–3 = 2 and 1, 2 and 0, 2 and 0; segmental formulas = 13-? (broken, R = 9), 10-7, ? (broken)-8; basal setal formulas = 5-1-2-2, 2-1-1-1, 4-2-1-2.

Epimera 1 and 2 with setule placed in indentation on posterior margin; horizontal ventrofacial row of 2–3 setae on epimeron 2; epimeron 3 broadly rounded with posterior setule and 4 setae in horizontal ventrofacial row.

Lateral margin on peduncle of uropod 1 with 4 setae, 1 apicomedial seta, and 3–4 ventral setae; of uropod 2 with 2 (R = 3) apicolateral and 3 medial setae; ramus of uropod 2 with 2 (R = 1) medial setae. Apicolateral corner of peduncle on uropod 3 with 2 spines and 1 medium seta, medial margin with 1 medium seta, ventromedial apical row with 5 mixed setae, formula on lateral margin of article 1 on outer ramus = Es-Es, medial margin = E-E; formula on medial margin of inner ramus = E-Es.

Telson almost twice as wide as long, setal formula = 2p, p (medial setule being placed ventrally). Gland clusters indiscernible.

Holotype female "z," 1.4 mm (illustrated).—Main differences from female "y" mentioned.

Primary flagellum of antenna 1 with 6 articles, formula of long aesthetascs = 0-1-1-1-1-1. Facial armament formula on antenna 1 = 4 setae, one spinule; on article 4 of antenna 2 in 3 sections of 3, 2, and 9, very long setae dominant, on article 5 = 8. Inner plate of maxilla 2 with 5 facial setae (R = 3). Inner plate of maxilliped with 1 medial, 1 apicofacial, and 2 apical setae; palp article 2 with 2 setae in facial row. Coxa 3 with 3 long and 1 medium posteroventral setae and 1 medium and 2 short setae anterior to elongate setae; coxa 4 with 4 medium to short posterior setae. Setal and spine formula on pereopod 3 = 3, 2, 2-0, 3 + 1 + 2; pereopod 4 = 4, 3, 2-0, 3 + 1 + 3; segmental formulas of pleopods 1–3 = 12-7, 9-7, 9-7; basal setal formulas = 5-1-1-3, 2-1-2-1, 4-1-1-2.

Lateral margin of peduncle of uropod 1 with 3 setae and 2 ventral setae; of uropod

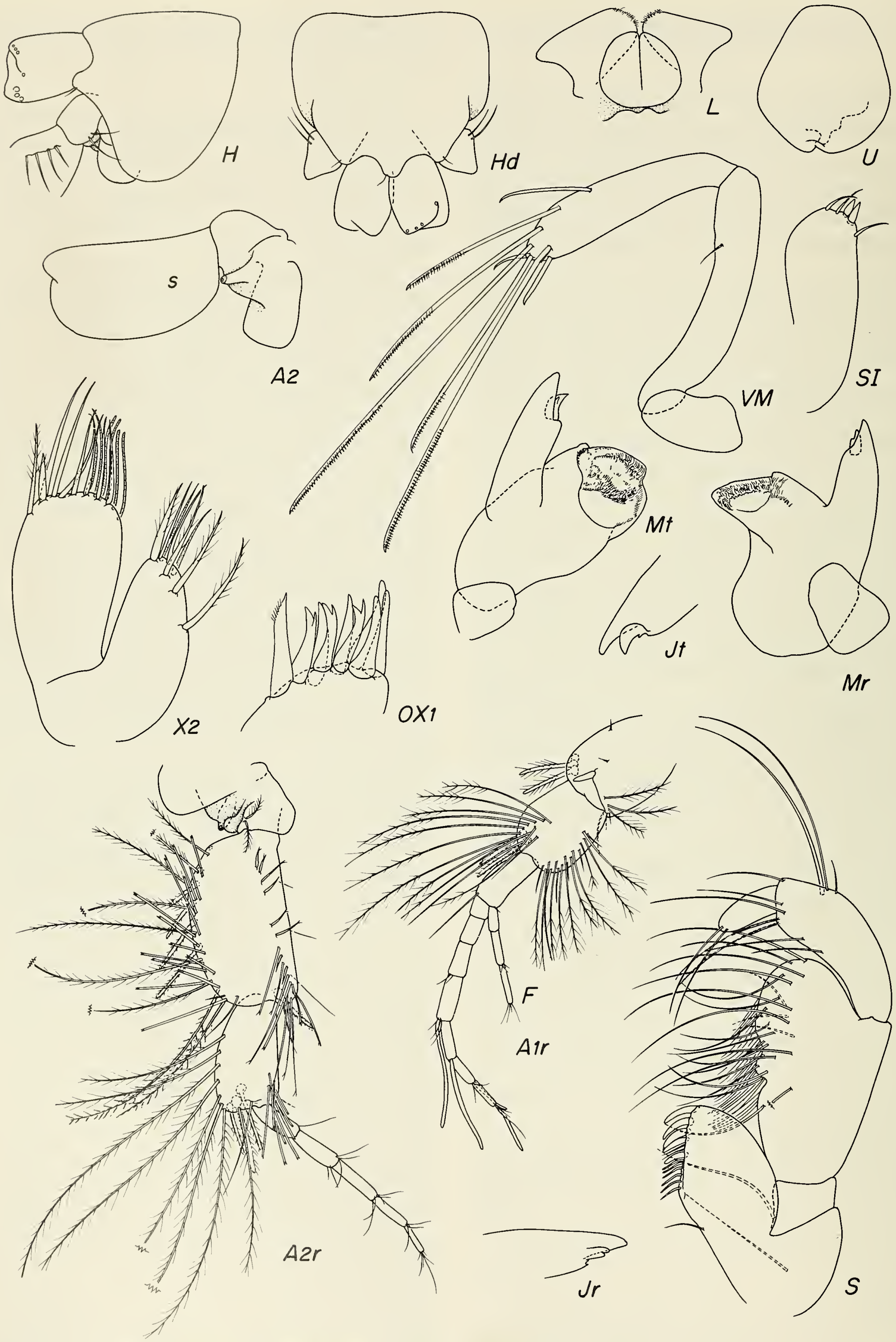

Fig. 1. *Chono angustiarum,* new species, holotype, female "y."

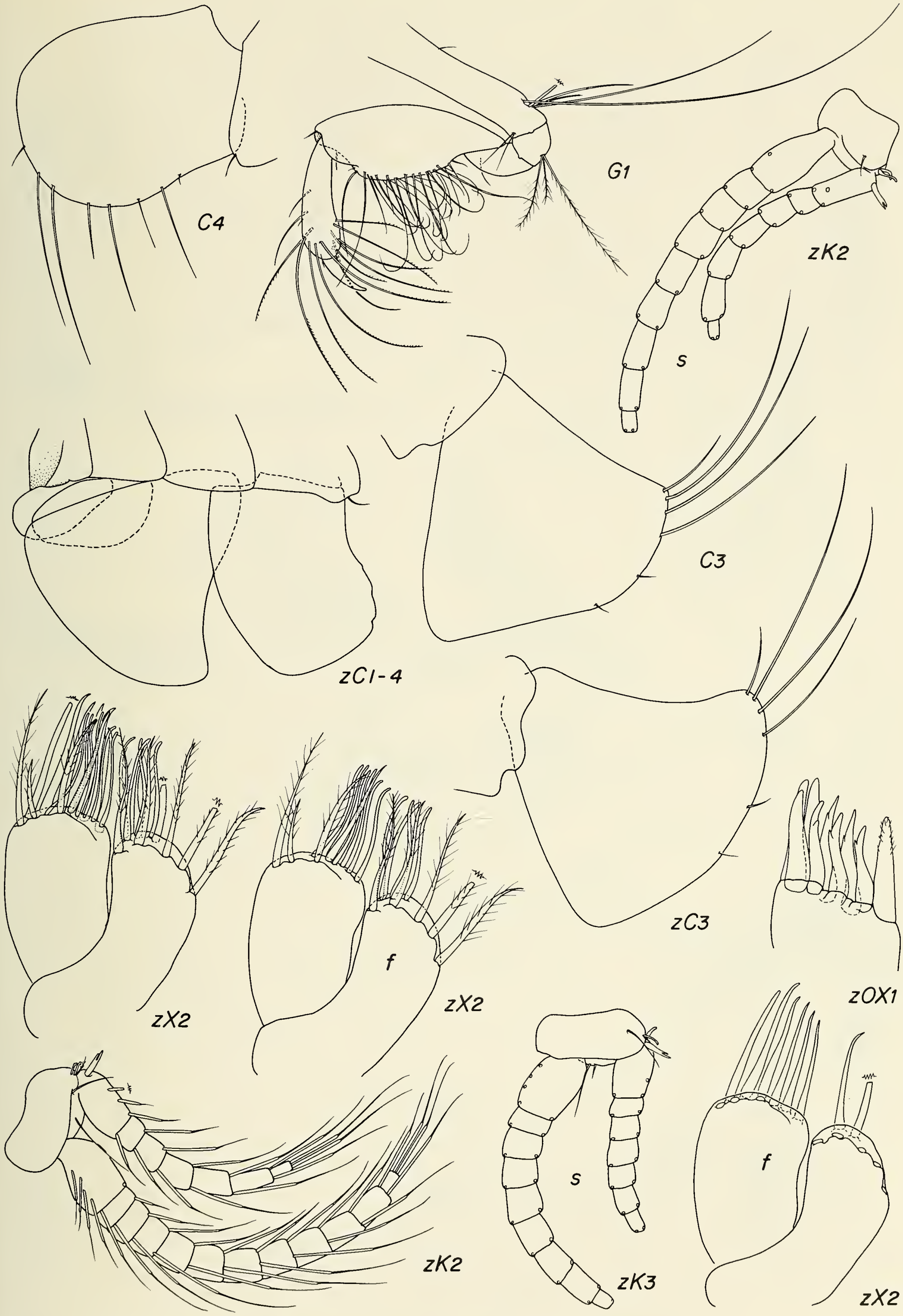

Fig. 2. *Chono angustiarum,* new species, holotype, female "y"; z = female "z."

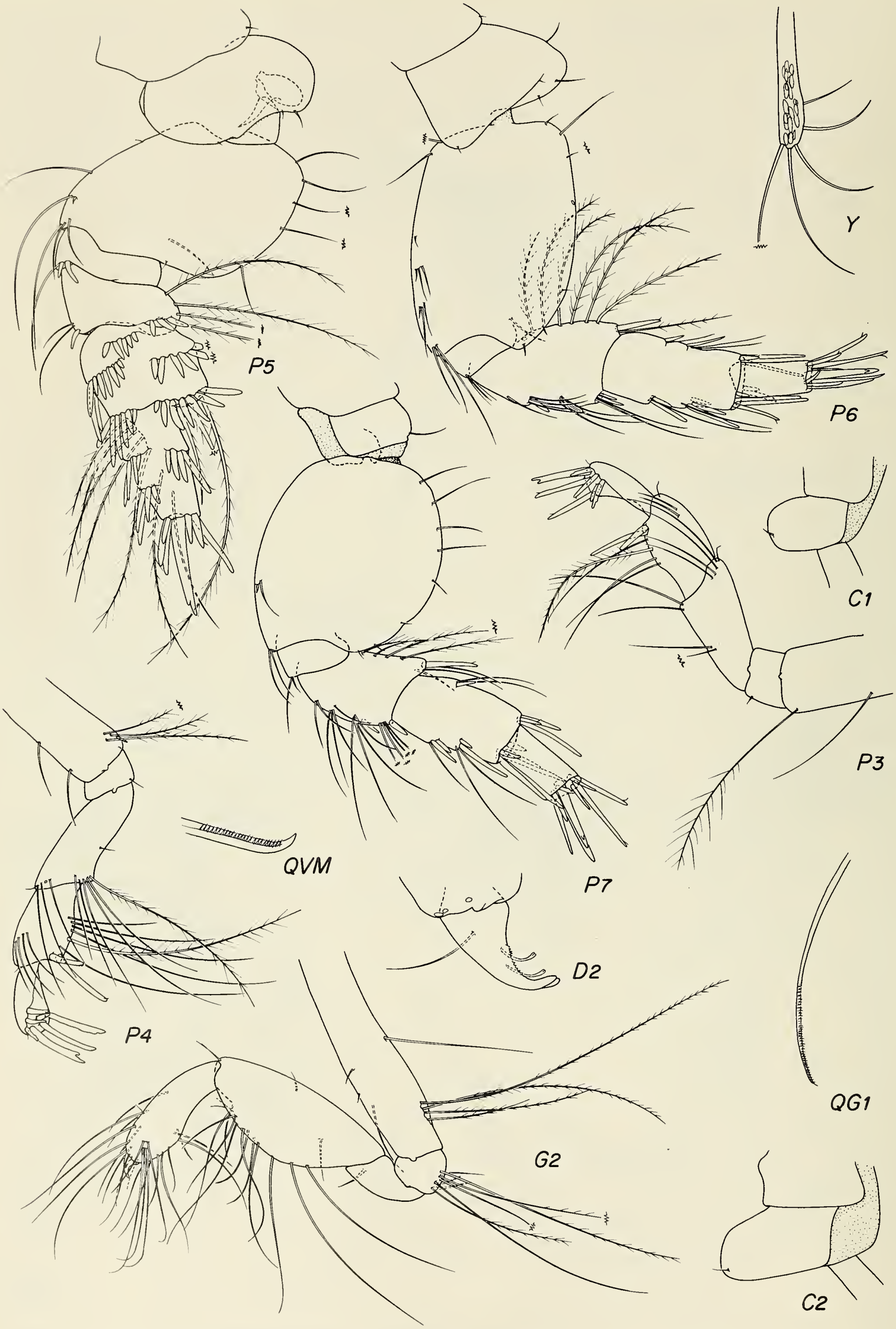

Fig. 3. *Chono angustiarum,* new species, holotype, female "y."

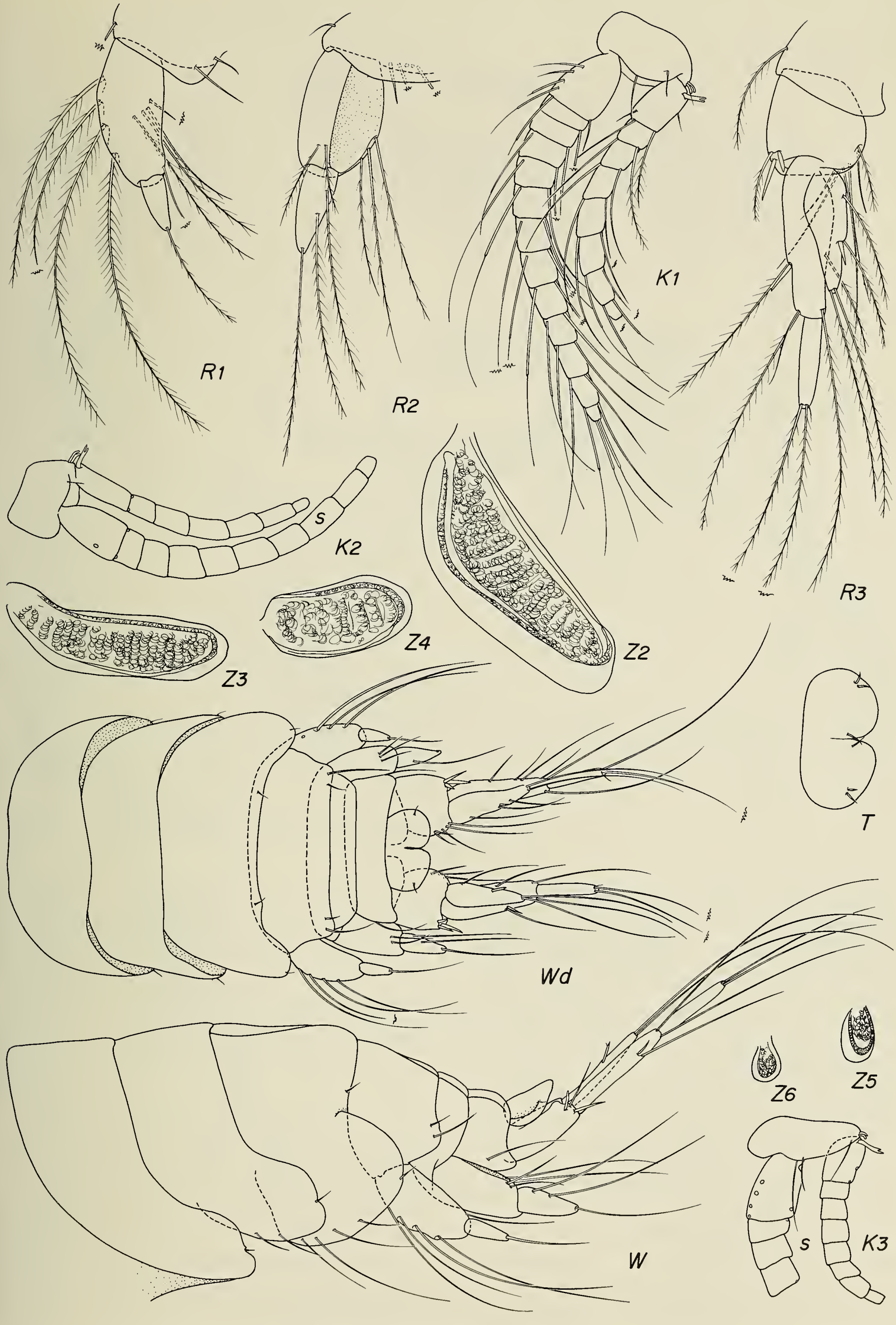

Fig. 4. *Chono angustiarum,* new species, holotype, female "y."

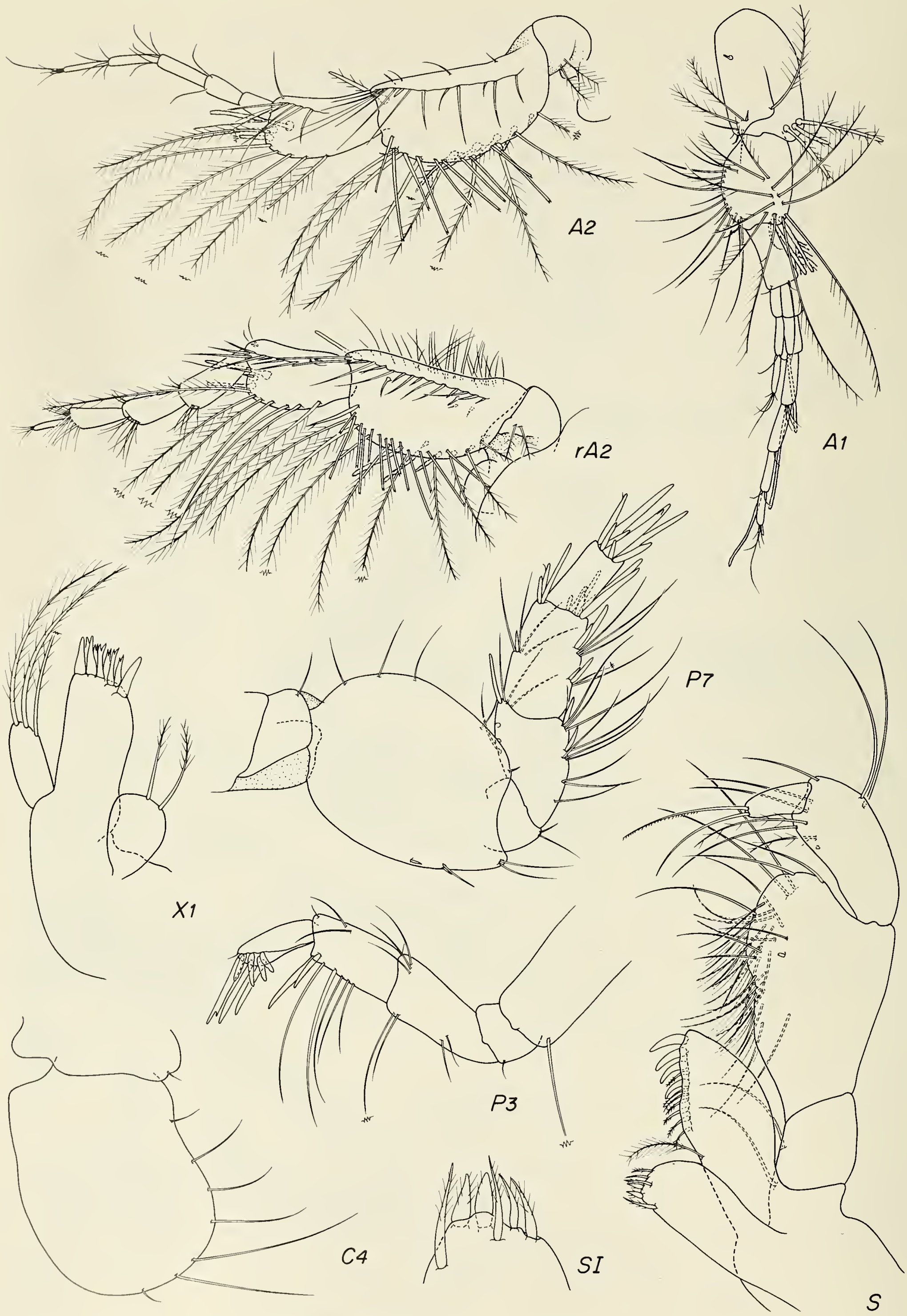

Fig. 5. *Chono angustiarum,* new species, female “z”; r = male “r.”

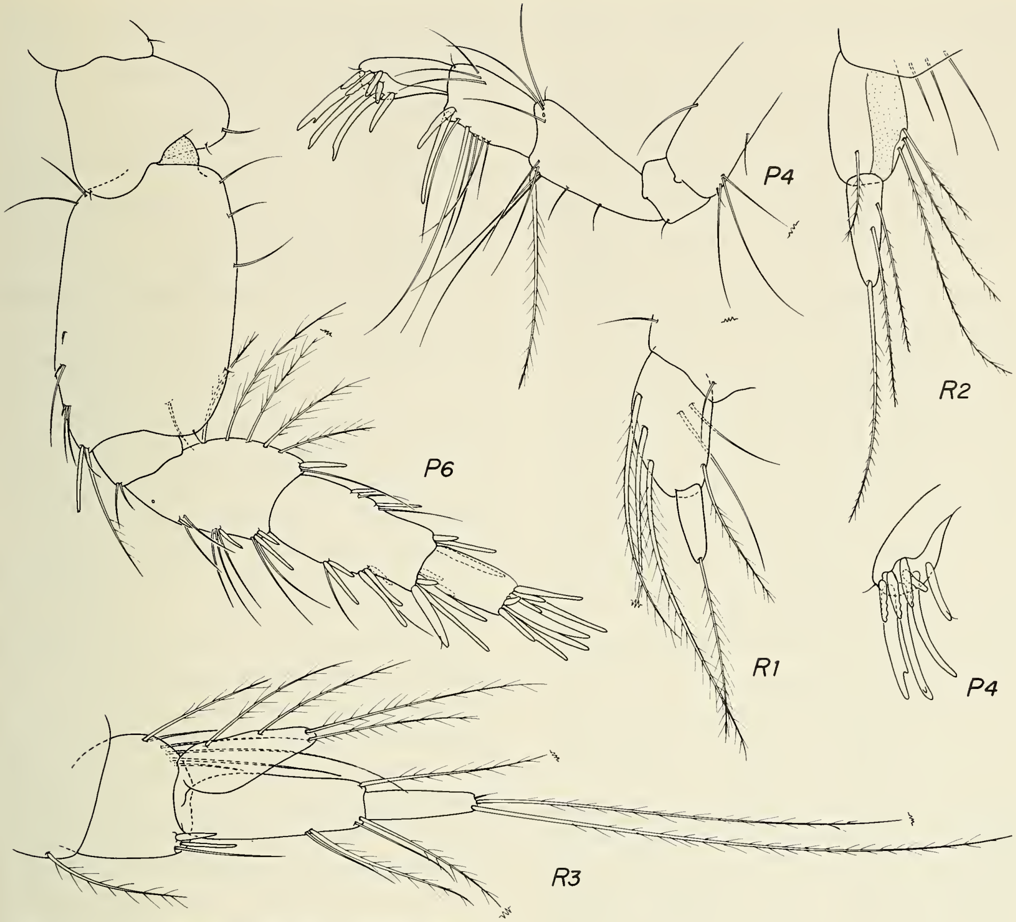

Fig. 6. *Chono angustiarum,* new species, female "z."

2 with 1 apicolateral and 3 medial setae; medial margin of outer ramus of uropod 3 naked, inner ramus formula = E-E.

Generally differing from female "y" in less setose article 2 of pereopods 6–7, larger uropod 3, longer spines on antenna 2, and more setose inner and outer plates of maxilla 2.

Immature female "x," 1.30 mm.—Main differences from female "y" mentioned.

Ostegites rudimentary. Primary flagellum of antenna 1 with 6 articles, formula of long aesthetascs = 0-1-1-1-1-1. Facial formula on antenna 1 = 3 setae; on article 4 of antenna 2 weakly divided into 3 sections of 1, 2, and 5, long spines dominant, on article 5 = 4, article 3 with 1 seta; flagellum with 4 articles. Formula on right and left mandibular palp article 3 = 2-1-2-1. Maxilla 1 outer plate with 8 spines. Inner plate of maxilla 2 with 5 facial setae. Maxilliped palp article 2 lacking facial row of setae.

Coxa 3 with 3 long posteroventral setae and 2 short ventral setae anterior to elongate setae; coxa 4 with 2 long ventral setae and 3 long to medium posterior setae.

Setal and spine formulas on pereopod 3 = 2, 1, 2-0, 2 + 1 + 2; pereopod 4 = 2, 1, 2-0, 2 + 1 + 2. Peduncular spine formulas of pleopods 1–3 = 2 and 0, 2 and 0, 2 and 0; rami articular formulas = 9-6, 8-5, 8-6 (R = 10-7, 8-5, 8-5); basal setal formulas =

4-1-1-1, 1-1-1-1, 1-0-1-2 (right = 4-1-2-1, 1-1-1-1, 1-1-1-1).

Epimeron 3 with 3 facial setae in horizontal row. Lateral margin on peduncle of uropod 1 with 2 setae and 1 ventral seta; of uropod 2 with 1 apicolateral seta and 2 apicomedial setae; ramus of uropod 2 with 1 medial seta. Peduncle of uropod 3 with 2 (R = 3) setae in ventromedial row, formula on lateral margin on outer ramus = E (R = naked), medial margin naked; inner ramus naked medially.

Generally different from female "y" in that uropods 1, 2 and 3 less setose, epimeron 3 less setose, pleopods fewer articles and basal setae, antennae 1 and 2 with fewer articles and setae, maxillipedal palp less setose, mandibular palp less setose, maxilla 1 outer plate less spinose, coxae 3–4 less setose, and all legs less setose.

Male "r," 1.52 mm.—Like female "y" except for the following.

Primary flagellum of antenna 1 with 8 (R = 9) articles, formula of long aesthetascs = 4-4-5-2-3-1-1-1 (R = 4-2-3-2-3-2-1-1-1); facial row on article 4 of antenna 2 with 16 medium to long spines in weakly divided sections; facial row on article 5 with 7 spines; article 3 with 2 setae; flagellum with 4 articles, all but distalmost article distally widened. Outer plate of maxilla 1 with 8 spines. Inner plate of maxilla 2 with 2 facial setae. Maxillipedal palp article 2 with 2 setae in facial row.

Gnathopod 2 dactyl with minute serrations along inner margin.

Coxa 4 with 4 (R = 3) medium to long posterior setaee.

Setal and spine formula on pereopod 3 = 4, 3, 2-0, 3 + 1 + 3; pereopod 4 = 4, 4, 2-0, 3 + 1 + 3.

Segmental formulas of pleopods 1–3 = 13-9, 10-8, 11-8; basal setal formulas = 5-1-1-2, 3-1-1-1, 3-1-1-2. Epimeron 2 with facial row of 4 setae, epimeron 3 with 5 in horizontal facial row.

Lateral margin on peduncle of uropod 1 with 5 setae and 3 ventral setae (R = 4); on uropod 2 with 2 medial setae. Apicolateral corner of peduncle on uropod 3 with 3 spines and 1 seta; ventromedial apical row with 4 setae, formula on lateral margin of article 1 on outer ramus = E-E-EE, medial margin = E-E (R = E); formula on medial margin of inner ramus = E-E-Es.

Generally different from female "y" in less setose coxa 4, fewer spines on maxilla 1 outer plate, more setae and spines on dactyls of pereopods 3–4, epimera 2–3 more setose, uropod 1 laterally more setose, uropod 3 rami more setose and peduncle more spinose, maxillipedal outer plate less spinose and setose, antenna 2 spines longer on articles 4–5, and article 6 on pereopod 7 anterior margin with one spine.

Male "u," 1.24 mm.—Like female "y" except for the following.

Primary flagellum of antenna 1 with 6 articles, formula of long aesthetascs = 1-1-2-1-1-1 (R = 1-1-1-1-1-1). Facial setae on article 4 of antenna 2 in 3 groups of 1-2-6 (R = 1-1-6), on article 5 = 5 in transverse apical row; flagellum with 5 articles, all but distal article distally widened. Formula on left mandibular palp article 3 = 2-1-2-1 (R = 2-1-1-1). Outer plate of maxilla 1 with 7 spines. Inner plate of maxilla 2 with 3 facial setae. Inner plate of maxilliped with 1 medial, 1 facial and 2 apical setae; palp article 2 with 1 facial seta.

Coxa 3 with 3 posterior apical and 2 short ventral setae; coxa 4 with 3 posterior and 2 ventral setae.

Setal and spine formula on pereopod 3 = 2, 1, 2-0, 2 + 1 + 2; pereopod 4 = 2, 1, 2-0, 2 + 1 + 2. Coupling spine formulas of pleopods 1–3 = 2 and 0, 2 and 0, 2 and 0; articular formulas = 9-6, 8-5, 8-5; basal formulas = 5-1-1-3, 1-1-1-2, 3-1-2-2.

Horizontal facial row on epimeron 2 with 2 setae, on epimeron 3 with 3 setae. Peduncle of uropod 1 with 3 setae along lateral margin, no ventral setae; uropod 2 peduncle with 1 apicolateral seta, ramus with 1 medial seta. Apicolateral corner of peduncle on uropod 3 with 2 spines and 1 seta, medial margin with 1 seta, ventromedial apical row with 2 setae, formula on lateral margin of article 1 on outer ramus = EE-EE, medial margin = E-E; formula on medial margin of inner ramus = E-E.

Generally different from female "y" in fewer setae and spines overall, and pleopod 1 with no simple spine in conjunction with coupling hooks.

Juvenile "t," 0.89 mm.—Like female "y" except for the following.

Primary flagellum of antenna 1 with 5 articles, formula of long aesthetascs = 0-1-1-1-1; facial formula on article 4 of antenna 2 in 3 sections of 1, 1, and 2 long spines, on article 5 = 2 (all in transverse apical set); article 3 with 1 seta; flagellum with 4 articles. Formula on right and left mandibular palp article 3 = 2-1-1-1. Outer plate of maxilla 1 with 6 spines. Inner plate of maxilla 2 with 3 facial setae. Inner plate of maxilliped with 1 medial, 1 facial, and 2 apical setae; palp article 2 with 1 facial seta.

Coxa 3 with 2 long posterior setae and 1 medium ventral seta; coxa 4 with 2 posterior and 1 ventral setae. Setal and spine formula on pereopod 3 = 1, 0, 2-0, 2 + 1 + 1; pereopod 4 = 1, 0, 2-0, 2 + 1 + 1.

Coupling spine formula of pleopods 1–3 = 2 and 0, 2 and 0, 2 and 0; segmental formulas = 8-5, 6-4, 6-4; basal formulas = 2-1-1-2, 1-1-1-1, 2-1-1-1. Epimeron 2 with 1 facial seta; epimeron 3 with 2 facial setae. Lateral margin on peduncle of uropod 1 with 1 seta, no ventral setae; of uropod 2 with no apicolateral setae and 1 medial seta; rami of uropods 1 and 2 naked except for single apical seta on each. Apicolateral corner of peduncle on uropod 3 with 1 seta, apicomedial corner with 1 seta; lateral margin of article 1 on outer ramus with 2 apical setae.

Different from female "y" in less setosity and spinosity generally, antenna 1 less setose than article 2, antenna 2 article 3 less setose, article 4 with glassy spines on distalmost margin only, and article 5 fewer facial and ventral setae.

Holotype.—USNM 195156, female "z," 1.44 mm (partially illustrated).

Type locality.—HZ1, University of Concepción, Metula Survey, Eastern Magellan Strait, 52°39.9′S, 69°35.9′W, 7–9 m, sand and shell, 9 Apr 1976, coll. Dr. Victor A. Gallardo.

Voucher material.—All close to type locality, 4–11 m. Female "z," 1.44 mm (holotype); female "y," 1.87 mm; female "w," 1.33 mm (immature); female "x," 1.30 (mmature), other females 1.35 mm, 1.30 mm, 1.25 mm, 1.24 mm. Male "r," 1.52 mm; male "v," 1.25 mm, male "u," 1.24 mm. Juvenile "s," 1.09 mm; juvenile "t," 0.89 mm, other juveniles 1.18 mm, 1.13 mm, 1.09 mm, 1.01 mm.

Etymology.—"angustiarum," meaning "of the straits," was selected because type locality is located between two narrows.

Distribution.—Magellan Strait, 4–11 m.

Note on *Phoxocephalopsis*

Barnard and Clark (1984) were unaware of a paper by Varela (1983) describing *Phoxocephalopsis mehuinensis.* That species appears to differ from our *Phoxocephalopsis gallardoi* in the presence of setae on the peduncle of uropod 2, a dense bundle of medioventral setae on the peduncle of uropod 1, much narrower article 6 of pereopod 5, tooth of epimeron 3 more strongly ventral and bearing a long posterior seta, lack of setae on article 2 of the mandibular palp, narrower rostrum, facial spines on article 4 of antenna 1 in a single row versus in groups of 3–4, weaker setation on the inner plate of maxilla 2, and much shorter article 2 on the outer ramus of uropod 3.

Acknowledgments

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HEADSTANDERS OF THE NEOTROPICAL ANOSTOMID GENUS *ABRAMITES* (PISCES: CHARACIFORMES: ANOSTOMIDAE)

Richard P. Vari and Ann M. Williams

Abstract.—The anostomid characiform genus *Abramites* Fowler (1906) is revised and two species are recognized. *Abramites eques* (Steindachner, 1878) occurs only in the Río Magdalena basin of Colombia. *Abramites hypselonotus* (Günther, 1868) is distributed through the Río Orinoco, Rio Amazonas, and the Río Paraguay-lower Río Paraná systems. The two species can be distinguished via differences in pigmentation, meristics, and morphometrics. *Leporinus solarii* Holmberg (1887), *Abramites microcephalus* Norman (1926), *Abramites ternetzi* Norman (1926) and *Leporinus nigripinnis* Meinken (1935) are placed as synonyms of *Abramites hypselonotus* (Günther). The genus is characterized by its deep body, postpelvic median keel, increased anal-fin ray count, and perhaps by a unique autogenous ossification on the dorsomedial surface of the fourth infrapharyngobranchial. A key is provided to the species of *Abramites*.

The genus *Abramites* comprises a small group of distinctive anostomid characiforms whose common aquarium name of "headstanders" derives from their habit of resting in life with the body at a distinct angle with the head down (see Géry 1977: 177 for life photos showing this trait). *Abramites* species occur in the Río Magdalena system of trans-Andean northwestern South America, and in the Río Orinoco, Rio Amazonas and the Río Paraguay and lower Río Paraná systems of the cis-Andean slope of the continent. The two species we recognize as valid, *Abramites hypselonotus* (Günther, 1868) and *A. eques* (Steindachner, 1878), were originally described as members of the large anostomid genus *Leporinus.* Fowler (1906:331) advanced *Abramites* for *A. hypselonotus,* citing the longer anal-fin base in that species as a character distinguishing it from the remainder of *Leporinus.* Eigenmann (1920a:31, 1920b: 16, 1923:117) expanded *Abramites* by adding *Leporinus eques* Steindachner of the Magdalena system in Colombia, a practice followed by Norman (1926:92–94). Borodin (1929:287), apparently unaware of Eigenmann's and Norman's publications, independently noted that *Leporinus eques* Steindachner was closely aligned to *L. hypselonotus.* Although Borodin discussed two additional characters diagnostic for *Abramites* relative to *Leporinus* (sensu stricto), he considered the two taxa to be congeneric. The synonymy of *Abramites* into *Leporinus* was continued by some authors (e.g., Eigenmann and Allen 1942:305 and 308), but most researchers have followed Fowler in recognizing a distinct *Abramites* for this readily distinguishable group of anostomid fishes.

Although the overall body form readily delimits the genus, the number of recognizable species of *Abramites* has not previously been analyzed in depth. Böhlke (1958:101–105) presented evidence for the synonymy of *Abramites microcephalus* Norman into *A. hypselonotus* (Günther). The other nominal cis-Andean species have not been the subject of thorough systematic studies. Different authors have inconsistently recognized some of the nominal forms at the specific or subspecific levels and have differed on the number of recognizable forms. The resolution of these problems was historically hampered by the limited samples of *Abramites* specimens in systematic collections. Recent collecting activities in the Amazon, Orinoco, and La Plata basins have provided additional specimens from all three systems, making possible a resolution of the remaining species-level questions.

Methods and materials.—Measurements were made with dial calipers and data recorded to tenths of a millimeter. Counts of total vertebrae were taken from radiographs and include the four vertebrae of the Weberian apparatus. The fused PU_1+U_1 is considered a single element. The numbers in parentheses following a particular vertebral count are the numbers of radiographed specimens with that count. In species descriptions, subunits of the head are presented as a proportion of head length (HL). Head length itself and measurements of body parts are given as proportions of standard length (SL). In the counts of median and pelvic fins, unbranched fin-rays are indicated by lower case Roman numerals, and branched fin-rays are indicated by Arabic numerals. The observed range of each count and measurement is presented first, followed by the value of the holotype or lectotype when available, in square brackets. The "Material examined" section of each species account follows the arrangement in Vari (1984).

Specimens examined for this study are deposited in the following institutions: American Museum of Natural History, New York (AMNH); Academy of Natural Sciences of Philadelphia (ANSP); British Museum (Natural History), London (BMNH); California Academy of Sciences, San Francisco (CAS); Coleccíon Ictiológica del Museo de La Plata (CIMLP), La Plata; Field Museum of Natural History, Chicago (FMNH); Los Angeles County Museum, Los Angeles (LACM); Museo de Biológia, Universidad Central de Venezuela, Caracas (MBUCV); Museum of Comparative Zoology, Cambridge (MCZ); Muséum National d'Histoire Naturelle, Paris (MNHN); Muséum d'Histoire Naturelle, Geneva (MHNG); Museo de Zoologia da Universidade de São Paulo (MZUSP); Naturhistoriska Riksmuseet, Stockholm (NRM); Naturhistorisches Museum Wien, Vienna (NMW); University of Michigan, Museum of Zoology, Ann Arbor (UMMZ); and National Museum of Natural History, Smithsonian Institution, Washington, D.C. (USNM).

Abramites Fowler

Abramites Fowler, 1906:331, type *Leporinus hypselonotus* Günther, by original designation.

Diagnosis.—*Abramites* is a distinctive group of anostomid characiforms, which attain an adult body size of 200 mm SL (Dahl 1971:112). The genus is characterized by a deep, laterally-compressed body, a distinct postpelvic median keel extending between the base of the pelvic fin and the anus, and a high anal-fin ray count. A unique autogenous ossification on the dorsomedial surface of the cartilaginous fourth infrapharyngobranchial may also characterize the genus (see below).

Rayed dorsal-fin rays i,10–11 or ii,9,i or ii,9–11 or iii,10 (when three unbranched rays present, first very small); anal-fin rays i,12 or ii,10–12 or iii,11–14 (when three unbranched rays present, first very small); pectoral-fin rays 13 to 15; pelvic-fin rays i,7–8 or i,7,i (rare); principal caudal fin rays 10+9; adipose dorsal fin always present. Pored lateral line scales from supracleithrum to hypural joint 33 to 36 (33 rare); 4 to 6 pored scales beyond hypural joint on base of caudal fin. Number of scales in a transverse series from origin of dorsal fin to lateral line 6 to 7½ (6 and 7½ rare); number of scales in a transverse series from origin of anal fin to lateral line 5 to 6½ (5 rare). Four teeth on each side of lower jaw and three teeth on premaxilla. No teeth on maxilla. Pharyngeal dentition bicuspidate, limited to fifth ceratobranchial and fifth upper pharyngeal tooth plate.

Remarks.—The two species recognized in this study, *Abramites hypselonotus* (Günther) and *A. eques* (Steindachner), were originally described as a part of the much larger genus *Leporinus.* Fowler (1906:331) advanced *Abramites* for *A. hypselonotus* in light of the longer anal-fin base in that species relative to the remainder of *Leporinus.* Eigenmann (1907:769) stated that "The name is not admissible" due to the absence of a distinct gap in the anal-fin ray counts of *Abramites* versus the remaining *Leporinus* species. He returned *hypselonotus* to *Leporinus* (Eigenmann and Kennedy 1907: 512; Eigenmann, McAtee, and Ward 1907: 125; Eigenmann 1909:323 and 344, 1910: 426). Later without comment, Eigenmann (1920a:31, 1920b:16, 1923:117) both recognized *Abramites* and expanded the genus to include *Leporinus eques* Steindachner. Although Norman (1926) noted some additional diagnostic characters for *Abramites,* Borodin (1929:287) preferred not to recognize the genus because he believed that a subdivision of *Leporinus* should be the result of a more inclusive study. With a few exceptions (Eigenmann and Allen 1942:308, Schultz 1944:268), subsequent authors have nonetheless recognized *Abramites.* Overall phylogenetic relationships within the Anostomidae remain unresolved other than for the subfamily Anostominae examined by Winterbottom (1980). The absence of information on the phyletic history of *Abramites, Leporinus* and associated genera makes it impossible unequivocally to determine whether the recognition of *Abramites* would make *Leporinus* non-monophyletic. If *Abramites* represents a specialized subunit within *Leporinus,* then the recognition of both genera would result in a nonmonophyletic *Leporinus.* There is, however, no phylogenetic analysis that indicates this is the situation, or even evidence that a broadly defined *Leporinus* including *Abramites* constitutes a natural assemblage. In the absence of such information and in light of a series of derived characters unique to *Abramites,* we prefer to recognize the genus.

The most obvious of the series of evidently derived characters delimiting *Abramites* is the increase in the greatest body depth relative to all other anostomids, which typically have fusiform or relatively shallow bodies. Correlated with that character is the possession of a postpelvic median keel unique to *Abramites* among anostomids. Fowler first proposed the genus (1906:331) due to its "larger anal basis," presumably referring to the higher number of branched anal-fin rays relative to the condition in other anostomids. That distinction is valid for the vast majority of *Abramites* and *Leporinus* (sensu stricto). Ten branched anal-fin rays, nonetheless, occur both in rare individuals of *Abramites hypselonotus* and some specimens of the anostomid *Anostomoides laticeps* Eigenmann (Eigenmann 1912:299, Géry 1977:178).

An additional character possibly synapomorphic for *Abramites* is found in the dorsal portion of the gill arches. Anostomids have an extensive fourth infrapharyngobranchial (PB_4) with a reduced, posterolaterally angled fourth upper pharyngeal tooth plate (UP_4) (see Vari 1983: fig. 20). In that bauplan the medial and dorsal surfaces of the cartilaginous PB_4 lack any bony covering. *Abramites hypselonotus* has a discrete autogenous ossification in the posterodrosal lateral surface of PB_4 (Fig. 1). The ossification is very small in a 62 mm SL cleared and stained specimen, but very prominent in a 97 mm SL individual. Such an autogenous ossification is not found in the remaining examined anostomid genera (*Anostomus, Gnathodolus, Laemolyta, Leporellus, Rhytiodus, Schizodon,* and *Synaptolaemus*) and its possession is consequently

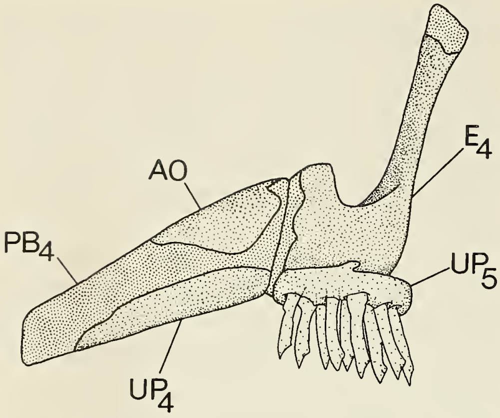

Fig. 1. *Abramites hypselonotus,* USNM 164036, fouth and fifth upper pharyngeal tooth plates (UP_4, UP_5), fourth infrapharyngobranchial (PB_4), fourth epibranchial (E_4) and autogenous ossification of fourth infrapharyngobranchial (AO), right side, medial view.

considered derived. The absence of material of *Abramites eques* suitable for clearing and staining prevents examination of the condition in that species. As such, we can only tentatively suggest that the autogenous ossification is a synapomorphy for the genus.

The form of upper jaw dentition suggested by Myers (1950:193) as distinctive for *Abramites* has not, on further examination, proved to be unique to the genus among anostomids. Borodin (1929:287) stated that "the gill membranes . . . are only feebly attached in *Leporinus hypselonotus*" contrary to the firm attachment in other *Leporinus* species. We have been unable to find any difference in the condition of the gill membrane attachment between *Abramites* and *Leporinus* (sensu stricto).

Key to the species of *Abramites* Fowler

1. Branched anal-fin rays 13 or 14. Five transverse bars on body; anteriormost bar under dorsal fin . . . . *A. eques* (Steindachner)

– Branched anal-fin rays 10 to 12. Eight transverse bars on body; bars distributed between nape and rear of caudal peduncle . . . . *A. hypselonotus* (Günther)

Abramites hypselonotus (Günther)

Figs. 2–6, Table 1

Leporinus hypselonotus Günther, 1868a: 480, type locality: Upper Amazon, Xeberos (=Jeberos), Peru.—Günther, 1868b: 244, pl. XXII, Peru, Xeberos.—Cope, 1878:690 Peru, Pebas.—Steindachner, 1882:12, Venezuela, Ciudad Bolivar.—Eigenmann and Eigenmann, 1891:51, citation.—Eigenmann and Kennedy, 1903: 512, Asuncion or Matto (=Mato) Grosso.—Eigenmann, McAtee and Ward, 1907:125, Paraguay, Puerto Max.—Eigenmann, 1909:323,344, Orinoco, Amazon and Paraguay basins.—Eigenmann, 1910:426, citation.—Bertoni, 1914:10, Paraguay.—Borodin, 1929:287, pl. 17, Brazil, Manacapuru.—Bertoni, 1939:54, Paraguay.—Eigenmann and Allen, 1942: 308, Peru, Iquitos.—Schultz, 1944:268, citation.

Leporinus Solarii Holmberg, 1887:222, type locality: Argentina, Río Paraná, Misiones.—Holmberg, 1891:187, Argentina, Río Paraná, Misiones.

Leporinus eques, Boulenger, 1896:34, misidentification of *L. hypselonotus,* Brazil, Descalvados and San Luis (=São Luís), Matto (=Mato) Grosso.—Eigenmann, 1909:344, Amazon and Paraguay basins.

Abramites hypselonotus, Fowler, 1906:331, designated as type species of *Abramites.*—Norman, 1926:94, in key.—Fowler, 1945:129, literature compilation.—Myers, 1950:193, Peru, Pevas.—Böhlke, 1958:101, Ecuador, Chickerota and Río Pucuno, *Abramites microcephalus* Norman placed as a synonym.—Ringuelet and Aramburu, 1961:37, Argentina.—Géry, 1964:35, Peru, Iquitos.—Ovchynnyk, 1968:249, Ecuador, Río Bobonaza and Río Pucuno.—Mago-Leccia, 1970:75,

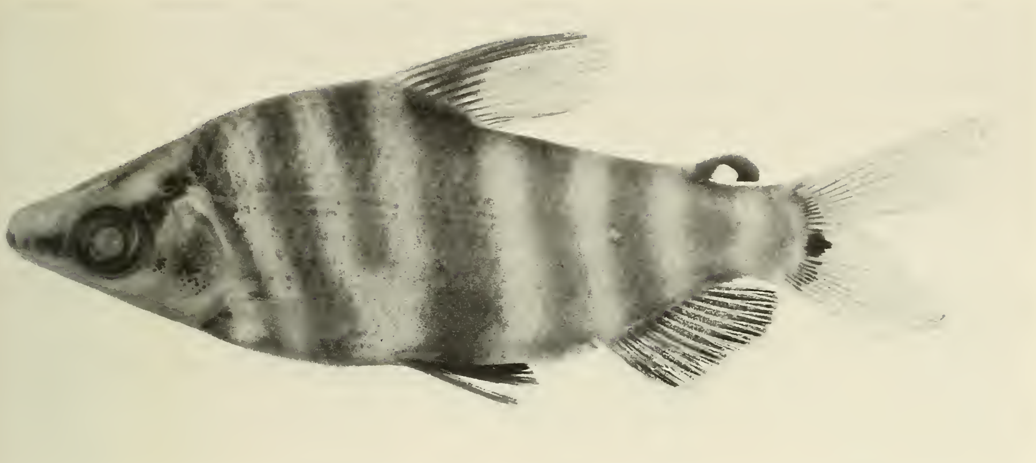

Fig. 2. *Abramites hypselonotus,* BMNH 1977.3.10:146–149, 33.0 mm SL; Peru, Loreto, vicinity of Iquitos.

Venezuela.—Fowler, 1975:108, citation.—Géry, 1977:175, in key.

Leporinus solarii, Eigenmann, 1909:349, lower Río Paraná and Río La Plata.—Eigenmann, 1910:426, Río de La Plata.—Pozzi, 1945:258, Argentina.—Meinken, 1937:74, middle Río Paraná, *L. nigripinnis* Meinken placed into synonymy.

Abramites microcephalus Norman, 1926:92 and 94, type locality: near the mouth of the River Amazon.—Pozzi, 1945:258, Argentina.—Fowler, 1950:250, literature compilation.—Böhlke, 1958:101, placed as synonym of *Leporinus hypselonotus* Günther.—Fowler, 1975:108, citation.

Abramites ternetzi Norman, 1926:93–94, type locality: Brazil, Matto (=Mato) Grosso, São Luís and Descalvados.—Ringuelet, 1975:72, upper Río Paraguay.—Fowler, 1975:108, citation.

Leporinus salarii Borodin, 1929:288, as a possible synonym of *L. hypselonotus,* specific name misspelled.

Leporinus nigripinnis Meinken, 1935:193, fig. 1, type locality: Argentina, Corrientes.—Meinken, 1937:74, *L. nigripinnis* placed as synonym of *L. solarii* Holmberg.—Pozzi, 1945:258, Argentina.

Abramites solarii, Ringuelet, Aramburu and Alonso de Aramburu, 1967:213, fig. 9A, Argentina, Santa Fe, Laguna Setúbal, and Corrientes, Isla Apipé Grande.—Ringuelet, 1975:61, Río Paraná and Río Paraguay.—Bleher, 1986:72, Paraguay, Río Pilcomayo.

Abramites eques, Fernández-Yépez, 1950: 116, Venezuela, Río Salinas.—Mago-Leccia, 1970:75, Venezuela.

Abramites hypselonotus ternetzi, Géry, 1977:175, Río Paraguay basin.

Abramites hypselonotus hypselonotus, Géry, 1977:75, Amazon and Orinoco basins.

Diagnosis.—The possession of 10 to 12 branched anal-fin rays and eight bars of irregular shape on the body between the nape and the caudal peduncle distinguishes *Abramites hypselonotus* from *A. eques,* which has 13 or 14 rays and 5 bars extending from under the dorsal fin to the caudal peduncle. The two species also differ in the relative length of the postorbital portion of the head and interorbital width (Table 1).

Description.—Morphometrics of the lectotype and other specimens of the species given in Table 1. Body compressed laterally;

Table 1.—Morphometrics of *Abramites hypselonotus* and *A. eques*: A, *Abramites hypselonotus,* lectotype; B, *A. microcephalus,* holotype; C, *A. ternetzi,* lectotype; D, Range for all examined specimens of *A. hypselonotus*; E, Lectotype of *A. eques*; F, Range for lectotype and paralectotypes of *A. eques.* Standard length expressed in mm; measurements 1 to 10 are proportions of standard length; 11 to 15 are proportions of head length.

	A	B	C	D	E	F
Standard Length	98.9	101.7	54.3	40.0–123.4	138.8	106.7–163.7
1. Greatest body depth	0.39	0.42	0.42	0.34–0.47	0.36	0.34–0.36
2. Snout to dorsal-fin origin	0.49	0.49	0.52	0.46–0.53	0.45	0.45–0.48
3. Snout to anal-fin origin	0.77	0.80	0.82	0.74–0.84	0.73	0.73–0.77
4. Snout to pelvic-fin origin	0.49	0.48	0.51	0.46–0.52	0.46	0.45–0.48
5. Snout to anus	—	0.77	0.77	0.73–0.79	0.71	0.71–0.75
6. Origin of hypural fin to hypural joint	0.58	0.62	0.61	0.56–0.63	0.61	0.57–0.61
7. Least depth of caudal peduncle	0.12	0.12	0.13	0.11–0.13	0.12	0.12
8. Pectoral-fin length	0.22	0.21	—	0.19–0.24	0.20	0.19–0.21
9. Pelvic-fin length	0.21	0.19	—	0.18–0.24	0.23	0.21–0.23
10. Head length	0.26	0.23	0.26	0.23–0.29	0.23	0.23–0.25
11. Snout length	0.28	0.31	0.30	0.27–0.34	0.30	0.29–0.32
12. Orbital diameter	0.26	0.28	0.33	0.25–0.33	0.29	0.25–0.29
13. Postorbital head length	0.38	0.40	0.35	0.34–0.42	0.43	0.43–0.46
14. Interorbital width	—	0.39	0.35	0.34–0.43	0.45	0.43–0.46
15. Gape width	—	0.22	0.19	0.18–0.23	0.20	0.18–0.20

deep, more so in larger individuals. Greatest body depth at origin of dorsal fin. Dorsal profile of head straight in specimens under 45 mm SL, becoming somewhat concave above orbit in larger specimens. Dorsal profile of body very slightly convex to insertion of dorsal fin in individuals under 50 mm SL, curvature increasing with size, largest individuals with a distinct predorsal hump. Predorsal region with an obtuse median ridge. Body profile straight, posteroventrally slanted at base of dorsal fin, straight or slightly convex from insertion of posteriormost dorsal-fin ray to caudal peduncle. Ventral profile of head nearly straight in juveniles, slightly convex in larger specimens. Prepelvic profile of body becoming increasingly convex in larger specimens. Postpelvic body profile smoothly rounded to caudal peduncle. Prepelvic region transversely rounded; postpelvic region with a trenchant median keel terminating posteriorly at anus.

Head pointed in profile, more so in larger specimens, interorbital region transversely convex. Upper and lower jaws equal. Anterior and posterior nostrils of each side distinctly separated, anterior tubular, posterior an oblique slit.

Lower jaw with four teeth on each side. Two medial teeth with inner surfaces spoon-shaped and a strong medial cusp grading into a smaller lateral cusp. Third tooth much smaller with cusps less distinct. Lateral tooth small, peg-like, not readily visible except in cleared and stained specimens, lacking in smaller individuals. Upper jaw with three teeth on premaxilla, none on maxilla. Two medial teeth with inner surfaces spoon-shaped. Distal portion of medial tooth triangular with a smaller medial cusp; middle tooth triangular; lateral tooth distinctly smaller with a straight distal margin. Gill membranes tightly attached to urohyal.

Scales cycloid, firm. Pored lateral line scales between supracleithrum and hypural joint 33 to 36 (33 only in the one available specimen from the Rio Araguaia) [35]; 4 to 6 pored lateral line scales extending beyond hypural joint onto base of caudal fin; canals

Fig. 3. *Abramites hypselonotus,* UMMZ 207433, 43.8 mm SL; Paraguay, Misiones, Rio Parana.

in lateral line scales straight or slightly divergent. Scales in transverse series from lateral line to origin of dorsal fin 6 to 7½ (6 and 7½ rare) [6½]. Scales in transverse series from lateral line to origin of anal fin 5 to 6½ (5 rare) [5½].

Rayed dorsal fin obtusely pointed, last unbranched and first and second branched rays longest. Dorsal-fin rays i,10–11 or ii,9,i or ii,9–11 or iii,10 (when three unbranched rays present, first very small; i,10–11, ii,9,i and iii,10 less common) [ii,10]. Adipose fin of moderate size, unscaled. Anal-fin margin slightly convex to slightly concave. Anal-fin rays i,12 or ii,10–12 or iii,11-12 (when three unbranched rays present, first very small) [ii,11]. Pectoral-fin obtusely pointed, extending about two-thirds to three-quarters distance to vertical through insertion of pelvic fin. Pectoral-fin rays 13 to 15. Pelvic fin obtusely pointed, extending approximately one-half to two-thirds distance to anus. Pelvic-fin rays i,7–8 or i,7,i [i,8]. Caudal-fin forked, unscaled. Principal caudal-fin rays 10+9.

Vertebrae 37(12), 38(8) [38].

Coloration in preservative.—Overall ground coloration of specimens fixed in formalin and lacking guanine on scales tan, more silvery in individuals retaining guanine. Head with band of dark pigmentation on snout from anterior surface of lower lip to anterior margin of orbit. A posterodorsally angled band from rear margin of orbit to above opercle. Middorsal portion of head dark. Body with eight vertical or slightly posteroventrally aligned bars; bars sometimes incomplete or broken vertically. First bar extends from nape to behind pectoral-fin insertion. Second bar from middle of predorsal region to posterior one-third of prepelvic region. Third bar developed ventrally to varying degrees; extending to pelvic-fin insertion in some individuals. Fourth bar very prominent, running between dorsal-fin base and region of pelvic fin. Fifth bar a distinct band (Fig. 2), or subdivided into dorsal and ventral sections (Figs. 3, 4), or vertically divided ventrally (Fig. 5). Sixth bar terminating ventrally at anterior portion of anal fin, anteriorly expanded midlaterally in individuals with horizontally subdivided fifth bar (Figs. 3, 4). Seventh bar on caudal peduncle. Eighth bar at base of caudal-fin rays, crescent shaped, with prominent dark spot at base of middle caudal-fin rays in juveniles (Fig. 2). Dorsal fin with anterior rays and basal portion of remaining rays darkly pigmented. Adipose fin darkly pigmented basally and sometimes along dorsal

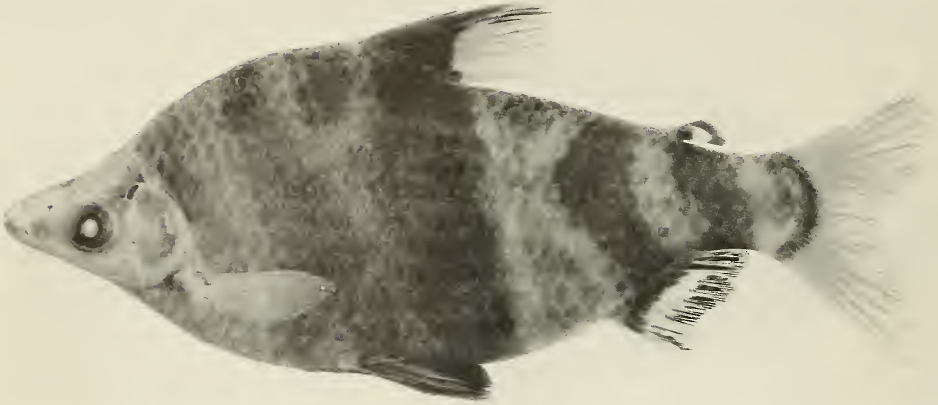

Fig. 4. *Abramites hypselonotus,* MZUSP 27721, 88.7 mm SL; Brazil, Mato Grosso do Sul, Rio Taquari.

margin. Anal fin ranging from darkly pigmented, through mottled, to clear. Pelvic fin darkly pigmented. Pectoral and caudal fins hyaline. See also "Remarks" for discussion of geographic variation in pigmentation.

Common names.—Peru: San Pedrito (Ortega and Vari 1986); Paraguay: Per-do-folha (Eigenmann and Kennedy 1903); Venezuela: Picúo (Mago-Leccia 1970); Argentina: Jikii (Ringuelet, Aramburu and Aramburu 1967).

Remarks.—Species of the genus *Abramites* have a very distinctive body form and pigmentation pattern and demonstrate relatively little morphological variation. Nonetheless, *A. hypselonotus* has four junior synonyms, one described from the Amazon basin and three from the Paraguay-lower Paraná system. In part this may be a consequence of the pronounced ontogenetic increase in body depth in the species, compounded by geographic variation in pigmentation.

Norman (1926:92) described *Abramites microcephalus* on the basis of a single specimen originating "near the mouth of the River Amazon." That nominal form was purportedly distinguished from *A. hypselonotus* Günther by differences in the relative length of the head and pelvic fins. Böhlke (1958:101–103) noted that these characters did not adequately delimit the two nominal forms and thought it "best to consider *microcephalus* a synonym of *hypselonotus.*" Our studies on a much larger series of Amazonian specimens than were available to Böhlke have shown a continuum in all characters between the nominal forms (Table 1) and support Böhlke's placement of *microcephalus* into the synonymy of *hypselonotus.*

The three nominal *Abramites* species from the Paraguay-lower Paraná system are *Leporinus solarii* Holmberg (1887), *Abramites ternetzi* Norman (1926) and *Leporinus nigripinnis* Meinken (1935). The proliferation of names for La Plata basin *Abramites* is in large part a consequence of Norman and Meinken's apparent lack of knowledge of *Leporinus solarii* Holmberg. Norman, in his key to *Abramites,* did not mention *solarii,* and a similar lapse characterized Meinken's (1935) publication. Once Meinken learned of the existence of Holmberg's species, he placed his nominal species, *Leporinus nigripinnis,* as a synonym of *L. solarii* (Meinken 1937). More recently Géry (1977) has drawn attention to the similarities between the three nominal La Plata basin *Abramites* species. Although neither the type series of *Leporinus solarii* nor that of *L. nigripinnis*

Fig. 5. *Abramites hypselonotus,* MCZ 59420, 98.6 mm SL; Ecuador, Rio Punino, above Coca.

is evidently extant, the data and figures in the original descriptions together with an examination of the lectotype and paralectotypes of *Abramites ternetzi,* leave no doubt as to the conspecificity of the three nominal *Abramites* species from the La Plata basin.

Specimens of *Abramites* from the Orinoco and Amazon basins and those from the Paraguay-lower Paraná system are indistinguishable on the basis of examined meristic and morphometric features (Table 1), although there are some differences in the "typical" pigmentation patterns between the populations. Individuals from the Amazon and Orinoco basins typically have unpigmented anal fins (Fig. 5) whereas samples from the La Plata basin usually have the fin pigmented (Fig. 4). However, individuals with varying amounts of dark pigmentation on the anal fin are found in low numbers in the Amazon populations, and individuals with little or no anal-fin pigmentation occur in Paraguay-Paraná samples. Similarly, the third and fifth vertical bars are typically vertically incomplete or broken in individuals from the Paraguay-Paraná system (Figs. 3, 4) contrary to their usual full development in Amazonian and Orinocan specimens (Figs. 2, 5). Nonetheless, Amazonian basin individuals with patterns similar to those of the La Plata basin form are encountered in moderate numbers. As a consequence, no discrete difference in pigmentation exists to discriminate the nominal *solarii* of the La Plata basin from Amazonian *hypselonotus.*

In light of the lack of any known characters, pigmentary, meristic or morphometric, to delimit the nominal forms from the different cis-Andean basins, they are considered conspecific. A single species, *Abramites hypselonotus* (Günther), ranging from the Orinoco to Paraná basins, is recognized with four synonyms: *Leporinus Solarii* Holmberg, *L. nigripinnis* Meinken, *Abramites microcephalus* Norman, and *A. ternetzi* Norman.

Leporinus hypselonotus was described by Günther from three specimens now in relatively poor condition. The individual in the best condition (BMNH 1867.6.13:40, approx. 100 mm SL) is designated as the lectotype, and the two remaining syntypes (BMNH 1867.6.13:41–42) thus become paralectotypes.

Norman (1926) based his description of *Abramites ternetzi* on two specimens from Sao Luis and Descalvados, Mato Grosso, Brazil. The individual from Sao Luis (BMNH 1895:5.17:156) is designated as the

Fig. 6. Geographic distribution of *Abramites hypselonotus* (square = lectotype locality, filled circles = sites of other collections) and *Abramites eques* (star = approximate lectotype locality) (some symbols represent more than one collecting locality or lot of specimens).

lectotype with the second syntype (BMNH 1895.5.17:155) thus becoming a paralectotype.

Reports of *Leporinus eques* from the Paraguay basin by Boulenger (1896) followed by Eigenmann (1909) were based on the two specimens used by Norman (1926) as the syntypes of *Abramites ternetzi.* That species is herein considered conspecific with *A. hypselonotus. Abramites eques* has also been recorded as an element of the Rio Orinoco ichthyofauna (Fernández-Yépez 1950: Mago-Leccia 1967, 1970). Fernández-Yépez (1950:116) noted that his single specimen had 10 branched anal rays. That value falls into the range for *A. hypselonotus* rather than *A. eques.* All examined Venezuelan *Abramites* specimens are *A. hypselonotus,* and we assume that the records of *A. eques* in the Orinoco are misidentifications.

Distribution.—Río Orinoco, Río Amazonas, Río Paraguay and lower Río Paraná basins (Fig. 6).

Material examined.—BRAZIL: near mouth of River Amazon, BMNH 1926.3.2:571, 1 (101.7, holotype of *Abramites microcephalus*). Rio Amazonas, MNHN 99-180 and 181, 2; MNHN 09-278 and 279, 2. *Pará.* Santarem, FMNH 55171, 4 (3, 39.0–43.0). *Amazonas.* Manacapuru, MCZ 21436, 9 (4, 59.3–63.8); MCZ 35348, 1. Ilha da Marchantaria, USNM 278281, 1, (60.3). Rio Solimoẽs, Ilha Sorubim, above Coari, 10 (5, 57.6–62.9). Santo Antonio do Içá, mouth of Rio Içá, MZUSP 20998, 5 (3, 60.4–77.2). Benjamin Constant, MZUSP 20727, 3.—*Goiás.* Rio Araguaia, Ilha do Bananal, MZUSP 20673, 1 (64.7).—*Mato Grosso.* Descalvados, BMNH 1895.5.17:156, 1 (48.5, paralectotype of *Abramites ternetzi*). São Luís do Caceres, BMNH 1895.5.17:155, 1 (54.3, lectotype of *Abramites ternetzi*; listed by Norman as being from San Luis); FMNH 55173, 2 (61.0–74.0). Santo Antônio do Leverger, Rio Cuiabá, MZUSP 4396, 1 (64.4).—*Mato Grosso do Sul.* Rio Taquari, Coxim, MZUSP 27721, 1 (88.7).

PERU: Peruvian Amazon, ANSP 21434, 1.—*Loreto.* Xeberos (=Jeberos), BMNH 1867.6.13:40, 1 (approx. 100 mm; lectotype of *Leporinus hypselonotus*); BMNH 1867.6.13:41–42, 2 (approx. 110–114 mm; paralectotypes of *Leporinus hypselonotus*). Shanso Caño, near Pebas, USNM 175915, 3 (45.7–52.6); USNM 175913, 1. Río Napo system, Cayapoza, NRM SOK/1984333.4162, 6. Iquitos, CAS 57629, 2 (86.4–112.5); USNM 167799, 3 (77.1–95.3). Río Maranon, due south of Isla Iquitos, ANSP 137814, 1. Peruvian Amazon, near Iquitos, BMNH 1977.3.10:146–149, 4. Río Yavari near Pau-mari, NRM THO/1971363.3085, 1 (78.7).—*Amazonas.* 1 km downstream from Caterpiza, LACM 41825-3, 1 (107.1). La Poza, LACM 36323-3, 1 (86.1).—*Ucayali.* Río Ucayali, Pucallpa, USNM 261479, 2 (61.4–75.2). Río Ucayali, Masisea, MZUSP 26452, 5 (2, 66.0–88.3); USNM 261491, 4 (2, 58.7–67.9); AMNH 35689, 1; AMNH 35690, 1. Río Ucayali, Utoquinia, USNM 261403, 2 (71.5–72.0).—*Pasco.* Río Picis, Puerto Bermudez, CAS 57628, 2 (101.1–108.2).

ECUADOR; *Napo-Pastaza.* Lower Río Bobonaza near Chicherota, ANSP 75958, 1 (110.8); ANSP 75957, 1 (121.4); USNM 164036, 1 (123.4); USNM 164022, 1 (92.6). Río Punino, tributary of Río Payamino, above Coca, MCZ 59420, 2 (96.8–102.8). Río Villano, USNM 164052, 2 (102.0–116.2). Río Copataza (02°00′S, 77°35′W), 2 (88.4–90.1).

BOLIVLA: *Beni.* Río Guaporé, near Costa Marquez, USNM 278282, 2 (63.0–81.6).

COLOMBIA: *Caqueta.* Río Orteguasa, near Florencia, USNM 120183, 1.—*Amazonas.* Leticia, USNM 216869, 1.—*Vaupes.* Río Vaupes, Mitu, USNM 278283, 1.—*Meta.* Río Negrito, midway between La Argelia and La Balsa, ANSP 128608, 1. Río Metica, near entrance to Lago Mozambique, ANSP 128912, 1. Río Metica, 1.5 km E of Rajote (03°56′N, 73°03′W), ANSP 128600, 1.

VENEZUELA: *Territorio Federal Delta Amacuro.* Río Orinoco (08°34′12″N, 62°15′48″W), USNM 233215, 1 (58.8). Río Orinoco, brazo Imataca, MBUCV V-13404, 1.—*Bolivar.* Río Orinoco, near Caño Araguaito, MBUCV V-13135, 1. Ciudad Bolivar, NMW 68430, 2; NMW 68429, 1.—*Guarico.* Río Portuguesa, Caño Falcon, near Camaguan, MBUCV V-9114, 2. Stream 15 km E of Calabozo, MBUCV V-04265, 1.—*Territorio Federal Amazonas.* Río Orinoco, Raudales de Ature near Puerto Ayacucho, MBUCV V-14395, 1.

PARAGUAY: "Mato Grosso or Asuncion," CAS 57627, 1 (64.1).—*Misiones.* Río Paraná, 2 km E of Ayolas, UMMZ 207433, 4 (2, 47.1–54.9).—*Itapua.* Río Paraná, 11.9 km E of Puerto San Rafael, UMMZ 206122, 2 (1, 96.8). Río Paraná, 1 km. E of Puerto San Rafael, UMMZ 206174, 1 (92.7).—*Concepcion.* Río Aquidaban, Paso Horqueta, UMMZ 207767, 1 (98.0).—*Presidente Hayes.* Puerto Max, FMNH 52623, 1. Río Pilcomayo, near Fortin Pilcomayo, MHNG 2226.25, 3. Villa Hayes, FMNH 55172, 3 (76.1–96.1).

ARGENTINA: *Corrientes.* San Sebastian, MZUSP 10243, 1 (77.2).—*Santa Fe.* Laguna Setúbal, CIMLP 2-VIII-73-2, 6 (2, 40.0–51.0).

Abramites eques (Steindachner)
Figs. 6, 7, Table 1

Leporinus eques Steindachner, 1878:56, pl. 10, figs. 2 and 2a; type locality: Colombia, Río Magdalena.—Eigenmann and Eigenmann, 1891:51, citation.—Eigenmann 1910:426, citation, in part.—Borodin, 1929:287, aligned with *Leporinus hypselonotus* Günther.—not Boulenger, 1896: 34, Descalvados and San Luis, (=São Luís), Matto (=Mato) Grosso.—Not Eigenmann, 1909:344, Paraguay and Amazon basins.

Abramites eques, Eigenmann, 1920a:31, lower (Río) Magdalena.—Eigenmann, 1920b:16, Río Magdalena basin.—Eigenmann, 1923:117, literature compilation, Boulenger record of species in La Plata system questioned.—Norman, 1926:93, in key.—Miles, 1947:140, presence in Río Magdalena system questioned.—Dahl, 1971:111, presence in Río Magdalena confirmed.—Fowler, 1975:107, citation.—Géry, 1977:175, in key.—not Fernández-Yépez, 1950:116, Mago-Leccia, 1970:75, citation of species for Venezuela.

Diagnosis.—The possession of 13 or 14 branched anal-fin rays and five bars on the body under and posterior of the dorsal-fin distinguishes *Abramites eques* from *A. hypselonotus,* which has 10 to 12 branched anal-rays and eight body bars distributed across the body. The two species also differ in the relative lengths of the postorbital portion of the head and interorbital width (Table 1).

Description.—Morphometrics of the lectotype and paralectotypes of the species given in Table 1. Body compressed laterally, moderately deep. Greatest body depth at origin of dorsal fin. Dorsal profile of head somewhat concave above orbit. Dorsal profile of body slightly convex from rear of head

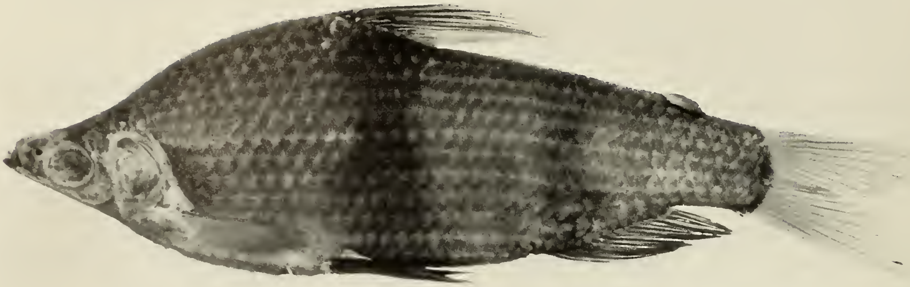

Fig. 7. *Abramites eques,* lectotype, NMW 69549, 138.8 mm SL; Colombia, Rio Magdalena.

to insertion of dorsal-fin, posteroventrally slanted at base of dorsal-fin, very slightly convex from rear of fin to caudal peduncle. Predorsal region with obtuse median ridge. Ventral profile of head straight. Ventral profile of body smoothly curved to caudal peduncle. Prepelvic region obtusely rounded; postpelvic region with median keel terminating posteriorly at anus.

Head pointed in profile, interorbital region convex. Lower jaw slightly longer than upper. Anterior and posterior nostrils of each side distinctly separated, anterior tubular, posterior elongate.

Lower jaw with four teeth on each side. Two medial teeth with inner surfaces spoon-shaped with two primary cusps, medial cusp larger with small central notch. Third tooth smaller with cusps less distinct, subequal. Lateral tooth small, with nearly straight distal margin. Premaxilla with three teeth in graded series; inner surfaces spoon-shaped. Margins of two medial teeth of each side notched, less so in smaller individuals. Lateral tooth smaller, with central notch in otherwise straight distal margin; notch absent or less apparent in smaller specimens. No teeth on maxilla. Gill membranes tightly attached to urohyal.

Scales cycloid, firm. Pored lateral line scales between supracleithrum and hypural joint 35 or 36 [36]; 4 to 6 pored lateral line scales extending beyond hypural joint onto base of caudal-fin; canals in lateral line scales straight. Scales in transverse series from lateral line to insertion of dorsal fin 6½ or 7 [7]. Scales in transverse series from lateral line to origin of anal fin 5½ to 6½ [5½].

Rayed dorsal-fin obtusely pointed, last unbranched and first and second branched rays longest. Dorsal-fin rays iii,10 (first unbranched ray very short) [iii,10]. Adipose fin of moderate size, unscaled. Anal-fin margin somewhat convex. Anal-fin rays iii,13–14 (first unbranched ray very short) [iii,13]. Pectoral fin obtusely pointed, extending nearly to vertical through insertion of pelvic fin. Pectoral-fin rays 14 [14]. Pelvic fin obtusely pointed, extending approximately two-thirds distance to anus. Pelvic-fin rays i,8 [i,8]. Caudal fin forked, unscaled. Principal caudal-fin rays 10+9.

Vertebrae 38 (2) [38].

Coloration in preservative.—Overall ground coloration of preserved specimens dark tan. Lips darkly pigmented; pigmentation continuing posteriorly as an obscure band to anterior margin of orbit. Body with five vertical, irregularly shaped bars. First bar dark, extending from base of dorsal-fin to midventral region immediately posterior of pelvic-fin insertion; posterior margin of bar concave. Second bar very faint, extending from region posterior of dorsal fin to area anterior of anus. Third bar darker, running from middorsal portion of body to anterior anal-fin rays; anterior and posterior margins of bars concave. Fourth bar extending from anterior of adipose fin to posterior rays of anal fin. Fifth bar covering posterior portion of caudal peduncle. Dorsal fin with anterior rays and basal portion of remaining rays darkly pigmented. Adipose dorsal fin darkly pigmented along margins. Anal and pelvic fins very dark. Pectoral and caudal fins hyaline.

Common names.—Colombia: Totumito, Bonito (Dahl 1971).

Remarks.—The original Steindachner description of *Leporinus* (=*Abramites*) *eques* was based on four specimens from an unspecified locality in the Rio Magdalena of Colombia. The specimen illustrated by Steindachner (NMW 69549, 138.8 mm SL) is designated as the lectotype and the remaining individuals (NMW 69548.1, 69548.2, 69550) thus become paralectotypes.

Although *Abramites eques* was described over a century ago, we have only been able to locate the original syntypic series of four specimens in systematic collections. Eigenmann (1923:117) and Miles (1947:140) both noted that they had been unsuccessful in their attempts to secure additional specimens, with the latter going so far as to suggest that Steindachner's specimens did not originate in the Rio Magdalena system. Dahl (1971:111) noted that the species is actually quite common in a series of localities in the Magdalena basin. The illustration of *A. eques* in Dahl differs in numerous characters from the syntypes, particularly in the overall head and body forms and in the distribution of dark pigmentation on the body and on the dorsal, pelvic and anal fins.

Boulenger (1896:34) reported *Leporinus eques* from two localities in the upper Rio Paraguay basin in Brazil. Eigenmann (1923:117) questioned this identification, and Norman (1926:93) designated that material as the type series of *Abramites ternetzi.* An examination of the two specimens (BMNH 1895.5.17:155–156) has shown they are *A. hypselonotus* (see "Remarks" under that species). The more recent citation of *A. eques* from Venezuela (Mago-Leccia 1967, 1970) has not been confirmed by available specimens of the genus from that country.

Distribution.—Río Magdalena basin (Fig. 6).

Material examined.—COLOMBIA. Río Magdalena, NMW 69549, 1 (138.8, lectotype of *Leporinus eques*); NMW 69548.1–2, 2 (118.7–163.7, paralectotypes of *Leporinus eques*); NMW 69550, 1 (106.7, paralectotype of *Leporinus eques*).

Resumen.—El género *Abramites* Fowler (1906) de la familia Anostomidae es revisado y dos especies son reconocidas. *Abramites hypselonotus* (Günther, 1868) se encuentra ampliamente distribuida en las cuencas de los ríos Orinoco y Amazonas, además do los ríos Paraguay y Paraná del sistema de La Plata. *Abramites eques* (Steindachner, 1878) se encuentra restingida al la cuenca del río Magdalena en Colombia. Las dos especies se distinguen por tener pationes de coloracion y caracteres merísticos particulares. *Leporinus solarii* Holmberg (1887), *Abramites microcephalus* Norman 1926), *Abramites ternetzi* Norman (1926) y *Leporinus nigripinnis* Meinken (1935), son colocados como sinónimos de *Abramites hypselonotus* (Günther). Una clave para diferenciar las especies de *Abramites* es propuesta.

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FOUR NEW SPECIES OF CLUPEOID FISHES (CLUPEIDAE AND ENGRAULIDAE) FROM AUSTRALIAN WATERS

Thosaporn Wongratana

Abstract.—Four new species of clupeoid fishes from Australian waters are described, one in the Clupeidae and three in the Engraulidae. The clupeid is *Herklotsichthys collettei* from Port Hedland, Onslow, Exmouth Gulf, and Shark Bay, Western Australia. It differs from its congeners which have similar wing-shaped median predorsal scales by having more lower arch gill rakers (38–40 cf. 29–36). Of the three new species of Engraulidae, *Stolephorus advenus* from the Cobourg Peninsula, Northern Australia is most closely related to *S. indicus,* but is readily distinguishable from that species in having a deeper body, an even shorter and broader maxilla, a shorter head, and in the lack of dark dots on the post-temporal region, and dorsal- and anal-fin bases. *Thryssa marasriae* from Shoal Bay, Darwin, and Chambers Bay, Northern Territory, is easily recognizable by the presence of a diffuse saddle blotch on the back just before the dorsal-fin origin (cf. on nape in other related species). *Setipinna paxtoni* from Cambridge Gulf, Western Australia, the only known species of the genus from Australia, is nearest to *S. tenuifilis* but is readily separable by having a humped dorsal profile, deeper body, higher dorsal fin, longer pectoral and pelvic fins, and much smaller serrae of the gill rakers.

During the course of my continuing study of Indo-Pacific clupeoid fishes, some 7000 additional specimens were examined after completion of my dissertation (Wongratana 1980). Among them, four new species were discovered. The purpose of this paper is to make the new specific names available to other workers studying phyletic relationships as well as those studying general taxonomy and population dynamics. More detailed descriptions, tables, figures and graphs for comparison with other congeneric species will be given in a monograph on Indo-West Pacific clupeoid fishes now in preparation.

Clupeoid fishes, the herrings, sardines, pilchards, sprats, shads, anchovies, and wolf-herrings, occur in all oceans and seas. Most of the approximately 317 species (Grande 1985) inhabit the continental shelves, especially near the shorelines and in estuaries. Many ascend rivers and some have become established in strictly freshwaters. Despite their great diversity in many taxonomic features, most congeneric species and even related genera are very similar in general appearances. Many useful taxonomic characters, e.g., striations and perforations on scales, and gill raker and pyloric caecal counts, change with growth. Without the help of frequency tables and/or meristic comparisons with the lengths of the fishes, and good drawings, their identification is uncertain. Moreover, within the Indo-Pacific region alone, no fewer than 300 nominal species have been proposed for these fishes, creating many difficulties in identification.

The new species were encountered in areas which were infrequently fished, surveyed, or sampled; therefore it is foreseeable that many clupeoid species from other poorly collected regions throughout the Indo-Pacific or the world still remain to be described. At the same time the distributional pattern of each species needs to be clarified by examination of specimens in systematic collections.

Specimens examined for this study are deposited in the following institutions: the Australian Museum, Sydney, (AMS); the Commonwealth Scientific and Industrial Research Organization, Hobart, (CSIRO); the Northern Territory Museum, Darwin, (NTM); the Western Australian Museum, Perth, (WAM), and the National Museum of Natural History, Smithsonian Institution, Washington, D.C. (USNM).

Herklotsichthys collettei,
new species
Figs. 1, 6

Holotype.—WAM P25464-004, 108 mm standard length (SL), Shark Bay, Western Australia (WA), 26°10′S, 113°11′E, Aug 1975; Fish and Wildlife party.

Paratypes.—43 specimens. WAM P25464-002, (6, 100–107), same data as for holotype. AMS IB1637, (1, 90), Port Hedland, WA; CSIRO. CSIRO C2880-81, (18, 85–98), Port Hedland, WA, 22 Aug 1949; FRV *Warreen.* CSIRO C2895, (12, 91–103), Port Hedland, 1 Sep 1949; FRV *Warreen.* WAM P22574, (1, 98), Shark Bay, WA, 25°21′S, 113°44′E, 20 Jan 1973. WAM P23870 (1, 97), Exmouth Gulf, WA, 22°05′S, 114°15′E, Aug 1973; R. Rowe. WAM P2544-45, (2, 59–67), Onslow, WA, 21°38′S, 115°07′E, Nov 1943; S. Fowler. WAM P26667-001, (1, 43), south passage off Wright's Anchorage, Shark Bay, WA, 26°10′S, 113°11′E, 12 Apr 1979; B. Hutchins. WAM P27380-001, (1, 91), Shark Bay, WA, 25°21′S, 113°44′E; R. McKay.

Diagnosis.—A species of *Herklotsichthys* with elongate wing-shaped scales beneath normal paired predorsal scales. Body moderately compressed, elongate, its depth 27–32% SL. Gill rakers on first arch 15–18 + 38–40, rarely to 42. Granular patches and very narrow series of teeth on palatines and pterygoids. Pyloric caecae about 60 to 85. Scales on nuchal and temporal regions with dense patches of anastomosing canals; posterior edges of scales on body unserrated but somewhat ragged. One or more fine lines from temporal region to caudal peduncle; extreme tip of dorsal fin jet black, tips of first three unbranched rays dark and apparently forming a broken dark line at front edge of fin, caudal fin without any prominent marking.

Relationships.—Among the 10 known species of *Herklotsichthys* this new species most closely resembles the sympatric *H. quadrimaculatus, H. lippa* and *H. koningsbergeri* at its type locality, especially in the possession of wing-shaped median predorsal scales. *Herklotsichthys castelnaui, H. blackburni, H. gotoi, H. lossei, H. spilurus, H. punctatus* and *H. dispilonotus* have, however, somewhat rounded median predorsal scales under the paired ones. These three species are readily characterized by their lower counts of lower arch gill rakers (29–36). It is also noteworthy that the anastomosing canals at the temporal region are similarly developed in the last two related species; however, both are further easily distinguished from *H. collettei* by having series of dark spots along the flanks. *Herklotsichthys koningsbergeri* is further differentiated by having a deeper body (33–41% SL) and with definitely higher counts of pyloric caecae (100 to 140).

It is now known that most specimens smaller than 60 mm SL and occasional larger ones of *H. lippa* (see species A and B of Whitehead 1985) have no characteristic dark spots along the sides or these markings are not pronounced. This may cause problems in identification and the other characters mentioned are therefore needed.

At first glance, *H. collettei* may also look like *H. blackburni* which also occurs along the coasts of the Western Australia, *H. castelnaui* (also *H.* species C of Whitehead 1985) of Queensland and New South Wales, *H. lossei* of the Persian Gulf and *H. spilurus*

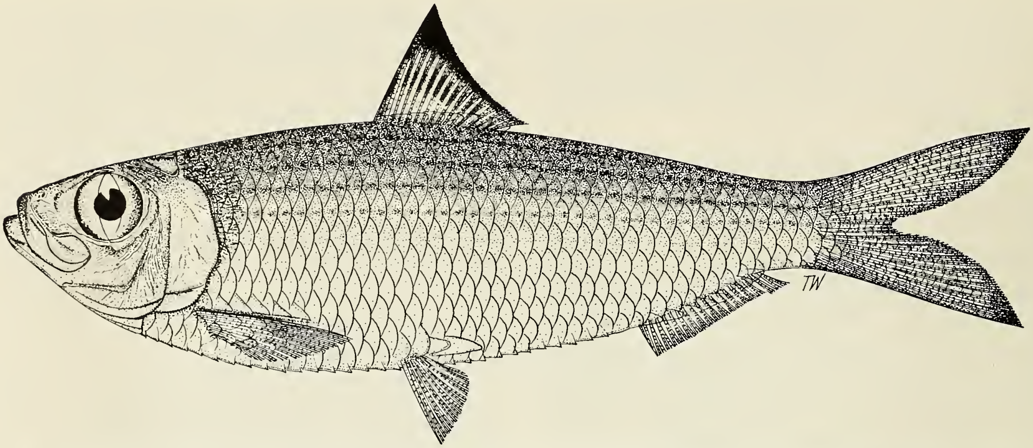

Fig. 1. *Herklotsichthys collettei,* new species, holotype, WAM P25464-004, 108 mm SL; Shark Bay, Western Australia.

of Zanzibar to Réunion Island, in general body form and especially the black tip of dorsal fin, but they differ in the shape of predorsal scales as noted above.

Etymology.—This species is named after Dr. Bruce B. Collette, Director of the National Marine Fisheries Service Systematics Laboratory in appreciation for his hospitality, encouragement, and interest in my work on Indo-Pacific clupeoid fishes, as well as his help during the course of my research in his laboratory.

Distribution.—Known from Port Hedland, Onslow, Exmouth Gulf, and Shark Bay, Western Australia.

Stolephorus advenus, new species
Figs. 2, 3, 6

Holotype.—NTM S10031-153, 72 mm SL, 27 m, north of Saulte Point, Cobourg Peninsula, Northern Territory, 18 Oct 1981; H. Larson.

Diagnosis.—*Stolephorus* (s.s. Nelson 1983) with short maxilla of 15.3% SL, and blunt point at tip which falls slightly short of anterior border of preoperculum; part posterior to the second supra-maxilla slightly deeper than long. Body moderately compressed, depth about 19.4% SL, head short 22.6% SL. Isthmus entirely covered with stenohyoideus muscle, urohyal not exposed. Gill rakers 19 + 24 on first arch, with 4 short rakers on posterior face of 3rd epibranchial. Hind border of preoperculum evenly rounded, without indentation at posteroventral edge. Small patches of teeth on palatines and pterygoids, no toothed knob at inner base of anterior gill rakers on epibranchials. Eleven branchiostegal rays, 3 attached to posterior ceratohyal, latter having entire upper edge. Lateral scale series 40, needle-like pre-pelvic scutes 5. Dorsal-fin rays iii 15, anal-fin rays iii 16, origin of anal fin commencing below 11th dorsal-fin ray, tip of pelvic fins (if not lost) reaching just before dorsal origin. Vertebrae 22 + 20.

Relationships.—The absence of an indentation at the posteroventral edge of the preoperculum and blunt tip of maxilla which terminates a short distance before anterior border of preoperculum easily distinguishes *S. advenus* from *S. holodon* (from east coast of Africa), *S. andhraensis* (from Bengal Bay to Gulf of Papua and northern coast of Australia), *S. carpentariae* (from the Gulf of Papua and northern coast of Australia), *S. ronquilloi* (from Taiwan and South China Sea) and *S. insularis* (from east coast of Africa to Taiwan and South China Sea). On the other hand, this new species also differs

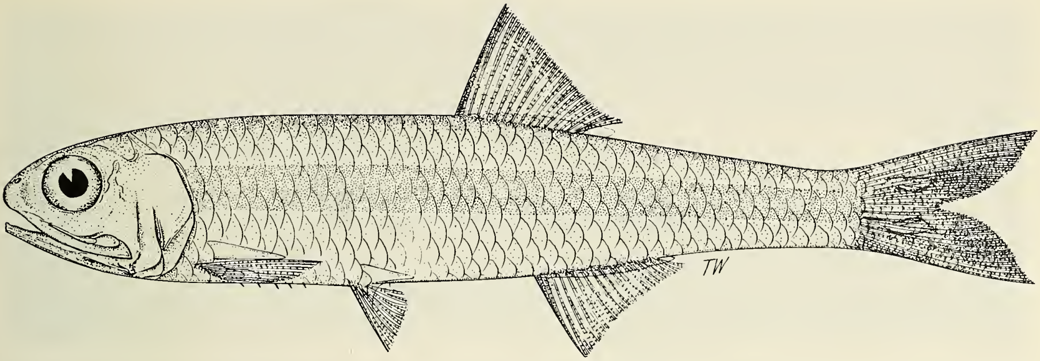

Fig. 2. *Stolephorus advenus,* new species, holotype, NTM S10031-153, 72 mm SL; north of Saulte Point, Cobourg Peninsula, Northern Territory, Australia. The pelvic fin is reconstructed.

from *S. insularis, S. dubiosus* (from Bengal Bay, Thailand, Malay Peninsula and Indonesia), *S. baganensis* (from Thailand, Malay Peninsula and South China Sea) and *S. tri* (from Thailand, Malay Peninsula and Indonesia) in the absence of a tiny spine in front of the dorsal-fin origin and between the pelvic-fin base, as well as in its much shorter maxilla. Among the remaining species in the genus, *S. indicus* (from east coast of Africa to South China Sea and South Pacific), *S. apiensis* (from Samoa and Fiji), *S. commersonii* (also from east coast of Africa to South China Sea and South Pacific), *S. apiensis* (from Samoa and Fiji), *S. commersonii* (also from east coast of Africa to South China Sea and South Pacific), *S. brachycephalus* (from the Gulf of Papua and northern coast of Australia), *S. chinensis* (from Thailand, Malay Peninsula and South China Sea) and *S. waitei* (from west coast of India to South China Sea and northern coast of Australia), *S. advenus* might only be confused with *S. indicus* in its bluntly short maxilla, the number of gill rakers, and the pelvic-fin tip which lies entirely before the dorsal-fin origin. These two species, however, differ from each other in many characters, the most notable being the complete separation in the depth of body (19.4% SL in *S. advenus* vs. 16.6–19.3% SL in 105 specimens of *S. indicus*; Wongratana 1980, 1985). The new species also has a relatively broader and shorter maxilla (15.5–17.5% SL in *S. indicus*), furthermore, it has a shorter head (23.5–26.1% SL in *S. indicus*), and fewer branchiostegal rays (22 vs. 12–14 in *S. indicus*).

Stolephorus pacificus from Guam and Kosrae (Kusaie), recently described by Wayne J. Baldwin (1983), also has a short maxilla (15.8–16.7% SL), which is slender in shape; it is, however, different from the new species in its higher gill-rakers counts (21–27 + 35–38) and approaches only *S. apiensis* (19–23 + 29–31). Baldwin's *Stolephorus* species as well as *S. apiensis* and also *S. indicus* have series of dark dots at the bases of the dorsal and anal fins, and a dark patch in the post-temporal region, that are absent in my new species.

Having examined more than 3000 specimens of *Stolephorus* (excluding those of *Encrasicholina,* Nelson 1983, s.s.) from most parts of the Indo-Pacific, I am certain that although my conclusions are based on a single specimen, it is nonetheless specifically different from other known species, in spite of its abnormal loss of pelvic fins, only the lateral ascending arms remain on both sides (Fig. 3) and the loss of the fourth needle-like pre-pelvic scute. Two tiny scute-like elements which lie behind the fifth pre-pelvic scute are possibly the malformed broken bones of the pelvic girdle. This conclusion is drawn from the fact that they are

Fig. 3. Negative print made from radiograph of *Stolephorus advenus,* new species, holotype, same data as for Fig. 2, showing the position of pelvic girdle (arrow).

within the site of actual pelvic girdle, and no pre-pelvic scutes of any *Stolephorous* species have been found to develop at this area.

It is also worthwhile to note here that the specimen of this new species was found among 6 specimens, 75.0–79.5 mm SL, of *Stolephorus waitei* (NTM S10031-100).

Etymology.—The specific epithet *advenus,* from the Latin for a stranger, is in reference to its peculiar taxonomic feature that make it uniquely different from other congeneric species.

Distribution.—Known only from the type locality.

Thryssa marasriae, new species
Figs. 4, 6

Holotype.—NTM S10707-002, 66.5 mm SL, King Creek, Shoal Bay, Northern Territory (NT), 12 Jun 1975; Northern Territory Fisheries.

Paratypes.—37 specimens. NTM S10707-001, (8, 48–66.5), same data as for holotype. NTM S10094-001, (9, 50.5–60), Darwin, NT, 22 Aug 1972; NT Fisheries. NTM S10095-001, (2, 49–57.5), Chambers Bay, NT, 5 May 1977; NT Fisheries. NTM S10102-002, (8, 58–68.5), King Creek, Shoal Bay, NT, 26 Jun 1975; NT Fisheries. NTM S10216-002, (5, 59.2–65.8), King Creek, Shoal Bay, NT, 15 May 1975; NT Fisheries. NTM S10259-005, (4, 40–61.8), Shoal Bay, NT, 15 Nov 1973; NT Fisheries. USNM 278480, (1, 49.5), NT, 1972–1977.

Diagnosis.—Small species of *Thryssa* with short body, its depth 29–33% SL, belly with 15–16 + 8–9, total 23–25 keeled scutes from isthmus to anus. Maxilla short, reaching about to hind border of preoperculum, first supra-maxilla long. Gill rakers on first arch 21–23 + (rarely 24) + 25–28, its serrae not clumped. Anal-fin rays iii–iv 26–28. Scales in lateral series about 33 to 35, sampled scales vertically above anal origin at axis of body with continuous transverse striae. Diffuse dark saddle blotch on back uniquely located near dorsal-fin origin.

Relationships.—*Thryssa marasriae* resembles *T. rastrosa* (Fly and Strickland rivers of New Guinea), *T. brevicauda* (Fly River of New Guinea and Shoal Bay of Northern Territory), *T. aestuaria* (northern coast of Australia to Grafton, New South Wales), *T. kammalensis* (Gulf of Thailand, Malay Peninsula, Java Sea and Celebes) and *T. scratchleyi* (rivers in New Guinea, Roper River of Northern Territory and Mitchell River, Queensland) in general appearances, especially the short maxilla. However, the first and the last mentioned species have no saddle blotch on the nape or before the dorsal fin, and have much higher gill-raker counts (33–45 + 48–61) in *T. rastrosa* or lower counts (17–20 + 18–23) in *T. scratchleyi. T. marasriae* is further differentiated

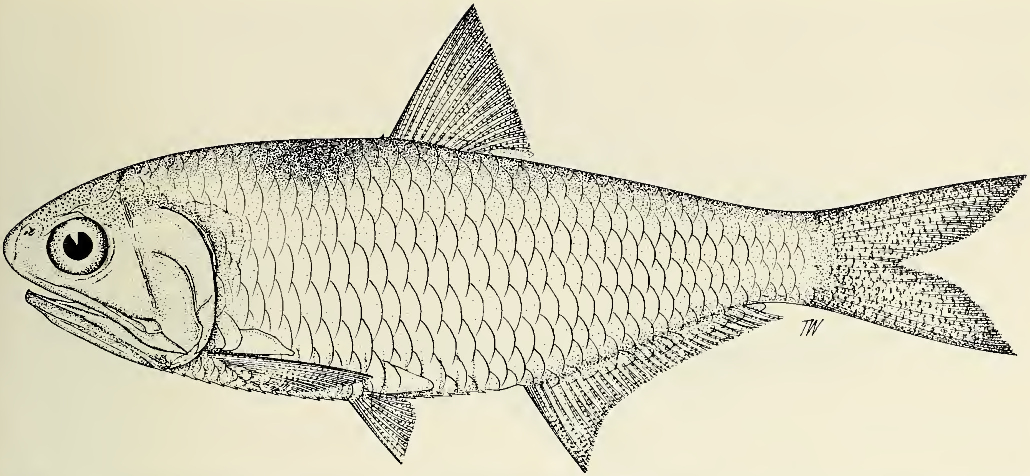

Fig. 4. *Thryssa marasriae,* new species, holotype, NTM S10707-002, 66.5 mm SL; King Creek, Shoal Bay, Northern Territory, Australia.

from the three remaining species in the placement of the diffuse saddle blotch which is just before the dorsal fin, instead of distinctly on the nape as found also in *T. chefuensis* (South Korea to Hong Kong), *T. kammalensoides* (Godavari estuary, India) and *T. dussumieri* (Pakistan to Southeast Asia and Taiwan). The sympatric *T. brevicauda* is further readily distinguishable from this new species by its reticulate striation on scales. Taxonomically, *T. marasriae* is closely related to *T. aestuaria,* but the latter fish significantly differs in the higher counts of lateral scale series (37 or 38), and also more anal-fin rays (iii–iv 31–34).

Etymology.—Named *marasriae* in recognition of my wife Marasri Ladpli Wongratana for her patient sharing of my study of fishes, her encouragement, and her tolerance of my trips away from home.

Distribution.—Shoal Bay, Darwin, and Chambers Bay, Northern Territory, Australia.

Setipinna paxtoni, new species
Figs. 5, 6

Setipinna papuensis, Wongratana, 1980:302 (unpublished revision).

Holotype.—WAM P16267-100, 110 mm SL, Medusa Bank, Cambridge Gulf, WA, 2 Mar 1968; K. Godfrey.

Paratypes.—WAM P16268-70-001, (3, 80.5–109), same data as for holotype.

Diagnosis.—Only known species of *Setipinna* from Australia. Dorsal profile distinctly humped. Body well compressed, its depth 33.2–34.6% SL, belly with 18–19 + 7–8, total 25–27 keeled scutes from isthmus to anus. Dorsal fin originating above base of sixth to eighth anal-fin rays, its height 21–23.4% SL; anal-fin rays iii 51–54; tip of main pectoral fins reaching to anal origin or nearly so, its filament greatly produced and reaching to base of 27th to 41st anal fin ray; pelvic-fin length 9.0–9.7% SL and reaching to anus. Gill rakers 10–11 + 14–15, most serrae small, only few enlarged but not distinctly clumped. Lateral scale series 43 or 44. Tip of dorsal fin, distal half of pectoral fins and pyloric caecae blackish.

The degree of convexity of the dorsal profile body depth and length of the pectoral filament in *S. tenuifilis gilberti* (from North China Sea), *S. tenuifilis tenuifilis* (from the Bay of Bengal to Sarawak and Gulf of Papua) and *S. paxtoni* progressively increase. The position of the anal-fin origin in relation to that of dorsal is also more forward in the latter species. *Setipinna melanochir*

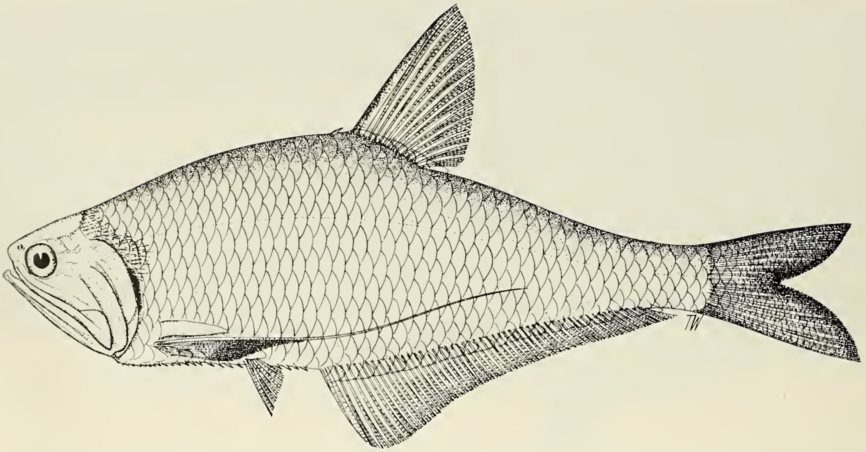

Fig. 5. *Setipinna paxtoni*, new species, holotype, WAM P16267-100, 110 mm SL; Medusa Bank, Cambridge Gulf, Western Australia.

(from South China Sea and Java Sea) differs chiefly in having fewer gill rakers (only 7–10 + 9–12), more lateral scale series (45 to 51) and more ventral scutes (21–26 + 8–10, total 30–35). In comparing the new species with the very common congeneric species, *S. taty* (Bay of Bengal, South China Sea and Java Sea), the latter has the dorsal and anal fins uniquely covered with scales (this character is so far unknown in any other clupeoid species), it has more gill rakers (13–17 + 18–20) and more ventral scutes (20–29 + 9–14, total 32–40).

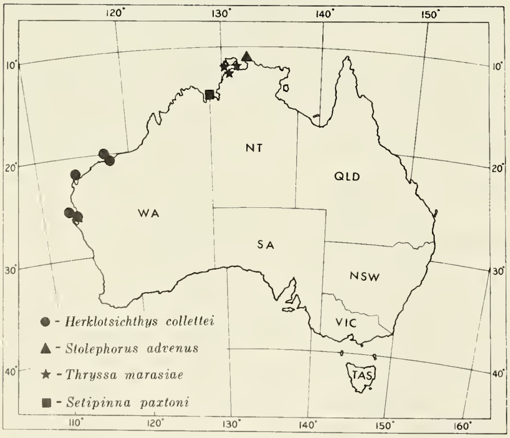

Fig. 6. Map of Australia showing the distribution of *Herklotsichthys collettei, Stolephorus advenus, Thryssa marasriae,* and *Setipinna paxtoni*, new species.

Etymology.—It is a pleasure to name this species for Dr. John R. Paxton of the Australian Museum, Sydney, who arranged the opportunity for me to broaden my knowledge of Australian clupeoid fishes.

Distribution.—Only known from the type locality, Medusa Bank, Cambridge Gulf, Western Australia.

Comments.—Re-examination of the type series including the holotype (CSIRO C3246) of *S. papuensis* Munro, 1964, leads me to treat this name as a junior synonym of *S. tenuifilis,* belonging to the subspecies *S. tenuifilis tenuifilis* (Wongratana 1980, 1983; Whitehead 1985).

Acknowledgments

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A NEW SPECIES OF *XENUROBRYCON* (TELEOSTEI: CHARACIDAE) FROM THE RÍO MAMORÉ BASIN OF BOLIVIA

Stanley H. Weitzman

Abstract.—*Xenurobrycon polyancistrus,* a new species of characid fish of the subfamily Glandulocaudinae, is described from the Río Mamoré and Río Isiboro of Bolivia. The new species is distinguished from *Xenurobrycon macropus, X. pteropus,* and *X. heterodon* by several characters outlined in the key and text. The geographic range of the new species lies between that of *X. macropus* to the southeast in the Río Paraná–Río Paraguay basins, that of *X. heterodon* to the northwest in the Río Ucayali–Río Huallaga basins, and that of *X. pteropus* to the north in the Rio Solimoẽs at Fonte Boa. The fish was taken from savannah areas in gallery forest pools adjacent to rivers.

Among a small collection of fishes from Bolivia recently sent by Gérard Loubens of the Office de la Recherche Scientifique et Technique Outre-Mer, Laboratoire d'Ichthyologie de l'Université de Trinidad, Estado Beni, Bolivia to the Smithsonian Institution for identification was a new species of *Xenurobrycon* Myers and Miranda-Ribeiro (1945:2). The three known species of *Xenurobrycon, X. macropus* Myers and Miranda-Ribeiro, *X. pteropus* Weitzman and Fink, and *X. heterodon* Weitzman and Fink, were treated in detail by Weitzman and Fink (1985:74–93). They attempted no phylogenetic analysis of these species pending a review and phylogentic analysis of the species in the related outgroup genera *Tyttocharax* Fowler (1913:563) and *Scopaeocharax* Weitzman and Fink (1985:56). No such analysis is attempted here for the same reason; however, the new species does appear most closely related to *X. pteropus* on the basis of the particular form and distribution of the derived anal-fin hooks shared by the males of these two species.

Methods and Materials

Counts and measurements recorded are as described by Fink and Weitzman (1974:1–2). Body depth is measured vertically from dorsal-fin origin. All measurements other than standard length (SL) are expressed as a percentage of SL except subunits of the head which are recorded as a percentage of the head length. Total vertebral counts, taken from radiographs and from two cleared, Alizarin and Alcian blue stained specimens, include all vertebrae of the Weberian apparatus, and with the fused $PU_1 + U_1$ of the caudal skeleton counted as one vertebra. In the text and table, the count or morphometric character given first is of the holotype. The next series of figures is for ranges and means of all specimens which are represented by one set of figures for both the males and the females except in cases of sexual dimorphism in which this information is given by sex. Specimens examined for this study are deposited in Muséum National d'Histoire Naturelle, Paris (MNHN) and National Museum of Natural History, Smithsonian Institution, Washington, D.C. (USNM).

Artificial Key to Species of *Xenurobrycon* Myers and Miranda-Ribeiro

1. Jaw teeth unicuspid, bicuspid, and tricuspid; anterior, large teeth of

Fig. 1. *Xenurobrycon polyancistrus*, new species, holotype, MNHN 1986-452, male SL 13.1 mm, Río Isiboro, Laguna Motacusal, Estado Beni, Bolivia, 1 Nov 1985.

lower jaw especially likely to be tricuspid; pouch scale in sexually mature males approximately tear-drop shaped with posterior process elongate and terminating in a relatively acute angle ... *Xenurobrycon heterodon*

– Jaw teeth all conical, without secondary cusps; posterior process of pouch scale in sexually mature males either elongate or short; when elongate, either bluntly or acutely terminated 2

2. Mature males with semicircular flange-like process on principal caudal-fin ray 18; sexually mature males with posterior anal-fin ray hooks slender, no larger than anterior hooks .... *Xenurobrycon macropus*

– Mature males without semicircular flange-like process on principal caudal-fin ray 18; sexually mature males usually with posterior principal anal-fin rays with hooks larger than those on anterior rays 3

3. Adipose fin present; pouch scale with acutely concave posteroventral border and posterior area of scale formed into modestly elongate but bluntly terminated process .... *Xenurobrycon pteropus*

– Adipose fin absent; pouch scale with posteroventral border nearly straight, not acutely angled or concave, pouch scale teardrop shaped with posterior process relatively acute ..... *Xenurobrycon polyancistrus*

Xenurobrycon polyancistrus, new species
Figs. 1–3, Table 1

Holotype.—MNHN 1986-452, male, SL 13.1 mm, Bolivia, Estado Beni, Laguna Motacusal, Río Isiboro, about 15°40′S, 65°00′W, 1 Nov 1985, L. Lauzanne, G. Loubens.

Paratypes.—MNHN 1986-453, 1 male, 5 females, SL 11.3–12.9 mm.—USNM 278191, 3 males, 2 females, SL 12.1–13.8 mm.—USNM 278188, 1 male, 1 female, (cleared and stained) SL 12.5–13.0 mm. All preceding paratypes with same collection data as holotype.—USNM 278190, 1 male, 1 female, 2 immatures, SL 11.0–11.8 mm, Bolivia, Estado Beni, Laguna Santa Rosa, Río Mamoré near Trinidad, about 14°47′S, 64°41′W, 21 Sep 1983, L. Lauzanne, G. Loubens.

Diagnosis.—Distinguished from all other species of *Xenurobrycon* by having a com-

Fig. 2. *Xenurobrycon polyancistrus,* new species, paratype, USNM 278191, female SL 13.8 mm, Río Isiboro, Laguna Motacusal, Estado Beni, Bolivia, 1 Nov 1985.

bination of unicuspid teeth, no adipose fin, hooks absent on posterior 3 or 4 anal-fin rays, teardrop-shaped profile of pouch scale, and no semicircular flange on principal caudal-fin ray 18. Most sexually mature males with hooks on posterior of anal fin distinctly larger than those on anterior of fin. Comparison of Table 1 with Tables 1–4 in Weitzman and Fink (1985:78–80, 86, 90, 91) show some ratios possibly distinguishing *X. polyancistrus* from previously described species. Since specimens of *X. polyancistrus* and *X. pteropus* too few for meaningful statistical analysis, these possible differences mostly omitted here. Upper jaw length possibly significantly different. *Xenurobrycon polyancistrus* with upper jaw ratio of between 20 and 29 percent of head length; other species with jaw to head ratio of 27 to 36 percent of head length, usually above 30 percent. Anal-fin hooks distributed differently than in two other species of *Xenurobrycon.* See description below.

Description.—See Table 1 for morphometric values. Body moderately elongate, sides compressed. Greatest depth usually about midway between nape and dorsal-fin origin. Predorsal body profile gently convex to snout tip. Body profile slightly, if at all, elevated at dorsal-fin origin, slightly concave along dorsal-fin base, and nearly straight to slightly concave to origin of dorsal procurrent caudal-fin rays. Dorsal-fin origin nearer to caudal-fin base than to snout tip. Ventral body profile gently convex from anterior of lower jaw tip to pelvic-fin origin, somewhat concave in region of pelvic-fin insertion. Body profile between pelvic-fin insertion and anal-fin origin somewhat concave to convex in both sexes. Body profile concave along anal-fin base and nearly stright posteriorly to origin of ventral procurrent caudal-fin rays.

Head and snout moderately elongate. Lower jaw protruding anterior to upper jaw. Mouth angled anteroventrally from snout tip to posterior mandibular joint. Maxilla extending posteriorly to point anterior of vertical line drawn through anterior border of eye.

Dorsal-fin rays ii, 7 (ii, 6, n = 2; ii, 7, n = 16; $\bar{x}$ = 6.9 for branched rays, n = 18); posterior ray not split to its base. Adipose fin absent. Anal-fin rays iii, 13 (iii, 12, n = 4, iii, 13, n = 13; iii, 14, n = 1; $\bar{x}$ = 12.8, n = 18); posterior ray split to its base. Anal fin with strongly lobed anterior portion in males, lobe less developed in females. Compare Figs. 1 and 2 and Table 1. Anal fin of

Table 1.—Morphometrics of *Xenurobrycon polyancistrus*. Separate entries for males and females are provided for sexually dimorphic characters.

		Laguna Motacusal				Laguna Santa Rosa		
		Holotype	n	Range	Mean	n	Range	Mean
Standard length (mm)		13.1	14	11.3–13.1		4	11.0–11.6	
		Percentage of standard length						
Greatest body depth		28.2	14	23.9–30.2	26.7	4	25.5–31.4	27.6
Depth at dorsal-fin origin		23.7	14	23.7–25.8	24.1	4	24.5–28.0	25.5
Snout to dorsal-fin orgin		61.1	14	59.2–63.2	60.9	4	61.2–64.5	62.8
Snout to pectoral-fin origin		26.7	14	25.2–28.4	27.2	4	26.4–29.1	28.1
Snout to pelvic-fin origin	m	36.6	6	35.7–38.9	36.7	1	37.3	
Snout to pelvic-fin origin	f	—	8	43.6–47.0	45.1	3	44.8–48.2	46.0
Snout to anal-fin origin		61.8	14	58.5–63.5	61.2	4	58.5–63.6	61.4
Caudal peduncle depth	m	13.7	6	12.7–14.0	13.2	1	13.6	
Caudal peduncle depth	f	—	8	10.4–12.4	11.7	3	12.0–12.7	12.3
Caudal peduncle length		20.6	14	19.7–23.2	21.2	4	20.0–22.0	21.0
Pectoral-fin length		21.4	14	19.1–22.5	21.0	4	20.7–25.4	22.0
Pelvic-fin length	m	37.4	6	33.3–41.5	38.4	1	39.0	
Pelvic-fin length	f	—	8	11.1–13.0	12.0	3	10.9–15.5	12.7
Dorsal-fin base length		9.2	14	7.7–9.2	8.5	4	8.0–10.3	9.6
Longest dorsal-fin ray		22.1	14	20.7–24.0	22.1	4	20.9–22.5	21.7
Anal-fin base length		19.8	14	19.8–22.3	21.1	4	20.3–20.9	20.6
Anal-fin lobe length	m	24.4	6	24.4–27.2	25.4	1	26.3	
Anal-fin lobe length	f	—	8	19.4–21.2	20.7	3	20.7–20.9	20.5
Bony head length		23.7	14	23.6–26.9	25.2	4	23.7–25.5	24.9
		Percentage of bony head length						
Horizontal eye diameter		41.9	14	35.9–41.9	38.8	4	41.4–42.9	42.5
Snout length		21.9	14	19.7–21.9	20.2	4	20.7–21.4	21.1
Least width interorbital		38.7	14	34.4–39.4	36.1	4	42.9–46.2	44.2
Upper jaw length		32.3	14	20.3–32.3	25.2	4	25.7–28.6	26.8

sexually mature males with bilateral antrorse bony hooks, usually one hook per finray segment. Anterior rays with largest number of hooks; progressively fewer hooks posteriorly. Hooks arranged as follows, in two morphological groups. Anterior first large unbranched ray and first 4 branched rays with largest number of medium-sized hooks, similar to those of *X. macropus*; see Weitzman and Fink (1985:31, fig. 42). Hooks on third anterior unbranched ray 5 (5–8, $\bar{x}$ = 6.2, n = 6). Hooks on first anterior branched ray 5 (4–8, $\bar{x}$ = 6.3, n = 6); one specimen (holotype) with 2 hooks on each of 2 distal segments. Hooks on second branched ray 5 (4–7, $\bar{x}$ = 5.3, n = 6); one specimen (holotype) with 2 hooks on distal ray segment. Hooks on third branched ray 4 (3–6, $\bar{x}$ = 4.5, n = 6). Hooks on fourth branched ray 3 (1–5, $\bar{x}$ = 2.8, n = 6). Hooks on fifth branched ray 1 (1–2, $\bar{x}$ = 1.2, n = 6). Hooks on sixth branched ray 1 (1–2, $\bar{x}$ = 1.2, n = 5). Branched rays 7 to 10 with 1 hook per ray in 5 specimens including holotype. Ray 11 with 1 hook in 3 specimens. All 6 males without hooks on rays 12, 13, or 14 (latter 1 or 2 rays may be absent). Posterior hooks large in all but one specimen, similar to those on branched rays 8 to 11 of *X. pteropus,* Weitzman and Fink (1985:31, fig. 43). Large hooks on sixth branched ray in 2 specimens, and large on all specimens (including holotype) on branched rays 7 to 10. Hook, when present, large on ray 11.

Pectoral-fin rays i, 7 in all specimens. Dis-

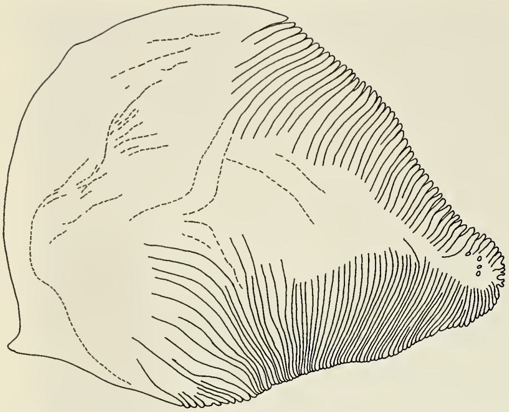

Fig. 3. *Xenurobrycon polyancistrus,* new species, pouch scale from paratype, USNM 278191, male, SL 13.0 mm, Río Isiboro, Laguna Motacusal, Estado Beni, Bolivia, 1 Nov 1985. Lateral view, left side.

tal tips of pectoral-fin rays extending posterior to pelvic-fin origin in females and well beyond that point in males due to anterior position of pelvic-fin origin in males. See Table 1 for comparison of ratios of pelvic-fin origin in males and females. Pectoral-fin length about equal in both sexes.

Pelvic-fin rays vii in all specimens except cleared and stained male in which second ray of left side branched distally. Pelvic fin sexually dimorphic, elongate in males. Compare ratios of male and female pelvic-fin lengths in Table 1. Pelvic fin of males arched, with interradial membranes extensive and similar to those described for *X. macropus* by Weitzman and Fink (1985:76–77, fig. 73). Fins form umbrella-like canopy when spread. Fins with unpaired bony hooks on ventral surface. Antrorse hooks on distal series of ray segments of all pelvic-fin rays. Terminal distal segment without hooks. Hooks per segment 1 or 2, rarely 3. Anterior ray of cleared and stained male with 19 hooks on 14 segments. Anterior 9 of these with 1 hook per segment and these hooks larger than any other on fin. Ray 2 with 19 hooks on 12 distal segments, ray 3 with 15 hooks on 12 distal segments, ray 4 with 20 hooks on 11 distal segments, ray 5 with 23 hooks on 11 distal segments, ray 6 with 16 hooks on 8 distal segments, and ray 7 with 18 hooks on 10 distal segments. Total hooks on pelvic fin of cleared and stained male 130.

Pelvic girdle of males similar to that of male *X. macropus.* See Weitzman and Fink (1985:77, fig. 37A).

Caudal fin with principal rays 10/9 in all specimens. Caudal-fin osteology and myology similar to that of other species of *Xenurobrycon* as described by Weitzman and Fink (1985:77, 81–83, figs. 11, 12, 25, and 47). Rays of dorsal and ventral caudal-fin lobes modified as in *X. macropus* except that ray 18 lacks ventrolaterally projecting bony laminae. Concavity on ventral surface of this ray present. Principal caudal-fin ray 19 (largest ventral undivided ray) not as thickened as in *X. macropus,* Weitzman and Fink (1985:fig. 11).

Hypural skeleton and caudal squamation of both males and females similar to that described for *X. macropus* by Weitzman and Fink (1985:77, 81–83). Pouch scale, Fig. 3, approximately teardrop-shaped in profile, most like that of *X. heterodon,* Weitzman and Fink (1985:92). Its posterior field pointed and completely bordered by striated radii, not fully free of striae as illustrated for all other species of *Xenurobrycon* by Weitzman and Fink (1985:figs. 28–30). However, pouch scale on right side of 14.3 mm SL specimen of *X. heterodon* with some striae along its posterior pointed border. That of right side, illustrated in Weitzman and Fink (1985:24, fig. 30) with its most posterior border free of striae. Small bilateral caudal-fin hooks present on principal caudal-fin rays 7, 8, 18, 19 of *X. polyancistrus* similar in appearance to those illustrated for *X. macropus* by Weitzman and Fink (1985:fig. 11). As in *X. macropus,* hooks on rays 7 and 8 point distally while those on 18 and 19 antrorse. Rays 7 and 8 with 3 bilaterally paired hooks on ventral branch of distal portion of ray, one pair per segment. Rays 18 and 19 having 5 unpaired hooks per ray. Each hook confined to one ray segment. Hooks successively alternating in direction, pointing to right or left of vertical plane of fin. Hooks on ray 18, except for one anterior hook, confined to dorsal border of dorsal branch of ray. Ray 19 unbranched and bearing hooks along dorsal border of distal half to one third of fin-ray length. Other species of *Xenurobrycon* with most hooks on ventral lobe rays bilaterally paired but unpaired hook occurring occasionally. No specimens found with hooks alternating, in series pointing right, then left as described for *X. polyancistrus.* Caudal-fin rays 11 and 12 of *X. polyancistrus* interrupted as illustrated for *X. macropus* by Weitzman and Fink (1985:fig. 11) but all other rays continuous.

Scales cycloid with few radii along posterior border except for pouch scale as described above. Lateral line incomplete, perforated scales 3 (3–5, $\bar{x} = 3.8$, n = 12), scales missing in several specimens. Scales in lateral series to caudal base and excluding pouch scale of males, 33 (32–34, $\bar{x} = 32.8$, n = 11). Scale rows between dorsal-fin origin and pelvic-fin origin 8 in all specimens. Scale rows around caudal peduncle 13 in all specimens. Predorsal scales 14 (13–15, $\bar{x} = 14.2$, n = 14); scales lost from specimens from Laguna Santa Rosa.

Teeth of all jaw bones conical, without accessory cusps. Teeth, especially smaller posterior teeth, buried in tissue; counts given below from 2 cleared and stained examples only. Premaxillary teeth 8–9, primarily in one, slightly irregular, wavy row, often 1 or 2 teeth pointing anteriorly. Sometimes these anterior 1 or 2 teeth forming almost separate, anterior row. Maxillary teeth 4 or 5; in one row. Anterior maxillary teeth projecting somewhat anterolaterally while posterior maxillary teeth projecting ventrally. Dentary teeth mostly in one row of 8 (female) to 11 (male) teeth. Usually 1 or 2 teeth placed more ventrally on external surface of anterior portion of dentary ramus. These teeth projecting anterodorsally or anterolaterally in varying degrees. Jaws and teeth very similar to those illustrated for *X. pteropus* by Weitzman and Fink (1985:41, fig. 64B).

Vertebrae 35 (33–35, $\bar{x} = 34.1$, n = 18). Dorsal limb gill rakers 4 (4–5, $\bar{x} = 4.3$, n = 17); ventral limb gill rakers 9 (8–9, $\bar{x} = 8.7$, n = 17). Branchiostegal rays in 2 cleared and stained specimens 4, 3 rays originating from anterior ceratohyal and 1 ray from border between anterior and posterior ceratohyals.

Color in alcohol.—Color pattern similar to that of *X. macropus* described by Weitzman and Fink (1985:83–84). Description from holotype, Figure 1, unless otherwise noted. Body pale brown, nearly white, apparently silvery in life. Narrow dark brown midside stripe extending through center of fourth horizontal scale row counted ventrally from dorsal-fin origin. Stripe interrupted anteriorly and becoming nearly continuous approximately at midregion of body length. Stripe extending from near dorsal portion of opercular opening posteriorly to caudal-fin base. Caudal peduncle with dark brown chromatophores at base of dorsal lobe of caudal fin, forming dark elongate acute mark continuous ventrally with horizontal stripe. Body dorsal to lateral midside stripe with dark brown chromatophores producing reticulate pattern on dorsal body surface. See especially female in Fig. 2. Area ventral to horizontal midside stripe with scattered dark chromatophores. Dark chromatophores along base of anal fin organized into line or stripe. Small scattered dark chromatophores occurring on dorsal, anal, and caudal fins. Pectoral fins hyaline except for some dark brown chromatophores along anterior ray. Pelvic fins of males with dark brown chromatophores denser along anterior rays. Pectoral and pelvic fins of females nearly hyaline.

Opercle, cheek (orbital region), and mandibular area with few dark chromatophores. Dorsum of head in region of supraoccipital, parietal, and posterior frontal bones dark, with many dark brown chromatophores covering area of brain. Head dorsal to eye and area of anterior part of frontal bones somewhat lighter than posterior area. Nasal area pale, area of premaxilla dark brown.

Sexual dimorphism.—Table 1 presents morphometric data, some arranged by sex and showing sexual dimorphism. Only obvious sexual differences presented. These are same as those presented for *X. macropus, X. pteropus,* and *X. heterodon* by Weitzman and Fink (1985:tables 1–4). Both population samples of *X. polyancistrus* with obvious sexual differences in distance from snout to pelvic-fin origin, depth of caudal peduncle, length of pelvic fin, and length of anterior lobe of anal fin. Hooks present on pelvic, anal, and caudal fins of males; females lack such hooks. Only males have caudal-fin pheromone pump organs and accompanying pouch scale.

Etymology.—The name *polyancistrus* is from the Greek *poly* (many) and *ancistrus* (hook), many hooks, referring to the numerous hooks on the pelvic fin of the male.

Discussion.—The phylogenetic relationship of *X. polyancistrus* appears to be with *X. pteropus,* sharing an apparently derived pattern of large posterior anal-fin hooks in the males and similar jaw teeth. However, the possible derived versus plesiomorphic nature of the teeth has not been determined. The two species differ primarily in the shape of the pouch scale (described in the key above [compare also Fig. 3 with fig. 29 in Weitzman and Fink (1985:23)] and the presence of an adipose fin in *X. pteropus* and its absence in *X. polyancistrus.* Pouch scale shape appears to be constant in species of *Xenurobrycon, Tyttocharax,* and *Scopaeocharax* and was used by Weitzman and Fink (1985) to distinguish both species of *Xenurobrycon* and the genera *Xenurobrycon, Tyttocharax,* and *Scopaeocharax.* The constancy of the presence or absence of an adipose fin is perhaps somewhat less certain. However, some species, both described and undescribed, of the related genus *Tyttocharax* can be distinguished in part by the consistent presence or absence of an adipose fin. Presence or absence of this structure appears constant within species of xenurobryconins. It should be noted that the vague structure that looks like an adipose fin in the photographed female of *Scopaeocharax atopodus* Böhlke in Weitzman and Fink (1985:7) is an artifact. This specimen lacks an adipose fin as do all members of that species that I have examined.

Ecology and distribution.—*Xenurobrycon polyancistrus* was taken from a savannah-like area of the Bolivian Amazon basin. Both localities are tributaries of (Laguna Motacusal) or adjacent to (Laguna Santa Rosa) the Río Mamoré, itself a tributary of the Rio Madeira which flows into the central Amazon River. Laguna Santa Rosa is in a gallery forest enclosing the Río Mamoré. At the time of capture the elongate shallow (to 2.5 m in depth) pond was connected to the Río Mamoré, the water was muddy, the bottom mud and the forest partly submerged. The fish were captured by rotenone from an area averaging 1 meter in depth. The Laguna Motacusal was a depression behind the bank of the Río Isiboro but connected to the river at time of capture. The fish were taken from an area about 5 by 30 meters which averaged nearly a meter in depth. The area was encumbered with macrophytes and dead trees.

The region of capture in relation to other species of *Xenurobrycon* is shown in Fig. 4. The species is isolated from *X. macropus* to the southeast by an independent drainage basin and *X. heterodon* to the northwest by drainage basins isolated by distance and probably ecology. *Xenurobrycon polyancistrus* is "isolated" from *X. pteropus,* its apparent closest relative, by probable differences in ecology (rainforest versus savannah) and/or elevation as well as by distance. Even if *X. polyancistrus* is distributed along the length of the Rio Madeira and its tributaries, the mouth of the Rio Madeira is over 700 kilometers to the east of the single known locality of *X. pteropus,* Fonte Boa on the upper Amazon River. In the Amazon basin certain species of *Tyttocharax* appear

Fig. 4. Map illustrating collecting localities of species of *Xenurobrycon.*

to be isolated perhaps only by ecological factors associated with elevation changes, a situation that may also be true for *Xenurobrycon.*

Supplementary note on Xenurobrycon heterodon *Weitzman and Fink.*—Recently 46 specimens of *Xenurobrycon heterodon,* CAS(SU) 53679, were found in the fish collection at the California Academy of Sciences. These were collected 21 February 1960 (sta no. 3) by George S. Myers and General Thomas D. White from a tributary of the Río Orteguaza at Puerto Lara near Florencia, Caquetá, Colombia. This is a first record of a species of *Xenurobrycon* from Colombia. The specimens are 16.3 to 20.1 mm SL with two adult males at 18.5 and 18.6 mm SL. These two males have well-developed hooks on the anal and pelvic fins only, and the smaller specimen has the hooks somewhat less developed. Eighteen maturing males 16.3 to 17.6 mm are present. The two largest specimens of these have a few very tiny hooks on the first large unbranched ray of the anal fin. All these specimens have a pouch scale and modified caudal musculature and fin rays in various stages of development. There are 23 females or immatures from 16.5 to 20.1 mm SL. None have ripe eggs but the largest has both ovaries with many developing eggs. Weitzman and Fink (1985:88) reported adults in population samples from Ecuador, Río Bobonaza and Río Napo, as adults from 16.2 to 18.5 mm SL in July 1968 and October 1983 respectively. Adults not exceeding 17.5 mm SL collected in July 1975 were reported by them from the Río Pachitia, Peru. The smaller size at maturity of the samples to the south may be a significant difference among these samples; however, all other characters investigated clearly indicate the Colombian specimens to be *X. heterodon.* Counts and measurements and the morphology of the teeth and pouch scale are like that for *X. heterodon* as reported by Weitzman and Fink (1985:88–93).

Acknowledgments

I wish to thank again many of the individuals cited by Weitzman and Fink (1985: 11–12) for making comparative xenurobryconin specimens available but I am especially indebted to Gérard Loubens, of ORSTOM, Trinidad, Bolivia, for providing the specimens described here. Marilyn Weitzman and Lynn Norrod provided technical assistance. Richard Vari, Marilyn Weitzman, and Naercio Menezes read the manuscript and offered advice and suggestions. This research was supported in part by the Smithsonian Institution Neotropical Lowland Research Program. I thank William Eschmeyer for loan of the specimens of *Xenurobrycon heterodon* from the California Academy of Sciences and Eric Anderson for processing the specimens.

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A NEW SUBSPECIES OF *SIPTORNIS STRIATICOLLIS* (AVES: FURNARIIDAE) FROM THE EASTERN SLOPE OF THE ANDES

Gary R. Graves and Mark B. Robbins

Abstract.—A new subspecies, *Siptornis striaticollis nortoni,* is described from the eastern slope of the Andes in Ecuador and northwestern Peru. The nominate form, *S. s. striaticollis,* is restricted to the Magdalena Valley of Colombia.

Until recently, the Spectacled Prickletail (*Siptornis striaticollis*) was known only from "Bogotá" trade skins without specific locality data, a few specimens collected in the Magdalena Valley of Colombia, and a single specimen from Mapoto on the eastern slope of the Ecuadorian Andes (Chapman 1917, Hellmayr 1925). Difference in plumage color among individuals was noted by Chapman and Hellmayr, but the lack of comparative material from known localities prevented them from assessing geographic variation among populations. Thus, *Siptornis striaticollis* has been considered monotypic (Peters 1951).

During the past twenty years a small number of prickletails were collected on expeditions to the eastern slope of the Andes in Ecuador and northwestern Peru (Eley et al. 1979; unreported specimens). We assembled specimens with definite locality data and compared them with the type ("Colombia" = "Bogotá") in the Museum of Comparative Zoology, Harvard University, and a series of "Bogotá" trade skins. Populations from the eastern slope of the Andes in Ecuador and Peru differ from those of the Magdalena Valley and from "Bogotá" specimens and represent a new subspecies.

Siptornis striaticollis nortoni,
new subspecies
Figs. 1, 2

Holotype.—Museum of Comparative Zoology, MCZ 298995; female, from Palm Peak on Volcán Sumaco, Provincia de Napo, Ecuador, elevation 1500 m; 7 Aug 1964, David W. Norton (original number 1277).

Characters.—Compared to *S. s. striaticollis,* the buffy central stripe on the feathers of the upper breast of *S. s. nortoni* are much wider and longer (Fig. 1) The white subocular spot and scattered white feathers on the forehead of *S. s. striaticollis* are largely absent in *S. s. nortoni*; white facial feathers

Fig. 1. Ventral view of typical specimens of *Siptornis s. striaticollis* (left; ANSP 155471 ♂, La Candela, Dpto. Huila, Colombia) and *S. s. nortoni* (right; type).

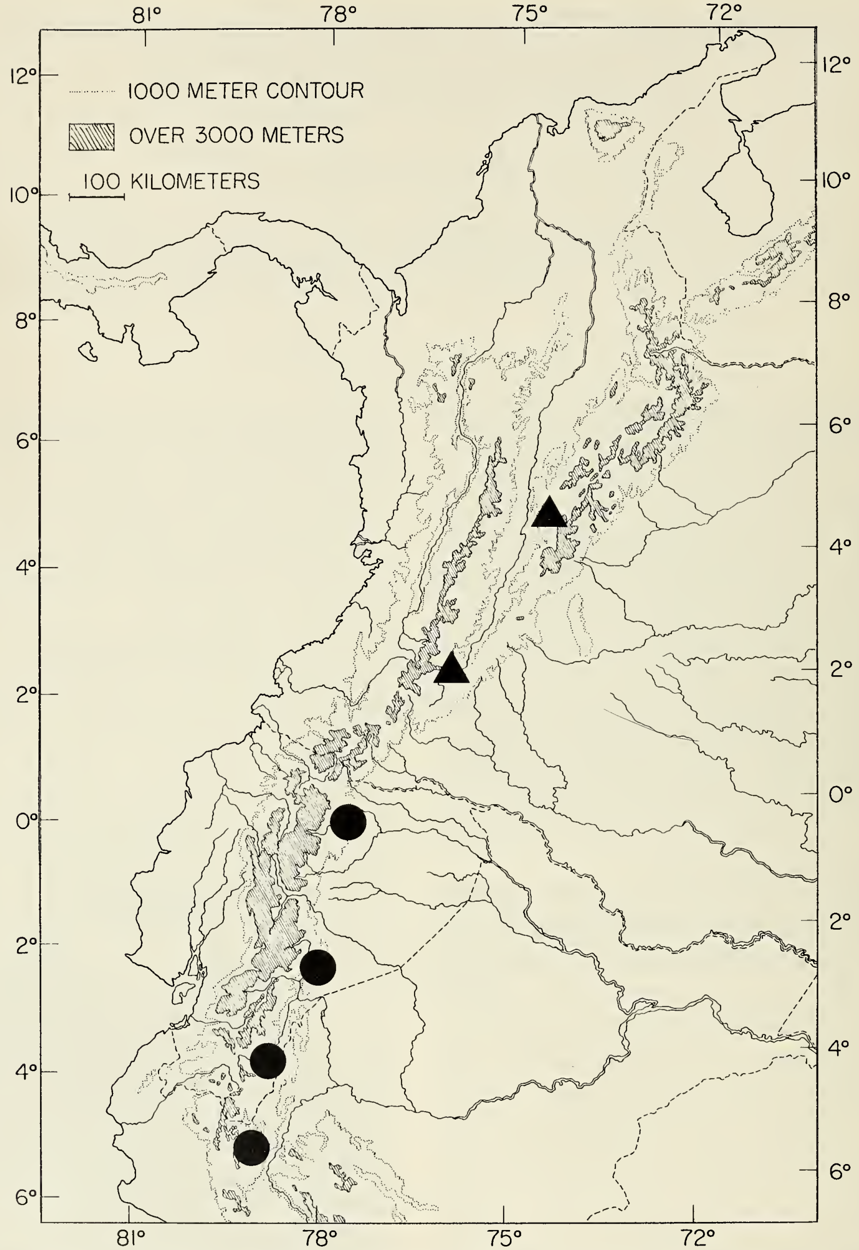

Fig. 2. Distribution of *Siptornis striaticollis* in the northern Andes of South America based on specimens examined in this study (triangles = *S. s. striaticollis*; circles = *S. s. nortoni*). Specimens from La Palma and La Candela are represented by the same triangle in the upper Magdalena valley.

are restricted primarily to the postocular portion of the superciliary. The lores are buffy gray to gray, not dark gray or black as in *S. s. striaticollis.*

Range.—Cloud forest (1400–1975 m elevation) along the eastern slope of the Andes from northern Ecuador to northwestern Peru (Fig. 2). Sight record of *Siptornis* above

Florencia, Dpto. Caquetá, Colombia, (Hilty and Brown 1986) probably refers to *S. s. nortoni.*

Measurements of type (mm).—Wing (chord) 61.0; tail 45.8; culmen (from anterior edge of nostril) 6.9.

Specimens examined.—Siptornis s. striaticollis: "Bogotá" or "Colombia" (MCZ Type, unsexed; UMMZ 1 unsexed; USNM 1 unsexed; AMNH 4 unsexed).—Magdalena Valley: Fusagasugá, Dpto. Cundinamarca (AMNH 1 ♂).—La Palma ("5500 ft"), Dpto. Huila (AMNH 1 ♀).—La Candela (1600 m), Dpto. Huila (ANSP 2 ♂, 1 ♀). *S. s. nortoni*: Ecuador: Type (MCZ); Cordillera de Cutucú (1975 m), Prov. Morona-Santiago (ANSP 1 ♀).—Km 45 Zamora Road (1670 m), Prov. Loja (MCZ 1 ♂).—Peru: Sapalache-Namballe mule trail, Dpto. Cajamarca (LSUMZ 3 ♂).

Remarks.—Concerning *S. s. striaticollis,* Chapman (1917:407) commented that "a specimen from La Palma is decidedly more fulvous below than one from Fusugasugá [sic] and two Bogotá skins." Of the specimens we examined, the individual from Fusagasugá was the grayest ventrally; however, this characteristic appears to be uncorrelated with geography. All "Bogotá" specimens examined are referable to the nominate form.

We detected no consistent sexual or geographic variation in the diagnostic characters of *S. s. nortoni.* Size variation among populations appears to be insignificant.

Ecological notes.—Data on specimen tags and the few field observations of *Siptornis* in Colombia, Ecuador and Peru (Eley et al. 1979, Ridgely 1980, Ridgely and Gaulin 1980) indicate that it has a cumulative elevational amplitude (over all locations, 1400–2300 m) of approximately 900 meters. This value is near the median elevational amplitude (= 1105 m; range of values 575–1875 m) recorded for 14 species of Furnariids that are widespread along the eastern slope of the Andes (Graves 1985). We suggest that the paucity of specimens in collections is due to the inconspicuous appearance and behavior of *Siptornis,* rather than to rarity or narrow elevational distribution.

Past observers have likened the foraging behavior of *Siptornis* as parid-like or similar to that of piculets (*Picumnus* sp.) and xenops (*Xenops rutilans*). In the Cordillera de Cutucú, Robbins observed birds (n = 3) "hitching" along moss-covered limbs and probing into leaves and moss about 8–10 m above the ground in a manner reminiscent of some species of *Cranioleuca.*

Acknowledgments

We thank the curators and staff of the Academy of Natural Sciences of Philadelphia (ANSP), American Museum of Natural History (AMNH), Louisiana State University Museum of Zoology (LSUMZ), University of Michigan Museum of Zoology (UMMZ), Museum of Comparative Zoology, Harvard University (MCZ) and the National Museum of Natural History, Smithsonian Institution (USNM) for permission to examine collections in their care.

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SPADELLA PIMUKATHAROS, A NEW BENTHIC CHAETOGNATH FROM SANTA CATALINA ISLAND, CALIFORNIA

Angeles Alvariño

Abstract.—*Spadella pimukatharos* is described and compared with closely related species *Spadella legazpichessi, S. nana,* and *S. schizoptera.* These species are related in part by the structure of the adhesive digital organs. The substratum apparently preferred by *S. pimukatharos* is a sediment rich in fragments of coralline algae.

The genus *Spadella* Langerhans was discussed by Alvariño 1970, 1981b, who summarized the differential characteristics of the species and their world distributions. The species of this genus can be divided into two groups, those with adhesive, digital, hand-shaped organs at the ventral part of the tail segment and those without digital, adhesive organs. Among the species with adhesive digital organs (Alvariño 1981a) are species of two types, which can be divided into two subgroups, In *S. pulchella* Owre, 1963, and *S. hummelincki* Alvariño, 1970, the digital organs are covered by thick tubercular papillae, whereas in *S. schizoptera* Conant, 1895, *S. nana* Owre, 1963, *S. legazpichessi* Alvariño, 1981, and *Spadella pimukatharos,* n. sp., the fingerlike structures are strengthened by thin muscular fibers and each fingertip has a pad of very fine papillae.

The species that are closely related to *Spadella pimukatharos* are *S. schizoptera, S. nana,* and *S. legazpichessi. Spadella schizoptera* inhabits the Bahamas (Conant 1895), Misaki, Japan (Yosii and Tokioka 1939), New South Wales, Australia (Mawson 1944), Cayos Soldier, Florida (Owre 1963), Cayo Gun, Bahamas (Feigenbaum 1976). The records from Japan and Australia are probably erroneous identifications because populations of species of *Spadella* do not extend over such wide areas; their distributions are limited to directly-connected zones. *Spadella nana* inhabits Cayos Soldier, Florida (Owre 1963), Bahamas (Owre 1972); *S. legazpichessi* was obtained at Enewetak, Marshall Islands (Alvariño 1981a). *Spadella bradshawi* Bieri, 1974, from San Diego, California, lacks the hand-shaped fingerlike adhesive organs.

Spadella pimukatharos, new species
Figs. 1, 2

Material.—Holotype (USNM 99379), 5 paratypes (USNM 99380) collected at Fisherman's Cove, Santa Catalina Island, California, 13 Mar 1985.

Diagnosis.—The descriptions of the anatomical features are based both on mature adult specimens (Stage IV of sexual development), and young specimens at Stages I, II, and III of maturity.

The body is opaque, with well developed muscles on the dorsal and ventral sides. Lateral sides are very narrow. No pigment or pigmentation pattern has been observed, although the specimens were examined with a microscope shortly after preservation. The colleague who collected them did not find the specimens pigmented.

Total length of full mature specimens reached 3.0, 3.5, and 3.75 mm, excluding the tail fin. Specimens measure 1.75, 2.0, and 2.5 to 2.75 mm at I, II, and III stages of maturity, respectively. The stages of ma-

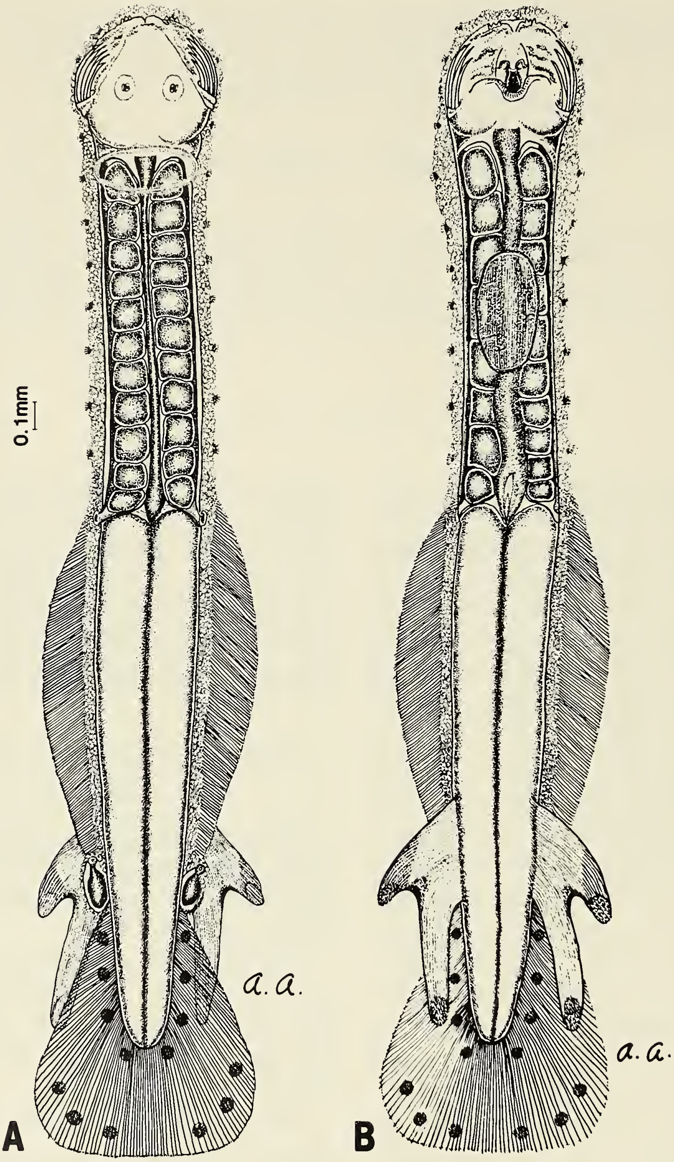

Fig. 1. *Spadella pimukatharos*: A, Dorsal view; B, Ventral view.

turity are based on the development of the gonads, mainly of the ovaries and the ova.

The body is about the same width from head to tail, slightly narrow at the neck and tapering at the end of the tail segment; it widens slightly at the region of the transverse septum that separates the trunk and tail segments.

The head is about as long as wide. Head, trunk, and tail are thickly covered by collarette or alveolar tissue, giving the animal the appearance of having the same width from head to tail, except for the tapering at the end of the tail.

The caudal segment makes up 50% of the total length of the animal.

The eyes are large and roundish, placed at the center of the dorsal side of the head, and are the same distance from each other as from the sides of the head. The pigmented region of the eyes is large and includes 2 branches, the longer branch is parallel to the longitudinal axis of the body, and the short branch extends perpendicularly at midlength from the large branch. The pigment separates 5 small, clear regions filled with lenses: one large region towards the side of the head, 2 small regions toward the center of the head limited by the short and long branches of pigment, and 2 very small regions at the end of the large vertical branch. This general pattern is typical of most chaetognaths.

There are 7–9 hooks at each side of the head. They are thin, curved, and in all examined specimens appeared to be pleated together at the sides of the head. There are 2 to 3 anterior teeth, which are thin, short and pointed. No posterior sets of teeth were observed.

The mouth is on the ventral side, has 2 round pads anterior to it (Fig. 1B).

The corona ciliata, located at the dorsal side of the neck, is ellipse-shaped, with the transverse axis more than twice the length of the vertical axis (Fig. 2A).

The collarette extends as a strong thick stratum, covering the head and extending along the neck, trunk, and tail.

Intestinal diverticula are absent.

The ventral ganglion is large and thick; it is located at about the midlength of the trunk and ⅔ of the ganglion extends over the anterior part of the trunk while approximately ⅓ of the ganglion extends over the posterior part of the trunk, being closer to the neck than to the posterior septum. The ganglion does not occupy the total width of the trunk, and it is not as large as in *S. legazpichessi* and most other species of *Spadella.*

The pair of lateral fins extends from the region of the opening of the oviducts to the seminal vesicles. The fins are completely rayed. The caudal fin is long, spatula-shaped, rounded laterally and wider at the tip of the tail segment, and ends with a straight posterior edge. It is independent of the posterior end of the lateral fins. Its origin is anterior to the posterior end of the seminal vesicles. The portion of the tail segment surrounded by the tail fin is about ⅓ of the tail segment.

The adhesive digital organs, located ventrally at each side of the tail segment in the region of the seminal vesicles, are formed by 2 fingerlike processes, similar to the thumb and index fingers of a human hand, the thumb being broader at the base than the index finger. Both the thumb- and index-like fingers at each side are strengthened by muscle-like fibers. At the ventral part of the tip of each finger is an oval pad of very fine papillae. These adhesive digital structures develop from the ventrolateral sides of the posterior part of the tail segment, and are independent of the lateral and tail fins and seminal vesicles. These digital organs extend ventrally to support the animal far away from the substratum while it is resting or when it is crawling. These organs help to attach the animal to the substratum (Fig. 2D). The fins are used during darting and swimming activities. Both types of behavior, attachment to the substratum and crawling and swimming, have been directly observed in *Spadella* by the author.

The digital structures of young 1.75 mm specimens up to the fully mature 3.75 mm specimens were of the same shape, and had the same number of fingers and structural characteristics. Thus, there is no evidence that the number of digital formations increases with growth in *S. pimukatharos,* as reported by Feigenbaum (1976) for *S. schizoptera.* Probably an increase with growth in the number of fingers in these adhesive organs does not apply to every species of *Spadella.* Also, the increase in the number of fingers Feigenbaum (1976) observed for *S. schizoptera* was due to the material he analyzed, that is, his specimens ranged from larval stage (newborn) to 14-day-olds. It is obvious that in growth from larvae to the phase before Stage I of maturity, some

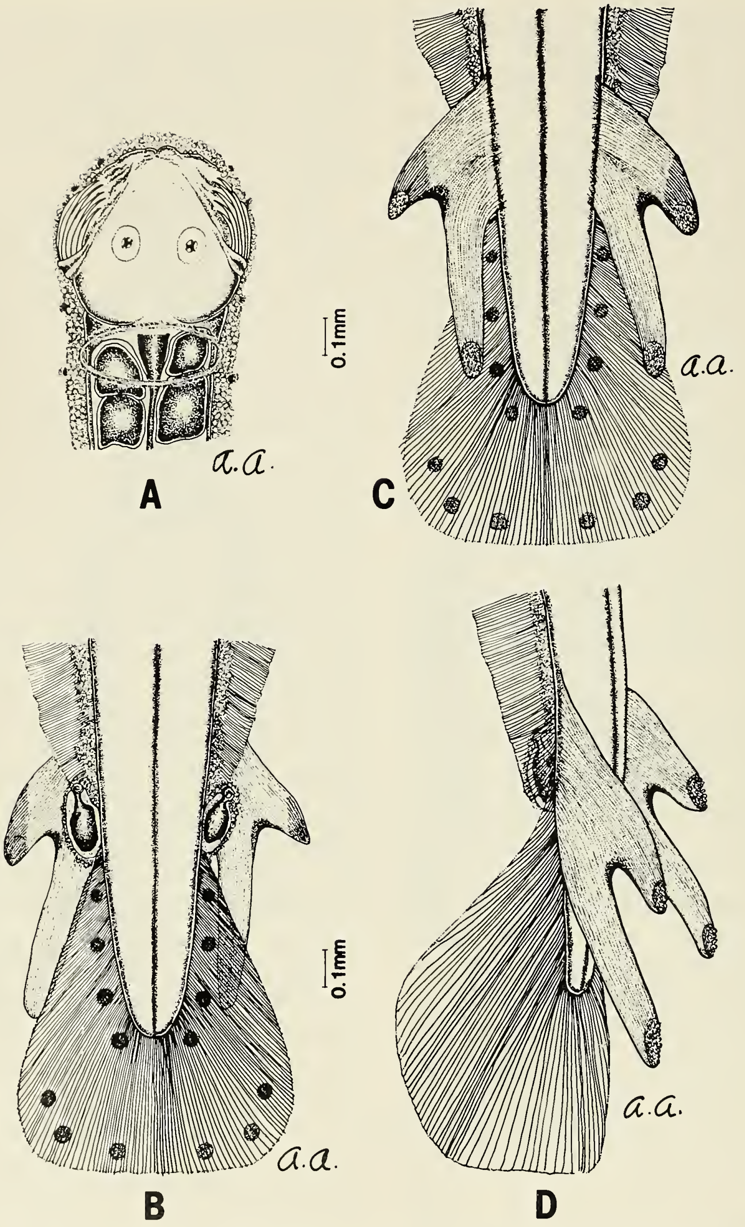

Fig. 2. *Spadella pimukatharos*: A, Dorsal view of head and neck; B, Dorsal view of posterior part of tail segment; C, Ventral view of posterior part of tail segment; D, Right side view of posterior part of tail segment showing dorsolateral position of seminal vesicles, and ventrolateral position of adhesive digital organs.

changes in meristic characteristics will be found, but does not imply that such changes take place during the development from Stage I to fully mature Stage IV.

From the ventral side to the dorsal side of the animal, the sequence of anatomical structures is: digital organs, tail fin, posterior part of lateral fins, seminal vesicles (Fig. 2D).

The ovaries extend to the neck region and fill the trunk cavity. The ova are large, hexahedral, with roundish edges and angles. They are pressed together and completely fill the ovaries, which compress the intestine towards the ventral side (Fig. 1A, B).

The oviducts open by cups dorsolaterally. The lateral fins extend ventrally anterior to the opening of the oviducts. The ventral position of the fins and dorsal setting of the oviducts results in an adequate functional device to ensure the transference of sperm during copulation (Fig. 1A).

The seminal vesicles touch both the posterior end of the lateral fins and the anterior end of the caudal fin. Seminal vesicles are protected ventrally by both the posterior and anterior parts of the lateral fins and tail fin. The seminal vesicles are oval, and smaller than in *S. legazpichessi.* The seminal vesicles resemble small amphores without handles, with anterior short neck open at the top of the neck. They are covered by the alveolar collarette tissue (Fig. 2B).

Sensory spots with sensory cilia are distributed over the tail fin and along the edge of the lateral fins and collarette from the head to the posterior part of the trunk. Fourteen of these spots occur on the tail fin, and about 10 appear to be distributed at each side from the head to the region of confluence of collarette and anterior part of lateral fins. More spots extend along the edges of the lateral fins.

Remarks.—Spadella pimukatharos differs from *S. schizoptera, S. nana,* and *S. legazpichessi* in the general aspect of the body, corona ciliata, hooks, ventral ganglion, shape of ova, shape of seminal vesicles, and shape of the adhesive organs. (See Table 1).

According to Conant (1895), *S. schizoptera* has two pairs of lateral fins, whereas *S. nana, S. legazpichessi,* and *S. pimukatharos* have one pair of lateral fins. Owre (1963: 380) indicates regarding *S. schizoptera,* "The specimen from Soldier Key has a single pair of lateral fins which begin 0.14 mm anterior to the transverse septum and terminate in the adhesive organs"). Owre (1972) referring to *S. schizoptera* explains it as "having 1 (2?) pairs of lateral fins," but unfortunately her illustration of this species does not elucidate this question, since the oviducts are drawn extending over the fins, making it impossible to define whether the lateral fins are one or two pairs. A ventral view of the species will show clearly the particular characteristics of the lateral fins. *Spadella schizoptera* has also been described by Conant (1895) as having intestinal diverticula, which are absent in the other species of *Spadella.*

Distribution.—The specimens of *Spadella pimukatharos* were collected by James (Tony) R. Chess at 10 m depth in 10 cm core samples (coffee cans) at Fisherman's Cove in Santa Catalina Island, California. According to Chess (pers. comm.), the highest number of specimens were obtained from locations where fragments of the coralline algae *Lithothamnion australe* made up more than 50% of the sediment, and at those locations the species occurred in densities of 3566/m^2, while in finer sediments the species was less abundant, from 127–636/m^2. Chess (pers. comm.) also indicated that the species was present in all five samples obtained from Fisherman's Cove on 13 Mar 1985.

Chess (pers. comm.) noted that specimens of this species were not found in samples from Fisherman's Cove obtained from 1972 to 1975, and during 1980, 1981, and 1983. However, specimens of *S. pimukatharos* were abundant at Fisherman's Cove during collections of 1984 and 1985.

Thus, it is not clear whether this species is established in this area. Either it is endemic in the region, or the population has been transported by the strong flow of warm waters from the south and has become established incidentally in Santa Catalina Island waters. It should be remembered that the warm climate in the Californian Pacific during 1984 and 1985 was probably related to the strong El Niño conditions of the South Pacific during 1982–1983, although the warmer than normal conditions persist in

Table 1.—Differential characteristics of species of *Spadella* having digital adhesive organs with apical papillar pads.

	Species			
Character.	*Spadella schizoptera* Conant, 1895	*Spadella nana* Owre, 1963	*Spadella legazpichessi* Alvariño, 1981	*Spadella pimukatharos* n. sp.
Body length mm	1.9–4.9, wider at level of posterior septum	0.75–2.70	1.8–2.2, trunk strong, opaque, widest at midlength	1.75–3.73, strong, opaque almost same width from head to tail
Head	Broader than body, narrow neck. 1 pair of pads at mouth	Broader than body. Neck distinct. 1 pair of papillae between anterior teeth and mouth	Large, wider than body. Neck clearly distinct	Roundish, same width as trunk. Neck slightly distinct. 1 pair of round pads in front of mouth
Tail segment as % of total length	47.0–53.7	40–50	50	50 or slightly more
Lateral paired fins	2 pairs. Anterior pair extending from level posterior to ventral ganglion to opening of oviducts. Second pair from this point to seminal vesicles. Only 1 pair of lateral fins (Owre 1963)	1 pair extending from a level anterior of oviducts to seminal vesicles	1 pair extending from level of oviducts to seminal vesicles	1 pair extending from level anterior of opening of oviducts to seminal vesicles
Caudal fin	Long, spatula-shaped	Spatula-shaped, starting at posterior end of seminal vesicles	Spatula-shaped, starting at posterior end of seminal vesicles. 12 sensorial spots. No rayless zone	Long, spatula-shaped, starting at level of posterior end of seminal vesicles. No rayless zone
Eyes			Large, oval, pigment in longitudinal band tilted to sides, and short band perpendicular at midlength	Large, round, pigment in longitudinal band crossed by short band pointing to center of head
Hooks	8–11, long curved, sharp pointed	5–9	8–9 at each side, thick, strongly curved	7–9 at each side, thin, curved
Anterior teeth	2–3, long, slender, curved towards midline	1–3, innermost longer than others, curved towards midline	Up to 5 on each side. First 3 longer than others. Third on each side longest. Curved towards ventral side	2–3 on each side, thin, short, pointed
Posterior teeth	None	None	None	None

Table 1.—Continued.

	Species			
Character.	*Spadella schizoptera* Conant, 1895	*Spadella nana* Owre, 1963	*Spadella legazpichessi* Alvariño, 1981	*Spadella pimukatharos* n. sp.
Corona ciliata	Three-cornered or pear-shaped. Part on head and neck	Variable in shape, extending from neck towards head	Ring-shaped at dorsal part of neck	Elliptical at dorsal side of neck. Transverse axis more than twice length of vertical axis
Ventral ganglion	Large, thick, overlaid by numerous sensory spots	As broad as long	Large, thick, at midlength of trunk. About 50% length of trunk, as close to neck as to posterior septum	Large, thick, at midlength of trunk, extending ⅔ to anterior part and ⅓ to posterior part. Closer to neck than to posterior septum. Not covering ventral width
Sensorial spots	Abundant, distributed in longitudinal and transverse rows	Symmetrically arranged in pairs on caudal fin, and longitudinal rows on body	Symmetrically arranged on tail fin (6 on each side). Conspicuous along edge of lateral fins, 6 or more on each lateral edge of collarette	Symmetrically arranged 14 on tail fin, other 10 on each side from head to confluence of collarette with lateral fins. More along edges of lateral fins
Ovaries	Reaching neck or anterior end or midlength of ventral ganglion	Reaching to neck. 2–5 huge ova, pressing intestine into "S" shape	Reaching neck region. Few large ova, pushing intestine into sinuous shape	Reaching neck region. Ova large, hexahedral, packed together, filling ovaries, pressing intestine towards ventral side
Seminal vesicles	Ellipsoidal, reniform, touching both lateral and tail fins	Oval, roundish, anterior to tail fin. Protected ventrally by lateral and tail fins	Ellipsoidal, reniform, touching posterior end of lateral fins and anterior end of tail fin. Open at middle edge towards posterior half of vesicle	Small, oval, amphora- or flask-shaped, anterior thin neck opening dorsally at anterior end
Intestinal diverticula	Present or absent according to various authors	Absent	Absent	Absent
Adhesive digital organs	Hand-shaped, continuation of lateral fins, with 4, 5, 6 fingerlike processes with adhesive papillae	Ventrally from posterior end of lateral fins to seminal vesicles. Divided into 2 stout fingers with muscular fibers	3 long, thin fingers on each organ, not connected to fins, but attached to tail at level of seminal vesicles. Outermost finger	2 fingers on each side, like thumb and index of human hand, strengthened by muscular fibers, with oval pad of

Table 1.—Continued.

Character.	Species *Spadella schizoptera* Conant, 1895	*Spadella nana* Owre, 1963	*Spadella legazpichessi* Alvariño, 1981	*Spadella pimukatharos* n. sp.
		and papillae or tubercules at tip. First finger longest	longest. Strengthened by thin muscular fibers. Large sensorial club at ventral side of tail	papillae at ventral tip
Collarette	Thick at neck, extending to seminal vesicles	Thick at neck, tapering towards seminal vesicles	Thick at neck, extending along body, tapering at posterior part of tail segment	Strong, covering head and body
Geographic distribution	Bahamas, Florida. Records from Japan (Yosii and Tokioka 1939), and from New South Wales, Australia (Mawson 1944) may be erroneous	Florida	Enewetak (Marshall Islands)	Fisherman's Cove, Santa Catalina Island, California

California up to this date. It is well known from the literature that during El Niño conditions, several populations from tropical eastern Pacific waters have been transported north off the U.S. and Canada, reaching as far north as Alaska. There is no information on the species of *Spadella* inhabiting waters south of San Diego, California. Thus, the question of whether *S. pimukatharos* is endemic to Santa Catalina Island or is transported to this area from a southern source will be elucidated when the populations of *Spadella* inhabiting Mexican and Central American Pacific waters are studied.

Etymology.—The specific name is a combination of "Pimu" and "katharos." Pimu was the original name of Santa Catalina Island until 1542, and *katharos* is the Greek root for Catalina, which means pure, clean, unsullied. This island was discovered in 1542 during the Spanish Expedition under Juan Rodríguez Cabrillo with two vessels, the *San Salvador* and the *Victoria.* He named San Salvador and Victoria the islands now called San Clemente and Santa Catalina (Instituto Historico de Marina 1943). In 1602, during the Spanish Expedition of Sebastián Vizcaino with three vessels, *San Diego, Santo Tomás* and *Tres Reyes Magos,* the islands were named San Clemente and Santa Catalina (Instituto Histórico de Marina 1944). The original name of San Clemente was Limun (Instituto Histórico de Marina 1943). Both Rodríguez Cabrillo and Vizcaíno indicate in their diaries of navigation that Santa Catalina, San Clemente, and the Channel Islands were inhabited by native Indians of California. Pimu, Pimuna, Pimun-gen apparently also meant "People of the Sea," and the Spaniards used to call these indians Pipimar and Pipimares (Kroeber 1925). According to Rodríguez Cabrillo and Sebastián Vizcaíno, the indigens fed mainly on fish, and sardines were very abundant.

Acknowledgments

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EUSARSIELLA THOMINX, A NEW SPECIES OF MYODOCOPID OSTRACODA FROM THE CONTINENTAL SHELF OF SOUTHERN CALIFORNIA

Louis S. Kornicker

Abstract.—A new species of myodocopid Ostracoda, *Eusarsiella thominx,* is described from the continental shelf of Southern California. It differs from *Eusarsiella tubipora* (Darby, 1965), the species to which the specimens studied had previously been referred, in having tapering rather than flaring bristles on the carapace.

In a prior study of *Eusarsiella tubipora* (Darby, 1965) living on the Atlantic and Gulf of Mexico continental shelves of North America, I reported specimens that had been collected off Southern California and identified as *E. tubipora* by James H. Baker (1977:43) to be an undescribed species (Kornicker 1986:124). The species is described herein as *E. thominx,* new species.

Eusarsiella thominx, new species
Figs. 1–4

Sarsiella tubipora.—Baker, 1977:43 (part).

Etymology.—From the Greek *thominx* (=thread).

Holotype.—Ovigerous female in alcohol and on 1 slide.

Type locality.—*Velero, IV,* sta 5710; 18 Apr 1958; 33°56′00″N, 118°29′17″W, 42.8 m.

Paratypes.—*Velero IV*: 1 adult female, sta 3389, 23 Aug 1955, 33°52′03″N, 118°32′33″W, 11.8 m. 1 adult female, sta 4817, 16 Jan 1957, 34°30′20″N, 120°32′45″W, 51.2 m. 1 A-2 female, length 1.14 mm, sta 4939, 9 Apr 1957, 34°23′20″N, 120°24′30″W, 119.4 m. 1 A-1 female, length 1.20 mm, sta 4984, 11 Apr 1957, 34°24′15″N, 119°34′35″W, 18 m. 1 adult female, sta 5161, 2 Jul 1957, 34°24′35″N, 119°54′00″W, 20.8 m. 1 ovig. female, sta 5583, 30 Jan 1958, 34°23′15″N, 119°32′25″W, 19.8 m. 1 ?A-3 female, length 0.80 mm, sta 5617, 20 Feb 1968, 32°42′45″N, 117°16′43″W, 32.2 m. 1 ovig. female, sta 5654, 19 Mar 1958, 33°36′12″N, 117°59′02″W, 24.8 m. 1 ovig. female, sta 5729, 15 May 1958, 34°01′00″N, 118°35′00″W, 33.5 m. 1 adult female, sta 5732, 15 May 1958, 33°59′10″N, 118°32′00″W, 35.3 m. 1 adult female, sta 5743, 16 May 1958, 33°38′20″N, 118°07′47″W, 33.5 m. 2 ovig. females, sta 5759, 30 Jul 1958, 32°37′16″N, 117°11′10″W, 24.5 m. 1 ovig. female, sta 5968, 22 Nov 1958, 34°02′00″N, 118°35′32″W, 13.2 m. 1 ovig. female, sta 6000, 16 Dec 1968, 34°27′35″N, 120°08′25″W, 34.4 m. 1 ovig. female, sta 6155, 11 Mar 1959, 34°14′00″N, 119°23′25″W, 26.4 m.

Depository.—Allan Hancock Foundation, University of California.

Distribution.—Continental shelf off Southern California, between 32°37′16″N–34°30′20″N, and at depths of 11.8–119.4 m.

Description of adult female (Figs. 1–4).—Carapace oval in lateral view with tapering and well developed posteroventral caudal process (Fig. 1). Incisur absent. Lateral surface with several ribs (Fig. 1): dorsal rib

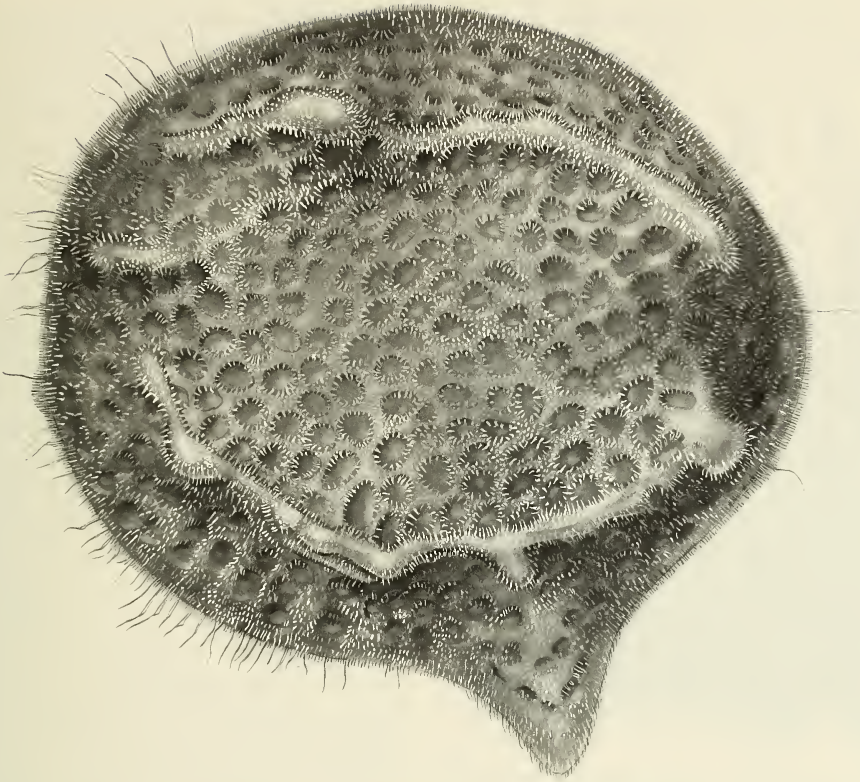

Fig. 1. *Eusarsiella thominx,* lateral view of holotype, length 1.44 mm.

paralleling dorsal margin and in some specimens divided at midlength into anterior and posterior segments; ventral rib paralleling ventral margin and with broad and narrow parts; very short horizontal anterior rib between anterior terminals of dorsal and ventral ribs and near midheight of anterior margin more evident on some specimens. Surface of carapace with abundant tapering spines between and bordering numerous shallow fossae (Fig. 2); bottom of fossae bare. Anterior and ventral edges of carapace with long bristles with a broad proximal segment (segment not shown on long bristles in Fig. 2). Surface of valves with transparent film embedding all but tips of bristles.

Infold (Fig. 3a, b): Anterior infold with minute bristle at midheight near inner edge (Fig. 3a). Infold of caudal process with 7–9 small bristles forming irregular row near base of process (Fig. 3b). Inner margin of infold anterior to caudal process with few minute bristles (Fig. 3b). Posterior infold with 2 setal bristles (Fig. 3b).

Selvage: Anterior, ventral, and posterior selvage with broad lamellar prolongation with bare outer edge; selvage extending outward from tip of caudal process with square end (Fig. 3b).

Size: Holotype, right valve under cover slip: length 1.44 mm, height including caudal process, 1.43 mm, height excluding caudal process 1.25 mm. Paratypes: adult female from sta 3389, length 1.33 mm, height including caudal process 1.21 mm; adult female from sta 4817, length 1.44 mm, height including caudal process 1.41 mm, height excluding caudal process 1.27 mm; oviger-

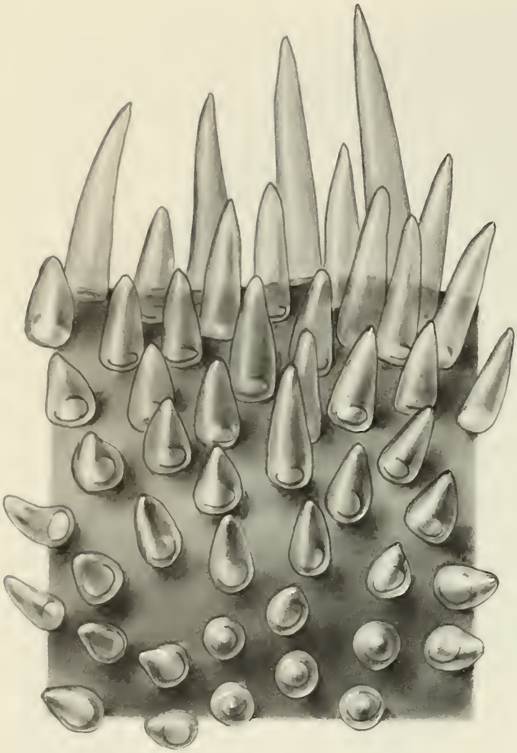

Fig. 2. *Eusarsiella thominx,* detail of bristles on carapace of holotype, width of detail 0.025 mm.

ous female from sta 5583, length 1.55 mm, height including caudal process 1.40 mm, height excluding caudal process 1.32 mm; 2 ovigerous females from sta 5759, length 1.50 mm, height including caudal process 1.45 mm, height excluding caudal process 1.27 mm; length 1.44 mm, height including caudal process 1.35 mm, height excluding caudal process 1.22 mm; 1 ovigerous female from sta 6155, length 1.33 mm, height including caudal process 1.32 mm, height excluding caudal process 1.17 mm.

First antenna (Fig. 3c): 1st joint bare. 2nd joint with few dorsal spines and spinous dorsal bristle. 3rd joint fused to 4th, with 2 bristles (1 dorsal, 1 ventral); 4th joint with 3 terminal bristles (1 dorsal, 2 ventral (1 ventral twice length of other)). Sensory bristle of 5th joint with 2 minute dorsal spines and terminal spine. 6th joint fused to 5th, with minute medial bristle near dorsal margin. 7th joint: a-bristle about 3 times length of bristle of 6th joint; b-bristle about 1½ times length of a-bristle, bare; c-bristle about same length as bristle of 5th joint, with 2 minute dorsal spines and terminal spine. 8th joint: d- and e-bristles long, bare, with blunt tips; f-bristle slightly shorter than c-bristle, with terminal spine; g-bristle almost same length as c-bristle, with terminal spine and possibly 1 or 2 minute dorsal spines (obscure).

Second antenna (Fig. 3d): Protopodite bare. Endopodite 2-jointed: 1st joint with 1 or 2 small anterior bristles; 2nd joint small, cylindrical, with short terminal bristle. Exopodite: 1st joint with short, recurved, medial spine on distal margin; bristle of 2nd joint long with slender proximal ventral spines, and natatory hairs proximally on dorsal margin and distally on both margins; bristles of joints 3–8 with natatory hairs, no spines; 9th joint with 2 bristles (ventral long, dorsal short, both with natatory hairs); joints 3–7 with faint spines forming distal row.

Mandible (Fig. 4a): Coxale endite comprising single spine with drawn-out tip; ventral margin of coxale with slender proximal spines. Basale with 5 small bristles near ventral margin and minute subterminal bristle on dorsal margin. Endopodite: medial surface of 1st joint with spines forming distal cluster and also forming row in distal dorsal corner; dorsal margin with spines forming distal row; ventral margin with stout terminal claw with faint teeth proximally along dorsal margin; minute medial bristle present near base of claw; dorsal margin of 2nd joint with small unringed subterminal bristle; ventral margin with stout terminal claw; end joint with stout terminal claw and fairly long ventral bristle, and small dorsal bristle near base of terminal claw.

Maxilla (Fig. 4b): Coxale with short dorsal bristles; endites I–III each with 5–6 bristles. Exopodite with 2 bristles (inner bare

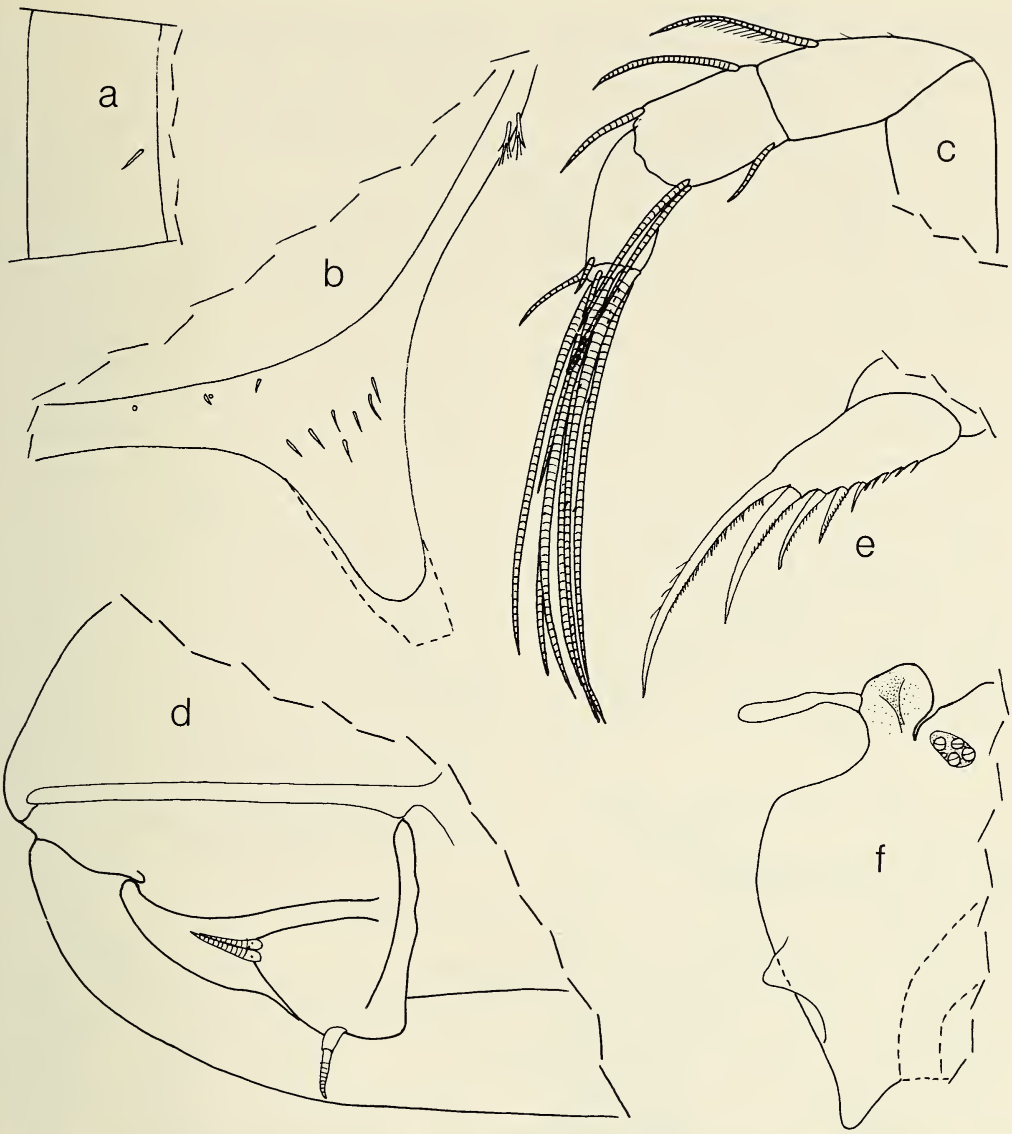

Fig. 3. *Eusarsiella thominx,* holotype, a, Inside view of anterior infold of right valve showing bristle; b, Inside view of posterior infold showing bristles and selvage (dashed); c, Medial view of right 1st antenna; d, Medial view of right 2nd antenna showing distal part of protopodite, endopodite, and part of 1st exopodial joint; e, Left lamella of furca; f, Anterior of body showing left lateral eye, medial eye and bellonci organ, anterior process below midheight, upper lip and part of esophagus (dashed).

bristle about half length of outer spinous bristle). Endopodite: alpha-bristle of 1st joint with 2–4 pairs of spines on proximal unringed part and numerous spines on ringed part; beta-bristle with about 4 pairs of spines on proximal unringed part and numerous spines on ringed part; end joint with 3 bare a-bristles, 1 bare c-bristle, and 5 stout end bristles (anterior end bristle with 6 pairs of stout proximal teeth on unringed part and

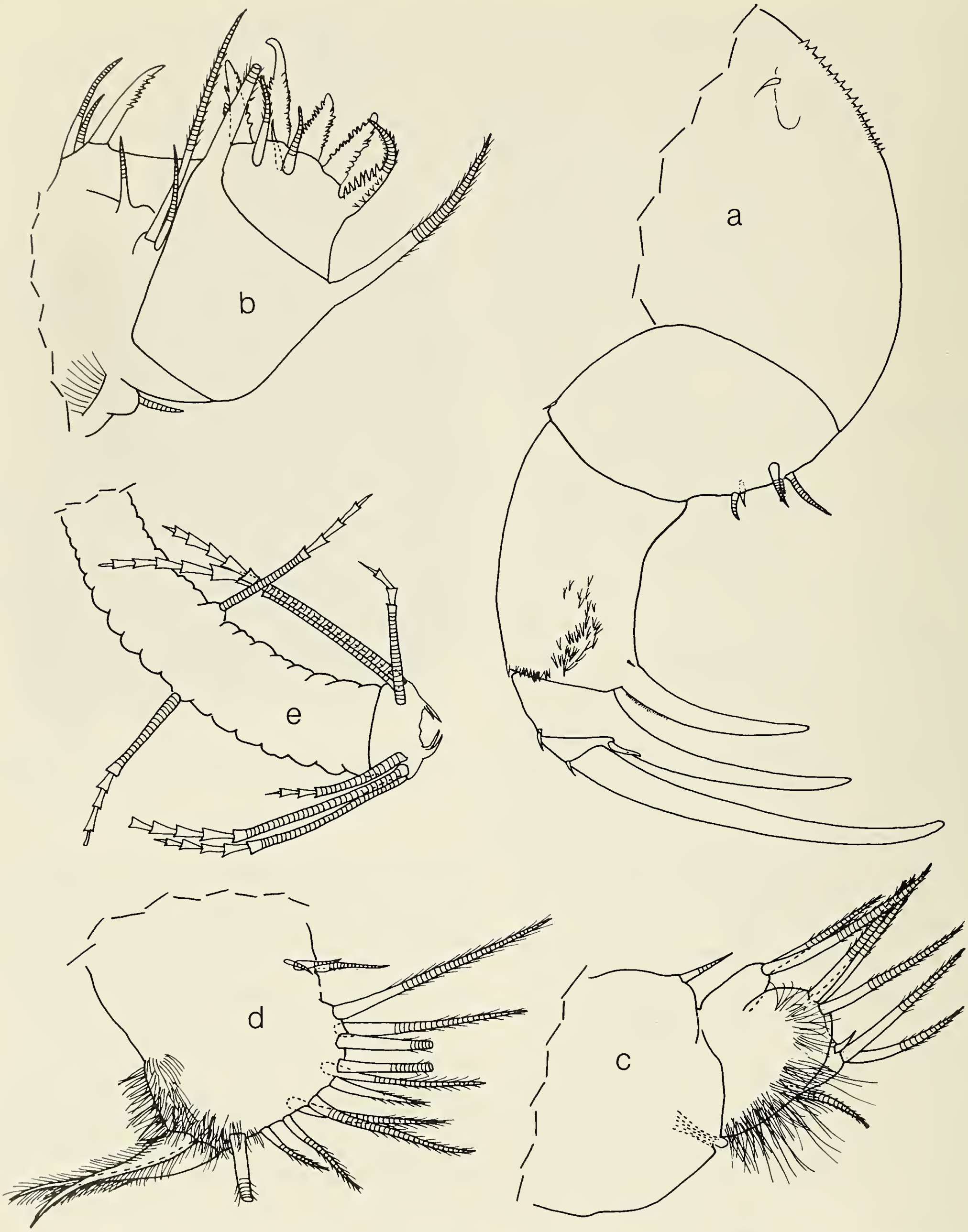

Fig. 4. *Eusarsiella thominx,* holotype, a, Medial view of right mandible; b, Lateral view of left maxilla; c, 5th limb; d, 6th limb; e, 7th limb.

about 12 pairs of more slender teeth on distal ringed part, remaining end bristles with 4–12 stout teeth on each side and without rings).

Fifth limb (Fig. 4c): Single endite with 1 short bristle. Protopodite with small glandular peg on outer edge near border with exopodite. Exopodite: 1st joint with 2 spinous bristles; 2nd joint forming lobe weakly separated outwardly from remaining joints but not by suture, hirsute with 3 spinous bristles; remaining fused joints hirsute, with 1 proximal and 3 terminal bristles. Epipodite with 29 bristles.

Sixth limb (Fig. 4d): Single endite with 3 small bristles; end joint hirsute near posterior margin, with 11 bristles with short marginal spines followed by 2 hirsute posterior bristles.

Seventh limb (Fig. 4e): Proximal group comprising 2 bristles, each with 4 bells; distal group with 6 bristles, each with 3–6 bells. Terminus with opposing combs, each with 3–4 teeth.

Furca (Fig. 3e): Each lamella with 5 claws followed by about 4 minute spines; claw 1 fused to lamella, remaining claws separated from lamella by suture; claws 1–4 with short and long teeth along posterior margin, claw 5 with only short teeth; claw 1 with few hairs along anterior margin; anterior margin of right lamella with faint spines; holotype with 5 fairly stout spines on left lamellae following claw 5, only 2 spines on right lamella; claws of right lamella slightly anterior to those of left.

Bellonci organ (Fig. 3f): Elongate with broadly rounded tip.

Eyes (Fig. 3f): Medial eye pigmented, bare; lateral eye smaller than medial eye, with brown pigment and 5 ommatidia (4 large divided, 1 smaller, undivided).

Upper lip (Fig. 3f): Helmet shaped, bare.

Genitalia: Oval with sclerotized rim (typical for genus).

Y-sclerite: Typical for genus.

Eggs in marsupium: Holotype, 5 eggs. Paratypes: sta 5583, 5–6 eggs; 2 specimens, sta 5759, 6 eggs in each (1 specimen also with smaller unextruded eggs); sta 6000, 6 eggs; sta 6155, 3 eggs.

Faunal composition.—17 specimens of *E. thominx* were in the collection, including 14 adult females, of which about half were ovigerous, and three juveniles. One of the ovigerous females also contained small eggs in the ovaries indicating that the species is capable of having at least two broods. Only two of the three juveniles were examined, both were females.

Comparisons.—The new species *E. thominx* differs from *E. tubipora* (Darby, 1965) in having carapace bristles with tips tapering to a point rather than being flared. The endopodite of the 2nd antenna of the female *E. thominx* differs from that of *Eusarsiella pseudospinosa* (Baker, 1977) in having a terminal bristle.

Three specimens (2 ovigerous females and 1 juvenile from *Velero IV* stations 4718 (female), 5109 (juvenile, length 0.97 mm), 5180 (ovigerous female with 9 eggs, length 1.38 mm)) that had been identified as *E. tubipora* by Baker do not belong to either that species or to *E. thominx,* but the condition of the specimens does not warrant their description. The endopodite of the female 2nd antenna of the 3 specimens differs from that of *E. thominx* in not having a terminal bristle.

Acknowledgments

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100(1), 1987, pp. 141–146

CONOPORA ADETA, NEW SPECIES (HYDROZOA: STYLASTERIDAE) FROM AUSTRALIA, THE FIRST KNOWN UNATTACHED STYLASTERID

Stephen D. Cairns

Abstract.—A new species of *Conopora* is described from off Queensland, Australia, the first known unattached stylasterid. It always occurs in a symbiotic relationship with a polynoid polychaete, which determines the colony morphology. *Conopora adeta* is also the first deep-water stylasterid reported from off Australia (398 m) and the ninth record of a stylasterid from the Australian region.

Of the approximately 225 valid species of Stylasteridae (Cairns 1983b, 1986a,b), almost all are firmly attached, arborescent (uniplanar or bushy) colonies. The exceptions are the three species of *Stylantheca,* which are encrusting; and the two species of *Errinopsis,* which form fenestrate flabella that have multiple attachment sites to the substrate. The species described herein differs from all other stylasterids in that it is not attached to a substrate. Instead, the colony stands erect by forming a massive globose base that is stabilized by three to six dense, robust branches that radiate outward from it. Aside from the basal branches, branching is minimal, relegated primarily to very short, nonbifurcating branches originating from the U-shaped polychaete tube that serves as a substitute for the main stem of the colony.

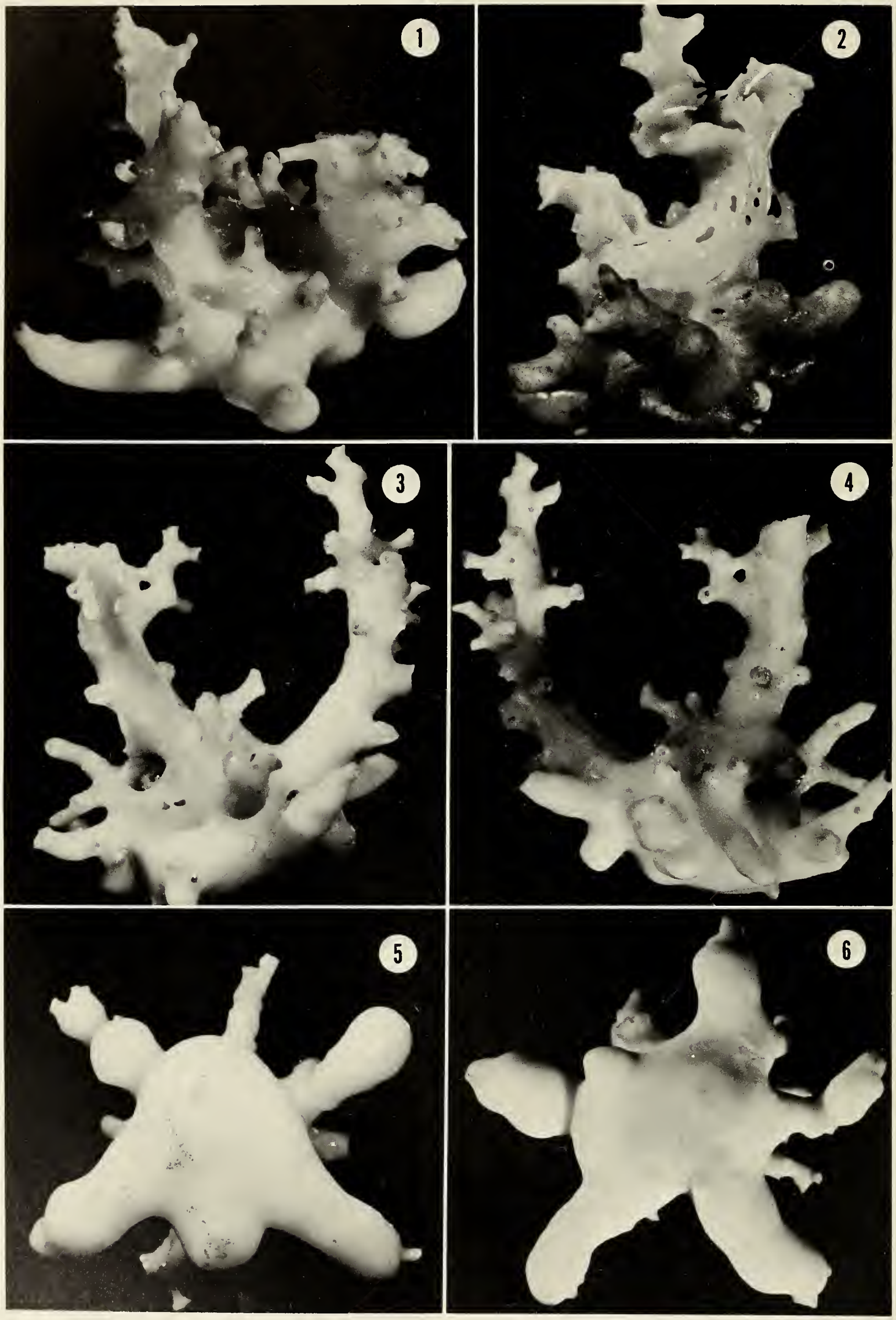
Class Hydrozoa Owen, 1843
Subclass Athecatae Hincks, 1868
Order Filifera Kuhn, 1913
Superfamily Hydractinioidea
Bouillon, 1978
Family Stylasteridae Gray, 1847
Conopora Moseley, 1879

Diagnosis.—Colonies usually flabellate but sometimes bushy when modified by a commensal polychaete. Coenosteum linear-imbricate with broad, flat platelets (Group A) or reticulate-granular (Group B); nematopores often present. Gastropore double-chambered, the larger upper chamber separated from the lower thinner one by a slightly constricted aperture. Gastro- and dactylostyles and gastrozooid tentacles absent. Female ampullae superficial; male ampullae both superficial and internal, often positioned near cyclosystems, with their efferent pores opening into a cyclosystem or adjacent to one. Type species: *Conopora tenuis* Moseley, 1879 (=*C. laevis* (Studer, 1878)), by monotypy.

Discussion.—Cairns (1983b) divided *Conopora* into two groups: Group A, having delicate branches with sympodially arranged cyclosystems and linear-imbricate coenosteum, including three Recent species; and Group B, having robust branches with randomly arranged cyclosystems and reticulate-granular coenosteum, including one Recent and one fossil species. *Conopora adeta* belongs to Group A.

Conopora adeta, new species
Figs. 1–15

Description.—Each colony consists of a globose mass 8–12 mm in diameter with a flat to slightly convex base from which 3–6 dense, robust branches project horizontal to substrate. Largest colony examined (the holotype) 32.5 × 28.7 mm in diameter, in-



Figs. 1–6. *Conopora adeta* (1, Holotype; 2–6, paratypes, all from F.R.V. *Soela* 25): 1, Holotype colony, oblique side view showing ascending polychaete tubes and basal stabilizing branches, ×2.2; 2, Side view of female colony showing porosity of worm tube, ×2.2; 3, 4, Opposing side views of a colony with tall ascending polychaete tubes, left tube of fig. 3 completely open, ×2.3; 5, 6, Basal view of two colonies showing robust radiating branches, ×2.2, ×2.3, respectively.

cluding branches, and 21.0 mm tall. Globular mass permeated by a commensal polychaete, which also forms a porous U-shaped tube above the mass with parallel vertical elements (see Remarks). Large basal branches up to 5 mm in diameter and 8–12 mm long, sometimes clavate. Shorter branches, up to 6 mm long and 1.5 mm in diameter and bearing only 3–5 cyclosystems, occur on upper part of globose mass, project from ascending polychaete tubes, and occasionally occur on upper part of basal branches. Each basal branch also usually bears one apical cyclosystem. Smooth base of colony also lacks cyclosystems.

Cyclosystems sympodially arranged, round (0.75–0.90 mm in diameter), and usually flush with coenosteum. Based on 32 cyclosystems, there is a range of 12–17 dactylopores per cyclosystem, mean = 14.19 (σ =1.21), and mode of 15. Diastemas not present.

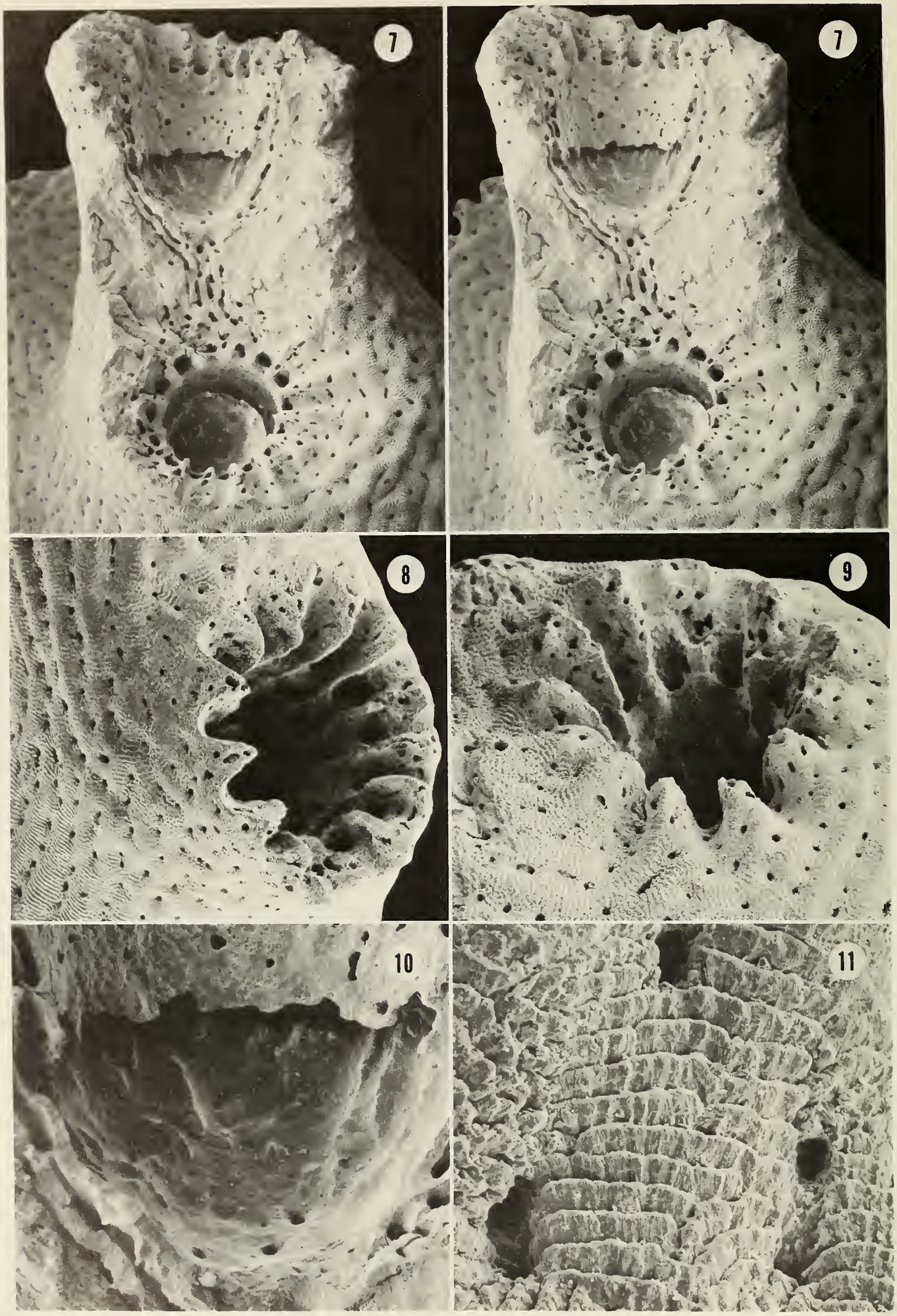
Upper chamber of gastropore tube cylindrical to very slightly tapered, about 0.5 mm in height and diameter. Aperture to lower chamber not constricted. Lower chamber slightly greater in diameter than upper and about 0.35 mm deep. Low, longitudinal carinae about 25 μm wide present in lower chamber (Fig. 10). Dactylotomes about 77 μm wide; pseudosepta of equal width and slightly convex.

Female ampullae massive, elongate hemispheres about 1.45 × 1.25 mm in diameter. Female efferent pores about 0.35 mm in diameter. Male ampullae also elongate and superficial but significantly smaller (e.g., 1.0 × 0.71 mm) and with less relief. Male efferent pores round, 50–60 μm in diameter, and in a lateral position. Some cyclosystems surrounded by 4 or 5 male ampullae, all of which have their efferent pores adjacent to the cyclosystem (Fig. 15). Ampullae also scattered over worm tube coenosteum.

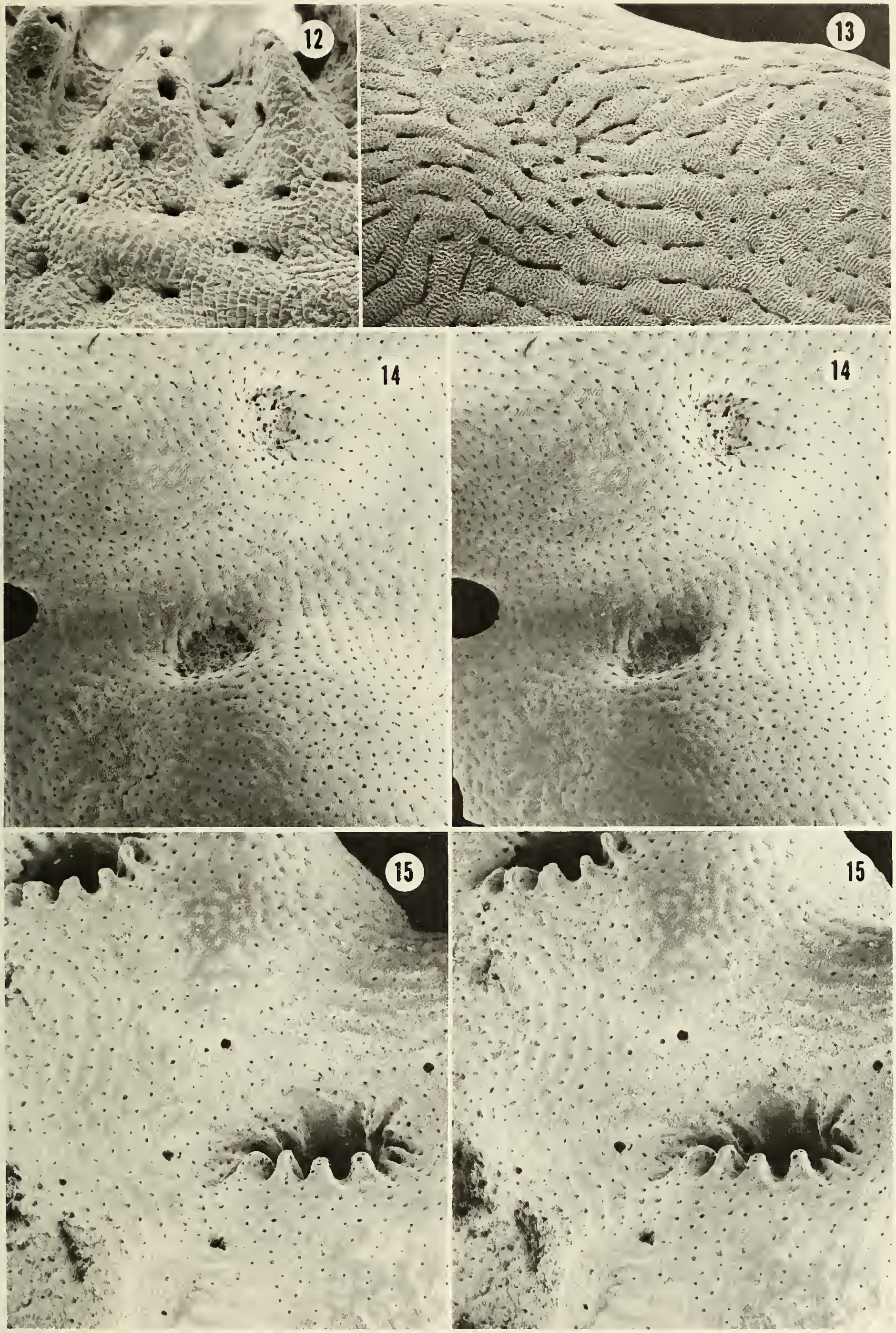
Remarks.—All ten specimens examined lived in association with a commensal polychaete, an undescribed genus and species of polynoid (pers. comm., M. Pettibone 1986), which creates a tubular cavity in the stylasterid's globular mass, the cavity consisting of an upward spiral of two or three horizontal revolutions. The tube emerges from the mass apically and induces the coral to form the characteristic U-shaped highly porous tube alluded to in the description. The vertical elements of the tube are up to 14 mm tall and about 3.5 mm in diameter. In two specimens, one of the vertical elements was bifurcate. In several cases the cavity also emerged from the side or base of the spherical mass with a pore diameter of 1.2–1.5 mm.

In two specimens a small aplacophoran mollusk inhabited the upper section of the polychaete tube.

Of the ten specimens available for study, all had smooth bases without evidence of former attachment. Nonetheless, it is hypothesized that each colony was originally attached to a substrate via planula settlement, as is the case for all stylasterids, but in *C. adeta* the substrate is assumed to have been small (e.g., a sand grain or a small mollusk shell) and that the coral quickly overgrew it. The symbiotic polychaete probably also became associated with the coral early in ontogeny. Because the hypothesized original substrate was small and not capable of supporting an arborescent colony, it is suggested that the colony stabilized itself by producing robust radiating branches from the basal globular mass. The adaptive value of an unattached colony is not clear. It is unlikely that the polychaete can move the colony to a different site or that the colony is ever transported any distance. This unusual adaptation may simply be the result of the lack of an adequately firm substrate and may even represent a form of a species that is normally attached when the proper substrate is available. Symbiosis with polynoid polychaetes that form similar globular cavities in attached stylasterid colonies is not rare (e.g., *Stenohelia concinna* Boschma, 1964, *Stenohelia ro-*



Figs. 7–11. *Conopora adeta,* paratypes from F.R.V. *Soela* 25: 7, Longitudinal section and top view of two cyclosystems, stereo pair, ×32; 8, 9, Cyclosystems, ×49, ×63, respectively; 10, Longitudinal section of lower gastropore chamber of specimen in fig. 7, ×109; 11, Coenosteal platelets, ×345.



Figs. 12–15. *Conopora adeta,* paratypes from F.R.V. *Soela* 25: 12, Several pseudosepta and adjacent coenosteal strip, ×123; 13, Two male ampullae and coenosteal strips, ×44; 14, Two female ampullae, each with a large efferent pore, stereo pair, ×26; 15, A cyclosystem surrounded by four male ampullae, each with an efferent pore adjacent to the cyclosystem, stereo pair, ×27.

busta Boschma, 1964, *Errina macrogastra* Marenzeller, 1904) (see Cairns 1986b).

Discussion.—There are only four previously described Recent species of *Conopora* (Cairns 1983b). *Conopora adeta* clearly belongs to Group A (sensu Cairns 1983b) because of its sympodially arranged cyclosystems and delicate branches with linear-imbricate coenosteum. This group includes three other species: *C. major* Hickson and England, 1905 (Banda and Celebes Seas, 204–1901 m); *C. verrucosa* (Studer, 1878) (Antarctic and Subantarctic, 216–2544 m; see *C. pauciseptata* of Cairns, 1983a); and *C. laevis* (Studer, 1878) (New Zealand, Kermadec Islands, 110–951 m; see Cairns 1983b:490). *Conopora adeta* is distinguished from all three species by its unattached growth mode, smaller cyclosystems, and higher number of dactylopores per cyclosystem. All four species have commensal polychaetes, broad imbricate platelets, and similarly shaped gastropore chambers.

Eight species of stylasterids have been previously reported from off Australia (Boschma 1957): *Distichopora violacea* (Pallas, 1766); *D. nitida* Verrill, 1864; *D. concinna* Gray, 1860; *Stylaster granulosus* Milne Edwards and Haime, 1850; *S. sanguineus* Milne Edwards and Haime, 1850; *S. gracilis* Milne Edwards and Haime, 1850; *S. incompletus* (Tenison-Woods, 1883); and the Miocene *S. mooraboolensis* (Hall, 1893). *Conopora adeta* is the first species reported from relatively deep water off Australia.

Etymology.—The specific name is from the Greek *adetos,* meaning "free," "loose," and "unbound," in reference to the unattached growth mode of this species.

Types.—Holotype: male, N.T.M. (Northern Territories Museum) C5385.—Paratypes: 4 specimens, USNM 76299; 5 specimens, N.T.M. C5386.

Type locality.—F.R.V. *Soela* 25: 20°46.2′S, 152°51.8′E (Marion Plateau, off MacKay, Queensland, Australia), 398–399 m, 22 Nov 1985.

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NEW SPECIES OF *NEOMEGAMPHOPUS* FROM TROPICAL AMERICA (CRUSTACEA: MARINE AMPHIPODA)

J. L. Barnard and James Darwin Thomas

Abstract.—*Neomegamphopus hiatus* is described from Venezuela and the Florida Keys, *N. pachiatus* and *N. heardi* from Pacific Panama, and *N. kalanii* from eastern Florida. *Neomegamphopus hiatus* and *N. pachiatus* differ from a close congener, *N. roosevelti* (tropical eastern Pacific), in the much larger coxa 1 of mature males, the less setose gnathopods, and the broader carpus of the first gnathopod bearing a much deeper incision defining the posterior tooth; the carpus is much shorter and stouter in *N. hiatus* and *N. pachiatus* than in *N. roosevelti. Neomegamphopus heardi* differs from the other species in the bifid tooth on the carpus of gnathopod 1 in males. Questions regarding the reclassification of the Isaeidae, Aoridae, and Neomegamphopidae are explored and the three families amalgamated again to their status of 1973 (except Corophiidae which is segregated).

Four new species are added to the two species previously known in *Neomegamphopus* Shoemaker (1942). The enlarged coxa 1 of two of these species, *N. hiatus* and *N. pachiatus,* resembles that of *Konatopus* J. L. Barnard (1970) but we conclude they belong with *Neomegamphopus* because of the elongate propodus and extremely broadened and strongly toothed carpus of male gnathopod 1. The new species, *N. heardi,* differs from all other species in the genus in the bifid character of the tooth on the carpus of male gnathopod 1 (however, a similar undescribed species occurs in Venezuela for which insufficient material is available for description). *Neomegamphopus kalanii* may be a growth stage of *N. hiatus* but this stage is frequently larger than adults of *N. hiatus* and no stages of transformation between the two species can be demonstrated.

Neomegamphopus belongs to a group of genera placed in the family Neomegamphopidae by Myers (1981). We agree that such a family (or cluster of genera) can be loosely defined but not with the generic composition proposed by Myers (1981). He states (1981:9): "It is theoretically possible for a neomegamphopid to have a gnathopod 2 secondarily enlarged so as to dominate the primarily enlarged gnathopod 1. Such a neomegamphopid would in practice be difficult to distinguish from an isaeid." We believe that *Amphideutopus* J. L. Barnard (1959), classified by Myers as an Isaeid, is this organism. Continuing the quotation, "However, the axial gradient is so well established in isaeids that the females generally have gnathopod 2 larger than gnathopod 1 and thus indicate their origins. Neomegamphopidae, on the other hand, show little evidence of an axial gradient in the females." Myers continues: "The suggestion of multiple evolutionary reversal (Barnard, 1973) is rejected, and all corophioideans with protogammaropsis head structure . . . bearing complex male gnathopod 1 and primitive unmodified gnathopod 2 are placed in the family Neomegamphopidae. Isaeid genera such as *Amphideutopus* and *Ledoyerella* Myers (1973), whilst exhibiting an enlarged gnathopod 1 in males also possess an enlarged, complexly subchelate gnathopod 2." We disagree and classify gnathopod 2 in these genera as ordinarily subchelate.

We disagree with this classification and the reasons for inclusion of several misplaced genera in various families cited by Myers (1981). Myers described or redescribed the families Corophiidae, Isaeidae, Aoridae, and Neomegamphopidae and follows the guidelines of the quotations cited above. For example, he creates the Neomegamphopidae with the type-genus being *Neomegamphopus,* which has a complexly subchelate gnathopod 1 quite in contrast to *Pseudomegamphopus* (1968c), one of the other genera he includes. Other genera are: *Konatopus, Varohios* J. L. Barnard (1979), and *Maragopsis* Myers (1973). *Varohios* has a very unusual male gnathopod 1 in which a dactyl and hand are present but no definitive carpus, the appendage having only 6 clear articles; one presumes articles 4 and 5 are fused. *Varohios* thus qualifies to be in the Neomegamphopidae based solely on the slightly enlarged female gnathopod 1 and not by the complexly subchelate gnathopod 1.

In contrast to the complex chelation of male gnathopod 1 in *Neomegamphopus,* Myers includes in the Isaeidae the genus *Amphideutopus* which also has a complexly subchelate gnathopod 1 but admittedly has a weakly enlarged female gnathopod 2, the primary character of Isaeidae. Gnathopod 2 of male *Amphideutopus* is as enlarged as gnathopod 2 but not complexly chelate. This qualifies *Amphideutopus* for inclusion in the Isaeidae according to Myers. *Acuminodeutopus* J. L. Barnard (1959), (=*Rudilemboides* J. L. Barnard [1959]), also with enlarged complexly subchelate gnathopod 1, on the other hand, is placed in the Aoridae where all genera are also characterized by poorly invaginated antenna 2. We consider the situation in *Acuminodeutopus* to be somewhat debatable as it is difficult to determine whether or not the genus belongs with those genera having deep or shallow invagination of antenna 2. For clarification, we present the following key to these families and include the Ischyroceridae, a companion family in the Corophioidea:

1. Pereonite 2 lacking coxal gill .... Corophiidae
– Pereonite 2 bearing coxal gills 2
2. Head not deeply recessed for insertion of antenna 2 .... Aoridae
– Head deeply recessed for insertion of antenna 2 3
3. Female gnathopod 1 larger than gnathopod 2 .... Neomegamphopidae
– Female gnathopod 2 larger than gnathopod 1 4
4. Outer ramus of uropod 3 without spines, apex hooked ... Ischyroceridae
– Outer ramus of uropod 3 with spines, apex not hooked .... Isaeidae

The Neomegamphopidae and Aoridae contain genera with male gnathopod 1 always enlarged, but Neomegamphopidae has two kinds of such gnathopod, complexly subchelate and ordinary (or "propodochelate" if such definition is desirable). The Aoridae seem to include three kinds of complexly subchelate gnathopod 1: propodochelate, carpochelate, merochelate, and noncomplex (ordinary). The Ischyroceridae have gnathopod 2 always larger than 1 but often complexly subchelate as in gnathopod 1 of Aoridae and Neomegamphopidae. As composed by Myers, the Isaeidae include males with carpochelate (*Amphideutopus*) and ordinary enlarged gnathopod 1 (*Aloiloi* J. L. Barnard [1970]) conjunct with males having small and female-like gnathopod 1. *Aloiloi* and *Amphideutopus* are included with Isaeidae because female gnathopod 2 is weakly enlarged (actually female of *Aloiloi* unknown). Hence, this classification divides carpochelate gnathopod 1 of males among Isaeidae, Neomegamphopidae, and Aoridae, retains merochelate gnathopod 1 of males in Aoridae where it is mixed with carpochelate and non-chelate genera, and places all carpochelate gnathopod 2 of males in the Ischyroceridae (which was the conclusion of Barnard 1973). Examples of carpochelate gnathopod 2 in males are *Cerapus* and *Ericthonius.*

Primary difficulties with the above classification we believe are the disassociation of *Amphideutopus* from the Neomegamphopidae and the difficulty in determining the size relationships of female gnathopod 2 in a few genera and a few species of certain other genera. For example, in the new species of *Neomegamphopus* described herein, female gnathopod 1 should be larger than gnathopod 2 by familial definition but is not and instead is identical to gnathopod 1. Other examples are: *Neomegamphopus kunduchii* Myers (1973), *Konatopus latipalma* Ledoyer (1979), and *Varohios topianus* J. L. Barnard (1979). Examples of the alternative case, in which female gnathopod 2 should be larger than gnathopod 1 occur in *Amphideutopus oculatus* J. L. Barnard (1959) where the condition is debatable; female gnathopod 2 has a longer propodus than gnathopod 1 and probably the total facial area of articles 5–6 is greater than on gnathopod 2. Classification is very difficult when value judgments are so vagarious as in these examples.

The depth of insertion below the head of antenna 2 is very difficult to decide in several crucial genera, such as *Acuminodeutopus* and *Rudilemboides,* etc. We believe that *Amphideutopus* should be in the same family as *Neomegamphopus* even though male gnathopod 2 is secondarily enlarged; it however is not carpochelate but simply a thickened version of the common kind of gnathopod found in species of the Neomegamphopidae. Owing to the completely distinctive gnathopod 1, we do not believe that *Pseudomegamphopus* and *Varohios* have very close affinities to *Neomegamphopus* in the Neomegamphopidae.

In its broad propodus, *Maragopsis* differs from the complexly subchelate kind of gnathopod 1 typical of *Neomegamphopus*; all other genera have a thin simple propodus; *Maragopsis* has almost no tooth on the carpus (thus not carpochelate) but as we have already placed *Rudilemboides* with Neomegamphopidae, *Maragopsis* could not be excepted.

We also believe that *Rudilemboides* can be separated from *Acuminodeutopus* as based on the following key; *Pseudomegamphopus, Maragopsis* and *Varohios* are removed from the key.

Key to the Neomegamphopid Genera

1. Hand of male gnathopod 1 as broad as carpus .... *Maragopsis*

– Hand of male gnathopod 1 much thinner than carpus 2

2. Article 3 of mandibular palp thickly clavate, with numerous inner setae 3

– Article 3 of mandibular palp thin, poorly setose 5

3. Male gnathopod 2 enlarged .... *Amphideutopus*

– Male gnathopod 2 not enlarged .. 4

4. Propodus of male gnathopod 1 elongate, coxa 1 only 120 percent as long (axial) as coxa 2 ... *Neomegamphopus*

– Propodus of gnathopod 1 short, coxa 1 more than 160 percent as long (axial) as coxa 2 .... *Konatopus*

5. Inner ramus of uropod 3 elongate, male gnathopod 1 not carpochelate .... *Rudilemboides*

– Inner ramus of uropod 3 short, male gnathopod 1 carpochelate .... *Acuminodeutopus*

Owing to the difficulties in making value judgements about the two primary categories of character that separate Aoridae, Isaeidae, and Neomegamphopidae from each other, we continue to consider the three groups as indivisible until some better way to develop subdivisions can be found. We agree with Bousfield (1973) that the four genera split away in the Corophiidae can be retained in that family as based on absence of coxal gill 2 until transitional genera are found. This would result in the Aoridae and

Neomegamphopidae being recombined under the name Isaeidae until some clear subdivision can be established. We must note, however, that differential loss of coxal gills in Podoceridae is not useful as a family character.

In order to ameliorate the confusion about the position of *Neomegamphopus* we present the following key which includes all genera from Aoridae, Neomegamphopidae, and Isaeidae which have a carpochelate male gnathopod 1 or which have the carpus of male gnathopod 1 dominating the propodus in terms of size or lateral surface area; thus *Maragopsis, Lemboides* Stebbing (1895), and *Rudilemboides* are included as based on the second definition.

Key to the Carpochelate or Dominant-Carpus Genera

1. Mandibular palp article 3 falcate 2
– Mandibular palp article 3 not falcate 3
2. Carpus of gnathopod 1 with tooth .... *Microdeutopus*
– Carpus of gnathopod 1 lacking tooth .... *Lemboides*
3. Coxae slightly disjunct, inner ramus of uropod 3 absent 4
– Coxae not disjunct, inner ramus of uropod 3 present 5
4. Uropod 2 biramous ..*Grandidierella*
– Uropod 2 uniramous ...*Chevreuxius*
5. Article 3 of mandibular palp stout and bearing medial setae 6
– Article 3 of mandibular palp slender and lacking medial setae 9
6. Propodus of male gnathopod 1 broad .... *Maragopsis*
– Propodus of male gnathopod 1 thin 7
7. Article 2 of male gnathopod 1 thick .... *Konatopus*
– Article 2 of male gnathopod 1 slender 8
8. Male gnathopod 2 thin .... *Neomegamphopus*
– Male gnathopod 2 enlarged and broadened ....*Amphideutopus*
9. Male gnathopod 2 broad *Zoedutopus*
– Male gnathopod 2 slender 10
10. Inner ramus of uropod 3 shortened, carpus of male gnathopod 1 with tooth ....*Acuminodeutopus*
– Inner ramus of uropod 3 not shortened, carpus of male gnathopod 1 without tooth .... *Rudilemboides*

In the above key one would assume from Myers' (1981) comments that there is a large degree of homology among the genera; he believes that axial reversal of gnathopods proposed by Barnard (1973) is to be rejected and one would therefore suppose that the carpochelate shape of the gnathopod has not arisen independently in each genus. This does not necessarily negate our opinion that axial reversal (dominance by gnathopod 1) has not occurred several times in the Isaeidae sensu lato because different kinds of first gnathopods are present in the amalgamated group.

Master Legend

Capital letters as follows refer to parts; lower case letters to left of capital letters refer to specimens noted in legends; lower case letters to right of capitals refer to adjectival modifications in list below:

B, body; D, dactyl; F, accessory flagellum; G, gnathopod; H, head; J, lacinia mobilis; K, palm of gnathopod 2; L, labium; M, mandible; N, molar; O, outer plate or ramus; P, pereopod; R, uropod; S, maxilliped; T, telson; U, labrum; V, palp; W, urosome; X, maxilla; Y, oostegite; Z, gill; r, right; s, setae removed; t, left.

Neomegamphopus Shoemaker

Neomegamphopus Shoemaker, 1942:35 (*Neomegamphopus roosevelti* Shoemaker, 1942, original designation).

Diagnosis.—Article 3 of mandibular palp thick and clavate, well setose on inner margin; coxa 1 longer axially than coxa 2; male gnathopod 1 carpochelate, propodus elongate; female gnathopod 1 usually larger than gnathopod 2; rami of uropod 3 subequal.

Notes on Problems

There are problems with length of accessory flagellum in this genus which we have not resolved. In species with robust males such as *N. roosevelti* the accessory flagellum is half as long as article 1 of the primary flagellum; because the latter article is elongate in robust species the accessory flagellum is relatvely short; however in taxa such as *Neomegamphopus* species C, both article 1 of the primary flagellum and the accessory flagellum are short and the accessory flagellum is half as long as the primary article. In dwarf species such as *N. hiatus* the accessory flagellum is as long as or longer than article 2 of the primary flagellum, but these adults apparently do not enlarge and undergo articular elongation of the primary flagellum as typical of *N. roosevelti.* There may be a good taxonomic difference between species based on this kind of character, but owing to the loss of antennae in most preserved specimens it becomes a poor identifying character and we cannot resolve the problem without better material.

We are constrained from describing females of our new species because their mixture in generalized samples is confusing.

Key to the Adult Males of *Neomegamphopus*

1. Tooth on carpus of male gnathopod 1 directly terminal .... *kunduchii*
– Tooth on carpus of male gnathopod 1 separated from body of article by large excavation 2
2. Carpal process of gnathopod 1 bifid 3
– Carpal process of gnathopod 1 simple 4
3. Gnathopod 2 simple, accessory flagellum half as long as article 1 on primary flagellum .... sp. C (Coche, Venezuela)
– Gnathopod 2 subchelate, accessory flagellum as long as article 1 on primary flagellum .... *heardi*
4. Gnathopod 2 simple, article 6 of gnathopod 1 with well defined proximal hump .... *roosevelti*
– Gnathopod 2 subchelate, article 6 of gnathopod 1 with weak proximal expansion or none 5
5. Carpus of gnathopod 2 with 8+ anterior setae .... *pachiatus*
– Carpus of gnathopod 2 lacking significant anterior setae 6
6. Carpus of gnathopod 1 about 0.8 times as wide as long, palm not beaded, tooth gaping .... *hiatus*
– Carpus of gnathopod 1 about 0.6 times as wide as long, palm beaded, tooth not gaping .... *kalanii*

Neomegamphopus roosevelti Shoemaker

Fig. 4, lower left

Neomegamphopus roosevelti Shoemaker, 1942:36–38, fig. 13.—J. L. Barnard, 1962: 10; 1969a:92, figs. 5–6; 1969b:192. not Myers, 1968a:505, figs. 5a–c, f; 1968b: 127–128, fig. 1.

Diagnosis.—Accessory flagellum half as long as article 1 of primary flagellum; coxa 1 about 1.25 times as long as coxa 2; carpus of male gnathopod 1 about 0.5 times as wide as long, simple tooth separated from body of article by incision 0.3 times as long as tooth, propodus about 0.4 times as wide as long, setose anteriorly, with strongly defined proximal lobe; gnathopod 2 simple, carpus strongly setose anteriorly, about 1.7 times as long as propodus.

Remarks.—We have examined the voluminous original material of this species described from Magdalena Bay, Baja California.

Young males of size approximating juveniles and adults of the dwarf species we describe herein have well setose anterior margins on the carpus of gnathopod 2. We believe this demonstrates a useful means to separate young males of the varous species from *N. roosevelti,* although we have no proof that young males of the dwarf species do not have a stage with well setose carpi. We have one young male "p" 1.52 mm in sample 114 from Bahia Honda, Panama, that has eight anterior setae on the carpus of gnathopod 2 and has the undifferentiated kind of gnathopod 1 typical of adult *N. roosevelti* and smallest juveniles of dwarf species; we therefore identify male "p" as possible *N. roosevelti*; this results in sample 114 containing three species of the genus, *N. roosevelti, N. heardi,* and *N. pachiatus*; however the sample is a generalized collection and probably overlapped several habitats.

Youngest males of *N. roosevelti* in the original Magdalena Bay material have palmar denticles on gnathopod 2 but in larger males these become so absorbed into the palm that they appear only faintly; of course, the palm is obsolescent in *N. roosevelti* (and *Neomegamphopus* sp. C. from Coche Island, Venezuela). These denticles are sufficiently large in males of dwarf species *N. pachiatus, N. hiatus,* and *N. heardi* to show clearly on medium power (40×) microscopy.

The juvenile male "n" 1.63 mm from Magdalena Bay has 19 anterior carpal setae on gnathopod 2.

Material.—Pacific, Baja California, Magdalena Bay no. 3, inside north entrance to bay between Blecker Pt. and anchorage, 10–15 fms, sandy weedy bottom, 18 Jul 1938, coll. Waldo L. Schmitt, juvenile male "n" 1.63 mm; Magdalena Bay no. 4, from deeper end of preceding dredge hauls, filamentous green algae, 18 Jul 1938, Waldo L. Schmitt, males "v," "x," "y," "z," and young male "w" 2.76 mm.

Distribution.—Corona del Mar, California to Bahía Honda, Panama, 0–42 m.

Neomegamphopus hiatus, new species

Figs. 1–3, 4 lower right

Diagnosis.—Accessory flagellum longer than article 1 of primary flagellum; coxa 1 about 1.6 times as long (axial) as coxa 2; carpus of adult male gnathopod 1 about 0.8 times as wide as long, simple tooth not directly terminally but separated from body of article by incision 0.60 times as long as tooth, propodus naked anteriorly, about 0.35 times as wide as long, not expanded or lobate proximally; gnathopod 2 subchelate, carpus almost naked anteriorly, about 1.10 times as long as propodus.

Description of male holotype "a" 2.27 mm.—As in illustrations; ocular lobe with weak apical flange, anteroventral corner of head with weak cusp; eyes orange-brown, clear of dense pigment in life and in preservative. Epistome not produced, upper lip weakly incised below. Right lacinia mobilis with 3 principal teeth, left with 4 teeth, molar lacking seta. Outer plate of maxilla 1 with 9 spines. Inner plate of maxilliped with 3 stout biserrate spines, apex of dactyl with 2 large and one small seta.

Article 2 of gnathopod 1 with anterior groove for reception of anterior margin of carpus. Palm of gnathopod 2 defined by small spine. Pereopods 3–7 each with 2 locking spines. Gills present on coxae 2–6.

Epimera 1–3 each with small notch and tooth on posteroventral margin, posterior margins strongly convex, exaggerated on epimeron 3. Uropod 1 with interramal tooth on peduncle, absent on uropod 2. Outer ramus of uropod 3 slightly shorter than inner, with tiny barrel-shaped article 2 bearing long seta, apex of inner ramus with stout spine. Telson with dorsoposterior bevel or excavation, each lateral apex with 2 small teeth, one thick spine, one long seta, one short penicillate setule.

Female "c" 2.16 mm.—Coxa 1 not longer than coxa 2; gnathopod 1 reduced and similar to male and female gnathopod 2 but very slightly larger than female gnathopod

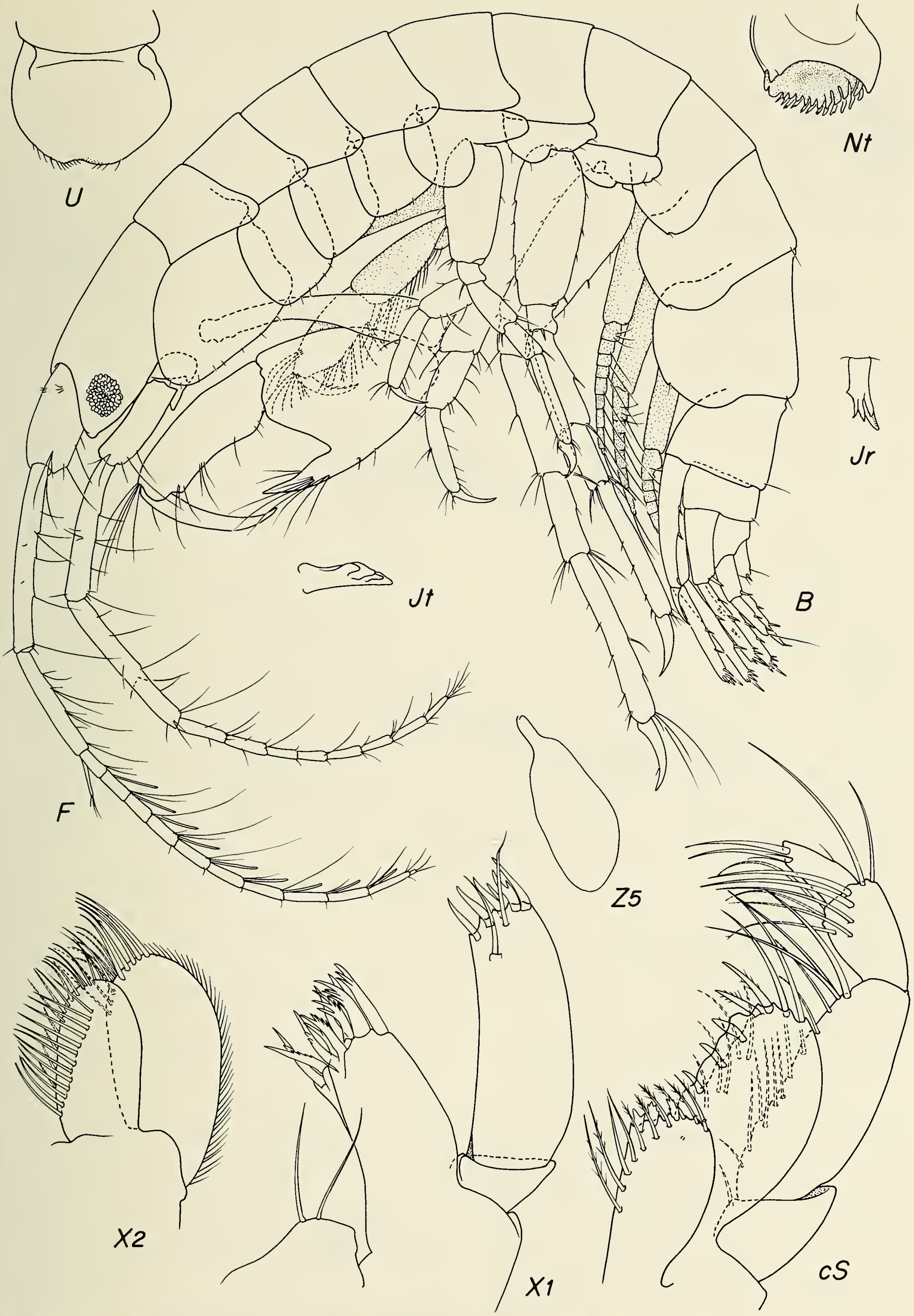

Fig. 1. *Neomegamphopus hiatus,* unattributed figures, male "a"; c = female "c."

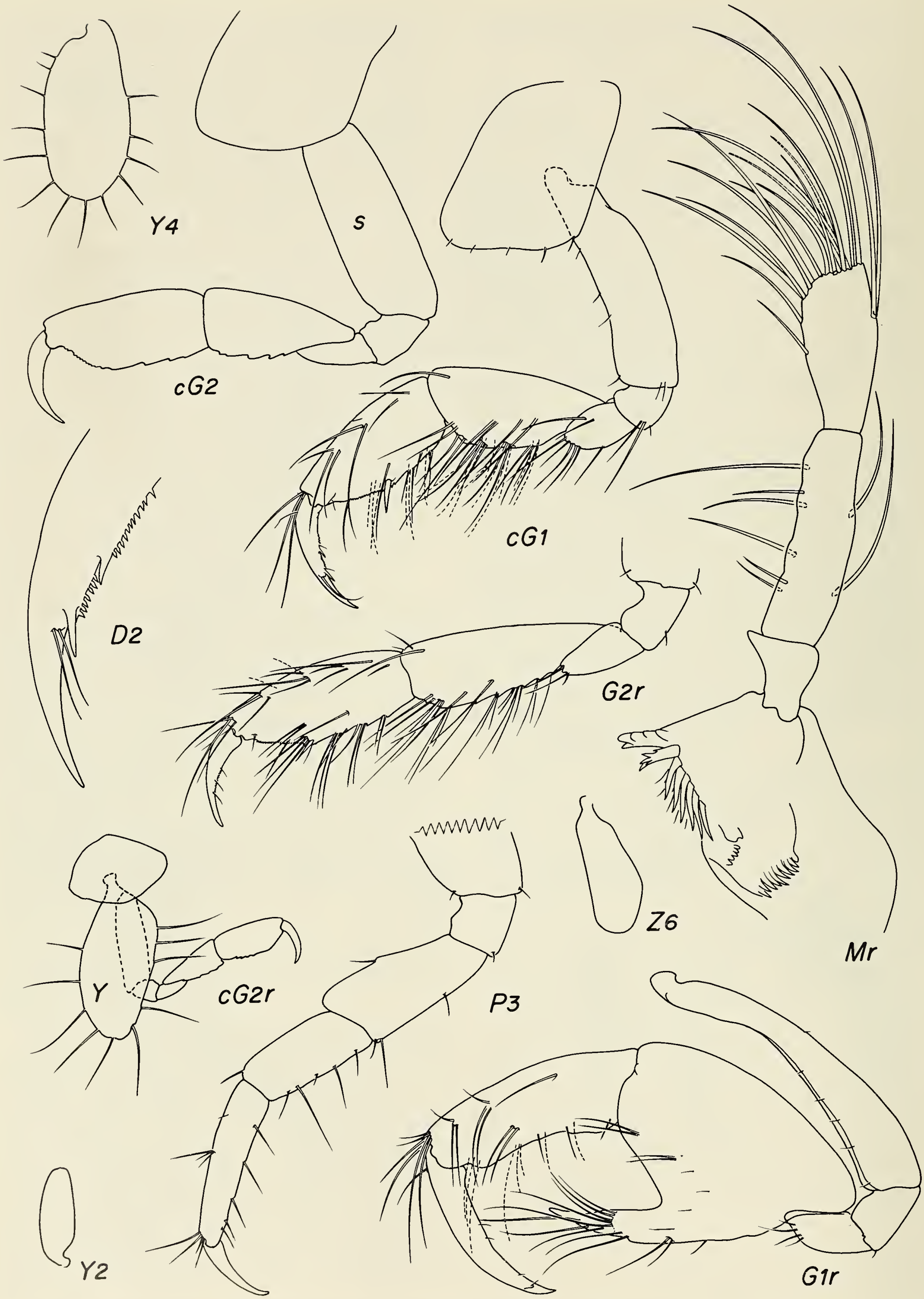

Fig. 2. *Neomegamphopus hiatus,* unattributed figures, male "a"; c = female "c."

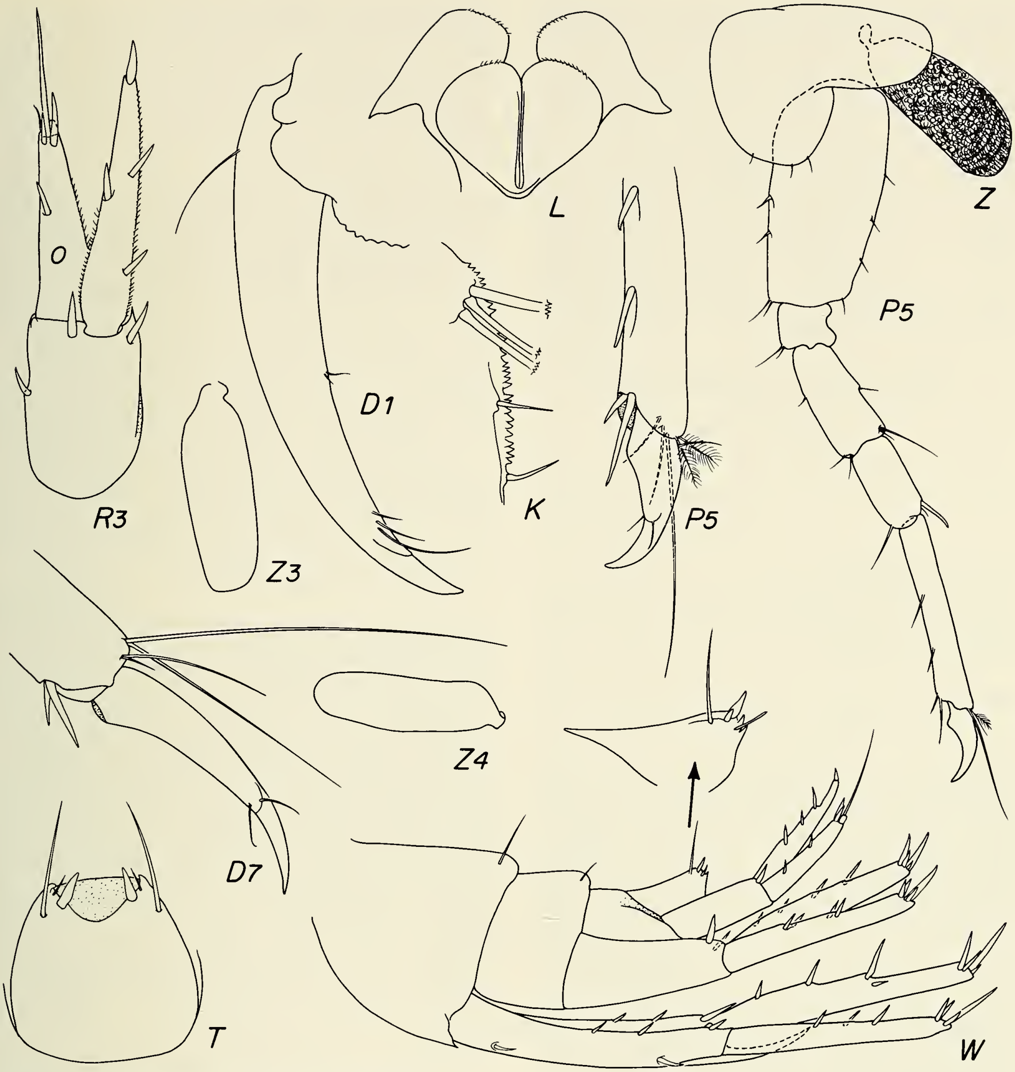

Fig. 3. *Neomegamphopus hiatus,* male "a."

2. Oostegites moderately broad, on coxae 2–5.

Illustration.—Following parts not enlarged, visible on body drawing: head, antennae, accessory flagellum, coxae, pereopods 4, 6, 7. Maxilla 2 much larger than maxilla 1, thus magnification of maxilla 2 strongly reduced relative to maxilla 1 in our illustrations.

Etymology.—Hiatus, (L.) = "gap." a noun in apposition, in reference to gaping tooth on gnathopod 1.

Holotype.—USNM No. 195143, male "a" 2.27 mm.

Type locality.—Venezuela, Islas Los Roques, 11°55′N, 66°40′W, in *Thalassia* bed on *Halimeda* rubble with small percentage of sand-silt sized particles, 0.8–1.0 m, temperature 27.5°, salinity 37 ppt, coll. Alan W. Stoner, 1 May 1980.

Material.—Type locality, female "c" 2.16 mm, female "d" 1.67 mm, male "e" 2.56 mm (total 15 specimens).—Florida Keys, Looe Key, LKFR-1B, forereef, wash of coral and coral rubble chipped from overhangs, 8 m, coll. J. D. Thomas, 18 Apr 1982 (25 specimens).—Kalani Cairns Harbor Branch Foundation Station 916, off Fort Pierce, Florida, 27°33.2′N, 80°02.8′W, 33 m, 0.1 m^2 Smith-MacIntyre grab, 26 Apr 1977, male "e," unmeasured; vial 2, same area, male "L" 3.18 mm, male "M" 2.78 MM, male "q" unmeasured.—Moody Canal, Biscayne Bay, Florida, 1.5 m, mixed *Syringodium* and *Thalassia,* 3 Apr 1982, coll. J. D. Thomas (7 specimens).—Off Jacksonville, Florida, 30°41′N, 80°16′W, 23 fms, 10 Mar 1986, coll. Bowers (1 specimen).—Dry Tortugas, Loggerhead Key, in broken rocks, 26 Jun 1931, coll. Waldo L. Schmitt (1 specimen).—US *Albatross* 2372, Gulf of Mexico, 29°15′30″N, 85°29′30″W, 27 fms, 7 Feb 1885 (4 specimens).

Distribution.—Venezuela to Jacksonville, Florida, 0.8–49 m.

Neomegamphopus kalanii, new species
Fig. 6, lower

Diagnosis.—Accessory flagellum as long as first article of primary flagellum; coxa 1 about 1.5 times as long as coxa 2; carpus of male gnathopod 1 about 0.60 times as wide as long, single tooth separated from body of article by incision about 0.25 times as deep as length of tooth, propodus naked anteriorly, about 0.43 times as wide as long, expanded proximally; gnathopod 2 well subchelate, carpus with 4 anterior setae, about 0.93 times as long as propodus.

Description of male holotype "r" 2.99 mm.—As in illustrations; parts not illustrated generally like *N. hiatus* except as mentioned; ocular lobe with weak apical flange, anteroventral corner of head with weak cusp; eyes with deep orange pigment in alcohol (specimens recently preserved in alcohol). Epistome weakly lobate in front of upper lip, latter with small ventral notch. Right incisor with 6 teeth, lacinia mobilis bifid, large third tooth present in crotch, rakers 6, molar lacking seta (?no socket found), palp article 2 with 2 dorsal and 5 ventral setae, article 3 with 2 A setae, 1 C seta, 2 D setae, 5 E setae; (left mandible lost). Mandibular lobes of lower lip moderately extended, tapering sharply (illustrated).

Inner plate of maxilla 1 with 5 setae (illustrated), outer plate with 10 spines on both sides, apex of palp with 4 forked spines (not as strongly as in *N. roosevelti* and other species described herein), one serrate spine and 4 setae in oblique row (illustrated). Inner plate of maxilla 2 with 18 facial setae in oblique row. Maxillipeds like *N. hiatus,* inner plate with 3 spines, 7 apicofacial setae, 6 medial setae, outer plate with 6 apical-medial spines, 2 apical setae, 5 pairs of ventral setae, palp moderately setose, dactyl with thick spine and 4 setae.

Article 2 of gnathopod 1 bearing weak anterior groove for reception of carpus. Palm of gnathopod 2 defined by stout spine. Coxae 3–7 generally like *N. hiatus* but those and pereopods more strongly armed; for example, article 2 of pereopods 5–7 with 11 posterior setules, some of these thickened and spine-like; pereopods 3–4 very slender (see illustration, apparently abnormal, see other specimens to follow), smallest locking spine on pereopod 5 only half as long as partner, about two thirds as long on pereopod 7 (this also probably abnormal); pereopod 4 scarcely smaller than 3. Gill 7 vestigial.

Epimera and uropods generally as in *N. hiatus* but spine counts greater: on lateral peduncles of uropods 1–3 = 5-1-1, other spines variable, spines on outer rami of uropod 1 left and right = 2 + 1 and 3 + 2, inner rami = 2 + 5 and 0 + 2; outer rami of uropod 2 = 1 + 0 and 3 + 2, inner rami = 1 + 2 and 2 + 5; outer rami of uropod 3 = 1 + 1, inner rami = 0 + 2 and 1 + 2; ventrolateral face of peduncle on uropod 1 with 2 spines (abnormally reduced to 1 seta on left).

Male "g" 2.78 mm.—Right and left incisors with 7 teeth, right lacinia mobilis bifid, lacking third tooth, rakers right and left =

5 and 6, right molar with seta, right palp article 2 with 3 dorsal and 8 ventral setae, setae on article 3 = 4 + 1 A, 2 C, 2 D, 10 E. Peduncle of uropod 1 with 5 lateral spines, formulas on outer and inner rami of uropod 1 = 2 + 1 and ?1 + 2, uropod 2 = 2 + 2 and 1 + 2, uropod 3 = 1 + 0 and 0 + 2; peduncle of uropod 1 with 3 ventrofacial spines. Articles 4–6 of pereopods 3–4 of ordinary breadth as in other species described herein.

Male "j" 2.48 mm and male "f" 2.27 mm.—Propodus of gnathopod 1 lacking beads on posterior margin; otherwise with weak basal swelling on carpal tooth.

Etymology.—Named for Kalani Cairns, Esq., who has helped us greatly with amphipod problems in Florida.

Holotype.—USNM No. 195155, male "r" 2.99 mm.

Type locality.—Kalani Cairns Sample XI-8, Harbor Branch Foundation, off Fort Pierce, Florida, 27°28.86′N, 79°56.40′W, 124 m, recolonization tray, 1 Oct 1980.

Material.—Cairns Harbor Branch Stations 916, off Fort Pierce, 27°33.2′N, 80°02.8′W, 33 m, grab, 26 Apr 1977, male "f" 2.27 mm, male "g" 2.78 mm.—Station 915, same data as 916, duplicate sample, male "j" 2.48 mm, female "h" unmeasured.—Station XVI, off Fort Pierce, 27°33.09′N, 80°03.06′W, 33 m, recolonization tray, 16 Apr 1982, male "k" 2.65 mm. Vial 2, same data as XVI, male "q" unmeasured.

Relationship.—At first we believed specimens of this species might be untransformed juveniles of *N. hiatus* but because the largest are larger and better armed than transformed males of *N. hiatus* we looked more closely at them. The propodus of gnathopod 1 has large serration-beads on the posterior margin. The basal swelling of the carpal tooth does not appear in adults of *N. hiatus.* The holotype is clearly much better developed than *N. hiatus* in view of the presence of five setae on the inner plate of maxilla 1, the maxillary palps are better armed (but the spines are less strongly bifid than in other species), the facial row of setae on maxilla 2 is very strong and the outer plate of the maxilliped is very well developed. However, the holotype is aberrant in the extremely slender pereopods 3–4 compared to other specimens of this species and with specimens of other species. Right and left uropodal spine counts are asymmetric but more uniform in male "g."

Distribution.—East coast of Florida, 33 m.

Neomegamphopus pachiatus,
new species
Fig. 4, upper

Neomegamphopus roosevelti.—Myers, 1968a:505, fig. 5f.

Diagnosis.—Accessory flagellum [as long as article 1 of primary flagellum in specimen other than holotype, this information missing in holotype]; coxa 1 nearly 1.4 times as long as coxa 2; carpus of male gnathopod 1 about 0.8 times as wide as long, tooth separated from body of article by incision 0.50 times as long as tooth, propodus naked anteriorly, about 0.25 times as wide as long, neither expanded nor lobate proximally; gnathopod 2 subchelate, carpus moderately setose anteriorly, about 1.35 times as long as propodus.

Description of male holotype "b" 2.04 mm.—As in illustrations and parts not illustrated generally like *N. hiatus* except as mentioned; antennae 1–2 and pereopods 3, 4, 6 missing; ocular lobe with weak apical flange, anteroventral corner of head with weak cusp; eyes clear in alcohol (specimens 52 years old). Epistome not produced, upper lip weakly truncate below. Right incisor with 4 teeth, lacinia mobilis bifid, third tooth obsolescent, rakers 5, molar with one long seta, palp article 2 with 8 setae, article 3 with 3 A setae, 2 D setae, 7 E setae; left incisor with 4 teeth, lacinia mobilis with 4 teeth, rakers 5, molar lacking seta. Mandibular lobe of lower lip sharp and curled (distinct from *N. hiatus*).

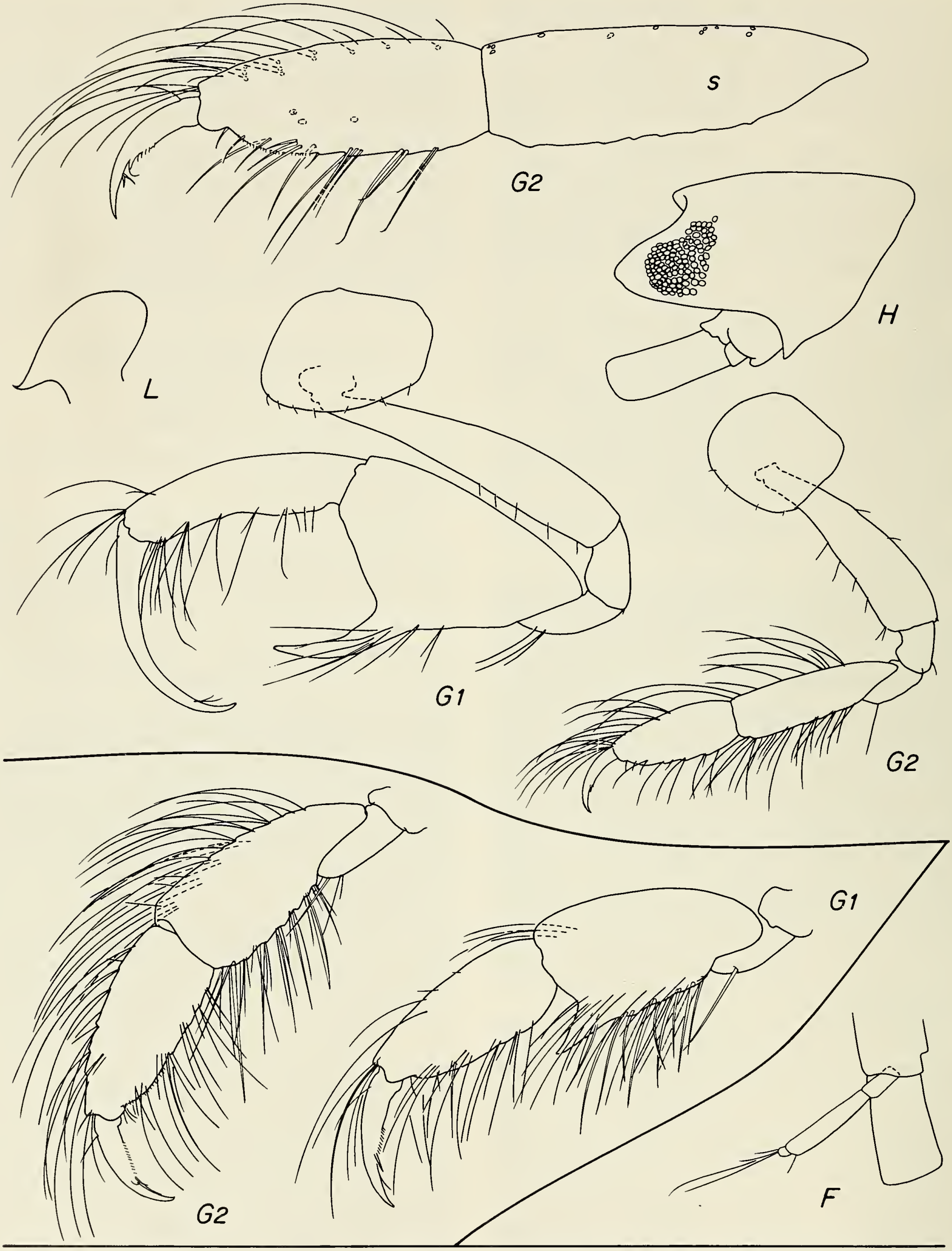

Fig. 4. Upper, *Neomegamphopus pachiatus,* holotype male "b" 2.04 mm. Lower left, *N. roosevelti,* juvenile male "n," 1.63 mm. Lower right, *N. hiatus,* male "l" 3.18 mm.

Inner plate of maxilla 1 with 1 seta, outer with 10 spines on both sides, apex of palp with 3 forked spines, one serrate spine, and 2 setae (scarcely in axial tandem). Inner plate of maxilla 2 with well developed facial row of 10+ setae. Maxilliped like *N. hiatus* but outer plate more slender, apical and medial spines reduced to 4, apical setae reduced to 2, ventral face with 3 pairs of setae; setae of palp sparser, dactyl with 4 setae.

Article 2 of gnathopod 1 lacking anterior groove for reception of carpus. Palm of gnathopod 2 defined by very slender spine. Coxae 3–7 like *N. hiatus*. Pereopods 5 and 7 like *N. hiatus* but setae sparser, article 2 on pereopod 5 with 7 posterior setules (thus more).

Epimera and uropods generally as in *N. hiatus*; spine counts on lateral peduncles of uropods 1–3 = 2-1-1; lateral and medial spine counts (not apical) on rami of uropods 1–2 = 1 + 0, 2 + 1, on inner rami = 0 + 1, 1 + 3; spines on outer and inner rami of uropod 3 = 1 and 1; ventrolateral face of peduncle on uropod 1 with 2 spines.

Etymology.—Pacific congener of *hiatus* (pac + hiatus).

Holotype.—USNM 195151 (but transferred to Allan Hancock Foundation as rightful owner), male "b" 2.04 mm.

Type locality.—*Velero III* station 114-33, Bahia Honda, Panama, near east point, 2 fms, 10 Mar 1933.

Material.—The type locality, 17 males.

Relationship.—This species is very close to *N. hiatus* from the Caribbean Sea but establishment of a species is justified on recent works by several taxonomists who have split Pacific and Atlantic sibling species in Phoxocephalidae and Ampeliscidae on very minor characters.

Neomegamphopus pachiatus differs from *N. hiatus* in the narrower article 6 of gnathopod 1, the greater length of and the presence of significant numbers of anterior setae on the carpus of gnathopod 2, and the shorter coxa 1.

Distribution.—Pacific Panama, 4 m.

Neomegamphopus heardi, new species

Figs. 5, 6 upper

Neomegamphopus roosevelti.—Myers, 1968a:505, figs. 5a, b.

Diagnosis.—Accessory flagellum as long as article 1 of primary flagellum; coxa 1 about 1.4 times as long as coxa 2; carpus of male gnathopod 1 about 0.65 times as wide as long, with 2 teeth at apex not separated by incision from body of article, inner tooth weakly palmate, separated from dominant tooth by incision one-third as long as dominant tooth, propodus anteriorly setose, about 0.6 times as wide as long, expanded proximally; gnathopod 2 well subchelate, carpus poorly or not setose anteriorly, almost 1.3 times as long as propodus.

Description of male holotype "c" 1.99 mm.—As in illustrations; parts not illustrated generally like *N. hiatus* except as mentioned; pereopod 5 missing, coxa 5 like *N. hiatus*; ocular lobe with weak apical flange, anteroventral corner of head with weak cusp; eyes clear in alcohol (specimens 52 years old). Epistome not produced, upper lip weakly truncate below. Right incisor with 5 teeth, lacinia mobilis bifid, third tooth absent, rakers 4, molar with one long seta, palp article 2 with 9 ventral and 4 dorsal setae (inner and outer respectively). Article 3 with 2 A setae, 2 C setae, 1–2 D setae and 9+ E setae; left incisor with 4 teeth, lacinia mobilis with 4 teeth, rakers 5, molar lacking seta. Mandibular lobes of lower lip long, slender, sharp uncurled.

Inner plate of maxilla 1 with 1 seta, outer plate with 10 spines on both sides, apex of palp with 3 forked spines, one serrate spine and 2 setae in axial tandem. Inner plate of maxilla 2 with well developed facial row of 10 setae. Maxilliped like *N. hiatus* but inner plate with 2 apical spines, 2 medial setae and 5 apicofacial setae, outer plate with 5 medial and apical spines and 1–2 apical setae, palp moderately setose, dactyl with 3 setae.

Article 2 of gnathopod 2 with anterior

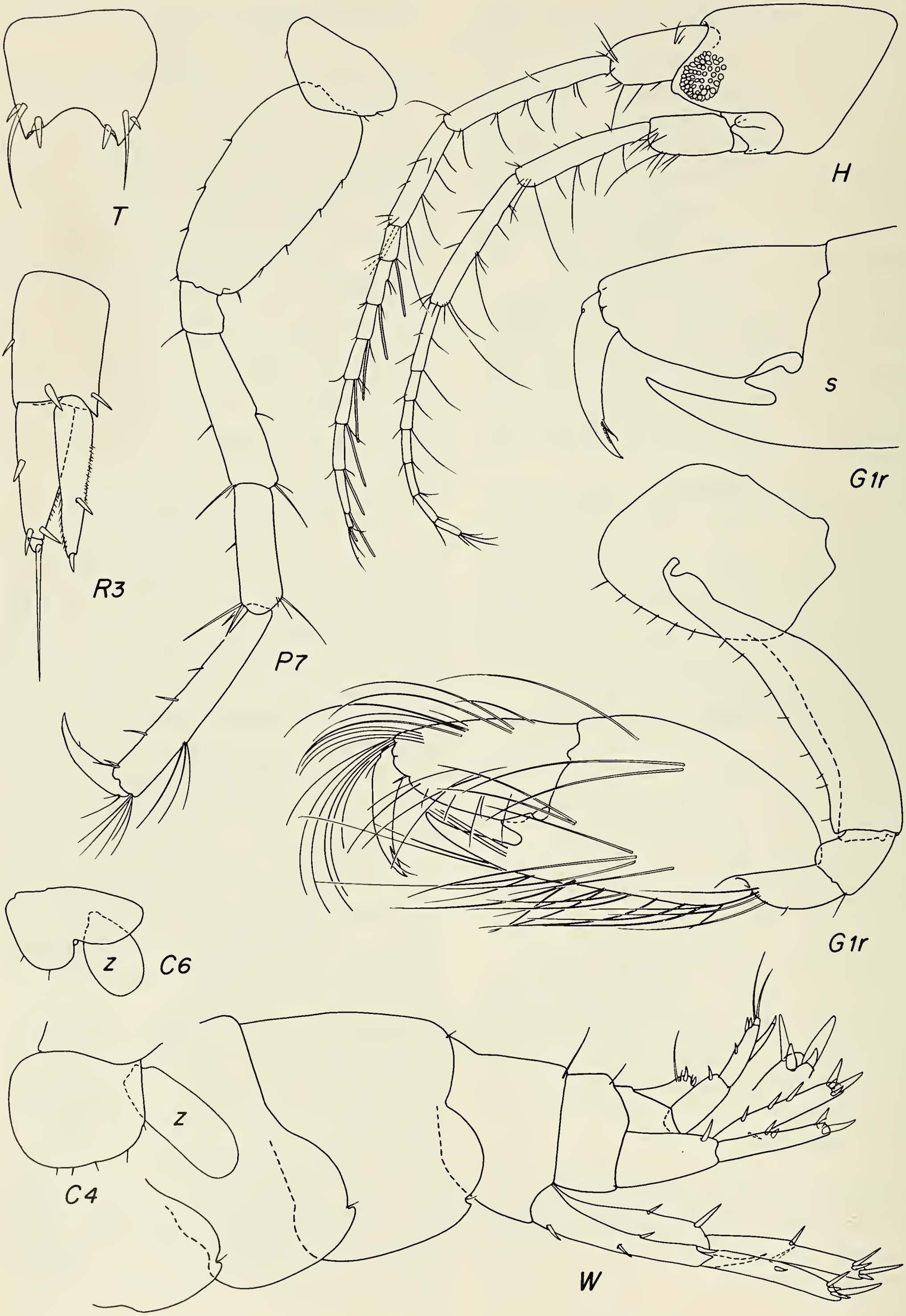

Fig. 5. *Neomegamphopus heardi*, holotype male "c" 1.99 mm.

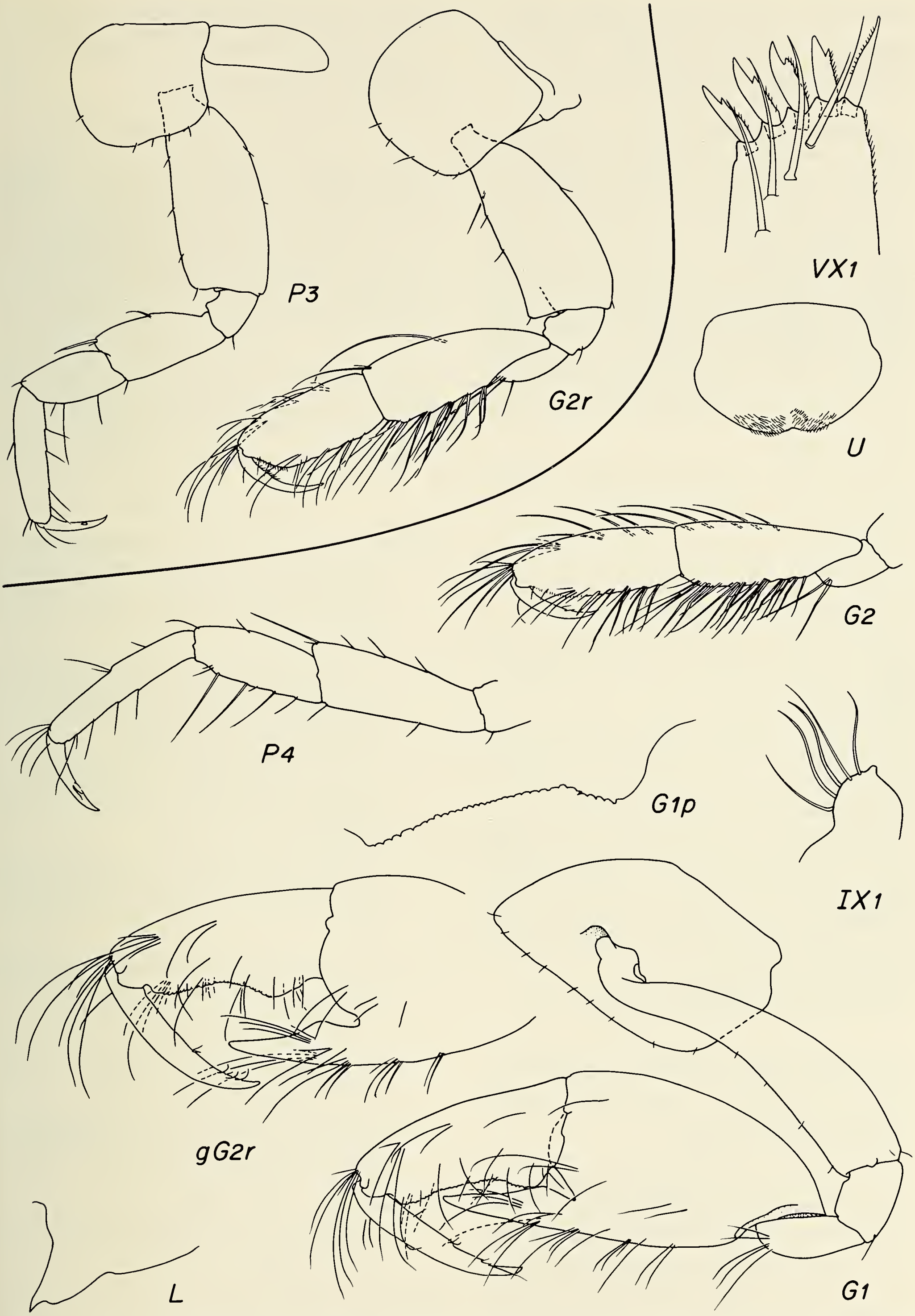

Fig. 6. Upper, *Neomegamphopus heardi,* holotype, male "c" 1.99 mm. Lower, *N. kalanii,* holotype male "r" 2.99 mm; g = male "g" 2.78 mm.

groove for reception of carpus. Palm of gnathopod 2 defined by setae. Coxae 3–7 and pereopods 5–7 (see illustration of 7) like *N. hiatus.* Gill 7 vestigial.

Epimera and uropods generally as in *N. hiatus*; spine counts on lateral peduncle of uropods 1–3 = 2-1-1; lateral and medial marginal spine counts (not apical) on rami of uropods 1–2 = 1 + 1, 1 + 1, on inner rami = 0 + 1, 0 + 3 (or 1 tiny and 2 on opposite side); spines on outer and inner rami of uropod 3 = 1 and 1; ventrolateral face on peduncle of uropod 1 with 2 spines.

Male "a" 2.32 mm.—Carpus of gnathopod 2 with 2 anterior setae; mandibular palp with 4 A setae.

Etymology.—Named for Dr. Richard Heard, for his many contributions to marine biology.

Holotype.—USNM 195150 (transferred to Allan Hancock Foundation as rightful owner), male "c" 1.99 mm.

Type locality.—*Velero III* station 114-33, Bahia Honda, Panama, near east point, 2 fms, 10 Mar 1933.

Material.—Type locality, male "a" 2.32 mm, young male "d" 1.86 mm, young male "p" 1.52 mm, young male "q" 1.93 mm and several other probable specimens.

Relationship.—This species is very close to *N. roosevelti* from the eastern Pacific Ocean but differs in the presence of 2 teeth on the carpus of gnathopod 1 (versus 1) and the poor development of anterior setae on the carpus of gnathopod 2.

Distribution.—Pacific Panama, 4 m.

Neomegamphopus species C (Venezuela)

Neomegamphopus roosevelti.—Myers, 1968b:127–128, fig. 1.

The material of this morph, from Coche Island, Venezuela (Caribbean Sea) is like *N. heardi* in that it has an inner accessory tooth on the carpal process of male gnathopod 1 but the tooth is small, not palmate, and the propodus of gnathopod 2 is simple; the accessory flagellum is only half as long as article 1 of the primary flagellum on antenna 1, a probable character of value (but see discussion in introduction).

Acknowledgments

We thank F. Graham Lewis of Applied Biology, Inc., and Alan W. Stoner and Kalani D. Cairns, of Harbor Branch Foundation, Fort Pierce, Florida, for providing the materials for this study apart from materials garnered from Smithsonian collections. Dr. A. A. Myers of Cork, Ireland, kindly reviewed our work and offered valuable suggestions. J. D. Thomas was supported by NSF Grant DEB 8121128. Linda B. Lutz of Baton Rouge, Louisiana, inked our plates.

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A NEW SPECIES OF *NANNOSTOMUS* (TELEOSTEI: LEBIASINIDAE) FROM NEAR PUERTO AYACUCHO, RÍO ORINOCO DRAINAGE, VENEZUELA

Justa M. Fernandez and Stanley H. Weitzman

Abstract.—*Nannostomus anduzei* is described as a new, miniature species of the characiform family Lebiasinidae from near the Río Orinoco, north of Puerto Ayacucho, Territorio Federal Amazonas. This species is distinguished from all other species of *Nannostomus* by its tiny adult size (to 16.2 mm SL), several reduced structures, and a distinctive live color pattern. Although the new fish is clearly a species of *Nannostomus,* its relationships among the other species are obscure.

The new species of *Nannostomus* described below brings the number of known species to 15, nearly half of them having been described in the last 30 years. The relationships of the species of *Nannostomus* have been discussed by Géry (1977: 127–135) and Weitzman and Weitzman (1982:416–419). The species have been described in some detail by Weitzman (1966), Weitzman and Cobb (1975), and Weitzman (1978). Weitzman and Weitzman (1982: 417) remark that with only a few exceptions they were unable to accept cladistic hypotheses of relationships among *Nannostomus* species based on 40 morphological characters extracted from Weitzman (1966: 8–53), Weitzman and Cobb (1975:6, 9–11, 25–33), and Weitzman (1978:2, 3, 7–9). They found a high degree of homoplasy and character lability causing them to distrust most phylogenetic hypotheses of relationships. Géry (1977:127–135), apparently partly based on Weitzman (1966:4–9) and Hoedeman (1950:22), recognized two genera and one subgenus of nannostomin lebiasinids. However, Weitzman and Cobb (1975:3–7) and Weitzman (1978:7–9) discuss why most of the morphological characters used by Géry (1977), Weitzman (1966) and Hoedeman (1950) are of dubious for generic diagnosis. Interestingly, Weitzman and Weitzman (1982:419) and Géry (1977:131) accepted different hypotheses of relationships among certain species of *Nannostomus.* Géry's hypotheses were based on unpublished karyotypic information sent to him by J. J. Scheel. The karyotypic information was not cladistically analyzed and appears to have the same limitations discussed by Weitzman and Fink (1983:394, 395) for similar data recorded for species of *Paracheirodon* Géry. We do not discuss here the many problems of relationships among the species and populations of *Nannostomus.* We only summarize current opinions in order to demonstrate that a satisfactory study of the phylogenetic relationships of the species of *Nannostomus* is lacking.

Methods and Materials

Data are recorded as described in Weitzman (1966:3–6). All measurements other than standard length (SL) are expressed as a percentage of SL except subunits of the head which are recorded as a percentage of head length unless otherwise noted. Total vertebral counts, taken from radiographs and from cleared and Alizarin red and Alcian blue stained specimens include all vertebrae of the Weberian apparatus counted

Fig. 1. *Nannostomus anduzei,* new species, holotype, male, MBUCV-V-15.141, SL 13.1 mm, Laguna Provincial, about 20 km north of Puerto Ayacucho, Departamento de Ature, Territorio Federal de Amazonas, Venezuela, 1 Dec 1984.

separately. The fused $PU_1 + U_1$ of the caudal skeleton is counted as a single vertebra. In the text and tables, the count or morphometric character given first is for the holotype; the next series of figures is the range for the sample cited. This is given separately in parentheses for each population sample. These figures are followed by a mean ($\bar{x}$) for each population sample. Specimens examined for this study are deposited in the Academy of Natural Sciences, Philadelphia (ANSP); American Museum of Natural History, New York (AMNH); the British Museum (Natural History) (BMNH); the California Academy of Sciences, San Francisco (CAS); Ministerio de Agricultura y Cria, Puerto Ayacucho, Venezuela (MAC-PAY); Museo de Biologia, Instituto de Zoologia, Universidad Central de Venezuela (MBUCV-V); Museu de Zoologia da Universidade de São Paulo (MZUSP); the Museum of Zoology, University of Michigan (UMMZ); and National Museum of Natural History, Smithsonian Institution (USNM).

Nannostomus anduzei, new species
Figs. 1–7, Table 1

Holotype.—MBUCV-V-15.141, male, SL 13.1 mm, Venezuela, Territorio Federal de Amazonas, Departamento de Ature, Laguna Provincial, approximately 20 km north of Puerto Ayacucho, about 5°50′N, 67°30′W, 1 Dec 1984, R. P. Vari, A. Machado, C. Ferraris, O. Castillo and J. Fernandez.

Paratypes.—102, USNM 277697, males 31, SL 11.1–13.4 and females 71, SL 11.6–12.9 mm; 4, AMNH 57010, SL 12.4–12.6 mm; 4, ANSP 157486, SL 11.2–12.7 mm; 4, BMNH 1985.12.31:4–8, SL 11.2–13.0 mm; 4, CAS 57819, SL 11.8–12.7 mm; 4, MZUSP 35433, SL 11, 8–12.2 mm; 4, UMMZ 213449, SL 11.4–13.0 mm; all with same collection data as holotype.—35, USNM 244696, males 18, SL 11.1–13.5 and females 25, SL 11.1–14.9 mm, Venezuela, Territorio Federal de Amazonas, Departamento de Ature, Caño Provincial, approximately 20 km north of Puerto Ayacucho, about 5°50′N, 67°30′W, 1 Dec 1984, R. Vari, A. Machado, C. Ferraris, O. Castillo, J. Fernandez.—6, USNM 277695, (cleared and stained with Alizarin red and Alcian blue), SL 12.8–14.5 mm; AMNH 57009, males 4, SL 11.5–14.0 and females 11, SL 9.8–13.9 mm; preceding two lots with same collection data as USNM 277696. MBUCV-V-15.601, males 8, SL 12.7–16.0 and females 4, SL 11.6–13.6 mm; MAC-PAY-0389, males 7, SL 12.9–14.9 and females 3, SL

Fig. 2. *Nannostomus anduzei,* new species, paratype, female, USNM 277697, SL 11.9 mm, Laguna Provincial, about 20 km north of Puerto Ayacucho, Departamento de Ature, Territorio Federal de Amazonas, Venezuela, 1 Dec 1984.

11.6–13.3 mm, both with same locality data as USNM 177696 above, collected 19 May 1981, E. Armas, J. Fernandez.—30 of which 14 cleared and stained, MBUCV-V-15.600, SL 9.6–16.2 mm; MAC-PAY-1.200, males 5, SL 11.3–15.4 and females 8, SL 10.2–15.7 mm, same locality data as USNM 277696 above, collected 18 Jun 1986, J. Fernandez.

Diagnosis.—Distinguished from all other species of *Nannostomus* by having a pelvic-fin ray count of ii-6 rather than ii-7, by a principal caudal-fin ray count of 9/8 rather than 10/9, and by having 4 premaxillary teeth rather than at least 5 in adults (up to 8 in some species of *Nannostomus*). All these characters appear to be progenic, and associated with small size of this species. *Nannostomus anduzei* is smallest known species of *Nannostomus,* sexually adult specimens maturing about SL 11.0 mm and reaching to at least SL 16.2 mm. *Nannostomus minimus* Eigenmann, next larger known species, matures at about SL 16.0 mm and known to reach SL 22.8 mm. *Nannostomus marginatus* Eigenmann matures at about 17.0

Table 1.—Morphometrics of *Nannostomus anduzei* arranged by sex. Standard length is in millimeters. First group of measurements expressed as percentages of standard length, second group as percentages of head length. n = 26 in all cases.

		Males		Females	
	Holotype	Range	$\bar{x}$	Range	$\bar{x}$
Standard length	13.1	11.2–13.4	12.5	11.5–13.5	12.3
Depth at dorsal-fin origin	28.2	23.6–28.3	25.3	25.4–29.5	27.4
Snout to dorsal-fin origin	55.7	51.6–58.9	56.5	52.9–58.9	55.7
Snout to anal-fin origin	74.0	71.2–76.4	73.5	74.2–78.6	76.6
Caudal peduncle depth	12.6	10.3–13.4	11.7	10.3–12.7	11.4
Anal-fin lobe length	26.0	20.3–29.2	24.8	14.8–17.8	16.2
Bony head length	28.2	24.5–28.4	27.1	24.1–27.4	25.8
Horizontal eye diameter	36.5	34.4–41.9	37.9	36.7–42.5	39.1
Snout length	24.3	20.8–25.4	23.9	20.9–24.6	23.0
Interorbital width	40.5	35.3–45.0	41.8	37.6–47.6	42.2

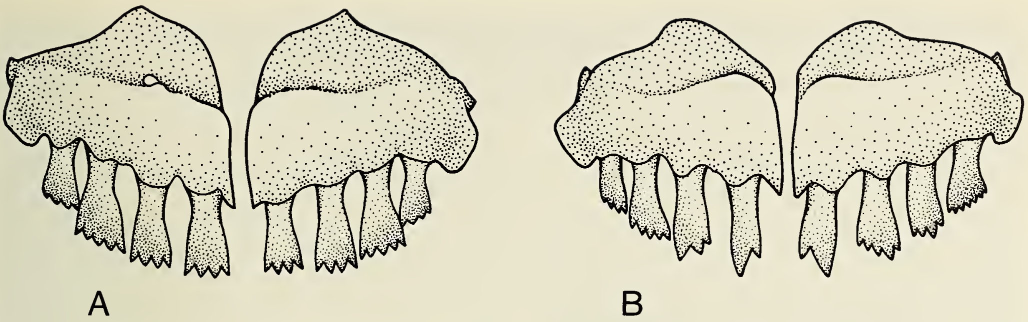

Fig. 3. *Nannostomus anduzei,* new species, paratypes, USNM 277695; anterior view of premaxillary bones and teeth of both sides of both specimens; A, male SL 12.0 mm; B, male SL 13.0 mm.

mm and reaches about 23.0 mm SL. All other species mature at over SL 20 to 30 mm depending upon species. Males of *Nannostomus anduzei* with distinctive life color pattern, having an intensely red caudal peduncle and anal fin. Some other species of *Nannostomus* with red on anal fin, usually as a spot or bar, never as an intense color covering nearly entire fin and part of adjacent body (except for an undescribed *Nannostomus* species of much larger adult body length). Some species of *Nannostomus,* for example, *N. marginatus,* have some populations with males having a red bar or blotch on middle rays of caudal fin and this color may extend onto base of caudal peduncle. It never covers almost entire caudal peduncle as in *N. anduzei.*

Description.—See Table 1 for morphometric values. Body elongate, robust, somewhat compressed in region of caudal peduncle. Greatest body depth at origin of dorsal fin or somewhat anterior to that point. Profile of body as in Figs. 1, 2. Head bluntly conic anteriorly, mouth terminal, snout blunt. Eyes large, horizontal diameter exceeds snout length. Interorbital width about equal to or exceeding horizontal eye diameter.

Premaxilla with single row of 4 teeth in 30 specimens. See Figs. 3, 4. Anterior tooth bicuspid to quadricuspid. This tooth occasionally unicuspid, often bicuspid, especially in males. In males this tooth infrequently tri- or quadricuspid but in females usually quadricuspid, rarely tricuspid and no female with this tooth unicuspid or bicuspid. In females cusps usually equal in size, while in males cusps usually subequal with lateral cusps being larger, especially in teeth with 2 or 3 cusps. When 4 cusps present in females, cusps subequal. Maxilla with one tooth in 30 specimens, usually bearing 3 cusps, rarely 1 or 2, cusps subequal or center cusp somewhat larger than others. Maxillary tooth of females occasionally with up to 6 relatively equal cusps. See Figure 4. Dentary with 4–5 (almost always 5) teeth in outer row, each tooth bearing about 3–6 more or less subequal cusps. Anterior teeth of dentary usually with central cusps largest (see Fig. 3). Inner row of dentary teeth simple, conic, 0–3 in 6 cleared and stained examples; some specimens have cusps on teeth in both jaws nearly worn away.

Gill rakers 8–9 + 13–14, no more than 22 total rakers in any of 6 cleared and stained specimens. Branchiostegal rays 3. First and second infraorbitals without complete laterosensory tube. Infraorbital 3 without closed bony tube, ossification often reduced. Remaining infraorbitals appear not to be ossified.

Dorsal-fin rays ii-8, n = 31; pectoral-fin rays i-7, n = 31; pelvic-fin rays i-6, n = 31; anal-fin rays ii-9, n = 31; and principal caudal-fin rays 9/7, n = 31. Adipose fin absent in all specimens.

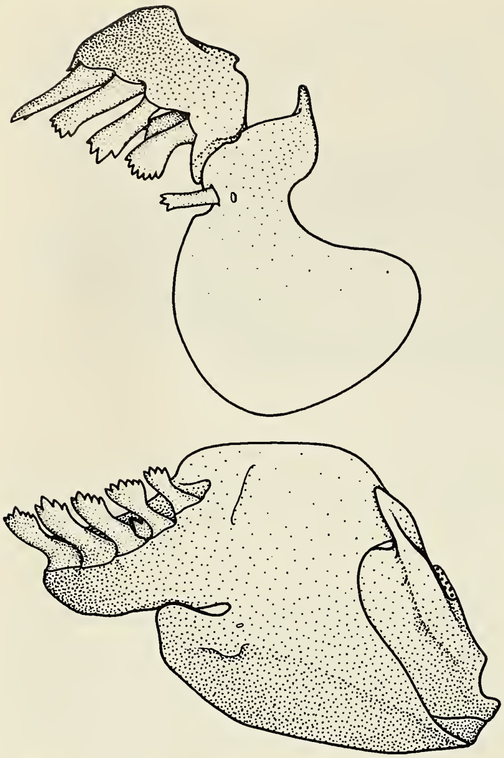

Fig. 4. *Nannostomus anduzei,* new species, paratype, USNM 277695, male SL 13.0 mm. Lateral view of jaws, left side.

Scales of third horizontal scale series ventral to dorsal fin having anterior field with 2, sometimes 3, radial grooves. Scale rows between origin of dorsal and pelvic fins 7 in 30 specimens. Predorsal scales 7–9, $\bar{x}$ = 8.0, n = 24. Lateral-line scales 0–1, usually 0. Scales in lateral series 21–22, $\bar{x}$ = 21.1, n = 31. Scale rows around caudal peduncle 11 in 30 specimens. Total vertebrae 31–33, $\bar{x}$ = 31.9, n = 95.

Color in alcohol.—Dorsal surface of head dark to light brown, more or less evenly covered with dark to light brown chromatophores. Top of head posterior to eyes usually darker than region between and anterior to eyes. Dorsal surface of body dorsal to narrow secondary horizontal stripe pale to medium brown. No median predorsal stripe or fourth horizontal stripe as in *Nannostomus eques* Steindachner or *Nannostomus britskii* Weitzman. Primary horizontal stripe extending from snout tip and lower jaw posteriorly across first (anterior) infraorbital bone, sometimes evident on eye, across preoperculum and operculum to beginning of fourth horizontal scale row at cleithrum and supracleithrum. Stripe on operculum may be weak, especially in males, to dark and very obvious, especially in females. On body primary horizontal stripe, when obvious, begins under fleshy opercular flap and extends along fourth horizontal scale row, terminating at base of ventral caudal-fin lobe in many specimens or extending posteriorly onto fin rays of ventral caudal-fin lobe in other specimens, especially large females. Primary horizontal stripe hardly perceptible to apparently absent on body in males, dark chromatophores constituting primary stripe often indistinguishable from those of body sides. Dark chromatophores in primary stripe area somewhat larger and sometimes organized into a weakly perceptible stripe, especially in larger males. Females with primary stripe on body much more evident, dark chromatophores being more numerous, larger and darker in most specimens (especially large females) than in males. Chromatophores sometimes very dense and dark in central area of distal field of scales of fourth horizontal row counted ventrally from dorsal-fin origin. Secondary dark horizontal stripe narrow, sometimes quite clearly defined, especially in large, darkly pigmented females. This stripe begins at area just dorsal to opercular bone (where it joins head dorsally), and extends posteriorly across middle of third horizontal scale row, ending at caudal-fin base. A narrow pale stripe present between primary and secondary horizontal stripes. Oblique bands appear absent. Well developed tertiary horizontal stripe appears absent although organized dark chromatophores occur around anus and extend anteriorly as an organized stripe to near pelvic-fin base. These more evident in darkly colored females than in all males. Sides ventral to primary horizontal stripe

Fig. 5. *Nannostomus anduzei,* new species, paratype, USNM 277697, male SL 13.2 mm. Lateral view, left side of anal fin and associated body region.

covered with small, scattered dark chromatophores in males, but almost devoid of chromatophores in females. Except for ventral lobe caudal fin described above, fins of females with only small chromatophores scattered along fin ray margins. Dorsal and pelvic fins of males with many dark chromatophores on fin membranes between rays. Anal fin also darkly colored in males with chromatophores being somewhat less dense than on dorsal and pelvic fin. Anterior border of anal fin with many scattered dark chromatophores. Other fins essentially like those of females.

Color in life.—Color recorded here from Ektachrome slides of freshly preserved male and female paratypes taken at time of capture at type locality and Caño Provincial. Male specimens in formalin retained much red pigment until placed in alcohol at USNM. Entire anal fin of male a deep blood red except anterior border which bears dark chromatophores, forming elongate black border in life. Body adjacent to anal fin also red. Posterior half of caudal peduncle and anterior half of caudal fin covered with same deep red pigment as anal fin. Body sides appear to reflect pale blue and some of this color appears on black pelvic fins. Distal portions of dorsal fin and entire distal half of anterior 3–4 rays of dorsal fin black. Dorsal and pelvic fins hyaline. Dark chromatophores on interradial membranes provide fins with dusky appearance. Head and body pale green or greenish yellow. Scales of back bordered with dark pigment giving back a reticulate pattern. Head also yellow-green. Primary horizontal dark stripe poorly-developed in males, black and well-developed in females, extending to caudal-fin base. Females with all fins hyaline, pale yellow.

Sexual dimorphism.—*Nannostomus anduzei* is sexually dimorphic in live and preserved color pattern, to a certain degree in the premaxillary teeth, relative size and structure of the anal fin, and in the form of the tissues around the anus. Differences between males and females are given in preserved and live color patterns described above in the sections on color pattern. Brief-

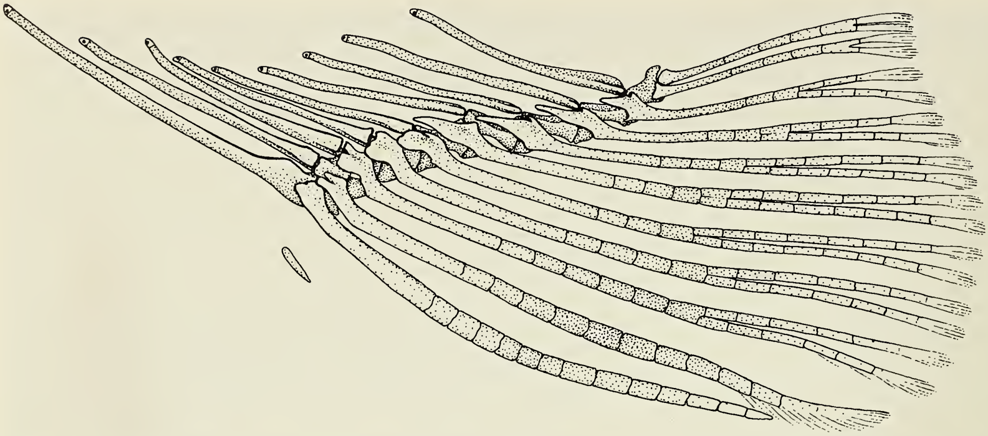

Fig. 6. *Nannostomus anduzei,* new species, paratype, USNM 277695, male SL 12.8 mm. Lateral view, left side of skeleton of anal fin. Fin rays not thickened.

ly and most prominently, males have a deep red anal fin and caudal peduncle (females lack the deep red) and the females often have a more prominent primary stripe, both in live and preserved specimens.

The anal fin of the male has more elongate rays. See the anal-fin lobe lengths of males and females in Table 1 and compare Figs. 1 and 2. Also see Figs. 5, 6, and 7. Many species of *Nannostomus* have modified anal-fin rays in the male. See Weitzman (1966), figs. 1, 2, 4, 5, 6, and 10 and Weitzman and Cobb (1975), figs. 3, 5, 18, and 21 for illustrations of the anal fins of males of species of *Nannostomus* with notably modified fins. The anal fin of male *Nannostomus digrammus* Fowler are the most modified of all known species of *Nannostomus* (see Weitzman 1966, fig. 6). The anal fin of male *Nannostomus anduzei* is not as derived as that of *Nannostumus digrammus.* Weitzman (1966:4, 24–25) briefly discussed the modified anal fins in males of species of *Nannostomus* and pointed out that derived muscles are present which deform anal fin into a cup-shaped structure that surrounds female's vent during spawning. Undoubtedly *Nannostomus anduzei* undergoes a similar spawning procedure and in Fig. 5 hypertrophied muscle tissue in the form of a large cone-shaped swelling is visible at the anterior base of the anal fin. Enlarged muscle tissue also occurs at the posterior base of the anal fin but it is much smaller and not as easily visible. *Nannostomus anduzei* sometimes has the anterior anal-fin rays somewhat thickened (Fig. 7), but often not thickened (Fig. 6), especially in smaller males.

Comparison of Figs. 1 and 2 shows the differences in the vent size between males and females of *Nannostomus anduzei.* The large vent in this species may be a function of large egg size relative to the tiny size of the female.

Relationships.—The new species fits nearly all the characters diagnosed for *Nannostomus* by Weitzman (1966:9) and as modified by Weitzman and Cobb (1975:3–6). The diagnosis of the subtribe Nannostomina by Weitzman (1964:150–151) currently also provides a diagnosis for *Nannostomus.* The new species does not alter that diagnosis except for the number of cusps on the anterior premaxillary teeth, as few as two rather than as few as three. *Nannostomus anduzei,* being a very small species, is distinguished from all other *Nannostomus* species by a series of reductive characters noted above in the diagnosis.

The relationships of this species to other species of *Nannostomus* are not clear. It is

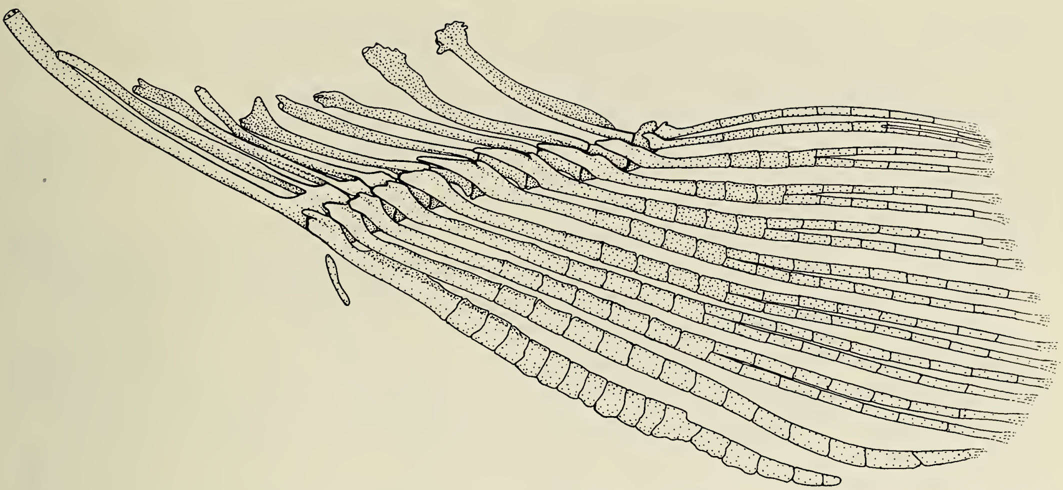

Fig. 7. *Nannostomus anduzei,* new species, paratype, USNM 277695, male SL 14.5 mm. Lateral view, left side of skeleton of anal fin. Anterior two fin rays somewhat thickened.

similar to some other small species of *Nannostomus* in having shared, apparently progenic, characters such as reduced laterosensory head canals, but the phylogenetic significance of these modifications are not understood. These reductions could be phylogenetically shared or independently derived. See comments by Weitzman and Fink (1983:345–346), Weitzman and Fink (1985: 9–10, 65–69) and Weitzman and Vari (in press) for discussion of similar problems in other small to miniature characiforms. Unfortunately, the reductive characters are not corroborated by non-reductive synapomorphies such as the various derived aspects of the color pattern or anal-fin specializations. We cannot place this species as a sister species to any other species of *Nannostomus.*

Ecological notes.—All specimens were taken at nearly the same locality, near the small community of Provincial. The water is clear, not black, in an area dominated by small blackwater streams and ponds. Caño Provincial is a permanent forest stream with mostly a slight current. It originates from a small spring surrounded by a plant community principally consisting of the palm *Mauritia flexuosa.* The water is transparent, shallow, to about one-half meter in depth. The temperature is about 27° Celcius depending on where it is taken, and with a pH of about 5.0. The bottom is principally white sand, roots, and fallen leaves. Laguna Provincial occurs about two kilometers downstream where Caño Provincial opens into a wide shallow lagoon in a flat savanna area next to the Rio Orinoco. The lagoon is often warmer than the caño, about 30° Celcius, often turbid and its pH varies from that of the caño to about neutral. The bottom of the laguna is of mud and floating and emergent vegetation is common. *Nannostomus anduzei* is confined to the caño or areas in the lagoon influenced by the caño. It occurs in areas of slow current among aquatic plants. The fish is not found in black waters and appears confined to the Caño and Laguna Provincial.

Etymology.—The name *anduzei* is for Dr. Pablo Anduze, a Venezuelan scientist and explorer who has provided much help to the senior author in her work on the fishes of the Territorio Federal de Amazonas.

Resumen.—*Nannostomus anduzei* es descrito como una nueva especie de pez caraciforme de la Familia Lebiasinidae. Esta especie proviene de la Laguna Provincial, una localidad cerca del río Orinoco al Norte de Puerto Ayacucho, Territorio Federal

Amazonas, Venezuela. *Nannostomus anduzei* puede ser distinguida del resto de las especies del género por su pequeño tamaño cuando adulto, numerosas estructuras reducidas y patión de coloración particular. Aunque la nueva especie aca descrita as claramente una especie del género *Nannostomus,* su relación con otras especies es obscura.

Acknowledgments

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SUPPLEMENTARY DESCRIPTION OF *CYPRIDINA AMERICANA* (MÜLLER, 1890), A LUMINESCENT MYODOCOPID OSTRACODE FROM THE EAST PACIFIC

Louis S. Kornicker

Abstract.—The original description by Müller in 1890 of *Cypridina americana,* the only representative of the genus known from the vicinity of the Americas, and one of the two luminescent myodocopid ostracode species known from the East Pacific, consists of two short paragraphs and a single illustration of the carapace, and is inadequate for recognition of the species. The supplementary description is in considerable detail and all appendages are illustrated.

Cypridina americana (Müller, 1890) is the only species in the vicinity of the Americas of a genus having many representatives in the Indo-West Pacific Region, and is one of the two luminescent mydocopid ostracodes known to live in the East Pacific. The specimens described by Müller were from off the west coasts of Ecuador and Columbia and the specimen described here is from off the west coast of Mexico. (The other luminescent species from the East Pacific, *Varqula tsujii* Kornicker and Baker, 1977, was collected off Southern California.) Müller (1890) described his species from five specimens collected in 1845; the species was not collected again until 1981 when two specimens were netted by David Lapota who reported them to be luminescent (Lapota 1983:307) and sent one specimen to the National Museum of Natural History for identification by Anne C. Cohen and myself.

As previously stated by Poulsen (1962: 255) species descriptions by Müller in his 1890 paper are very incomplete; therefore, the opportunity to redescribe the species was welcome, despite having only a single specimen to study, which fortunately is an adult male, the sex more useful in discrimination of species in the Cypridinidae.

Cypridina americana (Müller, 1890)
Figs. 1–4

Pyrocypris americana Müller, 1890:211, pl. XXV: fig. 3; 1912:17, 18.

Cyrpidina americana.—Poulsen, 1962:555 (referral inferred), 557 (map).—Lapota, 1983:307.

Not *Pyrocypris americana.*—Brady, 1902: 185, pl. XXI: figs. 14–19.—Sharpe, 1908: 426, fig. 4. [See discussion in *Misidentifications of the species.*]

Holotype.—Not designated, syntypes apparently not extant, since attempts to locate them in a number of institutions have been unsuccessful.

Material.—1 adult male (USNM 159080).

Distribution.—Müller (1890:233; 1912: 18) gave the locality as off the west coast of Central America, but according to the latitudes and longitudes of the collections (5°N, 82°W, 3°N, 85°W, 3°S, 81°W) they are from off the west coasts of Ecuador and Colombia, as previously noted by Lapota (1983: 307). The specimen described herein is from west of Mexico (19°23.8′N, 105°18.9′W) (Lapota 1983:307).

Description of adult male (Figs. 1–4).—Carapace with linear or slightly concave

Fig. 1. *Cypridina americana,* adult male, USNM 159080, length 1.87 mm, complete specimen from right side with details of diagnostic dentition and bristles along anteroventral margin.

dorsal margin and broadly convex ventral margin (Fig. 1); tip of rostrum with anterior projection creating slight concavity in anterior margin of rostrum (Figs. 1, 2a, b, e); anterodorsal corner of rostrum only slightly rounded (Figs. 1, 2a, b, e); caudal process fairly short, and broadly rounded (Figs. 1, 2c, f); surface of valve with lineations in anterior half paralleling valve edge (Fig. 2g). Anteroventral edge of valve with about 25 lateral teeth (Fig. 1); outer edge of teeth linear, inner edge convex and joining outer edge at posterior end of tooth forming rounded to pointed tip (Fig. 1); teeth shorter and more closely spaced posteriorly along valve edge (Fig. 1).

Surface bristles (Fig. 1): Anteroventral edge of left valve with 9 bristles, of right valve with 7 bristles; anterior bristles separated from following bristle by 4–6 teeth, remaining bristles separated by 3 or 4 teeth. Posterior margin of valve and lateral surface with very few slender bristles.

Infold (Fig. 2b, c, e, f): Rostral infold with 2–4 bristles forming row paralleling anterior edge of rostrum (Fig. 2b, e); bristles mostly double and largest bristle near tip of rostrum; 2 bristles (long and short) near inner end of incisur and 1 small bristle present dorsal to their bases (Fig. 2b, e). Anteroventral infold anterior to marginal teeth with 3 small bristles (Fig. 2b, e); anteroventral margin between marginal teeth with 4 short bristles; ventral infold with 3 widely spaced bristles along faint list distal to midwidth of infold; about 8 minute bristles or processes along list anterior to caudal process. Caudal process: posterior margin of anterior ridge with 20–25 irregular serrations (some poorly defined) (Fig. 2c, f); 2–3 serrations

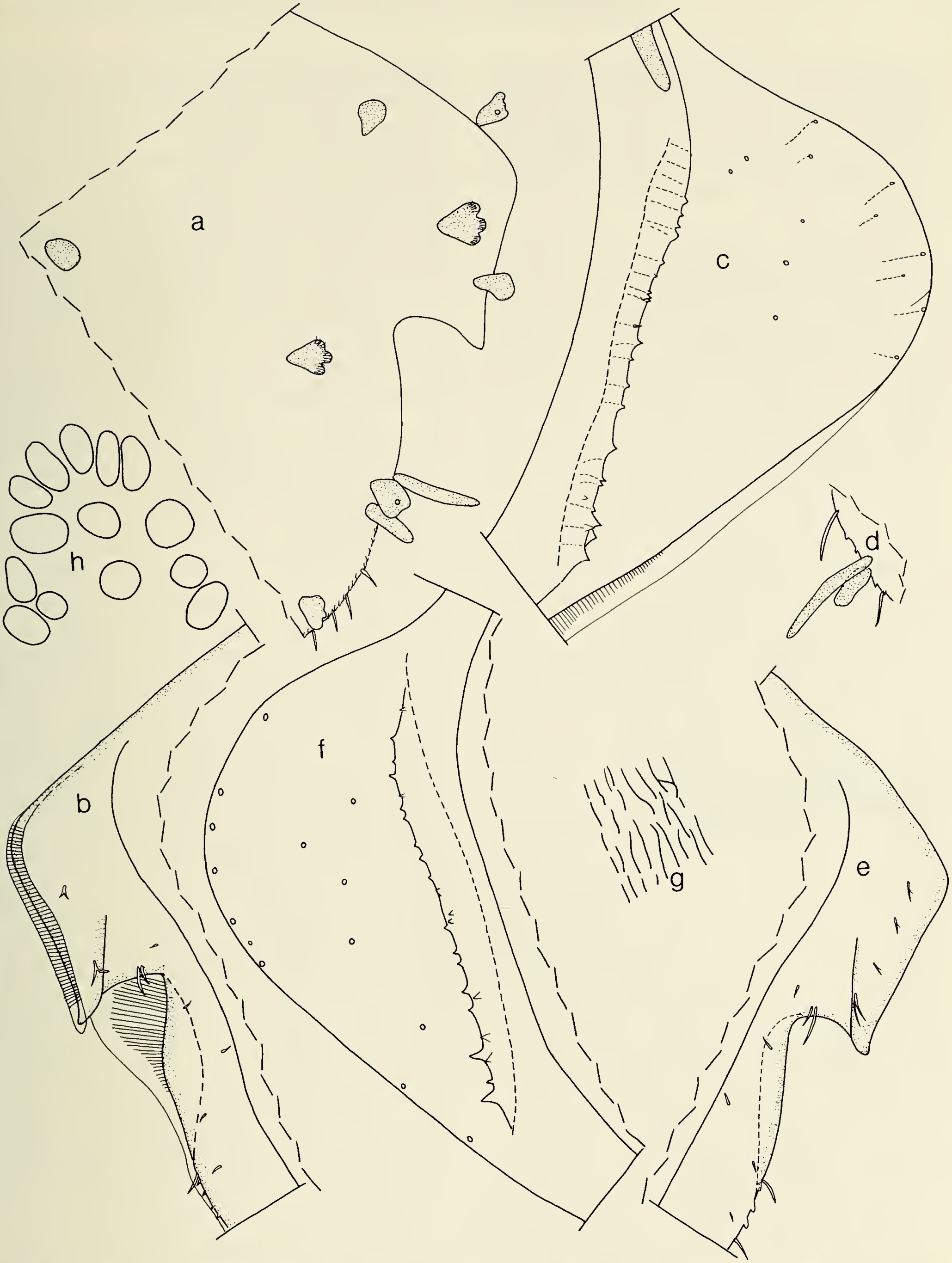

Fig. 2. *Cypridina americana,* adult male, USNM 159080, right valve: a, Lateral view of anterior showing attached epizoa (stippled); b, Inside view of anterior showing bristles of infold and selvage; c, Inside view of caudal process showing anterior ridge and pores of infold (posterior end of hingement stippled). Left valve: d, Outside view of part of anteroventral edge showing some dentition, 2 bristles, and 2 attached epizoa (stippled); e, Inside view of anterior showing bristles of infold, and anterior end of dentition and bristles along anteroventral margin; f, Inside view of caudal process showing anterior ridge and pores of infold; g, Surface lineations on anterior part of valve, viewed from inside, anterior to right; h, Central adductor muscle attachments viewed from inside, anterior to right.

at ventral end of ridge stouter than others; posterior edge of caudal process with several minute pores (each may contain small process) (Fig. 2c, f); additional similar pores between anterior ridge and posterior end of process.

Selvage (Fig. 2b, c): Anterior margin of rostrum with narrow selvage with inner edge set well back from valve edge and with narrow striations (Fig. 2b); selvage extending past tip of rostrum and apparently terminating there. Selvage along ventral edge of incisur very broad, also striate except near distal edge (Fig. 2b); selvage along anteroventral and ventral margin narrow, and striate only in proximal half; selvage becoming broader along posteroventral margin, then narrowing along ventral margin of caudal process, and apparently terminating near tip of process (Fig. 2c).

Central adductor muscle attachment (Fig. 2h): Consisting of about 14 ovoid and elliptical attachment areas.

Size: USNM 159080, length 1.87 mm, height 1.09 mm.

First antenna (Fig. 3a): 1st joint bare. 2nd joint with long hairs forming 2 distal rows on dorsal margin, abundant short spines forming rows on medial surface (not all shown on illustrated limb), and few long distal hairs on lateral surface near dorsal margin (not shown on illustrated limb). 3rd joint with short dorsal and longer ventral bristle, both with short marginal spines. 4th joint with 2 bristles (1 ventral, 1 dorsal (dorsal bristle only of illustrated limb with minute polyp with short stem and ovoid tip, probably foreign). Sensory bristle of 5th joint with 8 long proximal filaments and 2 shorter, distal, slender filaments; tip of bristle either blunt or with minute spine. 6th joint with short medial bristle. 7th joint: a-bristle about same length as bristle of 6th joint; b-bristle about same length as sensory bristle of 5th joint, with short proximal branch with stout base, round transparent sucker near middle, and small rounded process near pointed tip; distal part of b-bristle with 2 slender filaments, each bearing 5 or 6 minute suckers on small stalks (suckers missing from some stalks); tip of bristle with minute spine; c-bristle very long, about 6 times length of b-bristle, with short proximal branch with stout base; round transparent sucker (about ⅓ greater diameter than sucker of b-bristle) near middle, and small rounded process near pointed tip; distal part of bristle with short proximal bare filament, followed by a longer more slender filament bearing 5 small suckers, and 5 long bare filaments; tip of bristle with minute spine. 8th joint: d-bristle slightly longer than b-bristle, bare with blunt tip; e-bristle similar but shorter; f-bristle very long, about same length as c-bristle, with 9 or 10 marginal filaments; g-bristle about half length of c-bristle, with 10 filaments (2 proximal filaments longer than 3rd filament).

Second antenna (Fig. 3b): Protopodite with small medial bristle with small marginal spines. Endopodite 1-jointed, with 6 bristles (4 short proximal, 1 longer distal, 1 longest terminal). Exopodite: 1st joint with minute distal spines forming few rows along ventral margin and on medial surface near ventral margin; bristle of 2nd joint reaching just past 5th joint, with about 11 ventral spines (spines stouter distally) and 1 faint proximal dorsal spine; natatory bristles of joints 3–8 without spines; 9th joint with 3 bristles (2 long with natatory hairs, 1 short (dorsal) bare); joints 3–8 with small basal spines increasing in size distally; spine of 8th joint about half length of 9th joint; 9th joint with lateral spine similar in size to basal spine of 8th joint; joints 6–8 with faint minute spines forming row along distal margin.

Mandible (Fig. 4a): Coxale endite well developed, spinous, with 2 stout terminal spines, 1 on each side of small triangular process; small bristle at base of endite. Basale: ventral margin with 2 small spinous ringed a-bristles, 1 small bare b-bristle, 2 c-bristles (proximal small, distal long, spinous; long bristle broken on illustrated limb),

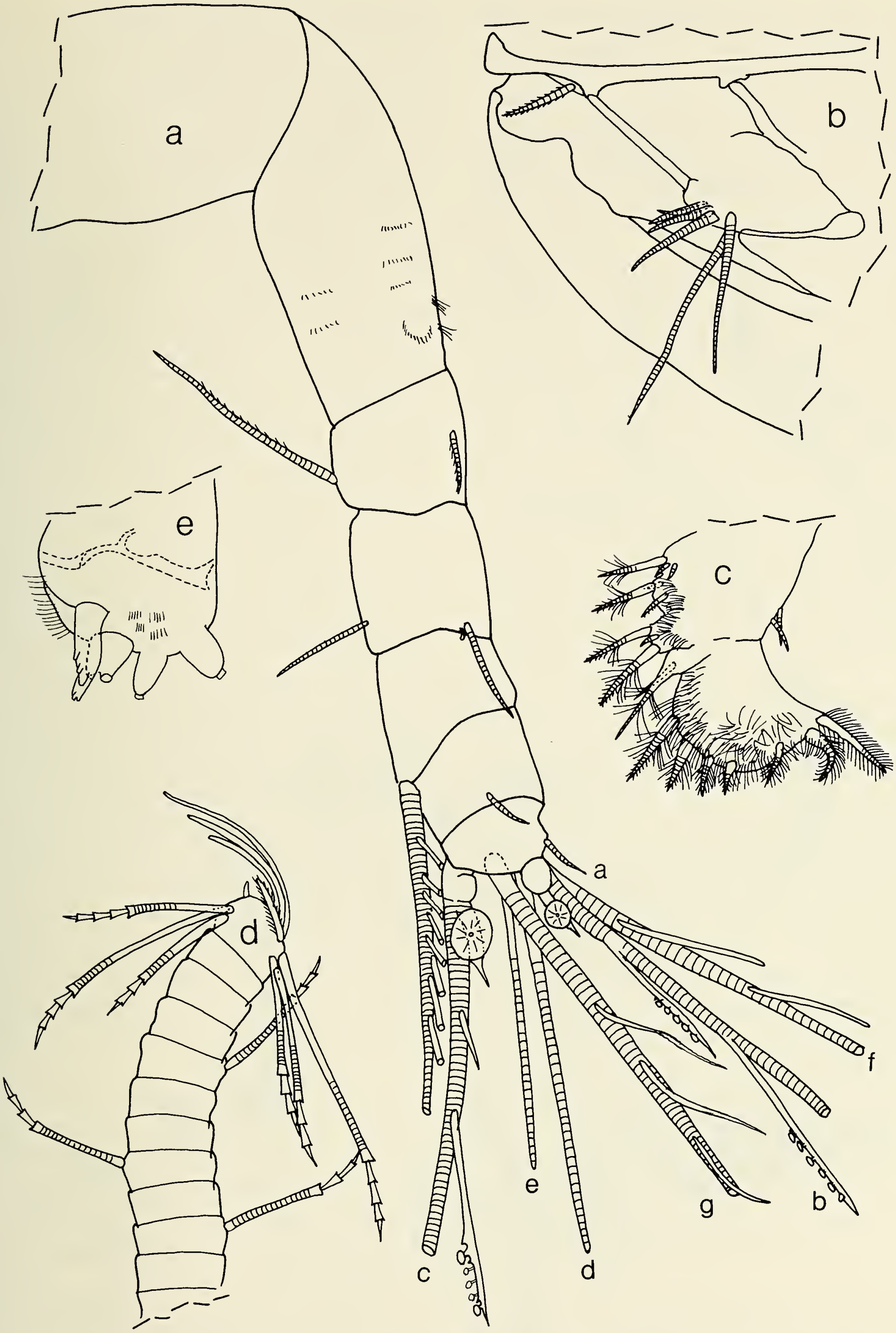

Fig. 3. *Cypridina americana,* adult male, USNM 159080: a, Left 1st antenna, medial view; b, Endopodite, distal part of protopodite, and proximal part of 1st joint of exopodite of right 2nd antenna, medial view; c, Right 6th limb, medial view; d, 7th limb; e, Upper lip, anterior to right (2 posterior tusks of left side not shown).

Fig. 4. *Cypridina americana,* adult male, USNM 159080: a, Right mandible, medial view; b, Maxilla (twisted); c, Left 5th limb, posterior view; d, Posterior of body from left showing left lamella of furca, left copulatory limb, left Y-sclerite, and ventral end of girdle; e, Right lateral eye; f, Medial eye and Bellonci organ.

and 2 d-bristles (proximal short, distal long, both with spines); ventral margin between a- and b-bristles spinous; dorsal margin with 3 bristles (1 distal to midlength, 2 terminal); medial surface of joint and proximal dorsal margin spinous. Exopodite reaching just past distal end of dorsal margin of 1st endopodial joint, with hirsute terminal pad and 2 distal bristles (distal of these stouter and shorter than proximal). 1st endopodial joint with 4 ventral bristles (1 minute, bare, others spinous and of unequal length. 2nd endopodial joint: ventral margin spinous with 2 single bristles and terminal paired bristles, all pointed; dorsal margin with 4 or 5 long bristles and 7 shorter bristles; medial surface spinous; end joint with 3 claws (2 pectinate proximally) and 4 bristles.

Maxilla (Fig. 4b): Endite I with 7 bristles; endites II and III, each with 5 bristles. Coxale with dorsal hairs near base of hirsute dorsal bristle. Basale with 2 short bare bristles. Exopodite broad, hirsute (hairs not shown on illustrated limb), with 3 bristles (proximal and middle bristle with long marginal hairs, other with short hairs. Endopodite: 1st joint (twisted on illustrated limb) with 1 alpha-bristle with long marginal hairs and 2-beta bristles (longer stout pectinate, shorter slender with short marginal spines or hairs); cutting tooth comprising bifurcate tooth with distal tooth much longer. 2nd joint with 3 slender bare a-bristles, 4 ringed b- and c-bristles, and 3 d-bristles (2 stout, unringed, pectinate, 1 stout, ringed, pectinate).

Fifth limb (Fig. 4c): Epipodite with 35 bristles. Anterior tooth-like process of protopodite absent. Endite I with 5 bristles (anterior short, others longer, with long proximal spines and short distal teeth; endite II with 5 bristles (1 posterior short, unringed, triangular; 2 ringed with long proximal spines and short distal teeth; 1 ringed, with short marginal spines; 1 unringed with short marginal spines); endite III with 7 bristles (1 posterior short, unringed, triangular; 1 posterior stout, ringed, with long proximal spines and short distal teeth; 1 anterior long, ringed, with long proximal and short distal spines; 2 ringed with short marginal teeth or spines; 2 unringed with short marginal teeth). 1st exopodial joint: main tooth comprising triangular peg and 6 pectinate teeth; bristle proximal to triangular peg with long proximal hairs and few short distal spines; anterior side with 2 ringed bristles with long proximal hairs and small distal spines. 2nd exopodial joint with total of 5 or 6 a- and b-bristles, 1 c-bristle with long proximal hairs and fairly long distal spines, and 1 d-bristle with long proximal and short distal spines. 3rd exopodial joint: inner lobe hirsute, with 3 bristles (proximal short with long proximal hairs and short distal spines; shorter terminal bristle unringed, with few short marginal teeth; longer terminal bristle ringed, with short marginal spines); outer lobe hirsute, with 2 short ringed bristles with short marginal spines; 4th and 5th exopodial joints fused, hirsute, with 3 ringed bristles with short marginal spines.

Sixth limb (Fig. 3c): With 2 small bare epipodial bristles. Endites I and II each with 2 short medial bristles and 1 long terminal bristle; endite III with 3 terminal bristles (small bristle with medial base between 2 long bristles with terminal bases); endite IV with 2 terminal bristles (small bristle with base on medial side, long bristle with terminal base). End joint with 4 bristles (with long proximal and short distal spines) along anterior half of ventral margin, followed by space and 1 bristle (with base on medial side and with long spines almost to tip), then a smaller space and 2 stout hirsute bristles; total of 7 bristles on end joint; medial surface of limb excluding endites I and II hirsute; ventral margin of end joint anterior to 2 posterior hirsute bristles with spines forming row (some spines with bases on lateral side of joint).

Seventh limb (Fig. 3d): Each limb with 9 bristles: 3 proximal (1 or 2 on each side, all with 3 bells); 6 terminal (3 on each side, with 3–5 bells). Terminal comb with 7 teeth (longest tooth in middle; lateral short tooth with long proximal and shorter distal spines).

Peg opposite comb elongate, with few small terminal spines.

Furca (Fig. 4d): Each lamella with 9 claws decreasing in length and width posteriorly; 3rd claw not weaker than 4th; claw 2 fused to lamella, remaining claws separated from lamella by well defined suture; all claws with small slender teeth along posterior concave margin; claws 1–4, possibly others, also with fine distal hairs along anterior convex margin; claw 1 with several fairly large, medial, distal teeth; claw 1 of right lamella anterior to claw 1 of left lamella by width of claw measured at its base.

Bellonci organ (Fig. 4f): Short, pear-shaped, with small terminal process.

Eyes: Medial eye bare, without pigment (Fig. 4f). Lateral eyes well-developed, with 15 or 16 reddish-brown ommatidia surrounded by amber matrix (Fig. 4e). (See *Remarks concerning pigmentation.*)

Upper lip (Fig. 3e): With 2 unpaired anterior processes, each with terminal glandular opening, and 2 pairs of posterior processes (anterior pair medial to posterior pair and shorter, each with 3 glandular openings near tip (1 medial, 2 terminal); posterior pair of processes each with 3 or 4 distal glandular openings); lateral surface of lip proximal to processes with spines forming rows; bulge posterior to processes hirsute.

Copulatory organ (Fig. 4d): Well developed, oval lobes with distal serrate process.

Posterior of body (Fig. 4d): Bare, smoothly rounded, without dorsal process.

Y-sclerite (Fig. 4d): Dorsal branch with offset distal part.

Pigmentation: Appendages and upper lip without pigmentation. (See *Remarks concerning pigmentation.*)

Bioluminescence: While alive, specimen produced intense blue luminous cloud (Lapota 1983:307).

Epizoa (Fig. 2a, d): USNM 159080, with elongate and digitate unidentified forms without visible stalk.

Remarks concerning pigmentation.—Müller (1890:233) stated that the appendages of *C. americana* have pigment as in *C. chierchia* (Müller, 1890:232), which has pigmentation in the 1st antenna, mandible, maxilla, and 5th limb (Müller 1890:232). In a key to members of the genus, Müller (1912: 16) used the presence of pigmentation in the 1st antenna to separate *C. americana* from several species. The absence of pigmentation in appendages of the specimen described herein could be interpreted to indicate that it is not *C. americana,* and I concur that if newly collected specimens are without pigment the species should be considered new. I find it expedient to assume that the specimen described herein once had pigmented appendages, and that the pigment has become bleached during storage. Support for that conclusion comes from consideration of the lateral eye, which in other species of the genus has a matrix of black pigment surrounding amber ommatidia, but in the specimen described herein has a light amber matrix surrounding reddish-brown ommatidia.

Comparisons.—*Cypridina americana* closely resembles *C. dentata* (Müller, 1906: 20). The carapace differs in two characters: 1, the serrations along the posterior edge of the anterior ridge on the infold of the caudal process are less well defined on *C. americana*; and 2, the small plates along the anteroventral margin are squarish with rounded corners on *C. dentata* and plano-convex (almost comma-shaped) on *C. americana.*

Misidentifications of the species.—Brady (1902:185) reported the species (as *Pyrocypris americana*) and described an adult male. He stated (1902:185) that the sample was collected by the *Galathea* Expedition, 10 Sep 1875, but gave no other locality information. Mrs. Anne C. Cohen, at my request, wrote to Dr. Torben Wolff of the Copenhagen Zoological Museum, Denmark, for information concerning the locality of the sample. Dr. Wolff (in litt, 15 Jan 1976) kindly informed us that he had two *Galathea* samples with specimens of *P. americana* identified by Brady, but that the published dates were incorrect and should have been 9 Oct 1845. The given locality of the sample is Trincomale, East Ceylon. Brady's description of the species is not in sufficient detail to permit its exclusion from *Cypridina americana* with absolute certainty, but it is more likely to be one of the many species of *Cypridina* now recognized in the Indian Ocean, and for that reason I have not included Brady's specimens in the synonymy above. Brady (1902:185) actually attributed the identification of the specimens as *C. americana* to Dr. G. W. Müller, but Müller (1912:18) questioned the identification, and did not include the Ceylon (Sri Lanka) locality in the distribution of *C. americana.*

Sharpe (1908:426) reported *C. americana* (as *Pyrocypris americana*) based on a specimen collected off Honolulu, Hawaii, in 1902 at the surface and at night. The furca of Sharpe's specimen (Sharpe 1908:fig. 4) differs from that of *C. americana* in having the 4th claw stouter than the 3rd. Müller (1912:19) correctly removed the specimen from *C. americana*; he referred it to *Pyrocypris sharpei* Müller, 1912 (=*Cypridina sharpei*).

Baker (unpublished dissertation 1975:86) identified specimens collected on the continental shelf (silty sand to silt substrate) off Southern California. The specimens were restudied by Kornicker and Baker (1977: 218) who referred them to a new species *Varqula tsujii.* Hobson and Chess (1976: 584, 585) reported *Varqula americana* in shallow water off Santa Catalina, California, but in a later paper (Stepien and Brusca 1985: 93) these specimens were reidentified as *V. tsujii.*

Acknowledgments

I wish to thank the following people for their help: Dr. David Lapota for the specimen on which the work was done, Drs. T. E. Bowman and I. G. Sohn for reviewing the manuscript, Mrs. Kathryn Schroeder Brown and Mr. Jack Schroeder for assisting in preparing the inking illustrations and Mrs. Carolyn Gast for rendering the shaded drawing of the carapace.

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100(1), 1987, pp. 182–185

LIMNODRILUS TORTILIPENIS, A NEW NORTH AMERICAN SPECIES OF FRESHWATER TUBIFICIDAE (ANNELIDA: CLITELLATA: OLIGOCHAETA)[1]

Mark J. Wetzel

Abstract.—*Limnodrilus tortilipenis* n. sp. (Annelida: Oligochaeta: Tubificidae) is described from four specimens collected from the Cache River drainage, southern Illinois. This description brings to 14 the number of species in this genus, ten of which are now known to occur in North America. *Limnodrilus tortilipenis* is distinguished from its congeners by its extremely long penis sheaths and the corkscrewlike distal ends of its penis. A key is presented to distinguish *L. tortilipenis* from other morphologically similar species of *Limnodrilus.*

Members of the family Tubificidae, particularly species in the genus *Limnodrilus,* are common and often overwhelmingly abundant inhabitants of rivers, streams, lakes, and ponds throughout the world, especially in areas receiving organic enrichment. During a faunistic assessment of aquatic Oligochaeta in the Cache River drainage, southern Illinois (Wetzel 1980, 1981), specimens of a previously undescribed *Limnodrilus* were collected. This discovery increases to 14 the number of species in the genus *Limnodrilus,* ten of which are now known to occur in North America.

Materials and Methods

Specimens of this new species were collected 9 Mar 1978 from Dutchman Creek, Johnson County, Illinois. Live worms were fixed immediately in 10% buffered formalin and taken to the laboratory for processing and identification. Microscopical studies were made of specimens in Hydramount[2] on glass slides.

Limnodrilus tortilipenis,
new species
Figs. 1–11

Material examined.—HOLOTYPE: USNM 100439, Illinois: Johnson County; Dutchman Creek; 2.4 km west of Vienna; 9 Mar 1978; coll. D. A. McCormick & M. J. Wetzel. PARATYPES: USNM 100440. Illinois: Johnson County; Cache River; 1.9 km west of West Vienna; 24 May 1976; coll. M. J. Wetzel; 1 specimen. INHS Annelida Collection, Illinois: Johnson County; Dutchman Creek; 2.4 km southwest of Vienna; 2 May 1978; coll. D. A. McCormick & M. J. Wetzel; 1 specimen. Illinois: Johnson County; Cave Creek; 2.1 km northeast of Forman; 27 Feb 1976; coll. L. R. Richart & M. J. Wetzel; 1 specimen.

Etymology.—"*tortilus*"—Latin, "twisted," refers to the twisted, corkscrewlike distal ends of the cuticular penes.

Diagnosis.—This medium-sized *Limnodrilus* is distinguished from all other members of the genus by extremely long and slender penis sheaths with elaborately developed heads. The shaft of each penis tapers

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[1] Due to unforseeable changes in the submission and publication dates of Brinkhurst (1986) and this present manuscript, part of this description unfortunately was published in Brinkhurst 1986 (pp. 168–169) as *Limnodrilus tortilipenis* Wetzel, 1986.

[2] Hydramount, previously available from Biomedical Specialties in Santa Monica, California, was discontinued recently by its manufacturer.

gradually from basal to distal end. Although superficially similar to *L. claparedianus* Ratzel, *L. tortilipenis* is 4 to 7 times as long. The head of each penis resembles a corkscrew, with proximal, fingerlike projections directed basally and medially.

Description.—Length: 15 to 22 mm (preserved). Diameter: 0.4 to 0.7 mm (preserved). Number of segments: 28 to 108; one paratype incomplete and one paratype regenerated posteriorly. Prostomium appearing triangular in dorsal view, rounded in lateral view. Width of prostomium at peristomial junction greater than length. Dorsal and ventral chaetae all bifid crotchets, 79 to 113 μm long, 5 to 7 μm diameter. Dorsal chaetae 5 to 10 per bundle anteriorly; 4 to 5 per bundle posteriorly from IX. Ventral chaetae 6 to 8 per bundle anteriorly; 3 to 4 per bundle posteriorly from VII. Anterior chaetae each with distal tooth longer and thinner than proximal tooth (Fig. 1); posterior chaetae each with distal tooth equal to or shorter than proximal tooth (Fig. 2). Some chaetae on types worn.

Penis sac with spiralled muscle bands. Cuticular penis sheaths 2741 to 4080 μm in length, 28.2 to 50.4 μm in basal width, tapering gradually through entire length to narrowest area just posterior to head (8.4 to 9.6 μm) (Fig. 3). Width at midshaft 14.4 to 20.4 μm. Base of head resembling corkscrew, with fingerlike proximal projections (Figs. 4–9). Bases of penes originate around posterior portion of XVI. Spermatozeugmata 335 to 441 μm in length and 70 to 94 μm in width. Outer layer of spermatozeugmata 4 to 22 μm thick, with axial cavity 13 to 67 μm in diameter (Figs. 10, 11).

Additional diagnostic characters often used in the description of *Limnodrilus,* such as the length and breadth of vas deferens and atrium, were impossible to diagnose accurately because of the macerating nature of the mounting medium. Repeated attempts to collect additional specimens from the type locality and elsewhere for diagnosis from their known localities have been unsuccessful.

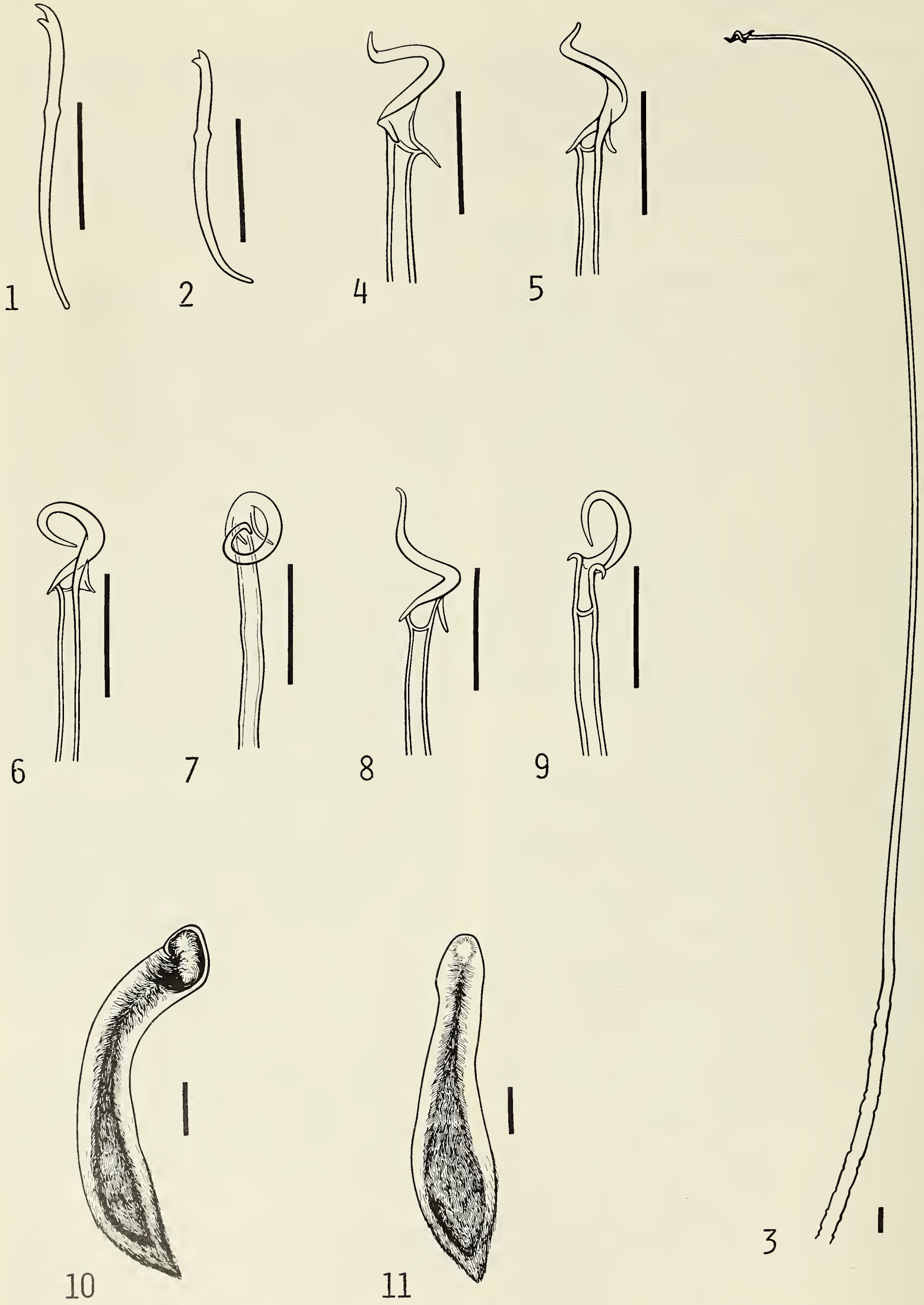
Other congeners of *Limnodrilus tortilipenis* occurring within the Cache River drainage include *L. angustipenis* Brinkhurst & Cook, *L. cervix* Brinkhurst, *L. claparedianus* Ratzel, *L. hoffmeisteri* Claparède, *L. maumeensis* Brinkhurst & Cook, *L. profundicola* (Verrill), *L. rubripenis* Loden, and *L. udekemianus* Claparède.

Discussion

This species, typical of the genus, is characterized by two dorsal and two ventral bundles of chaetae which are exclusively bifid and three to six in number, hearts in segments VIII and IX, long vasa deferentia, atria with solid prostates, and true penes with chitinous sheaths. The penes are elaborately developed and surrounded by penial sacs with spiral muscles. Genital chaetae, hair chaetae, and pectinate chaetae are absent. Coelomocytes are absent; the spermathecae have spermatozeugmata (Brinkhurst and Jamieson 1971). Considerable intraspecific variation can be observed in the characters used for identification of members in this genus.

The penes of *L. tortilipenis* are morphologically more elaborate than other members of the genus, as illustrated in Brinkhurst (1965); Hiltunen (1967); Kennedy (1969); Brinkhurst and Jamieson (1971); Loden (1977); Stimpson, Klemm, and Hiltunen (1982); and Brinkhurst and Wetzel (1984); the heads of the penes terminate like those of corkscrews (Figs. 4–9).

Stimpson, Klemm, and Hiltunen (1982) provided a guide to freshwater Tubificidae known to occur in North America. Characters used to identify the tubificids in this key included those external and internal structures readily observable in whole-mounted material, using conventional light microscopy. These characters included somatic chaetae and structure of the male reproductive system. *Limnodrilus tortilipenis* will key to couplet 59 in Stimpson, Klemm, and Hiltunen (1982), which I have modified as follows:



Figs. 1–11. *Limnodrilus tortilipenis*: 1, Anterior seta of VI; 2, Posterior chaeta of median segment; 3, Cuticular penis sheath of holotype; 4, 5, Distal ends of penes of holotype; 6–9, Distal ends of penes of paratypes; 10–11, Spermatozeugmata of holotype. Scale bars = 50 μm.

59(58)*a* Head of penis sheath with overhanging hood and broad, flat proximal lip; distally, diameter of shaft flares into head; mature tube length 300 to 600 μm .... *Limnodrilus hoffmeisteri* Claparède, 1862

– Head of penis sheath without overhanging hood 59*b*

59*b* Shaft slender, long (600 to 700 μm), sigmoid, with head equilaterally triangular, hence bilaterally symmetrical .... *Limnodrilus claparedianus* Ratzel, 1869

– Shaft slender, extremely long (2700 to 4100 μm); distal end of head of penis corkscrew-like; proximal end of head with fingerlike projections, directed basally and medially .... *Limnodrilus tortilipenis*

Acknowledgments

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RECORDS OF MARINE ISOPOD CRUSTACEANS ASSOCIATED WITH THE CORAL *MADRACIS MIRABILIS* FROM BARBADOS

Brian Kensley and Paul Snelgrove

Abstract.—Eleven isopod species are recorded from the coral *Madracis mirabilis* in Barbados. Two of these are described as new: *Chalixanthura lewisi,* which differs from its congener in possessing more antennal and antennular flagellar articles and a shorter maxillipedal endite, and in lacking a strongly incised uropodal exopod, and *Eisothistos teri,* which is characterized by the possession of middorsal spination of the telson, a recurved tooth on the female uropodal exopod, and a laminate process on the basal peduncular article of the antennule. Five of the previously described species had thus far only been recorded from Belize in the western Caribbean.

Since the first description of the coral reefs of Barbados, West Indies by Lewis (1960), a number of studies have contributed to the quantification of the marine fauna around the island (e.g., Ott 1975, Lewis and Bray 1983, Tomascik and Sander 1986). However, little work has been done on the cryptofauna associated with these reefs, and a baseline study of the organisms present is lacking.

In April 1985, a study of the crustaceans associated with *Madracis mirabilis* was undertaken along the west coast of the island. *Madracis mirabilis* is an erect branching coral that grows in small isolated heads in shallow water (approximate depth 5 m) or in large monospecific beds in deeper water (approximate depth 10 m). The spaces and crevices between the branches provide an ideal habitat for a diverse crustacean cryptofauna that is numerically dominated by isopod species. The present paper documents this isopod fauna, which includes two new species of anthurideans.

Holotypes and paratypes are deposited in the National Museum of Natural Sciences, Ottawa (NMNS); paratypes are also deposited in the National Museum of Natural History, Smithsonian Institution, Washington, D.C. (USNM).

Methods

Swimming transects perpendicular to shore were used to locate *M. mirabilis* at six sites along the west coast of Barbados (Fig. 1). Between June and October 1985, each of the sites was visited three times, and five samples were obtained during each visit. Samples were taken from the large beds by forcing a section of PVC tubing into the coral and then inserting a metal plate to cut the coral off at the base. A polyurethane bag was then wrapped tightly around the base of the tubing and the coral allowed to fall into the bag. Once the contents had settled, the tubing and metal plate were gently removed and the bag sealed. At the Paynes Bay site *M. mirabilis* was found only in isolated heads approximately 20 cm in diameter, therefore sampling was accomplished by wrapping a polyurethane bag around the head and prying it from the substrate with the metal plate. Samples were then transported to a Bellairs Research Institute for overnight treatment with an irritant solution of 20 ml 4% formalin and 51 ml seawater (Brander et al. 1971), before washing over a 0.297 mm sieve and fixing in 5% formalin the following morning. The washings and coral were later examined under a dissecting microscope and all crustaceans were removed and stored separately. The isopods found in these samples are described below.

Family Anthuridae
Chalixanthura lewisi, new species
Figs. 2–5

Material.—HOLOTYPE, NMNS NMC-C-1986-1122, non-ovig. ♀, 3.0 mm, Bank Reef, 11 Jun 1985; PARATYPES, NMNS, 3 juvs., North Bellairs, 19 Jun 1985; 4 non-ovig. ♀, 2.1–3.1 mm, Six Men's, 1 Jun 1985; 2 non-ovig. ♀, 2.0 mm, 1 juv., Six Men's, 1 Jun 1985; 2 non-ovig. ♀, 1 juv., Bank Reef, 11 Jun 1985; 1 non-ovig. ♀, 3 juvs., North Bellairs, 19 Jun 1985; 2 non-ovig. ♀, Six Men's, 1 Jun 1985; 2 non-ovig. ♀, 4 juvs., Bank Reef, 11 Jun 1985; 2 juvs., Brighton, 5 Jul 1985; 1 ♂, 2.1 mm, Six Men's, 1 Jun 1985; 1 ♂, 2.1 mm, Six Men's, 19 Jul 1985; 1 ♂, damaged, Sox Men's, 1 Jun 1985. An additional 40 juvs. collected at Paynes Bay, 13 Jul 1985. PARATYPES, USNM 211428, 5 non-ovig. ♀, 2.0 mm, Brighton, 20 Aug 1985; PARATYPES, USNM 211429, 2 ♂, 2.2 mm, Greensleeves, 26 Jun 1985.

Description.—Female: Body about 10× longer than wide, widest at pereonite 6. Proportions: C < 1 < 2 = 3 < 4 > 5 > 6 > 7. Cephalon with very low rounded rostral point; eyes small, pigmented, of about 10 ommatidia. Pleonites short, free, 1–4 subequal, 5 slightly longer, 6 with posterior margin broadly bilobed. Telson lacking statocysts, lanceolate, widest at midlength, lateral margins in posterior half with 6 serrations; few setae on rounded apex.

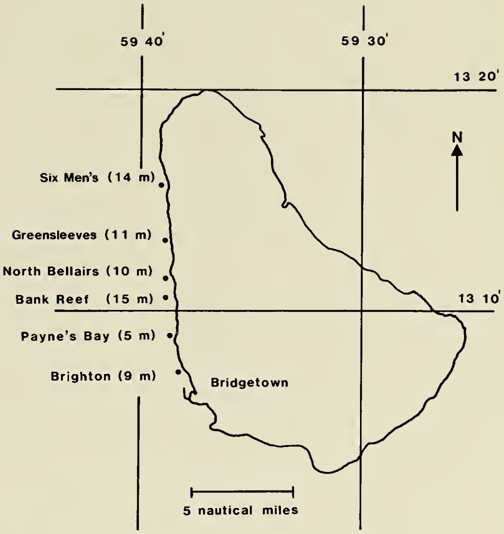

Fig. 1. Map of Barbados, West Indies, with sampling sites and approximate depths.

Basal antennular peduncular article longest and broadest; flagellum of 3 articles, article 2 longest, with single aesthetasc, article 3 with 2 aesthetascs. Antennal peduncle with article 2 longest and widest; articles 3 and 4 together slightly shorter than article 5; flagellum of 7 setose articles. Mandibular palp of 3 articles; terminal article bearing 3 spines; lamina dentata of 5 serrations; molar short, truncate; incisor of 2 or 3 sclerotized cusps. Maxilla with 6 distal teeth. Maxilliped with palp of 5 articles, article 3 longest; broad endite almost reaching base of palp article 4, distally acute.

Pereopod 1, propodus slightly expanded, palm straight, bearing few simple setae; unguis ¾ length of remainder of dactylus, with short auxiliary spine at base. Pereopods 2 and 3 similar, propodi less expanded than in pereopod 1, with 2 sensory spines on palm; short strong auxiliary spine at base of dactylar unguis. Pereopod 7, carpus with short anterior margin, shorter than posterior margin, small sensory spine at posterodistal angle; propodus with posterodistal sensory spine and 2 elongate distally fringed anterodistal spines. Pleopod 1, exopod operculiform, with 9 marginal plumose setae; endopod about ⅔ length and ¼ greatest width of exopod, with 2 distal plumose setae. Uropodal sympod with mesioventral

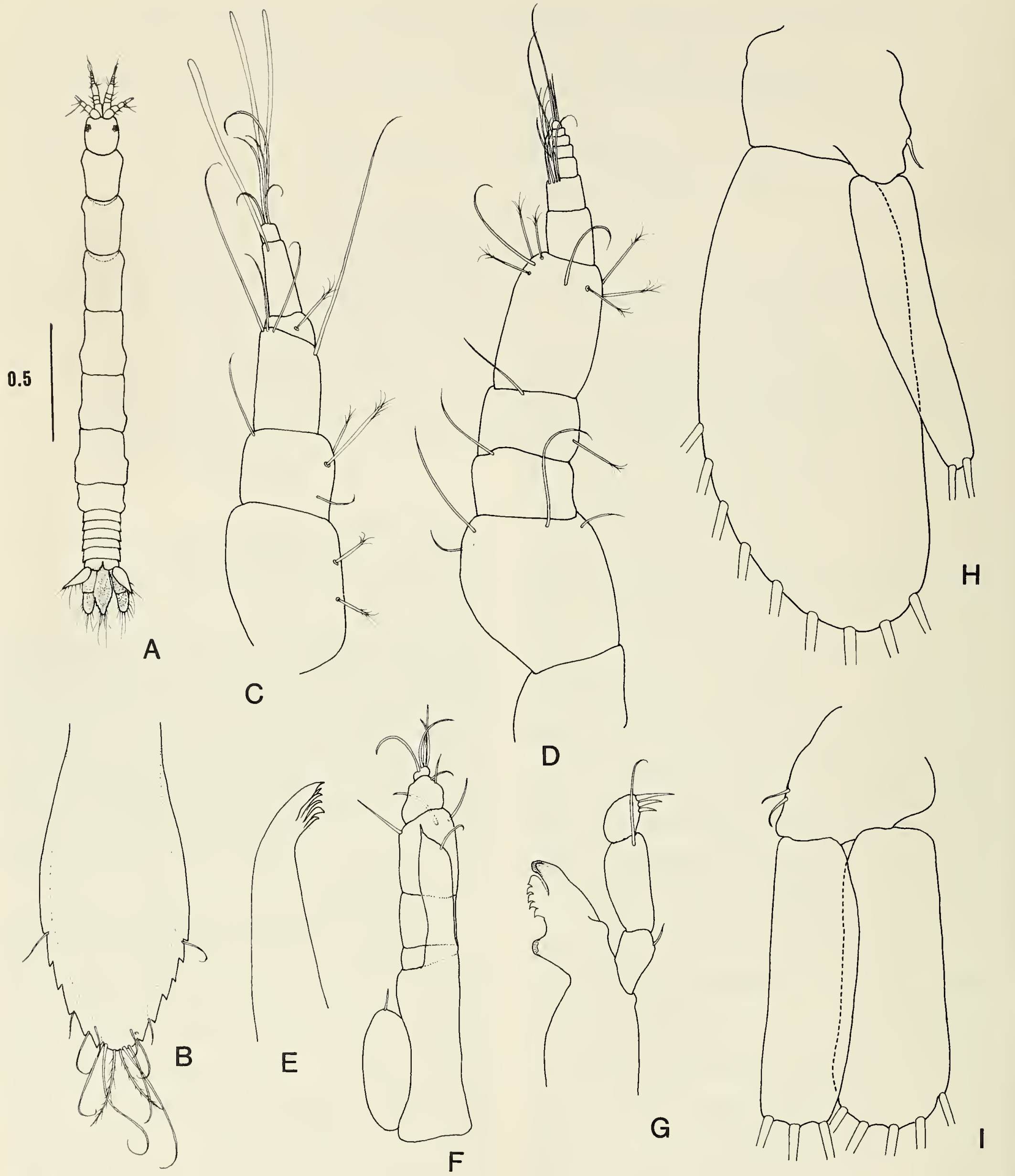

Fig. 2. *Chalixanthura lewisi,* female: A, Adult in dorsal view; B, Telson; C, Antennule; D, Antenna; E, Maxilla; F, Maxilliped; G, Mandible; H, Pleopod 1; I, Pleopod 2.

row of plumose setae; exopod ovate, apically acute, with 2–3 distal serrations on outer margin and several elongate setae; endopod equal in length to basis, distally broadly rounded, distolateral margin serrate, bearing elongate simple setae.

Male: Body about 13× longer than wide. Proportions: $C > 1 = 2 = 3 < 4 > 5 = 6 > 7$. Cephalon with low rostral point. Eyes enlarged, of about 30 ommatidia, almost contiguous middorsally, extending ventrally and leaving narrow median strip in which

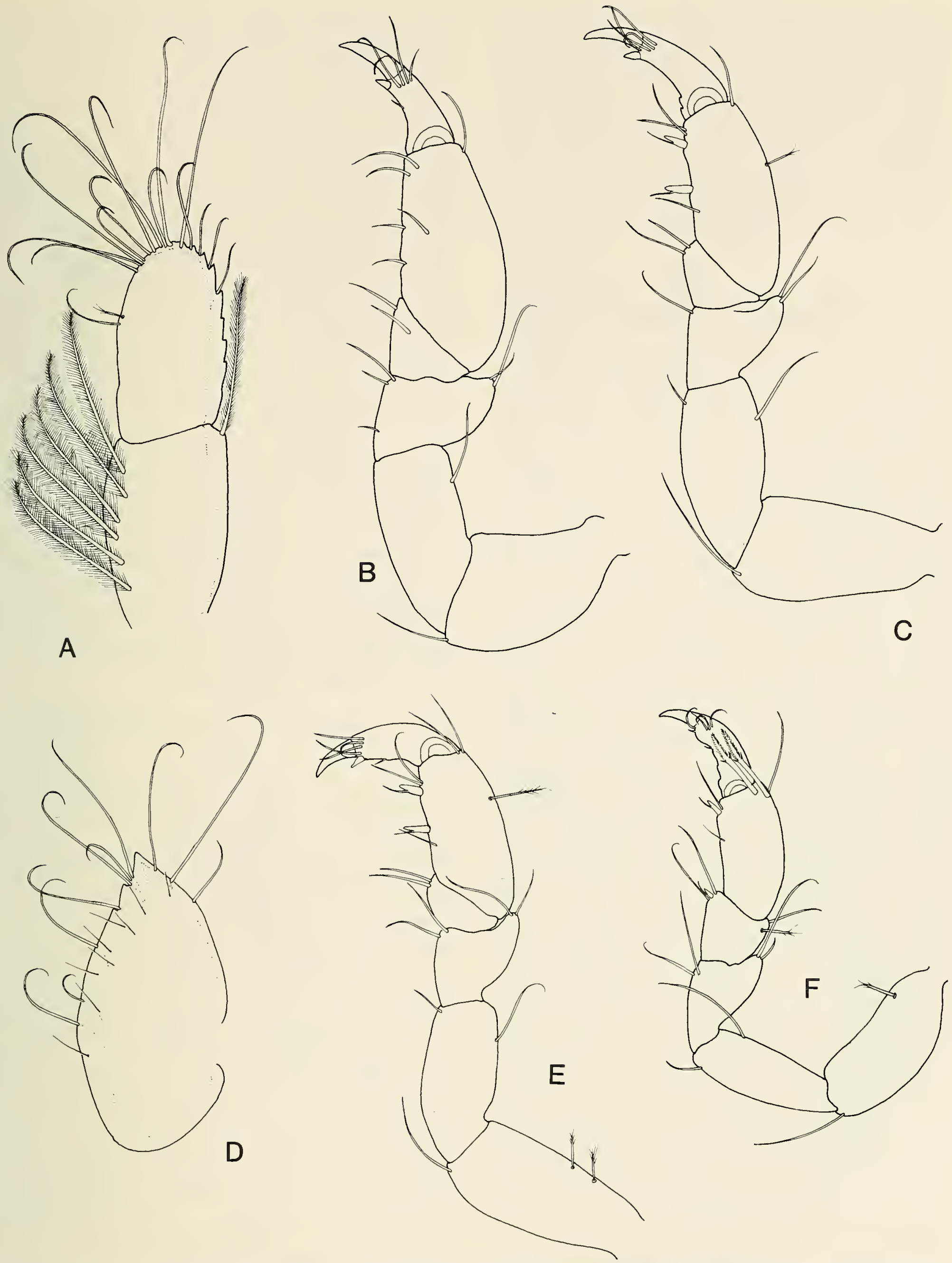

Fig. 3. *Chalixanthura lewisi,* female: A, Uropodal sympod and endopod; B, Pereopod 1; C, Pereopod 2; D, Uropodal exopod; E, Pereopod 3; F, Pereopod 7.

mandibular palp and maxilliped accommodated. Pleonites short, free, 1–4 subequal, 5 slightly longer, 6 with posterior margin middorsally bilobed. Telson lanceolate, posterior half of lateral margins with 8–9 serrations, several setae on rounded apex.

Antennular flagellum of 11 articles, proximal articles bearing numerous aesthetascs, number of aesthetascs reduced distally. Antenna similar to female, flagellum of 6 or 7 setose articles. Mandibular palp of 3 articles, terminal article with 4 spines; body of mandible reduced to narrow columnar structure. Maxilliped segmentation obscure, at least 3 distal articles, endite lacking.

Pereopod 1, propodus with slightly concave palm bearing 2 basally broadened spines, mesial surface near palm with 7 spines; unguis ⅔ length of remainder of dactylus, with auxiliary spine more slender than in female. Pereopods 2 and 3 similar; propodus more elongate and slender than in female, with 2 (pereopod 2) or 3 (pereopod 3) sensory spines on palm. Pereopod 6, carpus with anterior margin shorter than posterior, with posterodistal spine; propodus with 3 serrate sensory spines on posterior margin. Pereopod 7, carpus as in pereopod 6; propodus with strong serrate sensory spine at posterodistal angle, and with 2 elongate distally fringed spines anterodistally. Pleopod 1, rami subequal in length, endopod half width of exopod. Pleopod 2, copulatory stylet elongate, slender, reaching by more than half its length beyond distal margin of ramus, articulating in proximal half of endopod; latter with 5 distal plumose setae; exopod broader and slightly longer than endopod, with transverse suture at about midlength, 10 plumose setae on distal margin. Pleopod 3, exopod longer and wider than endopod with transverse suture. Uropodal endopod longer than sympod, with serrate distolateral margin, several elongate simple setae distally; exopod narrowly lanceolate, apically acute, outer margin with 5 serrations and few elongate setae.

Remarks.—The following features place this species in the group of genera apparently related to *Panathura*: Short free pleonites, pleonite 1 exopod operculiform, telson lacking statocysts, large apically acute maxillipedal endite, maxillipedal palp of 5 articles, pleopods 2–5 with biarticulate exopods, pereopod 1 propodus only slightly more inflated than in pereopods 2 and 3, posterior pereopods with carpus having anterior margin shorter than posterior margin.

Of these genera, the present species most closely resembles the monotypic *Chalixanthura* Kensley, 1984, in overall body shape and especially in the modifications of the male. The major differences lie in the antennal and antennular flagella which have more articles in the present species, and in the maxillipedal endite of the female, which is much shorter in *C. scopulosa.* The present species also does not have the strongly incised uropodal exopod seen in the female of *C. scopulosa.* The maxillipedal endite more closely resembles that of *Expanathura* Wägele, 1981, another member of the "*Panathura*" group of genera.

Etymology.—The species is named for Dr. John B. Lewis, professor of Oceanography at McGill University, who has contributed more than anyone to the knowledge of the marine fauna of Barbados.

Eisothistos teri, new species
Figs. 6, 7

Material.—HOLOTYPE, NMNS NMC-C-1986-1134, non-ovig. ♀, 3.2 mm, Six Men's, 1 Jun 1985. PARATYPES, NMNH, 2 ♂, 2.0 mm, Brighton, 20 Aug 1985; 1 ♂, damaged, Six Men's, 1 Jun 1985; 1 ♂, 1.8 mm, Greensleeves, 26 Jun 1985; 3 ♂, 2.0 mm, Bank Reef, 27 Jul 1985; 2 non-ovig ♀, 1.4 mm, Greensleeves, 26 Jun 1985; 2 non-ovig. ♀, 1.8 mm. 1 damaged, Six Men's 1 Jun 1985; 2 non-ovig. ♀, 1.3 mm, 2.4 mm, Six Men's, 1 Jun 1985; 1 non-ovig. ♀, 2.4 mm, Brighton, 20 Aug 1985. PARATYPES, USNM 211430, 3 ♂, 2.0 mm, Bank Reef, 11 Jun 1985; PARATYPES, USNM 211431, 2 non-ovig. ♀, 1.3 mm, 1.8 mm, Greensleeves, 13 Aug 1985.

Description.—Female: Body about 7× longer than wide. Only tailfan markedly indurate. Prominent anterolateral eye with 5 or 6 ommatidia. Pleonites short, free, 1–5 subequal, 6 longer than preceding pleonites, with broad posterolateral lobes separated by wide middorsal notch. Telson widening

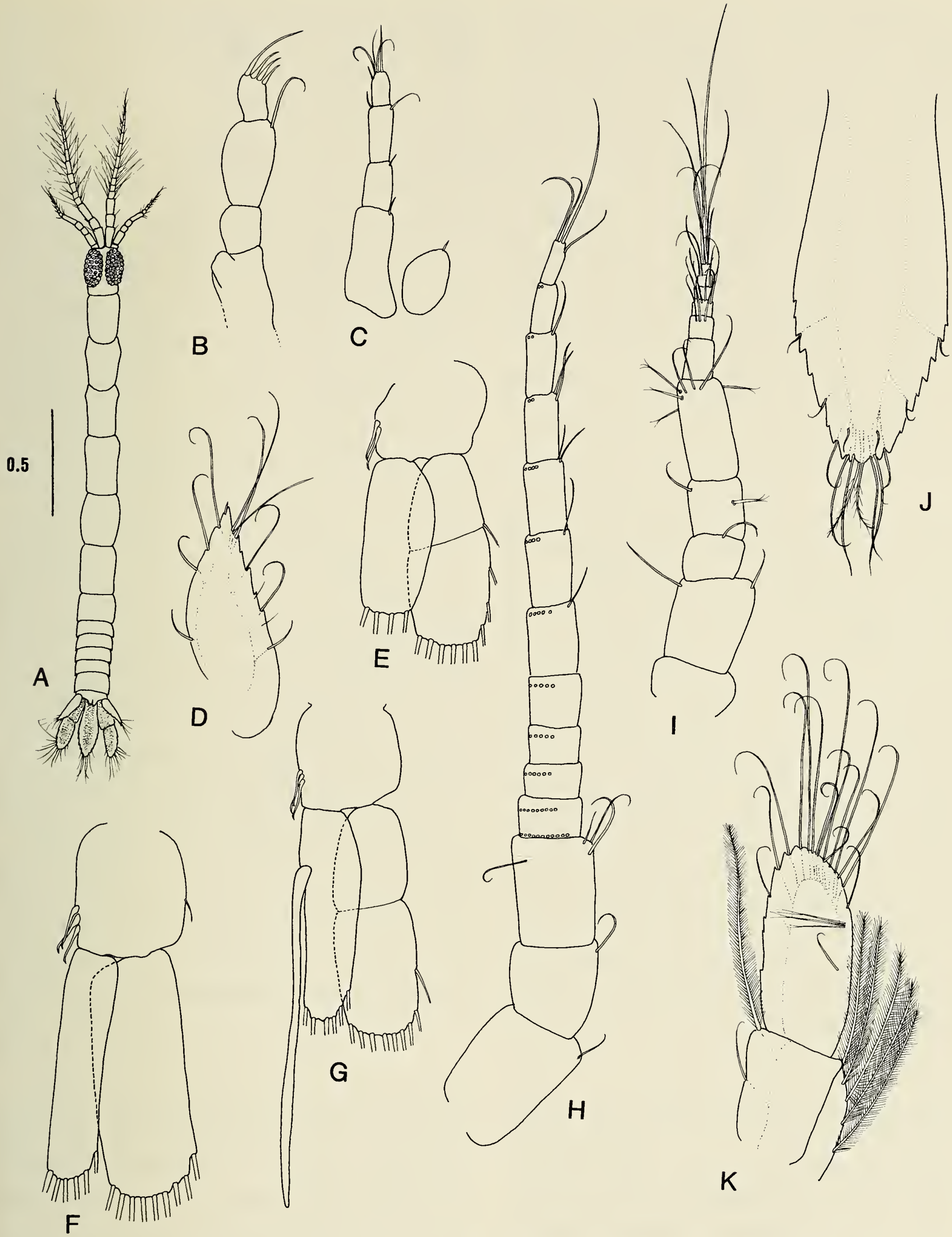

Fig. 4. *Chalixanthura lewisi,* male: A, Adult in dorsal view; B, Mandible; C, Maxilliped; D, Uropodal exopod; E, Pleopod 3; F, Pleopod 1; G, Pleopod 2; H, Antennule; I, Antenna; J, Telson; K, Uropodal endopod and sympod.

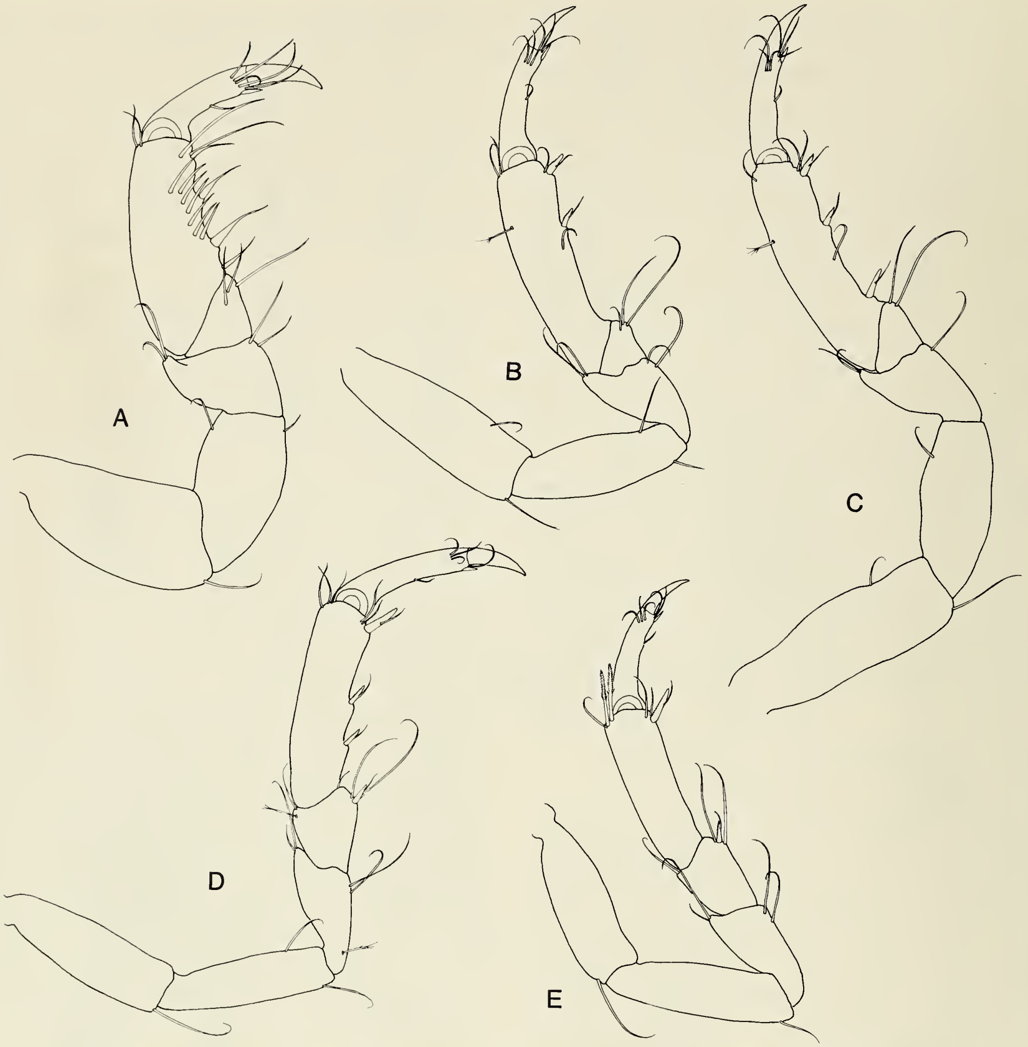

Fig. 5. *Chalixanthura lewisi,* male: A, Pereopod 1; B, Pereopod 2; C. Pereopod 3; D, Pereopod 6; E, Pereopod 7.

posteriorly, broadly rounded posterior margin deeply incised into 13–14 acute to narrowly rounded teeth; middorsally with row of 8 or 9 well separated erect teeth, becoming progressively larger and somewhat recurved posteriorly.

Antennule with basal article broad, bearing mediodistal flattened, narrowly triangular, apically narrowly-rounded process bearing single seta; peduncular articles 2–3 narrow, subequal; flagellum of 7 articles, article 1 short, article 2 longest; single aesthetasc on penultimate and antepenultimate articles each. Antenna with peduncular article 5 longest; flagellum of 6 setose articles. Mandible lacking palp; incisor with single broad strongly sclerotized cusp; subterminal lamina dentata of 2 teeth. Maxilla having 2 broad and 4 narrow distal teeth. Maxilliped elongate, slender, proximal segmentation obscure; short distal article with 4 setae.

Pereopod 1, carpus triangular, with very short free anterior margin; propodus elongate, distally tapering, palm unarmed except for few distal setae; unguis about ⅔ length of remainder of dactylus. Pereopod 2, ischium having 11 sclerotized tubercles near posterior margin, merus with 2 sclerotized tubercles; carpus triangular; propodus bearing row of about 20 fringed scales (appearing as spines in lateral view) plus strong posterodistal fringed spine; unguis about ½ length of remainder of dactylus. Pereopod 7, carpus roughly rectangular with row of about 9 fringed scales plus strong posterodistal fringed spine; propodus elongate-rectangular, with row of about 14 fringed scales on posterior margin plus strong posterodistal fringed spine; unguis slightly less than ½ length of remainder of dactylus. Pleopod 1, rami fused for ¾ length, distal endopod and exopod with 2–4 plumose setae each. Uropodal sympod with mesial margin serrate, 4 spines near lateral margin; endopod with mesial margin longer than lateral margin, extending well beyond telsonic apex, margins bearing acute to rounded teeth; exopod proximally broad, margins serrate, with distal spine-like, apically acute extension bearing strong recurved tooth on dorsal surface (2 on right, 1 on left in holotype).

Male: Body about 15 × longer than wide. Eyes relatively larger than in female, each with 9–10 ommatidia, extending onto ventrolateral surface; mouthparts obsolete. Pleonites free, 1–3 subequal, longer than 4 and 5. Telson widening slightly posteriorly, dorsally unarmed, posterior margin with 12 acute to narrowly rounded teeth.

Antennule with basal article slightly longer than article 2; articles 2 and 3 subequal; flagellum of 8 articles, article 1 inserted obliquely on peduncle, bearing 9 elongate aesthetascs; article 2 with 2 aesthetascs; articles 3–8 each with single aesthetasc. Antennal peduncle with 3 proximal peduncular articles short, 2 distal articles elongate, article 5 just less than twice length of article 4; flagellum of 6 setose articles.

Pereopod 1, carpus triangular, with short free anterior margin; propodus elongate-rectangular, with 19–20 fringed spines near posterior margin plus posterodorsal unfringed spine; unguis just more than ½ length of remainder of dactylus. Pereopod 2, propodus elongate-rectangular, with few posterodistal fringed scales and strong fringed posterodistal spine; unguis ½ length of remainder of dactylus. Pereopod 7, carpus rectangular, with 5 fringed scales and strong fringed posterodistal spine; propodus with about 14 fringed scales on posterior margin and 2 strong fringed spines. Pleopod 1, basis about ⅔ length of endopod; rami separate, each with 3–4 elongate plumose setae on distal margin. Pleopod 2, basis ¼ length of rami; endopod with copulatory stylet attached proximally; stylet distally rounded, not reaching beyond rami.

Remarks.—Of the 12 species of *Eisothistos* described, only four have middorsal spination of the telson, similar to that seen in the present species. These are the two Mediterranean species *E. macrurus* Wägele, and *E. pumilis* Wägele, *E. antarcticus* Vanhöffen from the Antarctic, and *E. crateris* Kensley from St. Paul and Amsterdam Islands. None of these species show the arrangement of large slightly recurved teeth increasing in length posteriorly on the telson of the female, and none possess the heavy recurved tooth on the "spike" of the uropodal exopod. One striking feature, the laminate process of the basal article of the female antennule, immediately separates *E. teri* from all other described species. A similar but more elaborate structure is seen in *Licranthura amyle* Kensley and Schotte, 1987. In the latter, however, the process arises from the third peduncular article of the antennule.

Etymology.—The species is named for Teri Snelgrove, who has the kindness to feign interest in marine biology.

Mesanthura paucidens
Menzies and Glynn

Mesanthura paucidens Menzies and Glynn, 1968:27, fig. 9a–g.—Kensley, 1982:335, fig. 150, 151.

Fig. 6. *Eisothistos teri,* female: A, Antennule; B, Antenna; C, Maxilliped; D, Left uropod and telson; E, Pleopod 1; F, Pereopod 1; G, Pereopod 7; H, Mandible; I, Maxilla; J, Pereopod 2.

Material.—1 specimen from Paynes Bay, 22 Oct 1985.

Previous records.—Puerto Rico; Carrie Bow Cay, Belize; shallow water.

Mesanthura pulchra Barnard

Mesanthura pulchra Barnard, 1925:145, fig. 9e—Kensley, 1982:337–338, fig. 152, 153.

Material.—3 specimens, Six Men's, 1 Jun

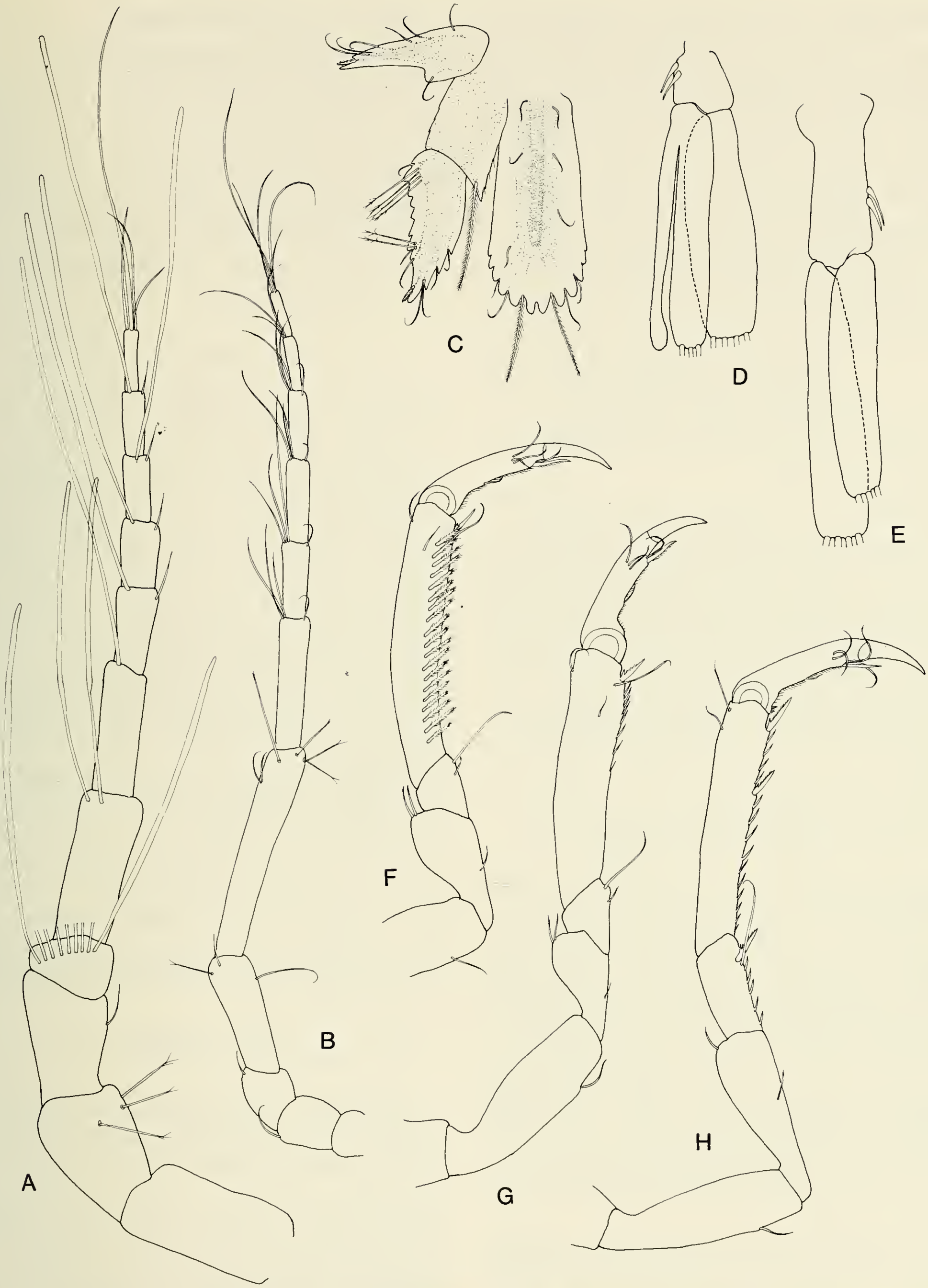

Fig. 7. *Eisothistos teri,* male: A, Antennule; B, Antenna; C, Left uropod and telson; D, pleopod 2; E, Pleopod 1; F, Pereopod 1; G, Pereopod 2; H, Pereopod 7.

1985; 1 specimen Bank Reef, 19 Jul 1985; 3 specimens, Paynes Bay, 13 Jul 1985; 1 specimen, Bank Reef, 8 Sep 1985; 1 specimen, North Bellairs, 19 Jun 1985.

Minyanthura corallicola Kensley

Minyanthura corallicola Kensley, 1982: 343, figs. 157, 158.

Material.—1 non-ovig. ♀, 2 manca, Six Men's, 1 Jun 1985. Numerous other specimens from Six Men's (1 Jun; 19 Jul; 16 Sep 1985), Greensleeves (26 Jun; 13 Aug; 13 Oct 1985), Bank Reef (11 Jun; 27 Jul; 8 Sep 1985). Present but rare at North Bellairs (19 Jun; 2 Aug 1985), Paynes Bay (22 Oct 1985), and Brighton (20 Aug; 10 Oct 1985). Overall, the most abundant anthuridean species.

Previous records.—Carrie Bow Cay, Belize, 6–24 m.

Family Cirolanidae
Cirolana minuta Hansen

Cirolana minuta Hansen, 1890:347, pl. 3 fig. 5, pl. 4 fig. 1.

Material.—2 specimens, Paynes Bay, 13 Jul 1985. Other specimens from Six Men's (19 Jul; 16 Sep 1985), Greensleeves (26 Jun; 13 Aug; 13 Oct 1985), Bank Reef (8 Sep 1985), Paynes Bay (13 Jul 1985), Brighton (5 Jul; 20 Aug; 10 Oct 1985). Rare at all sites and absent from North Bellairs.

Previous records.—St. Thomas, West Indies.

Family Gnathiidae
Gnathia rathi Kensley

Gnathia rathi Kensley, 1984:43, fig. 27a–i.

Material.—5 specimens, Six Men's, 1 Jun 1985; 12 praniza, Six Men's, 1 Jun 1985. Numerous other specimens from Six Men's (1 Jun; 19 Jul; 16 Sep 1985), Greensleeves (26 Jun 1985; 13 Aug; 13 Oct 1985), Bank Reef (11 Jun; 27 Jul; 8 Sep 1985), North Bellairs (19 Jun; 2 Aug; 24 Sep 1985). Present but rare at Paynes Bay (13 Jul; 27 Aug; 22 Oct 1985) and Brighton (5 Jul; 20 Aug; 10 Oct 1985).

Previous records.—Carrie Bow Cay, Belize, 0.5–36 m.

Family Stenetriidae
Stenetrium patulipalma Kensley

Stenetrium patulipalma Kensley, 1984:52, figs. 33, 34.

Material.—4 ♀, Six Men's, 1 Jun 1985. Numerous other specimens from Six Men's (1 Jun; 19 Jul; 16 Sep 1985), Greensleeves (26 Jun; 13 Aug; 13 Oct 1985), Bank Reef (11 Jun; 27 Jul; 8 Sep 1985), North Bellairs (19 Jun; 2 Aug; 24 Sep 1985), Brighton (5 Jul; 20 Aug; 10 Oct 1985). Present but rare at Paynes Bay (13 Jul; 27 Aug 1985).

Previous records.—Carrie Bow Cay, Belize, 9.1–15.2 m.

Stenetrium spathulicarpus Kensley

Stenetrium spathulicarpus Kensley, 1984: 55, figs. 35, 36, 37d.

Material.—1 ♂, 2 ♀, 3 juvs., Paynes Bay, 27 Aug 1985; 1 ♂, 3 juvs., Six Men's, 1 Jun 1985. Numerous other specimens from Paynes Bay (13 Jul; 27 Aug; 22 Oct 1985). Present but rare at Six Men's (1 June; 19 Jul; 16 Sep 1985), Greensleeves (26 Jun; 13 Aug; 13 Oct 1985), Bank Reef (11 Jun; 27 Jul; 8 Sep 1985), North Bellairs (19 Jun; 2 Aug 1985), and Brighton (5 Jul; 20 Aug; 10 Oct 1985).

Previous records.—Carrie Bow Cay, Belize, intertidal—20 m.

Family Janiridae
Carpias minutus (Richardson)

Bagatus minutus (Richardson), Pires, 1982: 231, figs. 1–16.

Carpias minutus: Bowman and Morris, 1979:650, figs. 1–3, 4a–d.

Material.—1 ♂, 1 ovig. ♀, 1 ♀, Six Men's, 1 Jun 1985. Numerous other specimens from Six Men's (1 Jun; 19 Jul; 16 Sep 1985), Greensleeves (26 Jun; 13 Aug; 13 Oct 1985), Bank Reef (11 Jun; 27 Jul; 8 Sep 1985), North Bellairs (19 Jun; 2 Aug; 24 Sep 1985), Brighton (5 Jul; 20 Aug; 10 Oct 1985). Present but rare at Paynes Bay (13 Jul; 27 Aug 1985).

Previous records.—Bermuda; Georgia, U.S.A. to Brazil; Azores, intertidal to shallow intratidal.

Family Joeropsidae
Joeropsis personata Kensley

Joeropsis personatus Kensley, 1984:70, fig. 44.

Material.—3 ♂, Bank Reef, 27 Jul 1985. Other specimens present but rare at Bank Reef (11 Jun; 27 Jul; 8 Sep 1985). Not present at any other site.

Previous records.—Carrie Bow Cay, Belize, 1–20 m.

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ON THE IDENTITY OF *ASTACUS* (*CAMBARUS*) *MEXICANUS* ERICHSON (1846) AND *CAMBARUS AZTECUS* SAUSSURE (1857) (DECAPODA: CAMBARIDAE) WITH THE DESCRIPTION OF *PROCAMBARUS OLMECORUM*, NEW SPECIES, FROM VERACRUZ, MEXICO

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Abstract.—The Mexican crayfish *Procambarus* (*Austrocambarus*) *mexicanus* (Erichson, 1846), from the state of Veracruz, is redescribed and declared a subjective senior synonym of *Cambarus aztecus* Saussure, 1857. The name *Procambarus* (*Austrocambarus*) *olmecorum* is proposed as a substitute name for the sympatric *Procambarus aztecus* Villalobos (1954) which is also redescribed and illustrated. As complete a list of references as the author has been able to assemble is offered for both species.

Uncertainty seems to have existed concerning the identity of both *Astacus* (*Cambarus*) *Wiegmanni* and *Astacus* (*Cambarus*) *Mexicanus* since they were described by Erichson in 1846, and the quandary was compounded with the description of *Cambarus aztecus* by Saussure in 1857. Of those who attempted to clarify the identity of these crayfishes and other of their close relatives, the most recent was Villalobos (1954, repeated in 1955 and 1983) who presented a historical summary of all recorded pertinent facts and opinions, added additional information, and offered proposals that he believed would clarify the confusion that was clearly evident in, and had persisted since the publication of, Hagen's (1870) monograph of the North American crayfishes. Only facts that seem immediately pertinent to establishing the identity of *Astacus* (*Cambarus*) *mexicanus* and de Saussure's (1857) *Cambarus aztecus* are repeated here, although as complete synonymies for the species treated as I have been able to ferret are included.

The two crayfishes described by Erichson were the first reported from Mexico, but, unfortunately, in his rather brief accounts of them, he did not record the locality from which his specimens had been collected. Apparently these crayfishes were not available to subsequent students of crayfishes. Whether or not Saussure sought Erichson's material is not known, but in describing the third and fourth species (*Cambarus Montezumae* and *Cambarus aztecus*) from Mexico, he did not mention having seen Erichson's "types." Almost certainly his knowledge of these species was derived solely from Erichson's descriptions, and only two specific differences were noted between his *C. aztecus* and *C. mexicanus*: ". . . les mains sont comprimées, non cylindriques comme chez l'espèce citée, puisque les bras sont épineux, etc." (Saussure 1858:461). Hagen was unsuccessful in his search for Erichson's types in the Berlin Museum in September 1870 (Faxon 1885:38) as was von Martens (1872:131), but Hagen (1870) expressed the opinion that Saussure's *C. aztecus* was identical to Erichson's *C. Wiegmanni* and that *C. Montezumae* was the young of *C. mexicanus*. These opinions are clearly without merit, for males of *C. Montezumae*, as described, possess hooks on the second and third pairs of pereiopods, *C.*

mexicanus, on the third, and *C. wiegmanni,* on the third and fourth. Hagen suggested that the different positions of the hooks were based upon Erichson's counting the chelipeds as the first pair of legs and Saussure's numbering the leg immediately posterior to the chelipeds as the first. This suggestion cannot be taken seriously since indeed the male of Saussure's *C. Montezumae* does exhibit hooks on the second and third pairs of pereiopods. Faxon (1885), while unable to distinguish between *Cambarus mexicanus* and *C. aztecus,* recognized the distinctness of *C. wiegmanni* and *C. montezumae* on the basis of the characters just cited.

Because of the lack of material from Mexico, not until 1954 was an apparently rewarding effort made to clarify the status of *Cambarus mexicanus, C. aztecus,* and *C. weigmanni.* In resolving the synonymy of *C. aztecus* with *C. mexicanus* proposed by Faxon (1885, 1914) it was necessary to associate the latter name with specimens from a known locality, and with good reason Villalobos (1954: 305) selected a specimen in the Academy of Natural Sciences of Philadelphia from El Mirador de Zacuapan, 8 km northeast of Huatusco, Veracruz, as the neotype of Erichson's *A.* (*Cambarus*) *mexicanus.* Apparently unaware that syntypes of *C. aztecus* were still extant, he described and illustrated specimens that he had collected in the presumed type locality, Tomatlán, 14 km south-southeast of Huatusco, Veracruz, as members of Saussure's species.

Had the syntypes of Saussure's *C. aztecus* not been extant, the problem of the identity of the two species would have been solved. That the specimens described by Villalobos as *Procambarus aztecus* were not conspecific with a syntype of Saussure's species in the collections of the Smithsonian Institution came to light when, in preparing illustrations for a checklist of the North and Middle American crayfishes (Hobbs 1974), I discovered that my drawing of the carapace of the Smithsonian syntype did not agree with Villalobos' illustration (Villalobos 1954:pl. III, fig. 1). I pointed this out to Dr. Villalobos, and, prior to his untimely death in October 1983, we had agreed to collaborate in attempting to rectify previously erroneous concepts of the two species. The most conspicuous difference between the specimens illustrated by Villalobos and the syntype is in the width of the areola. The illustration of *C. aztecus* provided by Saussure strangely lacks lines representing the branchiocardiac grooves so that in it the expanse of the areola cannot be determined. This could well be interpreted as the animal's possessing an obliterated one! But in the syntypes in the Muséum d'Histoire Naturelle, Geneva, and in that in the Smithsonian Institution currently available to me the areola is distinctly "open" throughout its length, about 10 times as long as broad—not obliterated along part of its length as occurs in Villalobos' *P. aztecus.*

On the basis of Villalobos' (1954:312) designation of a neotype of *Astacus* (*C.*) *mexicanus,* the identity of this species became established, and the locality from which the neotype was collected is known! Unfortunately, this specimen is in poor condition, and instead of preparing an inadequate description based upon it, I have chosen neotopotypic specimens which have been compared with the neotype, to illustrate the species. In view of the existence of syntypes, the identity of *Cambarus aztecus* Saussure seems clear, and now their source is reasonably assured. Since presumed topotypes proved to be members of another species, and there are at least five "communities" in Mexico bearing the name Tomatlán, the question had to be asked as to whether or not the locality given by Saussure, "Pris à Tomatlan, dans les Terres-Chaudes" is the same as that from which the specimens described by Villalobos, "Tomatlán, 14 km S.S.W. of Huatusco, Veracruz," came? Not until specimens that were conspecific with the syntypes became available from or nearby one of the Tomatláns could reasonable certainty of the location of that referred to by Saussure be assumed.

Of the five Mexican "communities" bearing the name Tomatlán listed in the gazetteer available to me, only that 14 km S.S.W. of Huatusco, Veracruz (19°02′N, 97°00′W), lies within the known range of the subgenus *Austrocambarus* to which *Procambarus* (*A.*) *aztecus* belongs. Moreover, specimens that differ only in minor respects from the syntypic male at hand were obtained from localities both north and south of the town. Thus, there is every reason to believe that it lies within the range of the species and is likely the same Tomatlán from which Saussure's specimens came.

The neotype and neotopotypes of *P.* (*A.*) *mexicanus* have been compared with the syntype of *C. aztecus* and with other specimens assignable to it from a number of localities in the vicinity of the two type localities (which are no more than 40 km apart), and I am convinced that the few differences noted between specimens assigned to the two, represent nothing more than individual variations. Among those features noted, none even seems to be restricted to a limited part of the range of the species. In view of these observations, I am proposing that *Cambarus aztecus* Saussure, 1857, be placed in the synonymy of *Cambarus mexicanus* (Erichson, 1846). Neither the characters pointed out by Saussure nor differences noted between the neotypes of the latter and syntypes of *C. aztecus* will serve consistently to separate populations of one from the other. I have examined, but do not have before me, the specimens that Villalobos described and figured as members of *Cambarus aztecus.* Available, however, are series from nearby localities that appear to be unquestionably conspecific with his material from Tomatlán and from near Coscomatepec, both localities in Veracruz. These specimens exhibiting an areola that is obliterated along a part of its length must be accorded a new name, and a description and illustrations of this crayfish are offered herein. Because of the confusion surrounding the identities of *Procambarus* (*A.*) *mexicanus* and *P.* (*A.*) *aztecus,* a description and illustrations of the syntypic male, form I, of the latter are included.

Procambarus (*Austrocambarus*) *mexicanus* (Erichson)

Fig. 1

Astacus (*Cambarus*) *Mexicanus* Erichson, 1846:99–100 [Type locality: Mexico, restricted by Villalobos (1954:305) to El Mirador de Zacuapan, 8 km NE of Huatusco, Veracruz; neotype: male, form I, Academy of Natural Sciences of Philadelphia, no. 4176].—Villalobos, 1953: 352, 353; 1954:299, 300, 301, 302; 1955: 15; 1983:19.

Astacus Mexicanus.—Erichson, 1846:87, 88.—Hagen, 1870:7.—Martens, 1872: 131.

Astacus mexicanus.—Dana, 1852:522.—Hobbs, 1972a:1.

Cambarus aztecus Saussure, 1857:503–504, fig. 23 [Type locality: "Pris à Tomatlan, dans les Terres-Chaudes," Veracruz, Mexico. Syntypes: Muséum d'Histoire Naturelle, Geneva, uncatalogued, 13 dry specimens; USNM, 20682, 1 male, form I.]; 1858:460–461, pl. III: fig. 23.—Hagen, 1870: 11, 12, 55.—Martens, 1872: 131.—Schmeltz, 1874:79.— Faxon, 1884: 141, 142; 1885:5, 9, 10, 38, 51 m, 123, 172, 174; 1914:410.—Torralbas, 1917: 596 (53), figs. 61, 62.—Villalobos, 1953: 353–363; 1954:300, 302, 314; 1955: 15; 1982:19.—Hobbs, 1972a:2.

Cambarus Mexicanus.—Saussure, 1858:460 (44).—Hagen, 1870:11, 12, 75, 84–85, 98, 102 (part).—Faxon, 1884:138, 139, 141–142 (part); 1885:5, 8, 9, 38–39, 47–48, 50–51, 53, 76, 158, 172–174, 177 (part).—Villalobos, 1950:381; 1955:140; 1983: 136.—Hobbs, 1972a:2.

Cambarus mexicanus.—Saussure, 1858:461 (45).—Ortmann, 1892:12 (part); 1902:

277, 283, 284, 341; 1905a:99, 103; 1905b: 435, 436.—Faxon, 1898:649; 1914:363, 410 (part).—Hay, 1899:964.—Harris, 1903:58, 108, 151, 155 (part).—Ellis, 1919:254, 264.—Goodnight, 1940:63.—van Straelen, 1942:5.—Villalobos, 1946: 216; 1950:381, 382; 1955:140; 1983: 136.—Hart, 1961:78, 79.—Hobbs and Villalobos, 1964:321, 324.—Holt, 1968: 15.

Cambarus Aztecus.—Hagen, 1870:11.

Astacus Aztecus.—Martens, 1872:131.

Cambarus (*Cambarus*) *mexicanus.*—Ortmann, 1905a:101, 103.—Villalobos, 1946:216.

Cambarus (*Procambarus*) *mexicanus.*—Ortmann, 1905b:437–438, 441 [by implication, in part]; 1906:11, 15, 21, 23; 1913:416, 417.—Hobbs, 1942a:57, 60, 61, pl. 2:fig. 12.—Rioja, 1940:249.—Villalobos, 1953:354; 1954:302; 1955:17; 1983:20.—Hobbs and Villalobos, 1964: 322.

Astacus Astecus.—Valdés Ragués, 1909:180 [erroneous spelling].

Procambarus aztecus.—Hobbs, 1942b:342 [by implication].—Villalobos, 1953:346, 363; 1954:300, 302, 304, 314 (in part); 1955:239; 1982:227.—Hart and Hart, 1974:124, 142.—Spitzy, 1976:445.

Procambarus mexicanus.—Hobbs, 1942b: 342 [by implication], 355, pl. III, figs. 11, 13; 1942c:38; 1943:203, 205, 206; 1966: 70, 71; 1967:8; 1969:118; 1971:3, 12, 30, 31, 41; 1972b:151, figs. 5h, 30f, 35b, 36a.—Villalobos, 1946:218; 1948:182; 1950:382, 385, pl. 4: figs. 2, 4; 1953:346, 365; 1954:299, 302–307, 310, 312–314, 317, 318, 321, 323, 328, 335, 346, 364, 375, pls. 1, 2; 1955:15, 22, 139, 140, 141, 159–169, 172, 173, 176, 178, 183, 201, 239, 240, pls. 28 (figs. 2, 4), 34, 35; 1983: 17, 25, 134, 136, 154–163, 166–168, 170, 171, 176, 192, 227, 228, pls. 28 (figs. 2, 4), 34, 35.—Rioja, 1949:316, 321 (part), 322, 327.—Hobbs and Villalobos, 1964: 313, 314, 346.—Hobbs III, 1969:21.—Straskraba, 1969:25.—Holt, 1973:4, 5, 17, 20, 25, 26, 32.—Hart and Hart, 1974:22, 23, 86.—Spitzy, 1976:443, 444.—Fitzpatrick, 1983:165, fig. 171.

Procambarus mexiacnus.—Villalobos, 1954:304 [erroneous spelling].

Procambarus Mexicanus.—Creaser, 1962: 7, fig. 8.

Procambarus (*Austrocambarus*) *mexicanus.*—Hobbs, 1972a:6; 1972b (1976):43; 1974:45, fig. 173.—Feldmann et al., 1981: 794, text-fig. 3.—Fitzpatrick, 1983:202.—Villalobos, 1982:219.

Procambarus (*Austrocambarus*) *aztecus.*—Hobbs, 1972a:6; 1972b (1976):43, 150, figs. 30e, 34c, 36b; 1974:44, 123, fig. 172.—Fitzpatrick, 1983:202.

Diagnosis.—Body pigmented, eyes well developed. Rostrum of adults without marginal spine and median carina. Carapace with or without small cervical spine or tubercle. Areola 6.5 to 17 times as long as wide and constituting 30.2 to 37.4 (average 32.8) percent of total length of carapace (37.1 to 46.0, average 40.3, percent of postorbital carapace length). Suborbital angle weak and obtuse; infraorbital spines lacking. Postorbital ridge moderately strong and anterior extremity with or without spine or tubercle. If present, branchiostegal spine small. Antennal scale about twice as long as broad, widest slightly distal to midlength. Cheliped studded with subsquamous tubercles from midlength of merus to about midlength of fingers. Ischium of third pereiopod of first form male with simple, strong, acute hook usually overreaching basioischial articulation; hook not opposed by tubercle on corresponding basis. First pleopods of first form male reaching coxae of third pereiopods, symmetrical, usually contiguous basally, lacking proximomesial spur; simple angular or produced shoulder present on cephalic surface at about base of distal eighth; lacking subterminal setae; terminal elements consisting of short, acute distolaterally directed mesial process extending beyond short, corneous subacute, cephalodistally directed

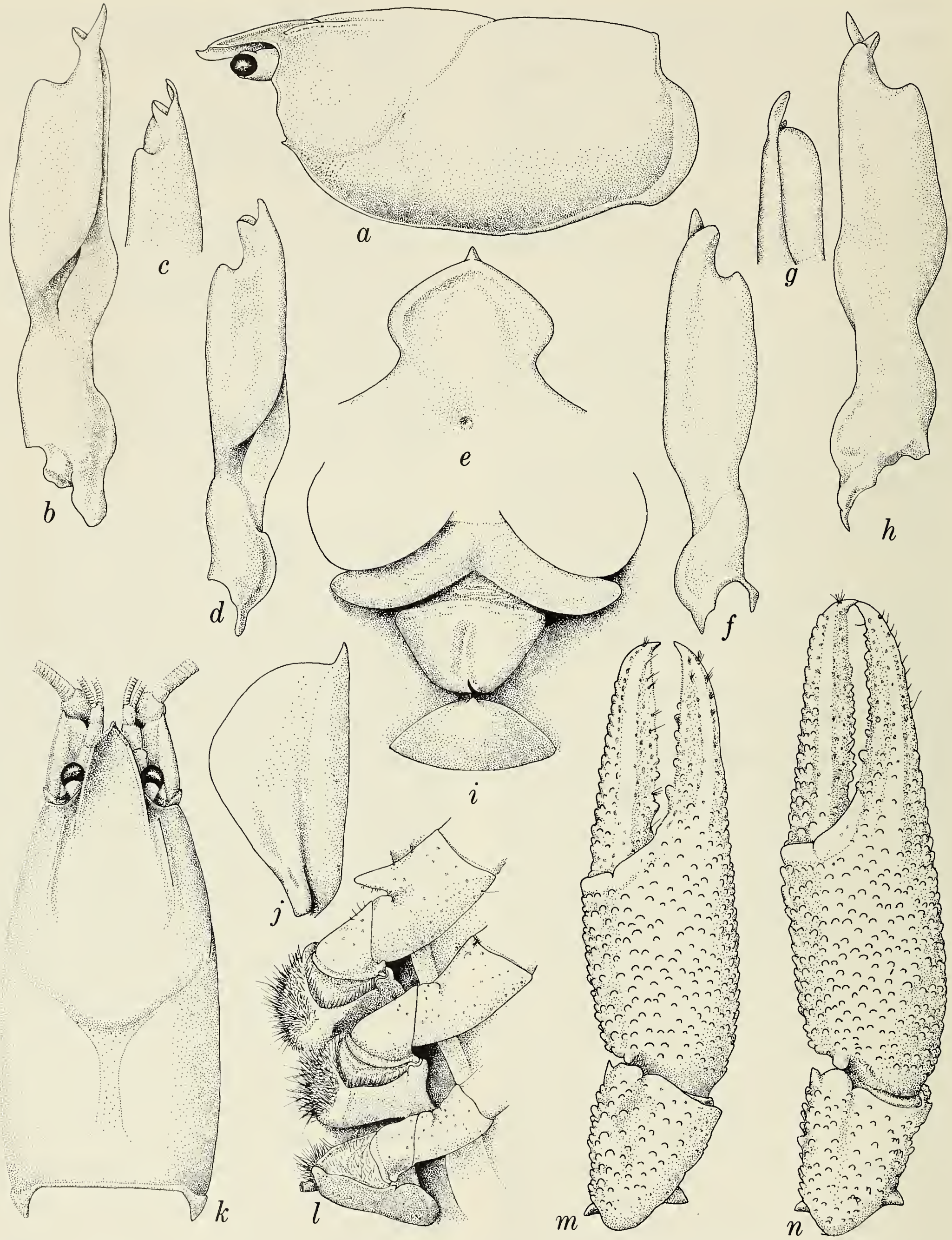

Fig. 1. *Procambarus* (*A.*) *mexicanus*—All except 1 (which from km 57 on Fortín-Huatusco-Conejos Road) from El Mirador de Zacuapan, 8 km NE of Huatusco, Veracruz, Mexico (a–c, e, g, h, j–l, n from first form male; d, f, from second form male; i, m, from female): a, Lateral view of carapace; b, d, Mesial view of first pleopod; c, Cephalomesial view of distal part of first pleopod; e, Epistome; f, h, Lateral view of first pleopod; g, Caudal view of distal part of first pleopod; i, Annulus ventralis and adjacent sternal elements; j, Antennal scale; k, Dorsal view of carapace; l, Proximal podomeres of third, fourth, and fifth pereiopods; m, n, Distal podomeres of cheliped.

central projection. Female with hinged annulus ventralis slightly longer than preannular plate, almost twice as wide as long, tapering posteriorly, and bearing short, sinuous sinus on midposterior surface; postannular sclerite as wide as, or slightly wider than, annulus but shorter; first pleopod reduced.

Topotypic male, form I: Cephalothorax (Fig. 1a, k) subcylindrical; maximum width of carapace slightly less than height at level of caudodorsal margin of cervical groove (11.8 and 12.0 mm). Abdomen only little narrower than thorax (11.2 and 11.8 mm). Areola 10.6 times as long as wide with 2 or 3 punctations across narrowest part. Cephalic section of carapace 1.5 times as long as areola, latter constituting 34.1 percent of entire length of carapace (40.9 percent of postorbital carapace length). Surface of carapace densely punctate dorsally, granulate laterally. Rostrum moderately broad with weakly convergent, slightly thickened margins, latter tapering rapidly from base of acumen which gently upturned apically and reaching slightly beyond distal end of penultimate podomere of antennular peduncle; upper surface distinctly concave, strongly so anteriorly. Subrostral ridge weak and evident in dorsal view only in posterodorsal part of orbit. Postorbital ridge moderately well developed and terminating cephalically in small acute spine not attaining level of orbit. Suborbital angle obtuse and not prominent. Branchiostegal spine clearly defined. Cervical spine represented by very small tubercle.

Abdomen longer than carapace (26.6 and 24.9 mm). Pleura of third through sixth segments subtruncate ventrally and rounded caudoventrally. Cephalic section of telson with 3 spines in right and 4 in left posterolateral corners, that adjacent to lateralmost on both sides movable. Cephalic lobe of epistome (Fig. 1e) subtriangular, lacking anteromedian excavation; main body with distinct fovea; epistomal zygoma arched. Ventral surface of proximal podomere of antennule with strong ventromesial spine short distance distal to midlength. Antennal peduncle with short distolateral spine on basis; ischium with small tubercle; flagellum broken but probably reflexed only slightly posterior to first abdominal segment. Antennal scale (Fig. 1j) about twice as long as wide, greatest width distal to midlength; lamellar area approximately twice width of thickened lateral part. Third maxilliped slightly overreaching penultimate podomere of antennal peduncle; mesial sector of ventral surface of ischium with crowded clusters of both stiff and plumose setae, lateral sector studded with mat of plumose setae, ischium not produced distolaterally; merus with setae similarly dispersed.

Right chela (Fig. 1n) ovate in cross-section, weakly depressed; palm about 1.3 times as long as broad; its length little less than half length of chela; except for ridges and distal part of fingers, almost completely studded with squamous tubercles. Mesial surface of palm with tubercles somewhat staggered but roughly forming 3 rows of 9 to 11. Both fingers with low submedian longitudinal ridges dorsally and ventrally; ridges flanked proximally by tubercles and distally by punctations. Opposable margin of fixed finger with upper row of 11 tubercles, second from base largest, extending from base of finger almost to terminal corneous tip, and lower row of 6, proximalmost largest, along distal half of finger (between level of third and ninth tubercles of upper row); band of minute denticles extending along entire length of finger, separating upper and lower rows of tubercles; lateral surface of finger with row of tubercles along proximal half followed by row of punctations. Opposable margin of dactyl with dorsal row of 14 tubercles (third from base largest, some too small to be included in illustration) and lower row of 6 lying at level between second and thirteenth tubercles of upper row; mesial margin of finger with basal cluster of tubercles narrowing distally to single row where approaching corneous terminal part of finger.

Carpus of cheliped, except for proximal

Table 1.—Measurements (mm) of *Procambarus* (*A.*) *mexicanus*. (Left chela of syntype of *Cambarus aztecus*; right of others.)

	Neo-holotype	Topotypes			
	♂ I	♂ I	♀	♂ II	♂* I
Carapace:					
Entire length	22.7	24.9	26.9	26.2	21.5
Postorbital length	19.8	20.8	21.8	21.3	17.3
Width	10.8	11.8	12.4	11.9	11.1
Height	11.6	12.0	12.9	11.9	9.1
Areola:					
Width	0.7	0.8	0.9	0.8	0.7
Length	7.9	8.5	8.4	8.4	7.2
Rostrum:					
Width	4.0	4.2	4.6	4.3	3.6
Length	4.6	4.6	5.8	5.1	4.5
Chela:					
Length, palm mesial margin	7.9	8.5	6.6	7.1	7.0
Palm width	6.0	6.6	5.9	5.4	4.5
Length, lateral margin	19.0	20.0	17.1	18.6	14.8
Dactyl length	8.1	10.6	9.4	9.5	6.8
Abdomen:					
Width	—	11.2	12.9	10.9	9.7
Length	—	26.6	28.4	26.8	—

* Syntype of *Cambarus aztecus*.

dorsal and ventral areas and distolateral band, almost entirely tuberculate; only few tubercles mesially and 2 distoventral ones noticeably larger and less squamous than others. Merus also strongly tuberculate except for much of mesial and lateral surfaces; no spiniform ones dorsodistally; ventrolateral row consisting of 9 tubercles and ventromesial one of 15; both rows flanked by additional tubercles. Ventromesial surface of ischium with row of 3 prominent tubercles subtended by few scattered ones.

Hook on ischium of third pereiopod (Fig. 1l) simple, acute, and overreaching basioischial articulation, not opposed by tubercle on basis. Coxa of fourth pereiopod without caudomesial boss, that of fifth with small rounded boss compressed in longitudinal axis of body.

Sternum between third, fourth, and fifth pereiopods shallow, margined with plumose setae.

First pleopods (Fig. 1b, c, g, h) as described in "Diagnosis."

Uropods with both lobes of proximal podomere bearing acute spines; mesial ramus with distomedian spine terminating premarginally and with well developed distolateral spine; lateral ramus with fixed distolateral spine.

Topotypic female: Differing, other than in secondary sexual characteristics, from male, form I, in following respects: cervical spine obsolete; cephalic section of telson with 3 spines in each caudolateral corner; tubercle on ischium of antennal peduncle vestigial; mat of plumose setae on ventrolateral sector of ischium of third maxilliped less conspicuous; opposable margin of fixed finger of right chela (Fig. 1m) with upper row of 5 tubercles (proximalmost largest) in proximal three-fifths and lower row of 4 along penultimate fourth; opposable margin of dactyl with double row of 9 (10 on left) tubercles (proximalmost largest) in proximal three-fifths; minute denticles arranged in single row on dactyl but forming narrow band on propodus; ventral surface of merus with lateral row of 11 tubercles and mesial one of 15 (10 and 14, respectively on left member); carpus with row of 4 tubercles. (See Table 1 for measurements.)

Annulus ventralis and associated sternal sclerites (Fig. 1i) as illustrated.

Topotypic male, form II: Differing from first form male in following respects: rostrum not so concave, especially anteriorly; subrostral ridges evident in dorsal aspect to base of acumen; cephalic section of telson with 3 spines in each caudolateral corner; ischium of left antennal peduncle with well developed spiniform tubercle; opposable margin of fixed finger of cheliped with upper row of 12 tubercles (proximalmost largest) and ventral row of 6 (10 and 5 on left chela); opposable margin of dactyl of cheliped with upper row of 9 tubercles (proximalmost largest) and lower row of 4 (5 on left); minute denticles forming much narrower band on both fingers than in male, form I; single spiniform tubercle present dorsodistally on merus of cheliped, ventral surface with lateral row of 9 and mesial row of 15 tubercles, rows joined distally by row of 4 tubercles; hook on ischium of third pereiopod not reaching basioischial articulation. First pleopods (Fig. 1d, f) not contiguous basally, strongly resembling those of first form male except both terminal elements more robust, and shoulder on cephalic surface slightly more strongly produced; oblique juvenile suture also clearly defined.

Size.—The largest specimen examined is a second form male having a carapace length of 31.0 (postorbital carapace length, 26.0) mm. The smallest first form male has corresponding lengths of 18.8 and 14.5 mm. Neither ovigerous females nor ones carrying young have been observed.

Type locality.—El Mirador de Zacuapan, 8 km northeast of Huatusco, Veracruz. As pointed out above, Erichson did not cite a specific locality in Mexico when he described this crayfish. In his treatment of the *mexicanus* group, however, Villalobos (1954:312) chose a specimen from the locality cited here as the neoholotype, thereby designating El Mirador de Zacuapan as the type locality of Erichson's species.

Types.—Neoholotype (♂ I), Academy of Natural Sciences of Philadelphia (ANSP 421); neoallotype (♀) and neomorphotype (♂ II), Instituto de Biología de la Universidad de Mexico (all designated by Villalobos 1954).

Range and specimens examined.—Specimens of this crayfish have been reported from a number of localities in Mexico south of the Cordillera Volcanica Transversal. All of those of which I am aware are listed here, and those from which material has been examined by me are followed by an enumeration of the specimens seen; at least some, and perhaps most, of the other localities need to be confirmed. Locations of the collections cited are recorded as follows: ANSP (Academy of Natural Sciences of Philadelphia), FMNH (Field Museum of Natural History, Chicago), IBM (Instituto de Biologia, Universidad Nacional Autonoma de Mexico), MCZ (Museum of Comparative Zoology, Harvard University), USNM (National Museum of Natural History, Smithsonian Institution).

VERACRUZ: (1) El Mirador (Faxon 1898:649) (=El Mirador de Zacuapan, 8 km NE of Huatusco—restricted type locality; see Villalobos 1954:312) 1 ♂ I (ANSP), neotype, 1894, Dr. Sartorius, coll.; 1 ♂ I, 2 ♂ II, 5 ♀ (USNM), Nelson & Goldman, coll. (2) Texola (near Xico), 1 ♂ I, 2 ♂ II (ANSP), 21 Mar 1899, S. N. Rhoades (Ortmann 1906: 11). (3) Jalapa (FMNH) (Faxon 1914:363). (4) Hacienda de Tenejapa (IBM?) (Rioja 1949:316). (5) Hacienda de Jalapilla, a 5 km al SE de Orizaba (IBM?) (Rioja 1949:322). (6) Rincón de La Doncella cercanías de Ciudad Mendoza (IBM?) (Villalobos 1953:365). (7) Tres Puentes, Col. Emiliano Zapala, Jalapa (IBM?) (Hobbs 1971:41). (8) Río Bejucos, 11.2 km S of Jalapa, 13 ♂ I, 30 ♂ II, 44 ♀, 24j ♂, 34j ♀ (USNM), 18 May 1930, E. P. Creaser & Gordon. (9) Río Bejucos, 4.8 km S of Jalapa, 18 May 1930, 1 ♂ II (USNM), E.P.C. et al. (10) Trib. to Río Bejucos at Coatepec, 1 ♂ I, 5 ♂ II, 10 ♀, 7j ♂, 7j ♀ (USNM), 25 Jul 1971, A. Villalobos F. (11) Arroyo Bejucos between Jalapa and Coatepec, among *Eichornia,* 1 ♂ I (USNM), 6 Sep 1971, N. Vidal. (12) Teocelo, at 300 m, 2 ♂ I, 1 ♀, 1j ♀ (USNM), 30 Dec 1940, W. W. Dalquest. (13) Km 35 carretera Cordoba-Huatusco, 3 ♂ I, 2 ♂ II, 5 ♀, 3j ♂, 3j ♀ (USNM), 26 Apr 1980, A.V.F.; 6 ♂ I, 15 ♂ II, 26 ♀ (USNM), 26 Apr 1980, A.V.F. (14) Huatusco, km 57 on Fortín-Huatusco-Conejos Road, 1 ♂ I, 1 ♀, 4j ♂, 2j ♀ (USNM), 8 Jul 1962, P. C. Holt. (15) Río Jamapa, 6 to

7 km NE of Coscomatepec (Holt 1973:17), 1 ♀, 9j ♂, 2j ♀ (USNM), 9 Jul 1962, P.C.H. (16) Spring at Tlilipan (Hobbs 1971:30), 1 ♂ I, 2 ♂ II, 2 ♀, 2j ♂ (USNM), 3 Aug 1967, J. R. Reddell. (17) Ojo de Agua, Tlilapan (Hobbs 1971:30), 3 ♂ II, 3 ♀ (USNM). 4 Aug 1967, J.R.R. (18) Pond 19.2 km E of Jalapa, 1 ♀, 4j ♂, 1j ♀ (USNM), 6 Mar 1941, N. E. Hartweg. (19) Santa María, 1 ♀ (USNM), 12 Feb 1894, USDA Biol. Expedition (Faxon 1898:649). (20) 3.5 km W of Huatusco on Hwy 143, 300 m alt, 1 ♂ II, 1 ♀ (USNM), 7 Jan 1978, J. R. Dixon. (21) 9.6 km SE of Coatepec on road to Teocelo, 1180 m alt, 1 ♀ (USNM) 8 Jan 1978, J.R.D. (22) Stream at water house about halfway up Los Cumbres, SW of Orizaba, 2 ♂ I, 3 ♀, 1j ♂ (USNM), 27 Dec 1940, H.H.H., Jr. (23) Nacimiento de Manzanilla, 11 km N Potrero, 5 ♂ II, 4 ♀, 1j ♂, 5j ♀ (USNM), 6 Jan 1977, J. R. R. & A. Grubbs.

In addition, specimens with areolae ranging from 12 to 17 times as long as broad, from two additional localities in the State of Veracruz (Fortín de Las Flores, 1 ♂ I, 7 ♀, 1j ♀ (USNM), 1 Nov 1969, A. Argano & V. Sbordoni; Copes Estate, Orizaba, 2j ♀ (USNM), date?, F. Sumichrast) are tentatively assigned to *P.* (*A.*) *mexicanus.* These specimens exhibit an array of variation sufficient to point out the difficulty in identifying members of the *mexicanus* Group of the subgenus *Austrocambarus.* (See Villalobos 1954:306.) Three of them possess rostra with produced, angular marginal prominences. One has strong cervical spines, another exhibits a strong spine on the left and a rather weak one on the right, four have weak ones, and, in three, there is hardly a trace of these spines; moreover, there is no correlation between the degree of their development and the size of the animal. The areola is narrower than that of most specimens here assigned to *P.* (*A.*) *mexicanus,* and the first form male is unique among all *Austrocambarus* that I have examined in that hooks are lacking from the ischia of the third pereiopods. The first pleopods are situated quite far apart; the mesial process is short, and the distal margin of the shoulder on the cephalic surface lies perpendicular to the axis of the pleopod, not produced cephalodistally.

Villalobos (1953:365–366) listed 18 localities from which he had specimens belonging to the "groupo *mexicanus*" (=Subgenus *Austrocambarus*). In his review of the group (1954, 1955, 1983), however, I have found references to only three of them: "5. Cerro Hueco . . . , Chis.," "10. Presidio, Ver.," and "11. El Castillo, . . . , Oax." These were designated the type localities of *Procambarus mirandai, P. veracruzanus,* and *P. acanthophorus,* respectively, in his 1954 publication and cited as such in 1955 and 1983. Perhaps specimens from some of the other localities not subsequently mentioned by Villalobos are referable to *P. mexicanus.* If they are still extant they will likely be reported by Sr. Miguel A. Morales Mora who is currently studying the Mexican representatives of the subgenus *Austrocambarus.*

"*Cambarus aztecus* Saussure"
Fig. 2

Syntypic male, form I (dry): Cephalothorax (Fig. 2b, e) subovoate; maximum width of carapace greater than height at level of caudodorsal margin of cervical groove (11.1 and 9.1 mm). Abdomen narrower than thorax (9.7 and 11.1 mm). Cephalic section of carapace about twice as long as areola; latter 10.3 times longer than broad with 1 or 2 punctations across narrowest part. Surface of carapace densely punctate dorsally, becoming finely granulate ventrolaterally. Rostrum comparatively broad with margins not thickened and gently converging anteriorly to base of acumen where armed with minute corneous tubercles, otherwise not produced; upturned, corneous tip of acumen almost reaching distal end of ultimate podomere of antennular peduncle; dorsal surface of rostrum subplane basally, gradually becoming weakly excavate anteriorly, and bearing setiferous punctations

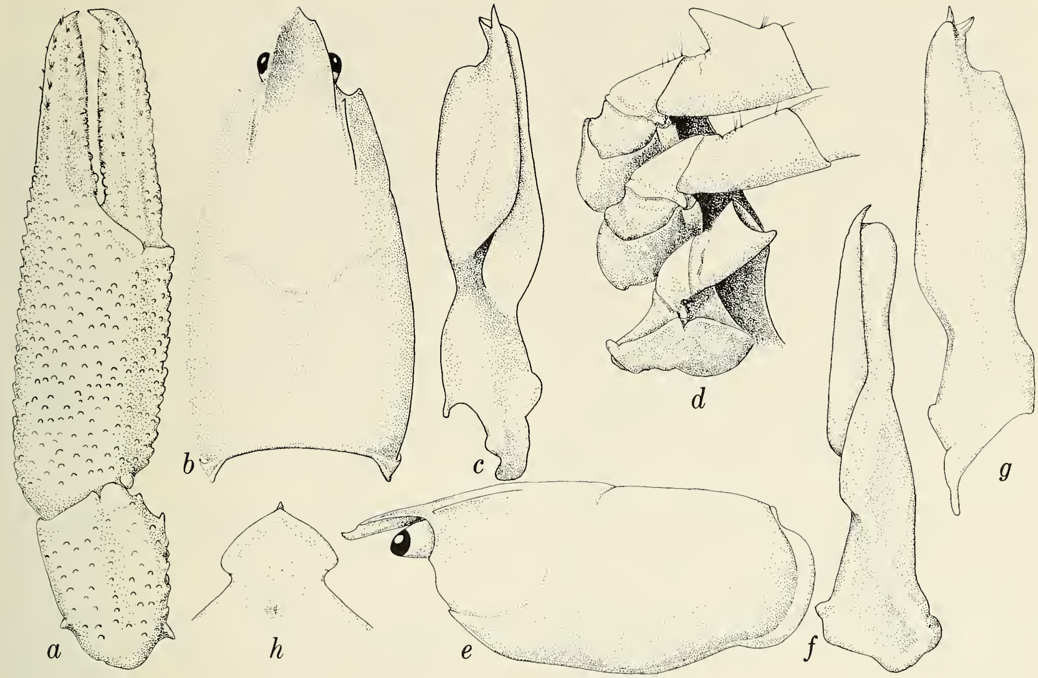

Fig. 2. *Cambarus aztecus,* syntypic male, form I: a, Dorsal view of distal podomeres of cheliped; b, Dorsal view of carapace; c, Mesial view of first pleopod; d, Proximal podomeres of third, fourth, and fifth pereiopods; e, Lateral view of carapace; f, Caudal view of first pleopod; g, Lateral view of first pleopod; h, Epistome.

which deeper and more abundant posteriorly than anteriorly. Subrostral ridge weak and evident dorsally only along about basal sixth of rostrum. Postorbital ridge well defined, moderately swollen caudally, and terminating anteriorly in small spine not reaching caudal margin of orbit. Suborbital angle weak and obtuse; branchiostegal spine small but clearly defined.

Abdomen longer than carapace but cannot be measured accurately because bent. Pleura of third through fifth segments very weakly arched and rounded caudoventrally. Cephalic section of telson with 3 spines in each caudolateral corner (middle one of each group movable). Cephalic lobe of epistome (Fig. 2h) subtriangular with anterolateral margins slightly thickened and very weakly arched; main body with clearly defined fovea; epistomal zygoma broadly arched. Ventral surface of proximal podomere of antennular peduncle with strong spine near midlength. Antennal peduncle with distolateral spine on basis; ischium with small subacute tubercle; (flagellum lost). Antennal scale about twice as long as broad, widest slightly distal to midlength, greatest width of lamellar area about twice that of thickened lateral part. Third maxilliped slightly overreaching antennal peduncle; mesial sector of ventral surface of ischium bearing dense clusters of stiff, simple setae, and more delicate plumose ones; lateral sector with shorter and fewer stiff setae; ischium not produced distolaterally.

Left chela (Fig. 2a), right regenerated, subovate in cross section, weakly depressed; palm 1.7 times as long as broad, its length almost half maximum length of chela; palm and proximal part of fingers studded with crowded small tubercles (median longitudinal ridges polished, and distal two-thirds of fingers with setiferous punctations). Mesial surface of palm with tubercles arranged irregularly, but 2 or 3 ill-defined rows, consisting of 10 or 11 in each, discernible between proximal and distal margins. Dorsal and ventral surfaces of both fingers with low median longitudinal ridges flanked along distal two-thirds by setiferous punctations. Opposable margin of fixed finger with row of 5 tubercles (proximalmost largest) extending along slightly more than proximal half of finger; broad longitudinal band of minute denticles extending from base to corneous tip of finger, and single massive tubercle located below band at distal end of proximal third of finger; lateral surface with 2 tubercles basally followed by row of conspicuous setiferous punctations. Opposable margin of dactyl with row of 7 tubercles (second from base largest; most too small to be included in illustration) reaching level of row on fixed finger; broad band of minute denticles and single large tubercle situated below band just proximal to midlength of finger; corresponding margin of right chela with only 2 distinct tubercles: one above denticular band at end of proximal sixth of margin, and that below, slightly more distally.

Carpus of cheliped longer than broad with very shallow elongate depression; surface almost entirely tuberculate except proximoventrally, only those tubercles on mesial surface larger than tubercles elsewhere, and distal members there subspiniform; ventrodistal margin with prominent tubercle at articular knob and smaller one mesial to it. Merus with all surfaces tuberculate except proximal half to fourth of mesial and lateral surfaces; ventral surface with mesial row of 13 (14 on right) tubercles and lateral row of 8. Ischium with ventromesial row of 7 (5 on right) small tubercles.

Hook on ischium of third pereiopod (Fig. 2d) simple, acute, and reaching to, but not overreaching, basioischial articulation, and not opposed by tubercle on basis. Coxa of fourth pereiopod without caudomesial boss, but that of fifth with compressed (in longitudinal plane of body) boss at caudomesial angle.

Sternum between third, fourth, and fifth pereiopods comparatively shallow, margined with plumose setae.

First pleopod (Fig. 2c, f, g) reaching coxa of third pereiopod; cephalic process wanting; mesial process and central projection unremarkable, shoulder on cephalic surface with cephalodistal extremity subtruncate, only slightly produced distally.

Uropods with both proximal lobes bearing acute spines; mesial ramus with distomedian spine situated premarginally and with well developed distolateral spine; lateral ramus with fixed distolateral spine flanked mesially by strong movable spine.

See Table 1 for measurements.

Procambarus (*Austrocambarus*) *olmecorum*, new species
Fig. 3

Procambarus aztecus.—Rioja, 1949:321.—Villalobos, 1954:306, 312, 314 (in part)–321, 323, 328, pls. 3, 4; 1955:160, 161, 169 (in part)–176, 178, 183, pls. 36, 37; 1983:154, 155, 164–170, 171, 176, 227, pls. 36, 37.—Hobbs and Villalobos, 1964: 313.—Hobbs, 1966:71; 1971:3, 12, 22, 27, 30, 31, 41.—Holt, 1973:4, 24, 25.—Hart and Hart, 1974:22, 23, 86.

Procambarus mexicanus.—Rioja, 1949:321 [part: Costomatepec, Ver.]

Procambarus (*Austrocambarus*) *aztecus.*—Villalobos, 1982:219.

All of the above synonyms are traceable to the misidentification of crayfish from Tomatlán, first cited as hosts of the entocytherid ostracod *Ankylocythere bidentata* by Rioja (1949:321) and later fully described and illustrated by Villalobos (1954). Hobbs (1966), in summarizing our current knowledge of the entocytherids of Mexico, accepted the previously reported identification of the host as did Hart and Hart (1974). In Holt's (1973) account of the Mexican branchiobdellid worms, he employed the identifications furnished by Villalobos.

After having compared Villalobos' description and illustrations with syntypes of

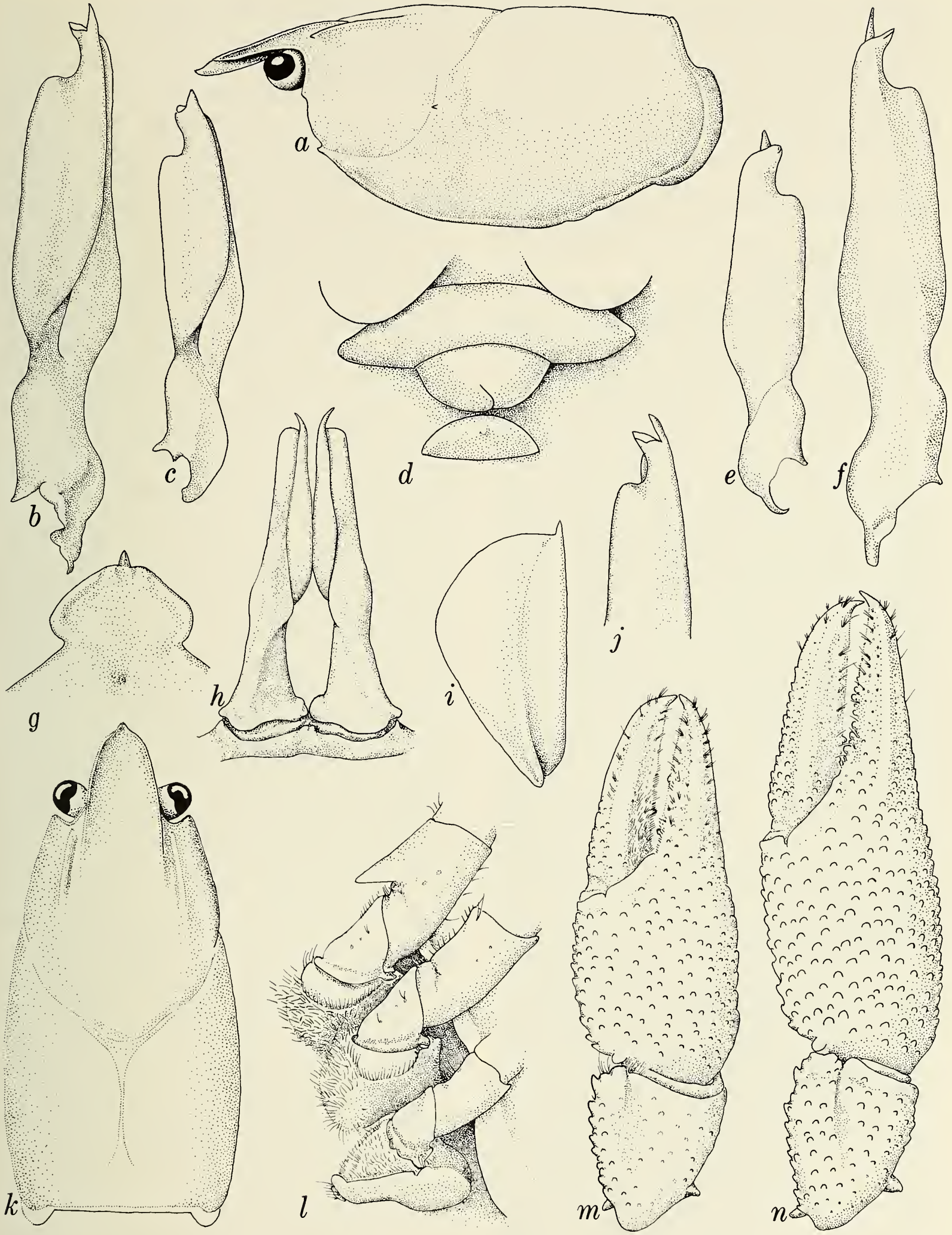

Fig. 3. *Procambarus* (*A.*) *olmecorum* (a, b, f–l, n from holotype; c, e from morphotype; d, m from allotype): a, Lateral view of carapace; b, c, Mesial view of first pleopod; d, Annulus ventralis and adjacent sternal elements; e, f, Lateral view of first pleopod; g, Epistome; h, Caudal view of first pleopods; i, Antennal scale; j, Cephalomesial view of first pleopod; k, Dorsal view of carapace; l, Proximal podomeres of third, fourth, and fifth pereiopods; m, n, Dorsal view of distal podomeres of cheliped.

Cambarus aztecus Saussure, Hobbs (1972b: 44) pointed out that "specimens described as *Procambarus aztecus* by Villalobos (1954: 44) are not members of this [Saussure's] species and must receive a new name." The name *olmecorum,* honoring the artistic Olmec nation which in earlier times contributed so much to Mexican culture, is offered as a substitute name for Villalobos' *Procambarus aztecus.*

Diagnosis.—Body pigmented, eyes well developed. Rostrum of adults without marginal spine and median carina. Carapace with small cervical spine. Areola linear or obliterated along part of its length and constituting 30.5 to 35.7 (average 33.8) percent of total length of carapace (38.9 to 45.5, average 41.2 percent of postorbital carapace length). Suborbital angle weak and obtuse; infraorbital spines lacking. Postorbital ridge moderately strong and anterior extremity with or without spine or tubercle. Branchiostegal spine small. Antennal scale about twice as long as broad, widest slightly distal to midlength. Cheliped studded with squamous tubercles from midlength of merus to midlength of fingers. Ischium of third pereiopod of first form male with simple, strong, acute hook overreaching basioischial articulation; hook not opposed by tubercle on corresponding basis. First pleopods of first form male reaching coxae of third pereiopods, symmetrical, contiguous basally, lacking proximomesial spur; subangular shoulder present on cephalic surface at about base of distal eighth; lacking subterminal setae; terminal elements consisting of short, acute, distolaterally directed mesial process extending beyond short, corneous, acute, cephalodistally directed central projection. Female with hinged annulus ventralis only slightly longer than well developed preannular plate, about twice as wide as long, broadly arched posteriorly, and bearing short sinuous sinus on midposterior surface; postannular sclerite as wide as annulus and only slightly shorter; first pleopod greatly reduced.

Holotypic male, form I: Cephalothorax (Fig. 3a, k) subovate, weakly compressed laterally; maximum width of carapace slightly greater than height at level of caudodorsal margin of cervical groove (12.9 and 12.0 mm). Abdomen narrower than thorax (11.0 and 12.9 mm). Areola linear. Cephalic section of carapace about 1.9 times as long as areola, latter constituting 34 percent of total length of carapace (42.2 percent of postorbital carapace length). Surface of carapace densely punctate dorsally and finely tuberculate laterally, only on anterior half of rostrum sparsely punctate. Rostrum comparatively broad with weakly convergent margins, tapering rather strongly anteriorly but base of acumen not clearly defined, apex slightly upturned and reaching midlength of ultimate podomere of antennular peduncle; margins not thickened; upper surface very weakly concave, almost flat. Subrostral ridge weak and not evident in dorsal aspect except along caudal margin of orbit. Postorbital ridge moderately strong, only faintly swollen caudally, and terminating anteriorly in small spine not attaining level of orbit. Suborbital angle weak and obtuse; branchiostegal spine very small but acute. Cervical spine small but distinct.

Abdomen longer than carapace (25.8 and 21.8 mm). Pleura of third through fifth segments weakly arched and rounded caudoventrally. Cephalic section of telson with 3 spines (middle one of group movable) in each caudolateral corner. Cephalic lobe of epistome (Fig. 3g) subtriangular with slightly excavate anterior angle, margins not thickened, main body with distinct fovea; epistomal zygoma arched. Ventral surface of proximal podomere of antennular peduncle with spine near midlength. Antennal peduncle with short distolateral spine on basis; ischium without spine or tubercle; flagellum broken but reaching second abdominal segment. Antennal scale (Fig. 3i) about twice as long as broad, widest slightly distal to midlength, greatest width of lamellar area about twice that of thickened lateral part. Third maxilliped overreaching antennal peduncle by length of ultimate podomere; mesial sector of ventral surface of ischium with crowded clusters of both simple stiff and more flexible plumose setae, lateral sector studded with mat of plumose setae, ischium not produced distolaterally.

Right chela (Fig. 3n) subovate in cross-section, weakly depressed; palm almost 1.2 times as long as broad; its mesial length almost half maximum length of chela; except for ridges and apices of fingers, almost entire surface studded with closely set squamous tubercles. Mesial surface of palm with 3 irregular rows of about 8 tubercles, others interspersed between rows. Both fingers with low median longitudinal ridges dorsally and ventrally; ridges flanked by tubercles except distally where replaced by setiferous punctations. Opposable margin of fixed finger with row of 13 (left with 14) tubercles (more distal ones too small to be included in illustration), second from base largest, extending along proximal four-fifths of finger, and row of 3 (2 on left) tubercles, proximalmost largest, on lower level along middle fifth of finger; minute denticles present between rows of tubercles and reaching corneous tip of finger. Opposable margin of dactyl bearing row of 12 (left with 13) tubercles, third from base largest and proximal 2 (0 on left) fused; narrow band of minute denticles interspersed between tubercles and extending to base of corneous tip of finger, opposing those on fixed finger.

Carpus of cheliped longer than broad with shallow furrow dorsally; furrow flanked by squamous tubercles; entire podomere studded with similar tubercles, one or 2 on mesial surface and another on ventrodistal margin slightly more elevated than others but none conspicuously larger than others. Merus with all surfaces tuberculate except proximal fourth of mesial and lateral surfaces; dorsal surface with tubercles increasing in size distally; ventral surface with mesial row of 12 tubercles and irregular lateral row of 14 (left with 13). Ischium with row of 3 (left with 5) tubercles ventromesially.

Hook on ischium of third pereiopod (Fig. 3l) simple, acute, and overreaching basioischial articulation, not opposed by tubercle on basis. Coxa of fourth pereiopod without caudomesial boss, but that of fifth with small tuberculiform one at caudomesial angle.

Sternum between third, fourth, and fifth pereiopods shallow, margined with plumose setae.

First pleopods (Fig. 3b, f, h, j) as described in "Diagnosis."

Uropods with both lobes of proximal podomere bearing acute spines; mesial ramus with distomedian spine situated distinctly premarginally and with well developed distolateral spine; lateral ramus with fixed distolateral spine flanked mesially by very strong movable spine.

Allotypic female: Differing from holotype, other than in secondary sexual features, in following respects: maximum width of carapace distinctly greater than height; base of acumen clearly defined by suddenly contracted rostral margins; tip of rostrum more strongly upturned and reaching base of distal third of ultimate podomere of antennular peduncle; postorbital spine reaching level of posterior margin of orbit; abdomen only slightly shorter than carapace; pleuron of fifth abdominal segment with ventral margin straight, not arched; anterior margin of epistome rather evenly and strongly arched, and zygoma broadly so; ischium of antennal peduncle with very small, acute, tuberculiform spine ventrally; third maxilliped almost reaching distal end of antennal peduncle.

In addition, chela (Fig. 3m) much smaller than that of holotype with width of palm slightly greater than length of mesial margin, latter much less than half length of chela; opposable margin of fixed finger with row of 6 tubercles (most too small to be evident in illustration), basal one largest, 3 in proximal group separated from those in distal group by considerable gap in which 1 tubercle situated on lower level at about midlength of finger; opposable margin of dactyl with row of 9 tubercles (small and hidden by setae), proximal 3 subequal in size and larger than more distal ones; carpus with 2

Table 2.—Measurements (mm) of *Procambarus* (*A.*) *olmecorum.*

	Holotype	Allotype	Morphotype
Carapace:			
Entire length	27.0	25.5	20.4
Postorbital length	21.8	20.3	16.3
Width	12.9	12.1	10.8
Height	12.0	12.1	10.0
Areola:			
Width	linear	linear	linear
Length	9.2	8.8	7.0
Rostrum:			
Width	4.4	4.0	3.5
Length	6.0	5.6	4.2
Right chela:			
Length, palm mesial margin	7.8	4.7	4.1
Palm width	6.7	5.0	4.2
Length, lateral margin	17.9	12.0	10.5
Dactyl length	9.8	7.0	5.5
Abdomen:			
Width	11.0	10.8	8.5
Length	25.8	25.0	20.6

distal tubercles on mesial surface and 1 on distal ventrolateral articular condyle distinctly spiniform and slightly larger than neighboring tubercles; ventral surface of merus with row of 11 tubercles mesially and 5 or 7 (left) laterally.

Sternum between third, fourth, and fifth pereiopods shallow. Annulus ventralis and associated sternites as figured (Fig. 3d) and described in "Diagnosis."

Morphotypic male, form II: Differing from holotype in following respects: base of acumen more sharply defined than in holotype although acumen broken, probably reaching anteriorly at least as far as midlength of ultimate podomere of antennular peduncle; postorbital ridge lacking spine at anterior extremity and not attaining level of orbit; suborbital angle more distinctly angular than in holotype; branchiostegal spine obsolete; cephalic lobe of epistome and zygoma as in allotype; third maxilliped just reaching utimate podomere of antennular peduncle; tubercles and spines on chelipeds only slightly different from those of holotype; hook of ischium of third pereiopod much reduced, and coxa of fifth pereiopod bearing only slightly reduced boss.

First pleopods (Fig. 3c, e) differing only slightly from that of first form male, differing chiefly in the absence of cornified tip on central projection and both terminal elements less acute.

Type locality.—Arroyo to Río Metlac near "edge" of Fortín de Las Flores, Veracruz, Mexico.

Disposition of types.—The holotypic male, form I, allotype, and morphotype are deposited in the National Museum of Natural History (Smithsonian Institution) nos. 217626, 217627, and 217628, respectively, as are the paratypes consisting of 1 ♂ I, 1 ♂ II, 5 ♀, and 1j ♀. These specimens constitute the type series.

Size.—The largest specimen available is a female from Cuitahuac having a carapace length of 36.4 mm (postorbital carapace length 30.0 mm); the holotype (see Table 2) is the smallest of the three first form males. Females carrying eggs or young are unknown.

Range and specimens examined.—*Procambarus* (*A.*) *olmecorum* is known to occur in only six localities, all in the state of Veracruz, Mexico: (1) type locality, 3 ♂ I, 2 ♂ II, 6 ♀, 1j ♀ (USNM), 13 Mar 1974, R. R. Miller et al. (2) Cuitahuac, 2 ♀ (USNM), 10 Aug 1964, P. J. Spangler. (3) Nacimiento de Manzanilla, 17.6 km N of Potrero, 1 ♂ I (USNM), 6 Jan 1977, J. R. Reddell & A. G. Grubbs. (4) Tomatlán, 14 km SSW of Huatusco (IBM?) (Villalobos, 1954:321; 1955:176; 1983:168). (5) 3 km S of Coscomatepec (IBM?) (Villalobos 1954:321; 1955:176; 1983:168). (6) Sinkhole on south side of highway between Jalapa and Veracruz (Hobbs 1971:30), 3 ♂ I, 1 ♂ II, 3 ♀, 1j ♂, 3j ♀ (USNM), 19 Dec 1966, R. R. M. & W. L. Minckley. These lie at altitudes between 800 and 1600 m in the drainage basins of Río Atoyac and Río Jamapa, which unite before entering the Gulf of Mexico a few km south of the city of Veracruz.

Variations.—The rostrum reaches anteriorly from the base to the end of the ultimate podomere of the antennular peduncle, and the margins vary from being distinctly subangular at the base of the acumen to tapering with little interruption from their bases; the postorbital ridges terminate anteriorly either in a short spine or tubercle; the areola is either obliterated along part of its length or is linear; and the cervical spine although never conspicuous may be rather well developed or reduced to a tubercle scarcely larger than others nearby. The telson is also variable, sometimes subrectangular, but often with the posterior section somewhat tapering. As in all members of *Austrocambarus,* the chelipeds are studded with crowded tubercles, but the numbers and disposition exhibit conspicuous individual differences.

The most distinctive of the populations assigned to this species is that from the sixth locality cited above. In the specimens from there, the rostral margins converge little anteriorly to the base of the acumen where they turn sharply mesially forming distinct angles before tapering to the apex of the acumen which just reaches, or only slightly overreaches, the base of the distal podomere of the antennular peduncle. The chelipeds in one of the males are conspicuously slender. Too, the shoulder on the cephalic surface of the first pleopod of two of the first form males is more strongly produced distally and more acute than that of the holotype, but in the other it is only little more prominent.

Relationships.—*Procambarus* (*A.*) *olmecorum* has its closest affinities with *Procambarus* (*A.*) *mexicanus, P.* (*A.*) *veracruzanus,* and *P.* (*A.*) *ruthveni zapoapensis.* As in *mexicanus,* the rostrum lacks marginal spines, but the areola is distinctly much narrower, similar to that of *veracruzanus* and *ruthveni zapoapensis,* but in them the rostral margins bear spines or spiniform tubercles at the base of the acumen. The development of the shoulder on the cephalic margin of the pleopod of the first form male is variable, ranging from being almost truncate to being produced cephalodistally in acute prominences but never sloping proximally as in *ruthveni zapoapensis.* Among the members of the subgenus *Austrocambarus,* the unique combination of characters exhibited by *P.* (*A.*) *olmecorum* is: rostrum without produced anterolateral margins; areola linear or obliterated along part of its length; and first pleopod of first form male with subangular shoulder subtruncate or produced distally but never sloping proximally.

Acknowledgments

I wish to acknowledge the cooperation and help given me by the late Dr. Alejandro Villalobos-Figueroa and to extend my appreciation to those (see the paragraphs devoted to "Range and Specimens examined") who donated specimens to the Smithsonian. I am also grateful to T. E. Bowman, a Smithsonian colleague, to Joseph F. Fitzpatrick, Jr., of the University of South Alabama, and to H. H. Hobbs III of Wittenberg University, for their criticisms of the manuscript.

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NEW RECORDS OF ISOPOD CRUSTACEA FROM THE CARIBBEAN, THE FLORIDA KEYS, AND THE BAHAMAS

Brian Kensley and Marilyn Schotte

Abstract.—Fourteen species of marine isopods are recorded from Belize, the Bahamas, and the Florida Keys. These include a new genus and species of anthuridean, *Licranthura amyle,* resembling the genera *Eisothistos* and *Stellanthura,* and characterized mainly by the presence of antler-like processes on the antennae, and the following new species: *Mesanthura looensis* (Anthuridae), *Phycolimnoria clarkae* (Limnoriidae) (apparently the first record of the genus found in decaying wood), *Cirolana albidoida, Cirolana crenulitelson* (Cirolanidae), *Ancinus belizensis,* and *Cassidinidea mosaica* (Sphaeromatidae). Six species of *Limnoria* are recorded as co-occurring: *L. multipunctata, L. pfefferi, L. platycauda, L. tuberculata, L. indica, L. unicornis.* Of these, the latter two are recorded from the Caribbean for the first time. *Cirolana minuta* Hansen is redescribed, this being the second record of the species.

Since the appearance of the work by Menzies and Glynn (1968) on the isopod fauna of Puerto Rico (and which summarized knowledge of the Caribbean isopodan fauna), several papers have appeared dealing with aspects of the marine isopod fauna of the area. Careful, small-scale collecting aided by SCUBA have added considerably to the Caribbean faunal list (e.g., Kensley 1982, 1984), and will no doubt continue to do so, as witness this present paper. The surprising and unsuspected richness of the isopod fauna is well illustrated by the growing number of new species and records coming from a relatively small area around the Smithsonian Institution's field laboratory on Carrie Bow Cay, Belize.

Unless otherwise indicated, all material dealt with in this paper was collected by the authors.

Family Anthuridae

Licranthura, new genus

Diagnosis.—Pleonites 1–5 short, free. Telson lacking statocysts. Tailfan cup-like, expanded, margins serrate, uropodal exopod with spike-like lobe. Antennular flagellum of 3 articles, terminal article with 2 aesthetascs. Antennal peduncle article 3 with serrate triangular process, flagellum of 6 articles. Mandible lacking molar process. Maxilliped palp of 5 articles. Pleopod 1, rami separate, together forming operculum. Pereopod 1, propodus somewhat enlarged, larger than pereopods 2 and 3.

Remarks.—The lack of statocysts and a mandibular molar, the spike-like lobe on the uropodal exopod, the serrate tailfan margins, the free anterior five pleonites, the non-subchelate pereopod 1, the poorly developed opercular pleopod 1 with both rami contributing, all point to a similarity to two genera, *Eisothistos* Haswell, 1884, and *Stellanthura* Wägele, 1979. *Licranthura* differs from both in several aspects. *Eisothistos* possesses fused rami of pleopod 1, lacks a mandibular palp, and has pereopod 1 of about the same size as pereopods 2 and 3. *Stellanthura* possesses a mandibular palp, a reduced molar, and four articles in the maxillipedal palp. Neither of these genera possess the unusual serrate lobe of the third peduncular article of the antenna. The function of these structures can only be speculated on: possibly it is related to some feeding behavior. The splayed and serrate tailfan would suggest that this species also preys on some tubiculous organism as does *Eisothistos*.

Etymology.—The generic name is derived from the Greek *likros,* an antler (referring to the structures on antennae), plus the commonly-used suffix "anthura."

Licranthura amyle, new species
Figs. 1, 2

Material.—HOLOTYPE, USNM 211408, ♀ tl 3.2 mm; sta H-15, Carrie Bow Cay, Belize, from *Agaricia* coral in forereef crest, 15 m, 20 Apr 1981, coll. G. Hendler.

PARATYPES, USNM 211409, ♀ tl 3.8 mm; sta H-1, Twin Cays, Belize, *Caulerpa* alga around red mangrove roots, 0–2 m, 17 Apr 1981, coll. G. Hendler.—USNM 211410, manca tl 1.9 mm; sta H-7, off Glover's Reef, Belize, 15–21 m, 24 Mar 1980, coll. G. Hendler.—USNM 211411, ♀ tl 2.8 mm; sta H-8, Carrie Bow Cay, Belize, from *Madracis* coral on forereef crest, 15.2 m, 19 Apr 1981, coll. G. Hendler.—USNM 211412, 3 ♀ tl 3.1, 3.5, 3.6 mm; sta H-11, Carrie Bow Cay, Belize, from *Madracis* coral on forereef crest, 15.2 m, 19 Apr 1981, coll. G. Hendler.—USNM 211412, ♀ tl 2.8 mm; sta H-16, Carrie Bow Cay, Belize, from *Agaricia* coral on forereef crest, 15.2 m, 20 Apr 1981, coll. G. Hendler.—USNM 211414, ♀ tl 3.0 mm; sta H-41, Carrie Bow Cay, Belize, from *Agaricia* on reef platform, 1–2 m, 25 Apr 1981, coll. G. Hendler.—USNM 211415, manca tl 1.9 mm; sta H-49, Carrie Bow Cay, Belize, from *Porites* coral on reef flat, 1–2 m, 26 Apr 1981, coll. G. Hendler.—USNM 211416, 2 ♀ tl 2.5, 2.8 mm; sta H-85, Carrie Bow Cay, Belize, from coral rubble and algae on forereef dropoff, 24.4–27.4 m, 21 Apr 1981, coll. G. Hendler.—USNM 211417, 2 ♀ tl 2.8, 3.0 mm; sta K-101, Carrie Bow Cay, Belize, coral rubble near drop-off, 25 m, 14 Apr 1981.—USNM 211418, ♀ tl 3.8 mm; sta K-142, Carrie Bow Cay, Belize, lower spur and groove zone, 11 m, 5 Dec 1982.—USNM 211419, ♀ tl 3.9 mm; sta K-162, between Carrie Bow Cay and South Water Cay, Belize, coral rubble from patch reef area, 6–8 m, 27 Nov 1985.

Description.—Female: Body slender, about 12 times longer than wide, widest at pereonite 1. Faint diffuse brown pigment most noticeable on dorsolateral margins of somites; cephalon with faint dorsal reticulation. Body proportions: $C < 1 > 2 = 3 < 4 = 5 > 6 > 7$. Pleonites short, similar in length. Telson thin, dorsally faintly concave, basally narrow, widening posteriorly to truncate or faintly bilobed serrate posterior margin.

Cephalon with small well pigmented eyes. Antennular peduncle of 3 articles, basal article longest and widest; flagellum of 3 articles, article 2 about 5 times length of terminal article, latter bearing 2 aesthetascs. Antennal peduncle with article 3 produced mediodistally into triangular process bearing 6 serrations on medial margin, process reaching distally beyond article 4, latter with medial margin flexed, resulting in article 5 and flagellum being borne at right angle to axis of body; flagellum of 6 setose articles. Mandibular palp of 3 articles, article 2 three times length of article 3, latter bearing 2 fringed spines distally; incisor of 3 blunt cusps directed anteriorly; lamina dentata of 5 marginal serrations; molar absent. Maxilla bearing 7 distal spines. Maxilliped with short endite tipped with 2 setules; palp of 5 articles, basal article very short, terminal article small, bearing 4 elongate setae.

Pereopod 1 larger than pereopods 2 and 3; dactylus articulating distally on propodus, with strong sclerotized unguis having smaller squat spine, thin-walled elongate spine, and 4 slender setae at its base; posterior margin having finely fringed ridges; propodus basally slightly broader than distally, having 2 fringed spines anterodistally and few elongate setae on posterior margin;

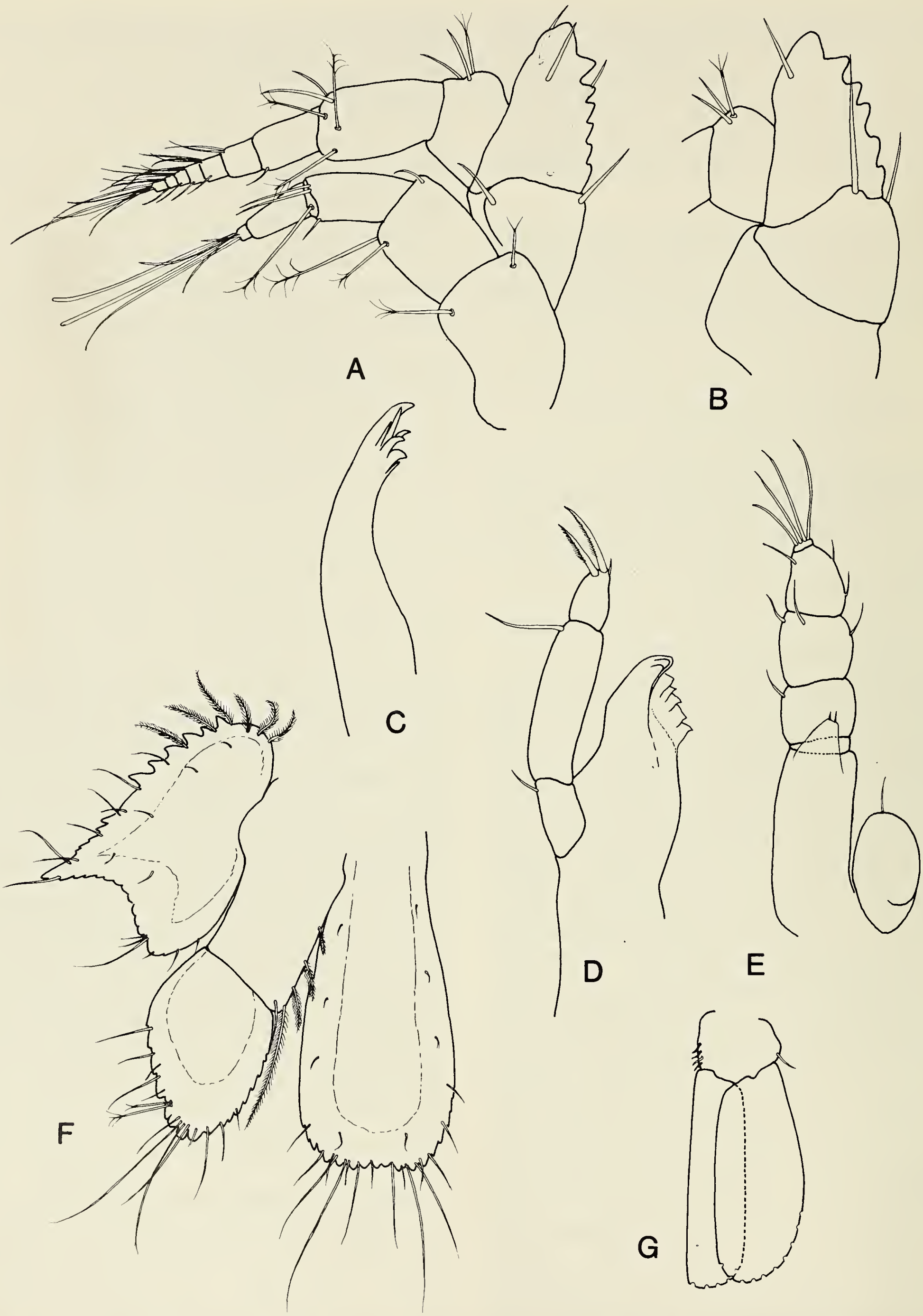

Fig. 1. *Licranthura amyle,* non-ovigerous ♀: A, Antennule and antenna; B, Antennal process enlarged; C, Maxilla; D, Mandible; E, Maxilliped; F, Uropod and telson; G, Pleopod 1.

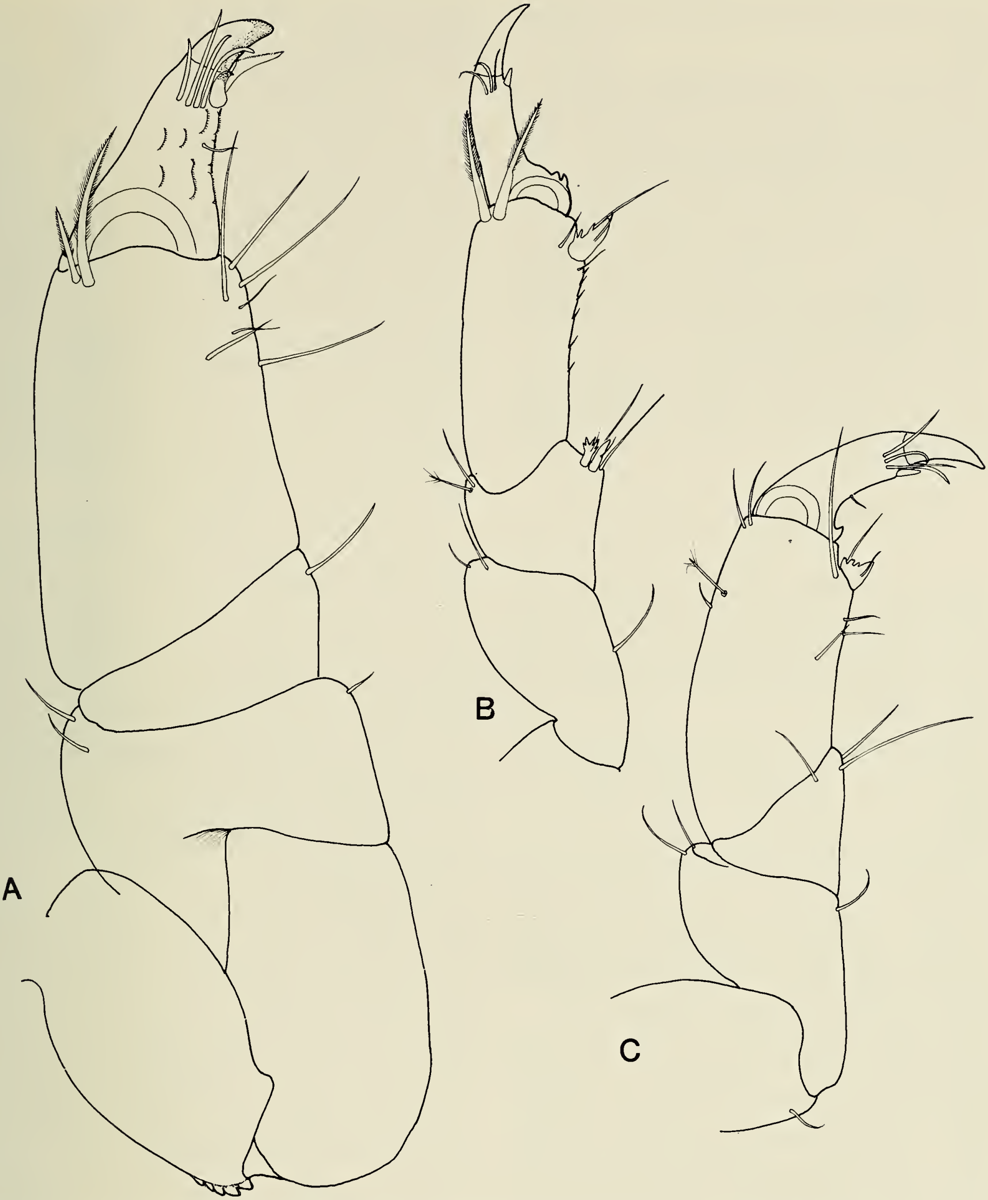

Fig. 2. *Licranthura amyle,* non-ovigerous ♀: A, Pereopod 1; B, Pereopod 7; C, Pereopod 2.

carpus short, with posterior margin longer than anterior; merus, ischium, and basis broad squat articles; basis having 4 or 5 broad serrations posterodistally. Pereopod 2, unguis about half length of remainder of dactylus, with small accessory spine at base; hook-like tooth present on posterior margin near articulation with propodus; latter roughly rectangular, with squat dentate spine posterodistally. Pereopods 5–7, dactylus with 2 basal serrations; propodus rectangular, with strong dentate posterodistal spine, 2 anterodistal fringed spines; carpus with posterior margin longer than anterior margin, bearing strong dentate posterodistal spine.

Pleopods essentially similar; pleopod 1 only slightly larger than following pleopods, rami both contributing to opercular function, of equal length, endopod about ⅔ width of exopod. Uropodal exopod widening distally, outer (free) margin serrate, ending in outer narrowly triangular acute lobe and more broadly rounded inner lobe; endopod ovate, with serrate margin.

Etymology.—The specific name is derived from the Greek *myle,* a grinder, and refers to the lack of a molar in the mandible of this species.

Mesanthura looensis, new species
Fig. 3

Material.—HOLOTYPE, USNM 211406, non-ovig. ♀, tl 10.0 mm; sta FLK-22, Looe Key, Florida, sandy bottom in gorgonacean bed with scattered sponges and corals, 1 m, 26 Jan 1983.

PARATYPES, USNM 211407, 2 non-ovig. ♀, tl 7.0, 7.0 mm. Same data as holotype.

Description.—Female: Body proportions, $C < 1 = 2 > 3 < 4 = 5 = 6 > 7 = Pl$. Pleonite 6 fused with telson ventrally; middorsally, posterior margin having tiny emargination. Telson thin, dorsally slightly concave, outline evenly elongate-oval.

Antennular flagellum of 4 articles, 2 distal articles each with 2 aesthetascs. Antennal flagellum of 5 setose articles. Mandibular palp of 3 articles, article 2 bearing fringed scales; article 3 with 8 fringed spines; lamina dentata of 4 serrations; molar thin-walled, truncate. Maxilliped lacking endite; palp of 3 articles, terminal article semicircular in outline, with 2 fringed setae and 3 simple setae on medial margin.

Pereopod 1 subchelate, unguis slightly less than half length of remainder of dactyl; propodus expanded, palm with proximal rounded scale-bearing lobe armed with 6 setae; carpus triangular, distally having rounded scale-bearing lobe carrying 5 simple setae. Pereopod 2, propodus rectangular, not expanded or subchelate, with serrate sensory spine at posterodistal angle; carpus short, triangular. Posterior pereopods, propodus somewhat curved, with posterodistal series of short setae and strong serrate sensory spine at posterodistal angle; carpus with posterior margin longer than anterior, sensory spine at posterodistal angle.

Pleopod 1, exopod operculiform, slightly longer and 3 times wider than endopod; protopod bearing 5 retinacula. Uropodal exopod ovate, with outer distal margin sinuate; endopod broadly ovate.

Color pattern: dorsum of cephalon, pereon, pleon, telson, and uropods with strong red-brown pigment; cephalon with broad patch between eyes, and extending to posterior margin; on pereonites 1–3 pigment anteriorly broad, posteriorly constricted; pereonites 4–6 covering most of dorsum, with oval middorsal unpigmented patch; pigment more constricted on peronite 7; covering most of pleon with middorsal open patch; telson and uropodal rami with patch in central area.

Remarks.—The present species differs from the seven previously described species of *Mesanthura* mainly in its distinctive dorsal pigment pattern. The spination of the mandibular palp article 3 is the other most useful character for species separation in *Mesanthura.* The series of eight spines in *M. looensis* differs from all the other seven species (*M. fasciata* Kensley, 1982—4, *M. hopkinsi* Hooker, 1985—4, *M. paucidens* Menzies & Glynn, 1968—6, *M. reticulata* Kensley, 1982—6, *M. punctillata* Kensley, 1982—7, *M. pulchra* Barnard, 1925—10, *M. floridensis* Menzies & Kruczynski, 1983—12–13).

Etymology.—The specific name is derived from the type locality, Looe Key, Florida.

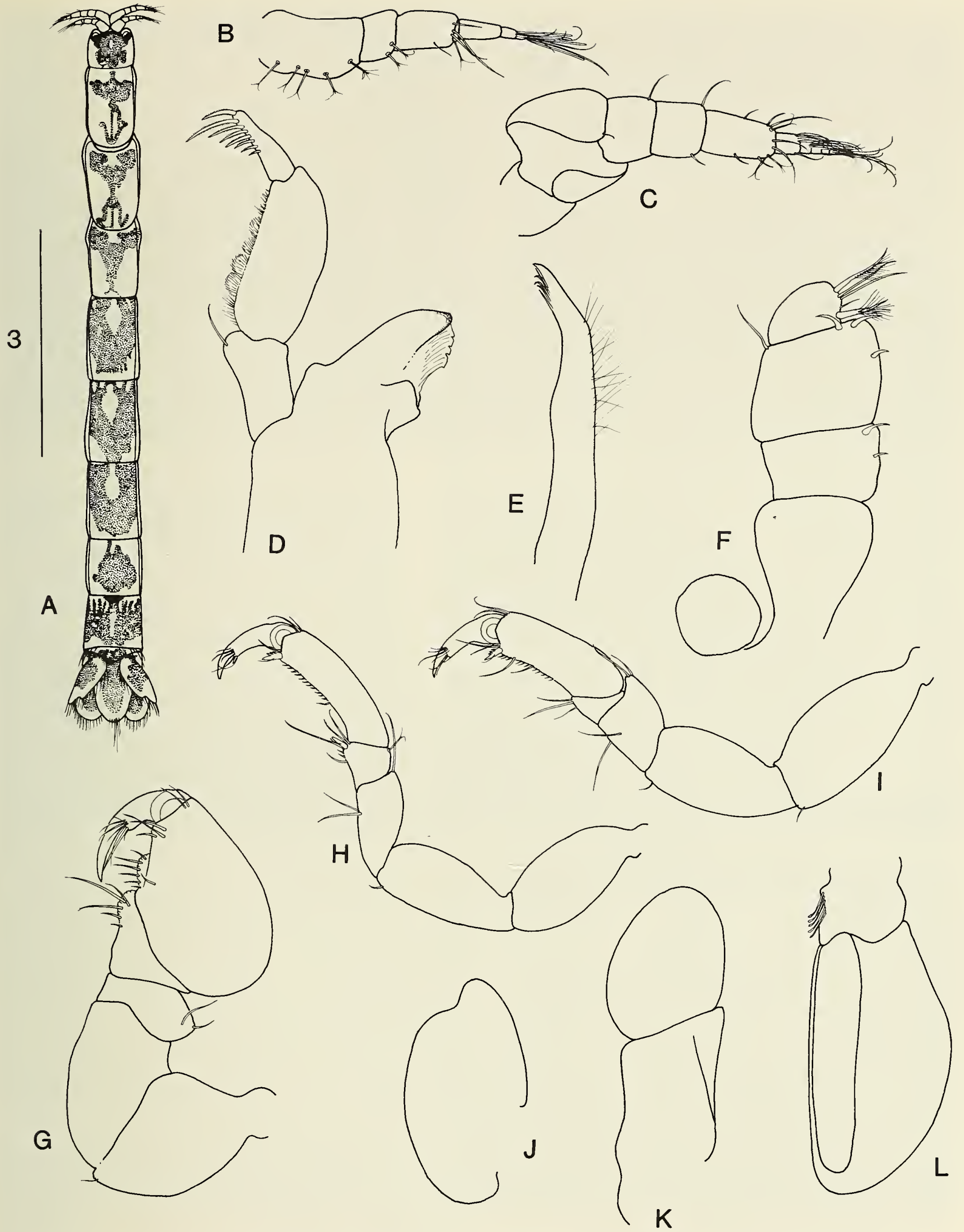

Fig. 3. *Mesanthura looensis,* non-ovigerous ♀: A, Whole animal in dorsal view; B, Antennule; C, Antenna; D, Mandible; E, Maxilla; F, Maxilliped; G, Pereopod 1; H, Pereopod 7; I, Pereopod 2; J, Uropodal exopod; K, Uropodal endopod and basis; L, Pleopod 1.

Family Limnoriidae

Menzies and Glynn (1968), and Menzies and Kruczynski (1983) together list six species of limnoriids recorded from the Gulf of Mexico and the Caribbean. These are *Limnoria platycauda* Menzies, 1957, *L. pfefferi* Stebbing, 1904, *L. simulata* Menzies, 1957, *L. saseboensis* Menzies, 1957, *L. tripunctata* Menzies, 1951 (=*L. tuberculata* Sowinsky, 1884), and *Paralimnoria andrewsi* (Calman, 1910). Kühne (1975) records *L. tripunctata, L. saseboensis, L. pfefferi,* and *L. multipunctata* Menzies, 1957, from the Caribbean. From the Twin Cays and Man o'War Cay areas of Belize, six species of *Limnoria* have now been recorded, including all the abovementioned except *L. saseboensis,* plus two new records, viz. *L. indica* Becker and Kampf, 1959, and *L. unicornis* Menzies, 1957. Most of the material comes from decaying red mangrove (*Rhizophora mangle*) wood, with all except *P. multipunctata* co-occurring in a single station on Man o'War Cay.

A single undescribed species of *Phycolimnoria* is recorded from the Bahamas, rather surprisingly also from decaying mangrove wood.

The records of *L. simulata* are treated with caution, as female *L. indica* can easily be confused with the former species. The question of sexual dimorphism in *Limnoria* generally requires closer scrutiny, in light of such possible confusion.

The dark-green tests of folliculinid ciliate protozoans were found externally on several of the *Limnoria* species, (see Mohr and LeVeque 1948) and were especially common on the dorsal pleotelson and ventral coxae of *L. platycauda.*

Limnoria (*Limnoria*) *indica*
Becker and Kampf, 1959
Fig. 4

Limnoria indica Becker and Kampf, 1958: 3, figs. 2–4.—Kühne, 1975:546, figs. 3, 4.

Material.—USNM 211422, 56 specimens, sta CBC K166, Man o'War Cay, Belize, from submerged red mangrove roots, 0.5 m, 29 Nov 1985.

Remarks.—This species was described from the east coast of the Indian Peninsula, while Kühne (1975) records the species from Hong Kong and Manila, as well as Madras, India. Becker and Kampf (1959) detail the sexual dimorphism reflected in the pleotelsonic structure; this dimorphism may well be the source of confusion in the identification of such species as *L. simulata* and *L. quadripunctata* from the Caribbean.

Distribution.—Mandapam Camp and Madras harbor, India; Hong Kong; Manila, Philippines.

Limnoria (*Limnoria*) *multipunctata*
Menzies, 1957
Fig. 5

Material.—USNM 211421, 4 ♂, 6 ovig. ♀, 3 non-ovig. ♀, 7 immature, Twin Cays, Belize, from dead red mangrove wood, coll. J. Kohlmeyer, 28 Nov 1985.

Remarks.—Kühne (1975) points out the variability found in this species, with material from Japan having the two pairs of submedian pleotelsonic tubercles as in the type material from the Kai Islands, while material from Puerto Rico and Jamaica lacks these tubercles. The present material from Belize also lacks these anterior tubercles, but does possess a strong middorsal longitudinal pleotelsonic ridge with rounded tubercles in the posterior half.

Distribution.—Puerto Rico; Jamaica; Koniya, Japan; Kai Islands (South Pacific).

Limnoria (*Limnoria*) *pfefferi*
Stebbing, 1904

Limnoria (*Limnoria*) *pfefferi*: Menzies, 1957:135, fig. 15.—Kühne, 1975: 547, fig. 7.

Material.—USNM 221621, 12 specimens, Twin Cays, Belize, under red mangroves, 24 Oct 1979.—USNM 221623, 7 specimens, sta H-6(80), Glover's Reef, Be-

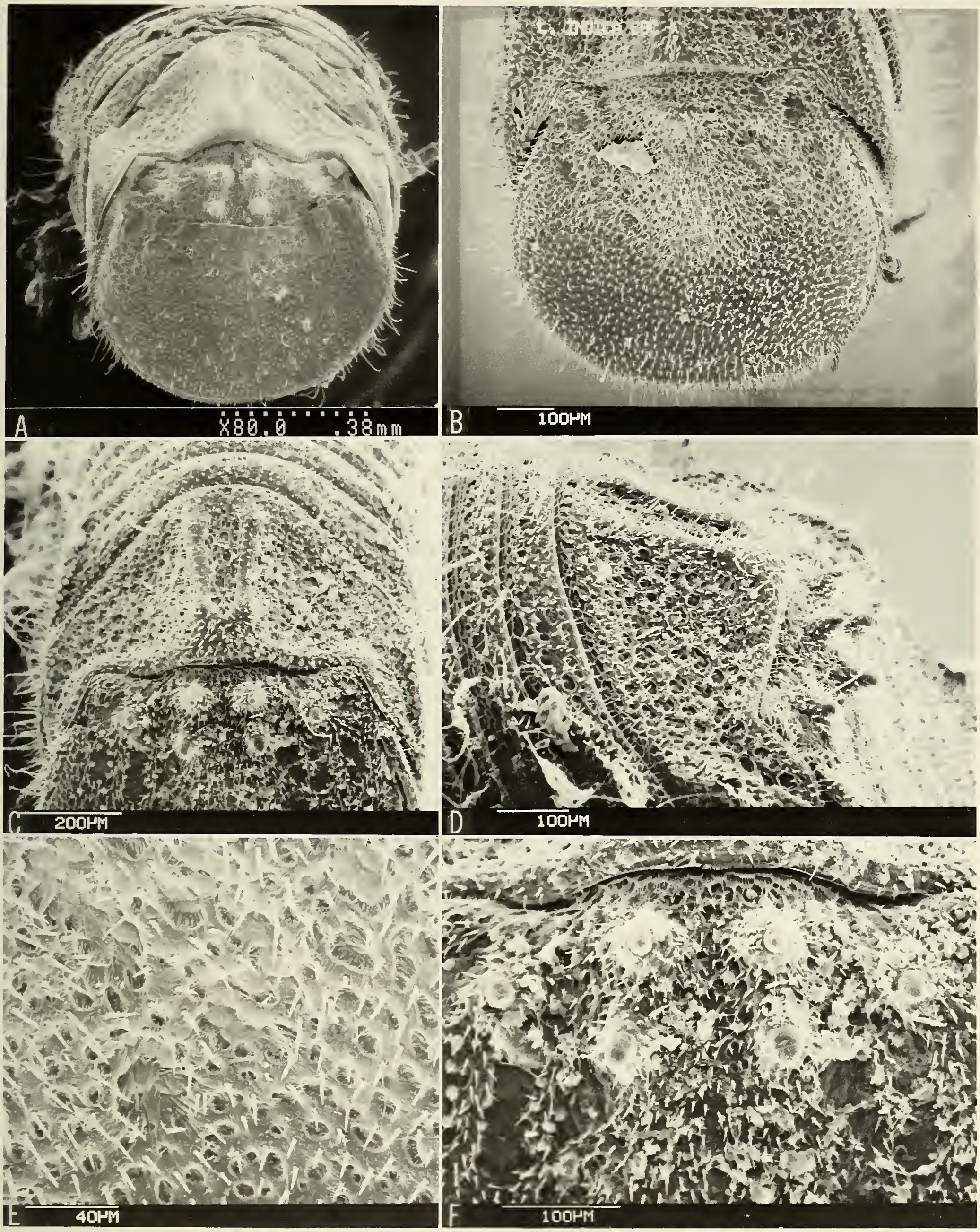

Fig. 4. *Limnoria indica*: A, Pleotelson ♂; B, Pleotelson ♀; C, Last pleonite and anterior pleotelson ♂; D, Pleotelson ♂, in lateral view; E, Pleotelsonic surface enlarged; F, Anterior pleotelson ♂, enlarged.

lize, 0–3 m, 24 Mar 1980, coll. G. Hendler.—USNM 221624, 4 specimens, sta AC-CBC-610B, Carrie Bow Cay, coarse *Halimeda* sediment, 1.5 m, 14 Jun 1981, coll. A. Cohen.—USNM 221625, 10 specimens, sta CBC-K166, Man o'War Cay, Belize, submerged red mangrove wood and roots, 0.5 m, 29 Nov 1985.—USNM 221626, 2

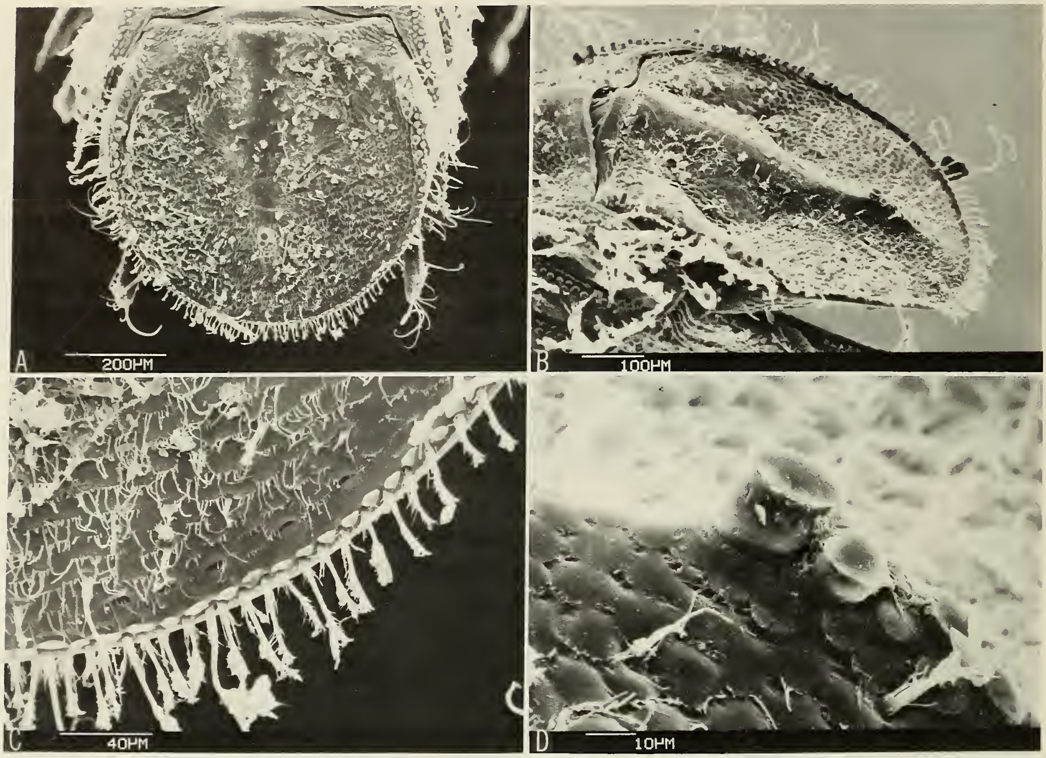

Fig. 5. *Limnoria multipunctata*: A, Pleotelson; B, Pleotelson in oblique-lateral view; C, Pleotelsonic margin; D, Middorsal tubercles of posterior pleotelson.

specimens, sta H-18(80), Twin Cays, Belize, under mangroves, 1–2 m, 28 Mar 1980, coll. G. Hendler.—USNM 221627, 5 specimens, sta CBC-K45, Twin Cays, Belize, algal mat under red mangrove roots, 0.1 m, 9 Apr 1979.

Distribution.—Indian Ocean; Florida; Puerto Rico; Panama; Philippines; New Guinea.

Limnoria (*Limnoria*) *platycauda* Menzies, 1957

Limnoria (*Limnoria*) *platycauda* Menzies, 1957:139, fig. 17.—Ortiz, 1983:7.

Material.—USNM 221622, 23 specimens, Twin Cays, Belize, from red mangrove wood, 3 m, 28 Nov 1985, coll. J. Kohlmeyer.—USNM 221628, 38 specimens, sta CBC-K166, Man o'War Cay, Belize, submerged red mangrove wood and roots, 0.5 m, 29 Nov 1985.

Distribution.—Cuba; Puerto Rico to Curaçao.

Limnoria (*Limnoria*) *tuberculata* Sowinsky, 1884

Limnoria (*Limnoria*) *tripunctata* Menzies, 1951:86, pl. 30; 1957:137, fig. 16.

Limnoria tuberculata Sowinsky, Kussakin, 1979:322, figs. 187–190.

Material.—USNM 221630, 4 specimens, sta CBC-K166, Man o'War Cay, Belize, submerged red mangrove wood and roots, 0.5 m, 29 Nov 1985.

Distribution.—Yellow Sea; Hong Kong; Rhode Island to Venezuela; Gulf of Mexico;

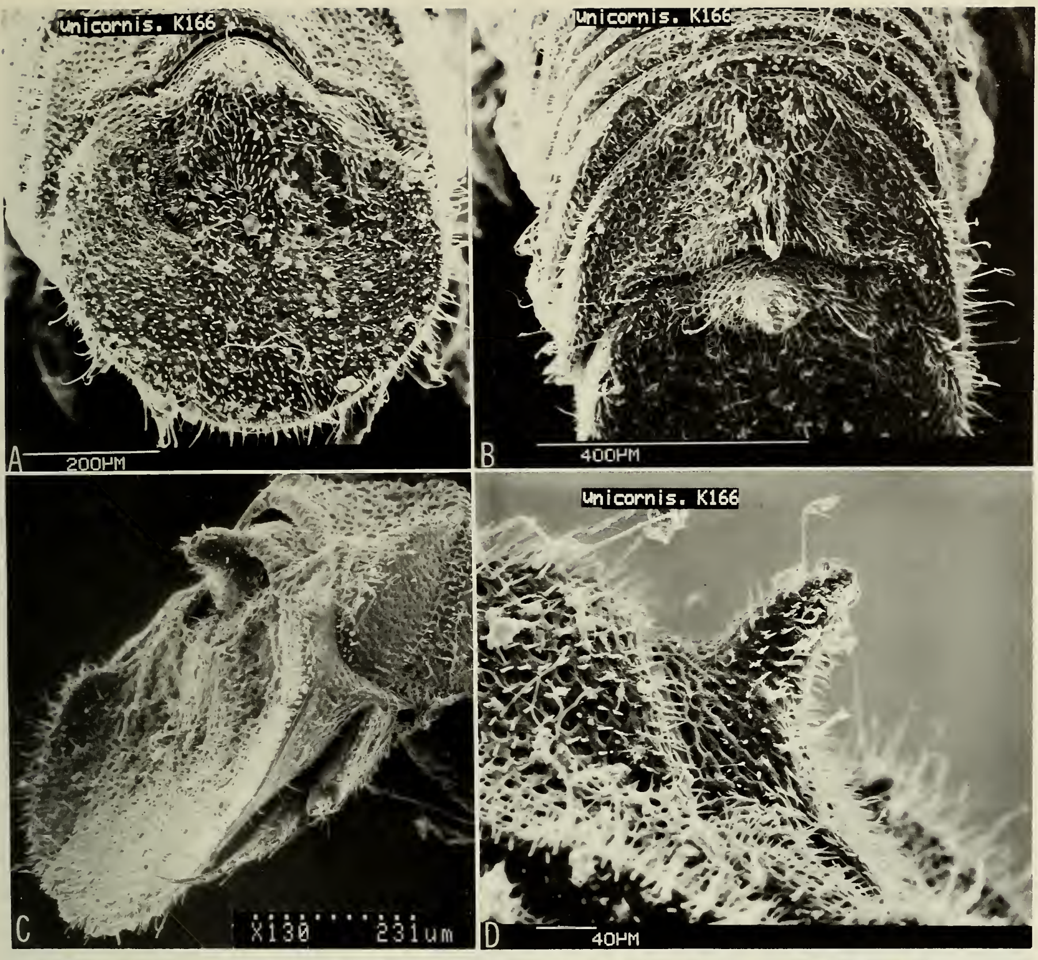

Fig. 6. *Limnoria unicornis*: A, Pleotelson; B, Last pleonite and anterior pleotelson; C, Pleotelson in oblique-lateral view; D, Pleotelsonic tooth enlarged.

Caribbean; Uruguay; California; Hawaii; Australia; Mediterranean; Black Sea; India; Ghana.

Limnoria unicornis Menzies, 1957
Fig. 6

Limnoria unicornis Menzies, 1957:173, fig. 32.

Material.—USNM 221631, 6 ♂, 8 ovig. ♀, 3 non-ovig. ♀, Pigeon Creek, San Salvador, Bahamas, 22 May 1986, coll. J. Clark.—USNM 211423, 2 ♂, sta CBC-K166, Man o'War Cay, Belize, submerged red mangrove wood and roots, 0.5 m, 29 Nov 1985.—USNM 211424, 2 ♂, 1 non-ovig. ♀, Twin Cays, Belize, from green algal turf under *Rhizophora mangle,* 0.5 m.—USNM 211425, 9 ♂, 3 ovig. ♀, 6 non-ovig. ♀, 7 juvs., Ngeruktabel Is., Palau, from anchialine cenote, 9 Feb 1985, coll. T. Iliffe and D. Williams.—USNM 102745, 1 ♂, 1 ♀, 1 juv., Baie de Maroe, Huahine Is., Society Islands, 1 m, 30 Apr 1957, coll. T. Bowman.

Remarks.—This species has been mentioned once in the literature, i.e., in the original description. For this reason, all the Smithsonian Institution (USNM) holdings, both from the Pacific and the Caribbean, are included here.

Distribution.—Caroline Islands; Society Islands; Palau; Bahamas; Belize.

Phycolimnoria clarkae, new species
Figs. 7–9

Material.—HOLOTYPE, USNM 211426, ♂ 4.3 mm, PARATYPES, USNM 211427, 44 ♂, 18 ovig. ♀, 3.3-4.4 mm, 10 non-ovig. ♀, 14 juvs., Pigeon Creek, San Salvador, Bahamas, from dead red mangrove wood, coll. J. Clark, 22 May 1986.

Description.—Dorsal integument, especially of pleotelson, bearing very fine, imbricate, minutely setulose ridges, giving appearance of fine, regular foveolation. Pleonite 5 with broad raised middorsal region, having irregular bumps. Pleotelson wider than long, with two rounded submedian ridges basally, becoming obsolete posteriorly.

Antennular peduncle of 3 articles, basal article longest and widest; flagellum consisting of basal article, wider than long, bearing 4 aesthetascs, and tiny terminal article bearing single aesthetasc and several setae. Antennal flagellum of 5 setose articles, basal article equal in length to 4 distal articles. Mandibular palp of 3 articles, two basal articles subequal in length; article 2 bearing 3 distal fringed spines; terminal article two-thirds length of article 2, bearing 6 distal fringed spines; spine row of left mandible of 2 laciniate spines, flanked by 2 short rounded lobes; spine row of right mandible of about 9 laciniate spines increasing in length proximally, plus bilobed distal process; incisor consisting of roughly triangular, strongly sclerotized, unornamented cusp. Maxilla 1 and 2 as figured. Maxillipedal endite with single coupling hook, 8 spines on distal margin, all save one bearing fine setules; palpal article 2 longest and widest; epipod about 3½ times longer than basal width, distally narrowly rounded, reaching to base of palp. Pereopod 1, accessory spine at base of dactylar unguis short, bidentate; propodus with 2 fringed posterodistal spines; propodus, carpus, and merus each having row of 4 or 5 rounded tubercules on posterior surface. Pereopod 2 with 5 distal articles each having few tubercles on or near posterior surface; accessory spine at base of dactylar unguis short, bidentate; carpus with stout dentate spine at posterodistal angle; merus with single stout dentate spine at anterodistal corner. Pereopod 7, accessory spine of dactyl faintly bidentate; carpus with several fringed spines of varying lengths on distal margin; merus with 4 fringed spines on anterodistal margin. Paired penes on ventrum of pereonite 7. Pleopod 2, copulatory stylet sabre-shaped, articulating slightly proximal to midlength of median margin of endopod, just reaching beyond ramus. Uropodal endopod elongate-ovate, about twice longer than wide; endopod less than half length of exopod, triangular, tipped with short squat non-curved spine (claw); basis with row of fringed setae along outer margin.

Remarks.—This is the first record of the genus *Phycolimnoria* from the Caribbean, and is unusual in that the material was found, not boring into an alga as is usually the case, but in decaying red mangrove wood.

The absence of a "rasp" and "file" structure on the mandibles, along with the very unequal size of the uropodal rami, place this species in the genus *Phycolimnoria* Menzies.

Two features easily separate this species from the other 11 species of *Phycolimnoria* already described. None of these species possess a uropodal exopod with a short straight terminal claw. Only *P. zinovae* Kussakin, 1963, from the Sea of Japan, has a uropodal exopod in which the terminal claw is almost straight. This latter species, however, has a distinctive Y-shaped ridge on pleonite 5. *Phycolimnoria clarkae,* with its raised and rounded central area of pleonite 5, and the two longitudinal submedian rounded ridges of the pleotelson with no

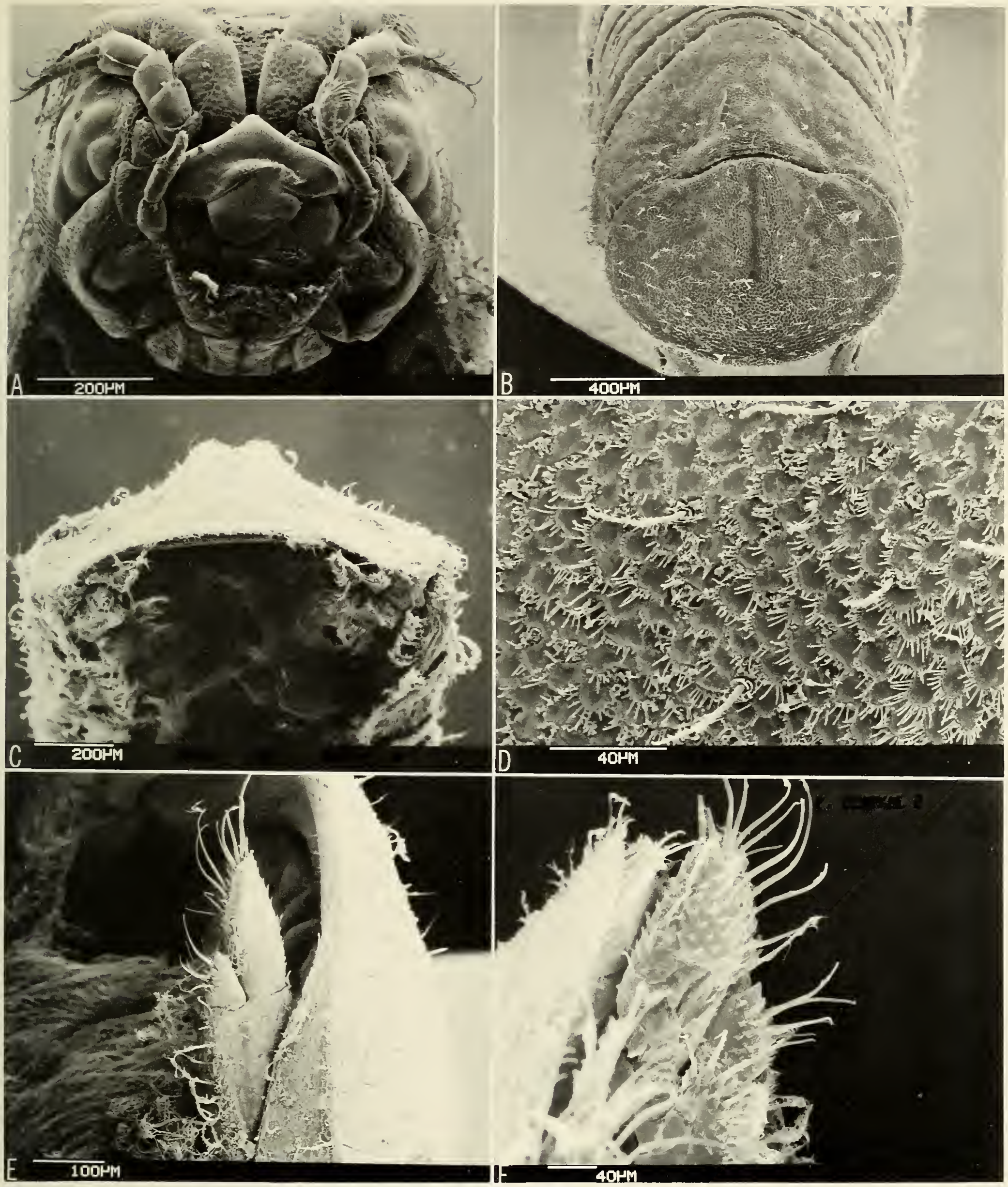

Fig. 7. *Phycolimnoria clarkae*: A, Cephalon in ventral view; B, Pleotelson; C, Pleotelson seen from posterior margin; D, Pleotelsonic integumental surface enlarged; E, F, Uropod.

other ornamentation would also seem to be unique in the genus.

Etymology.—The species is named for Janice Clark of the Department of Invertebrate Zoology, Smithsonian Institution, who collected the type material.

Family Cirolanidae

Cirolana albidoida, new species

Figs. 10–12

Material.—HOLOTYPE, USNM 211419, ♂ tl 7.8 mm; sta GB-7, off Lucaya, Grand

Fig. 8. *Phycolimnoria clarkae*: A, Left mandible; B, Incisor and spine row of right mandible; C, Antennule; D, Antenna; E, Maxilla 1; F, Maxilla 2; G, Maxilliped.

Bahama, 180–220 m, from trap baited with fish, set for 8 days, 24 May 1981, coll. D. Camp.

PARATYPES, USNM 211420, 55 specimens, 4.6–9.0 mm; same data as holotype. All specimens lack internal organs and musculature, suggesting that they may have been retained dead in the fish trap for some days.

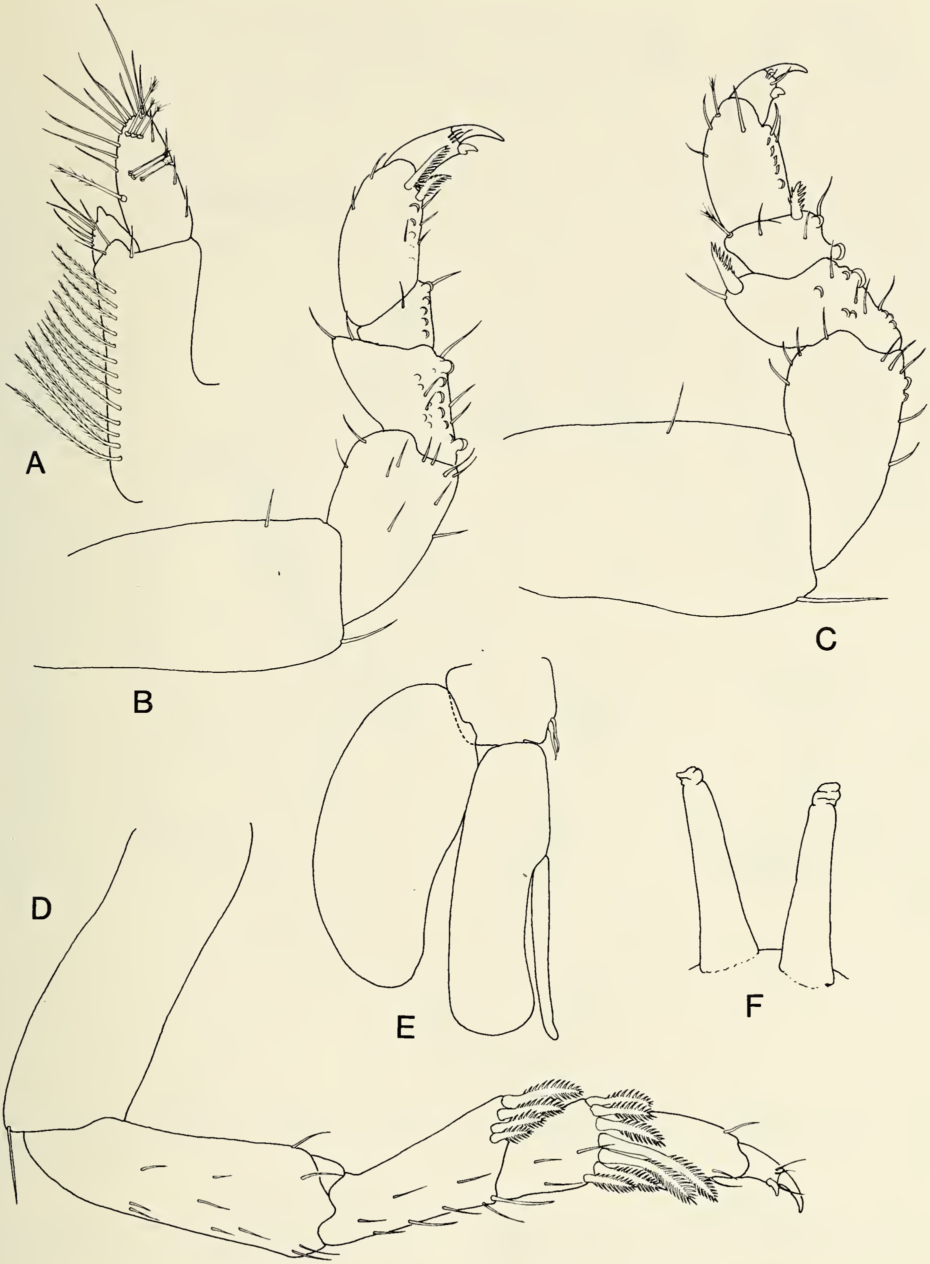

Fig. 9. *Phycolimnoria clarkae*: A, Uropod; B, Pereopod 1; C, Pereopod 2; D, Pereopod 7; E, Pleopod 2 ♂; F, Penes.

Description.—Male: Body about 3½ times longer than wide, widest at pereonite 1. Integument sparsely pitted. Cephalon width about ⅓ longer than medial length, with small rostral point between antennal bases. Frontal lamina an equilateral pentagon. Pereonite 1 about 2½ times length of pereonite 2; pereonites 3–6 subequal in mid-dorsal length, pereonite 7 slightly shorter. Coxae of pereonites 2 and 3 rounded, of

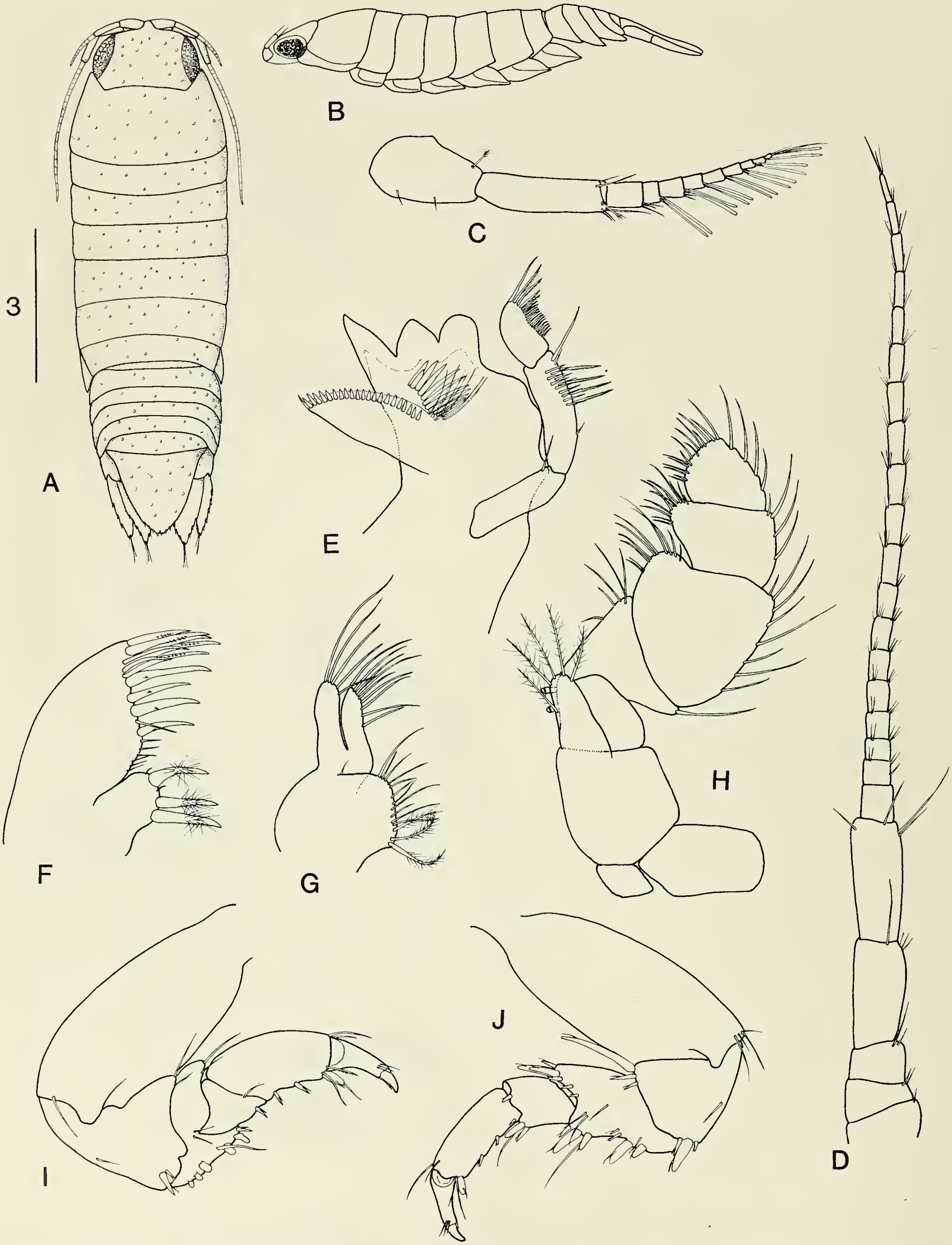

Fig. 10. *Cirolana albidoida*: A, Holotype in dorsal view; B, Whole animal in lateral view; C, Antennule; D, Antenna; E, Right mandible; F, Maxilla 1; G, Maxilla 2; H, Maxilliped; I, Pereopod 1; J, Pereopod 2.

pereonite 4 just less than right-angled, of 5–7 somewhat produced, acute, with oblique upcurving furrow. Pleonite 1 laterally overlapped by pereonite 7; epimera of pleonites 1–2 acutely produced, of pleonite 4 broader, subacute; pleonite 5 lacking free lateral margin.

Antennule reaching to posterior margin

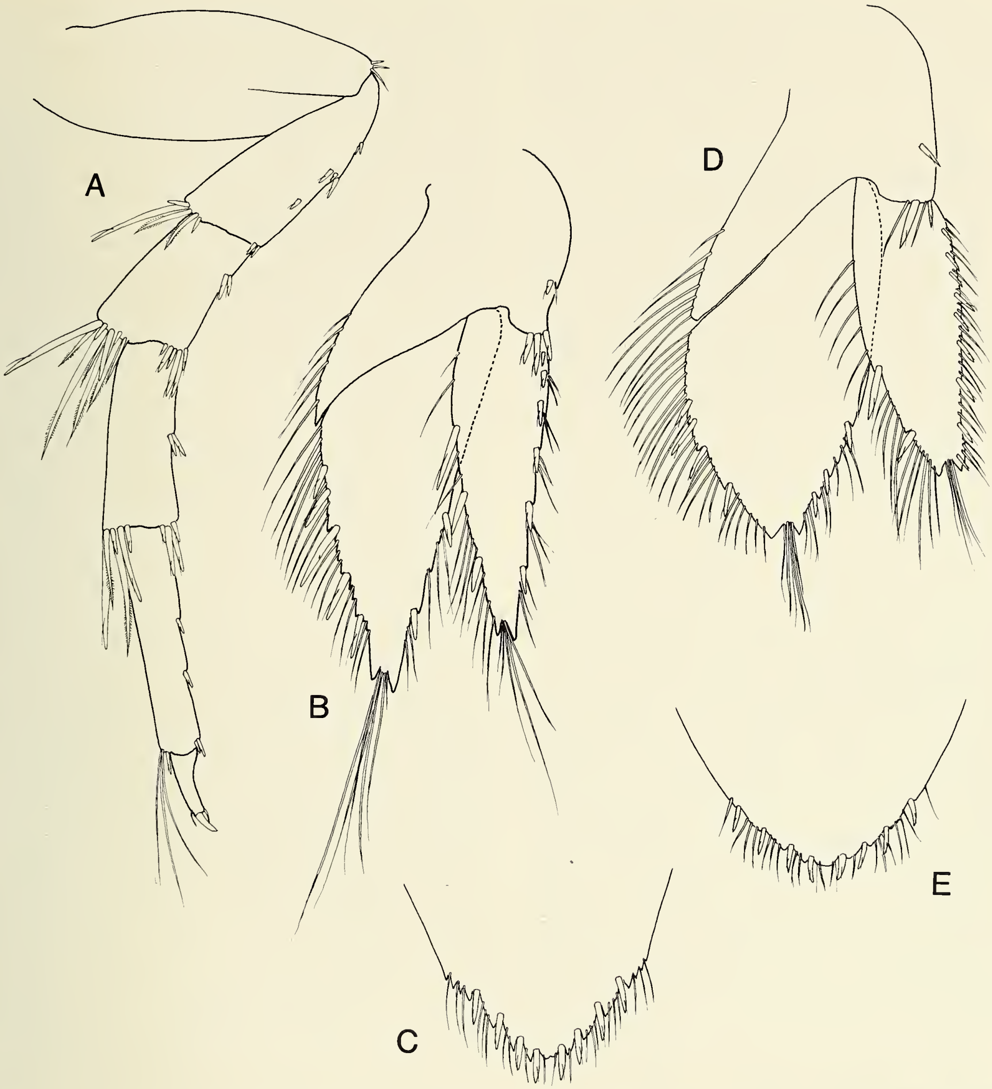

Fig. 11. *Cirolana albidoida*: A, Pereopod 7; B, Uropod; C, Pleotelsonic apex. *Cirolana albida*: D, Uropod; E, Pleotelsonic apex.

of cephalon; two basal peduncular articles fused, line of fusion faintly visible, article 3¼ longer, but narrower than basal article; flagellum of 10 articles, aesthetascs present on distal 8 articles. Antennal peduncle with three basal articles short, articles 4 and 5 more elongate, 4 slightly shorter than 5; flagellum of 19 articles. Mandibular palp of 3 articles, article 2 with 5 elongate and about 11 shorter distal spines, article 3 with 18 marginal spines becoming distally progressively longer; incisor of 3 cusps; molar bearing 22 teeth. Maxilla 1, inner ramus with 3 stout setae; outer ramus with about 11 spines on mediodistal margin. Maxilla 2, inner ramus with 3 fringed proximal setae and about 11 simple distal setae; inner lobe of outer ramus with 9 distal setae, outer lobe with 5 setae. Maxillipedal endite reaching to end of basal palp article, with 2 coupling hooks and 5 fringed setae; palp article 3 longest and widest; articles 2–5 with dense setae on

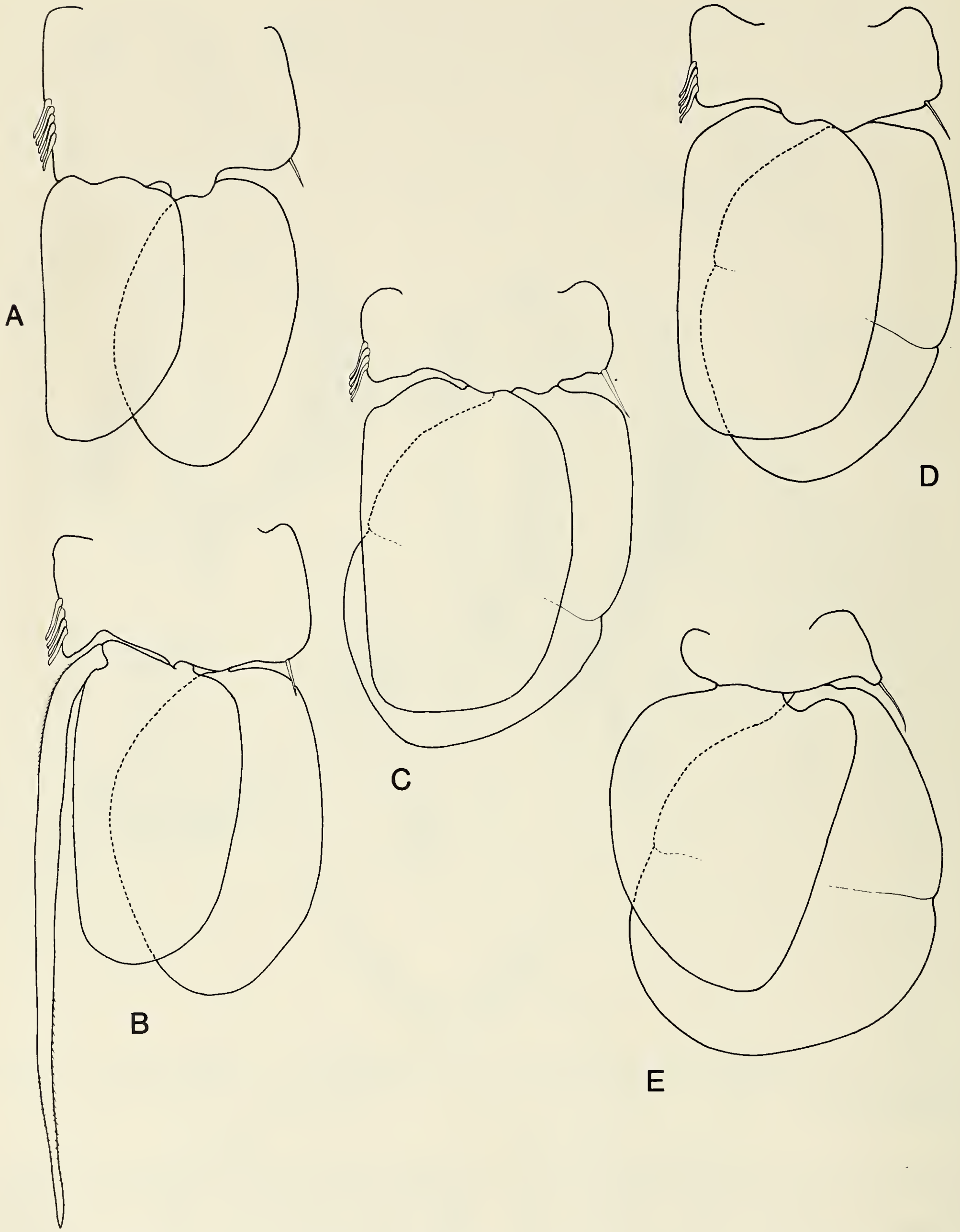

Fig. 12. *Cirolana albidoida* ♂: A, Pleopod 1; B, Pleopod 2; C, Pleopod 3; D, Pleopod 4; E, Pleopod 5.

mediodistal margins, sparser setae on outer margins.

Pereopod 1 robust, dactyl slightly more than half anterior length of propodus; propodus with stout rounded posterodistal spine and 2 smaller sensory spines on posterior margin; carpus triangular, with single sensory spine; merus with 5 stubby rounded spines on posterior margin; ischium with 2 acute posterodistal spines. Pereopods 2 and 3 similar, dactylus about ⅔ length of propodus; latter with rounded posterodistal spine and 2 smaller sensory spines on posterior margin; carpus with 2 posterodistal spines; merus with 5 large sensory spines on posterior margin, several anterodistal spines of varying length; ischium with 1 elongate and 2 smaller posterodistal spines, 1 elongate and 2 small anterodistal spines. Pereopods 4–7 similar, becoming progressively more elongate; dactylus about ⅓ length of propodus; latter elongate-cylindrical, with 3 small spines on posterior margin; carpus about ⅔ length of propodus, with 2 spines at midlength of posterior margin, clump of 4 posterodistal spines, clump of 6 anterodistal spine of which 2 fringed; merus about ⅔ length of carpus, with 2 spines in proximal half of posterior margin, clump of 6 posterodistal spines, clump of 9 or 10 anterodistal spines, several of which fringed; ischium with several small spines on posterior margin and clump of 5 anterodistal spines, 2 of which fringed. Pleopods, all rami fringed with plumose setae; pleopod 1 peduncle roughly rectangular, with 5 coupling hooks on median margin, endopod slightly shorter and narrower than exopod, latter elongate-ovate; pleopod 2, peduncle roughly rectangular, with 4 coupling hooks on medial margin, copulatory stylet articulating at base of endopod, slender, tapering reaching by half its length beyond rami; pleopod 3, peduncle with 4 coupling hooks, exopod longer and broader than endopod, with indistinct transverse articulation at midlength; pleopod 4 peduncle with 4 coupling hooks, exopod broadly ovate, with distinct articulation at midlength; pleopod 5 exopod becoming almost circular in outline, with distinct articulation at midlength. Uropodal peduncle bearing 3 spines at laterodistal angle, mesiodistal angle produced into acute triangular setose lobe; exopod subequal in length to, but half basal width of, endopod, with 5 spines on lateral margin, 3 on inner margin, apically bifid; endopod with 2 or 3 spines on lateral margin, 5 on inner margin, apically bifid; apices of both rami bearing elongate simple setae.

Remarks.—Of the Caribbean species of *Cirolana,* the present species closely resembles *C. albida* Richardson, 1901, known only from the type locality, Sugarloaf Key, Florida. This resemblance is seen in the overall size, the shape of the frontal lamina, the integumental pitting, and the overall similarity of the appendages. The major differences are seen in the proportions of the uropods and telson. In *C. albidoida,* the uropodal rami are more slender, the endopod especially being almost straight-sided; the posterior telson is also straight-sided, apically somewhat narrowed, with four marginal serrations anterior to the apical spination. *Cirolana albida* has the outer margin of the uropodal endopod distinctly convex, with both endopod and exopod proportionally broader; the telson is posteriorly more rounded than in the new species, and lacks the proximal serrations. The copulatory stylet of pleopod 2 in the male provides another differences, extending by almost half its length beyond the rami in the new species, and just barely beyond the rami in *C. albida.* The number of antennal flagellar articles in *C. albida* (20–32) would seem to be higher than in *C. albidoida* (18–20).

Etymology.—The specific epithet, meaning "like albida," refers to the high degree of similarity of the two species.

Cirolana minuta Hansen, 1890
Fig. 13, 14

Cirolana minuta Hansen, 1890:347, pl. 3 fig. 5, pl. 4 fig. 1.—Richardson, 1901:512; 1905:83, 92, fig. 74.—Menzies and Glynn, 1968:11.—Schultz, 1969:180, fig. 279.—Bruce, 1981:961.

?*Cirolana minuta:* Stebbing, 1900:634 [Loyalty Islands].

Material.—SYNTYPES, Copenhagen

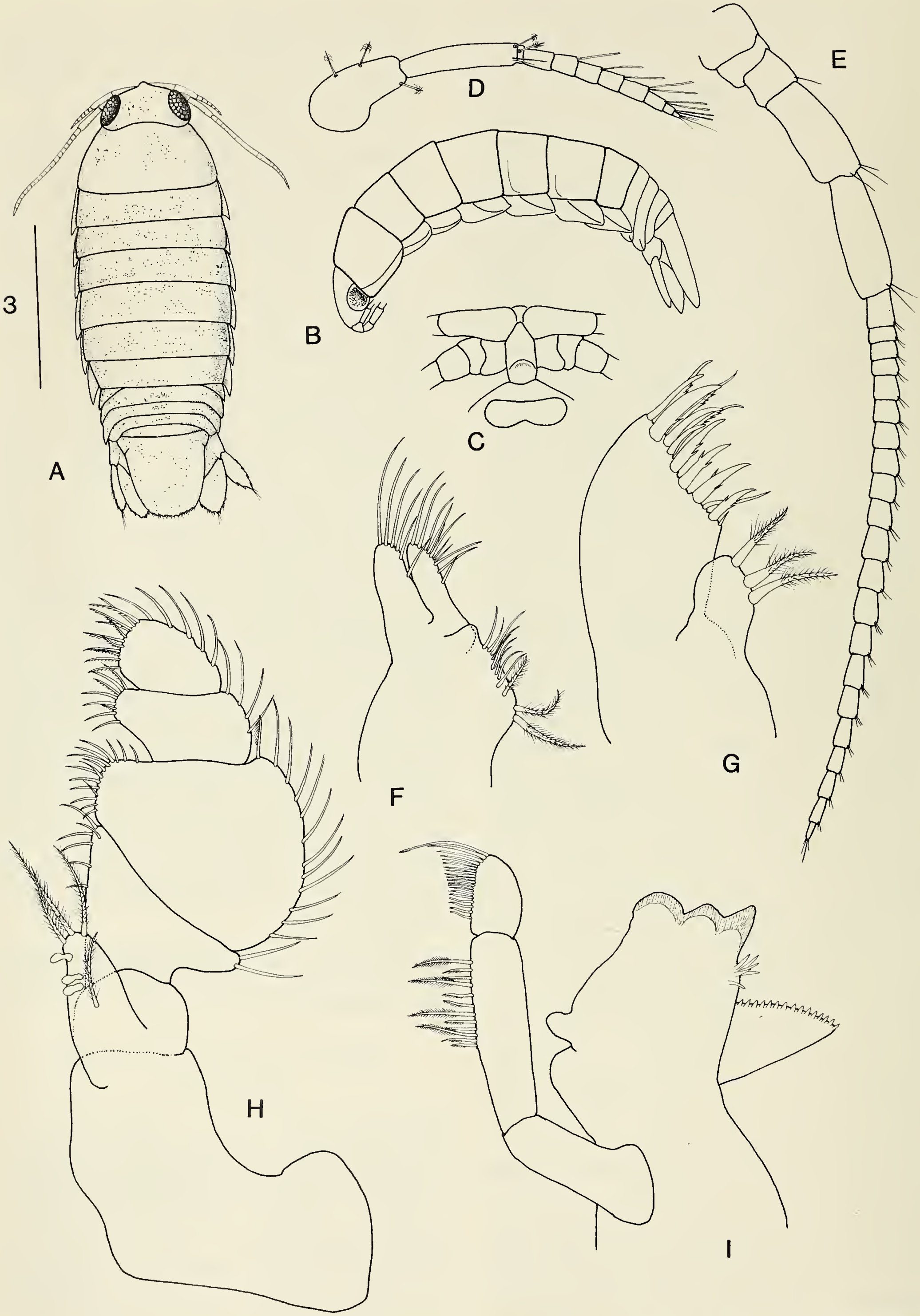

Fig. 13. *Cirolana minuta*: A, Adult ♀ in dorsal view; B, Adult in lateral view; C, Antennal, antennular bases and frontal lamina; D, Antennule; E, Antenna; F, Maxilla 2; G, Maxilla l; H, Maxilliped; I, Mandible.

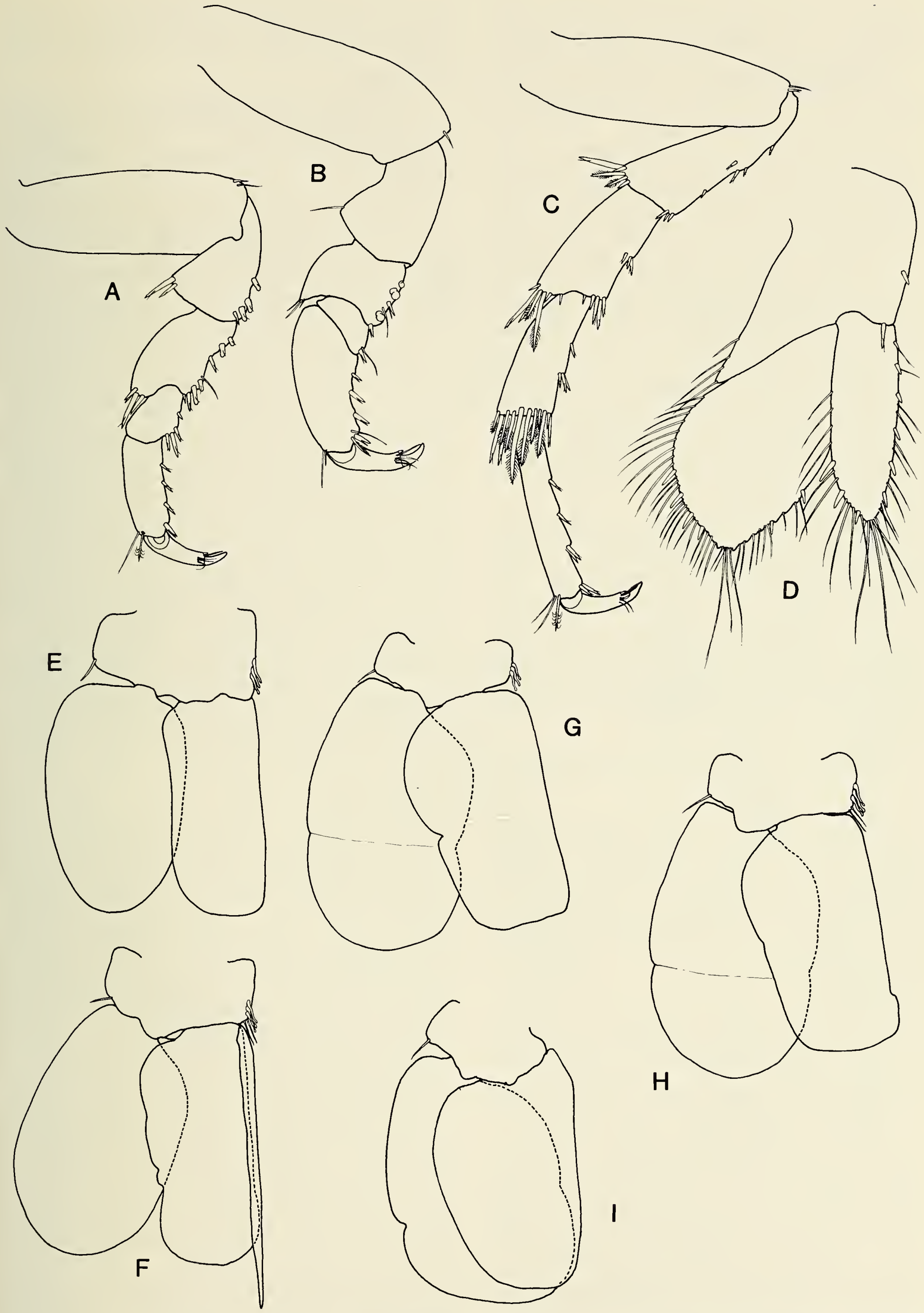

Fig. 14. *Cirolana minuta*: A, Pereopod 1; B, Pereopod 2; C, Pereopod 7; D, Uropod; E, Pleopod 1; F, Pleopod 2; G, Pleopod 3; H, Pleopod 4; I, Pleopod 5.

Museum, 3 specimens, 5.0, 4.6, 4.1 mm, probably St. Thomas, U.S. Virgin Islands.

USNM 221618, 4 ♂, 7.0-8.9 mm, 1 ♀, 4.6 mm, sta GB-7, off Lucaya, Grand Bahama, 180–220 m, coll. D. Camp.

Remarks.—Hansen (1890:348) stated under the heading 'Occurrence' for the description of *C. minuta*: 3 specimens, without locality, found in a vial with 1 specimen of *C. parva,* which leads to the probable conclusion that they originate from the West Indies, and most likely from St. Thomas. (Translation from J. Just, in litt.). These three syntypes were compared with the six USNM specimens from the Bahamas; no differences other than size could be found, leading us to suspect that the syntypes are immature specimens.

Stebbing's record (1900) from the Loyalty Islands and his suggestion that *C. minuta* is synonymous with *C. latistylis* Dana, 1853, from the Indo-Pacific, are not dealt with here. Even though Nordenstam (1946) also suggested this synonymy, it seems unlikely that the Indo-Pacific species is the same as the present Caribbean species.

Cirolana crenulitelson, new species

Figs. 15, 16

Material.—HOLOTYPE, USNM 221619, ovig. ♀, tl 6.8 mm, sta H41-80, PARATYPES, USNM 221620, ♀, 7.0 mm, ovig. ♀, 6.2 mm, ♂, 7.0 mm, sta H41-80, Carrie Bow Cay, Belize, 36 m, 5 Apr 1980, coll. G. Hendler.

Description.—Male: Body 2½ times longer than wide, widest at pereonite 5. Cephalon with well developed eyes; frontal lamina pentagonal, longer than wide. Pereonite 2⅔ length of pereonite 1; pereonites 2–6 subequal in middorsal length, pereonite 7 slightly shorter; coxa of pereonites 2 and 3 posteriorly rounded, of pereonites 4–7 acute, becoming more elongate posteriorly. Pleonite 1 overlapped laterally by pereonite 7; epimera of pleonites 1–3 elongate-acute, of pleonite 4 rounded; pleonite 5 lacking free lateral margin. Telson basally wider than long, tapering gently to posterior truncate margin; latter with small but distinct crenulations.

Antennule barely reaching to end of antennal peduncle; articles 1 and 2 fused, together almost 1½ times length of article 3; flagellum of 10 articles, aesthetascs present on 8 distal articles. Antennal peduncle with 3 short proximal articles, 2 distal articles more elongate, subequal; flagellum of 15 articles. Mandibular palp of 3 articles, article 2 with about 18 spines on outer face; article 3 with row of 22 serrate spines, becoming distally more elongate; incisor of 3 cusps; molar bearing 10 teeth. Maxilla 1, inner ramus with 3 stout setae; outer ramus with about 11 spines, some with few lateral teeth, on mediodistal margin. Maxilla 2, inner ramus broadly truncate, bearing about 15 setae, 2 proximal setae fringed; inner lobe of outer ramus with 9 distal setae, outer lobe with 4 elongate setae. Maxillipedal endite reaching to distal margin of palp article 1, bearing single coupling hook and 5 fringed setae; palp article 3 longest and broadest, articles 3–5 with setae on inner margins, outer margins with setae more widely spaced.

Pereopod 1 robust, dactyl about half length of anterior margin of propodus; latter with strong rounded posterodistal spines and 2 smaller acute spines on posterior margin; carpus short with 2 small spines on posterior margin; merus with 5 stout rounded spines and 5 small acute spines on posterior margin; ischium with few scattered small spines posterodistally. Pereopods 2 and 3 similar, with propodus bearing strong posterodistal spine and 2 smaller spines on posterior margin; carpus more elongate than in pereopod 1, roughly rectangular, with group of 3 posterodistal spines; merus with group of 6 anterodistal spines, posterior margin bearing about 9 spines of varying lengths; ischium roughly triangular, with two anterodistal spines and 4 posterodistal spines. Pereopods 4–7 becoming more elongate, similar; dactyl slightly less than half length

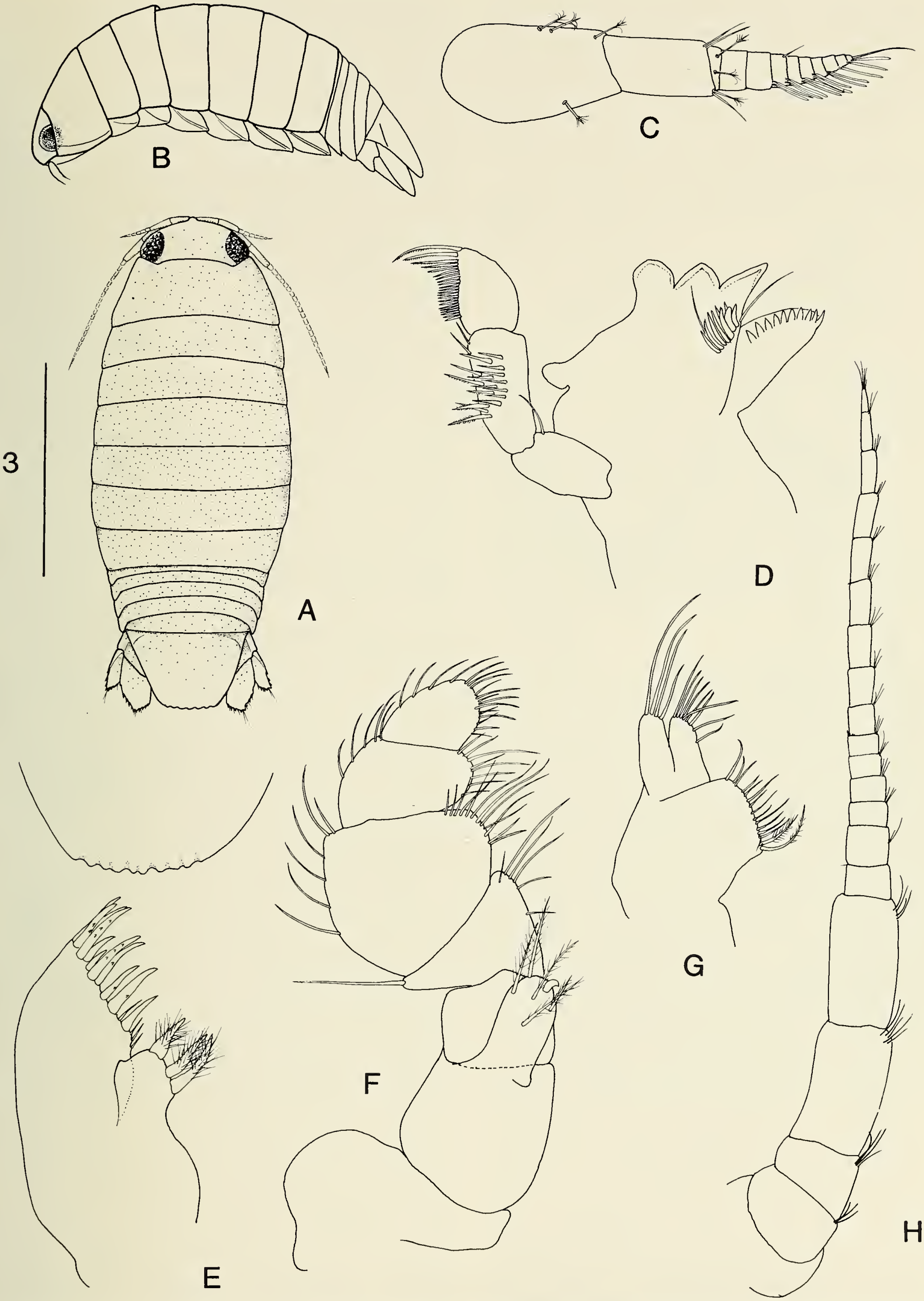

Fig. 15. *Cirolana crenulitelson*: A, Adult in dorsal view; B, Adult in lateral view; C, Antennule; D, Mandible; E, Maxilla l; F, Maxilliped; G, Maxilla 2; H, Antenna.

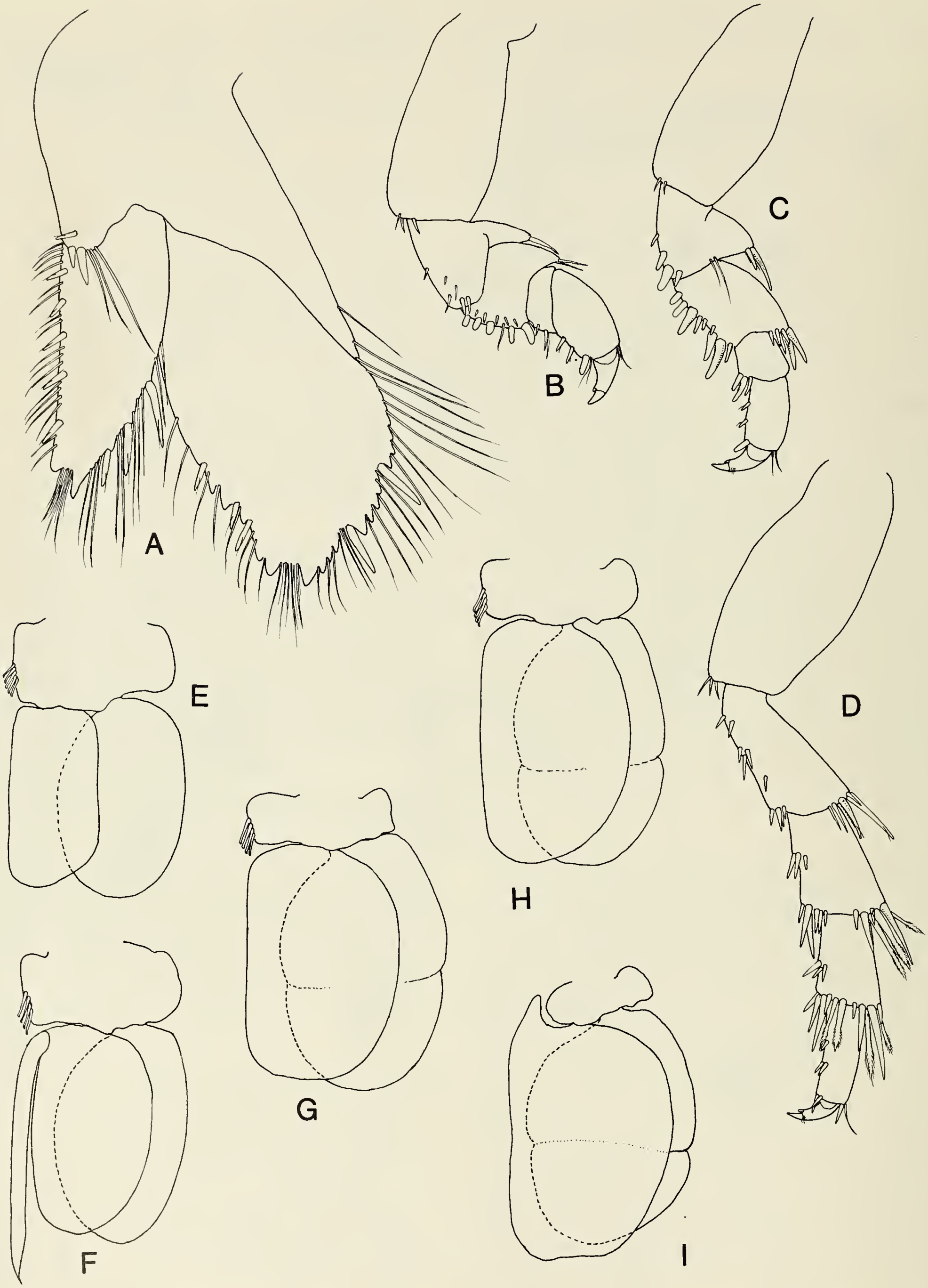

Fig. 16. *Cirolana crenulitelson*: A, Uropod; B, Pereopod 1; C, Pereopod 2; D, Pereopod 7; E, Pleopod 1; F, Pleopod 2; G, Pleopod 3; H, Pleopod 4; I, Pleopod 5.

of propodus; latter elongate-rectangular, with 3 pairs of small spines on posterior margin; carpus with entire distal margin bearing spines of varying length, some elongate and distally fringed, with group of 3 spines on posterior margin; merus with group of spines at antero- and posterodistal corners, former more elongate, group of 3 spines on posterior margin; ischium with group of anterodistal spines, group of 4 short posterodistal spines and several spines scattered on posterior margin.

Pleopods with all rami bearing marginal plumose setae. Pleopod 1 peduncle roughly rectangular, with 5 coupling hooks; endopod parallel-sided in proximal half; exopod ovate. Pleopod 2, peduncle with 4 coupling hooks; endopod with basally articulating copulatory stylet reaching by ¼ its length beyond rami, apically acute. Pleopods 3–5, exopods with indistinct transverse articulation at about midlength.

Uropodal exopod tapering, elongate-triangular, with 5 sensory spines on outer margin, 3 spines on medial margin, apically bifid, with short rounded tooth and longer acute tooth; endopod broad, somewhat tapering, with 3 spines on medial margin, 2 spines on outer margin, both margins with irregular serrations between spines, apically bifid, with 2 subequal triangular teeth.

Remarks.—The present species bears a close superficial similarity to *Cirolana obtruncata* Richardson, 1901, recorded from Jamaica, and Puerto Rico. Examination of the holotype of this species, as well as material from Puerto Rico and the Gulf of Mexico reveal several consistent differences. These include the posterior margin of the telson, which in *C. crenulitelson* is clearly crenulate, but entire in the earlier species; Richardson (1905:108, fig. 87b) figures spines on the posterior margin of the telson; these are not present in *C. crenulitelson.* The uropodal rami are distally broadly rounded in *C. obtruncata,* but tapering, marginally serrate, and distally acute-bifid in *C. crenulitelson.* The overall size of the two species also differs: *C. crenulitelson* ovig. ♀ 6.2–6.8 mm, *C. obtruncata* ♀ up to 11.2 mm. The antennular flagellum has two fewer articles, the antennal flagellum six fewer articles in *C. crenulitelson.*

Etymology.—The specific name refers to the faint crenulations on the posterior margin of the telson.

Family Sphaeromatidae

Ancinus belizensis, new species

Figs. 17A, B, 18, 19

Material.—HOLOTYPE, USNM 211401, ♀ tl 2.8 mm; sta CBC-K-153, near Colson Point, north of Dangriga, Belize, sweepings in seagrass beds, 0.5 m, 20 Nov 1985.

PARATYPES, USNM 211402, 2 ♂ tl 4.1, 4.1 mm, 2 juvs. tl 2.4, 2.0 mm; sta AC-CBC-600, between Colson Point and Salt Creek, north of Dangriga, Belize, sweepings in segrass beds, 0.1–0.2 m, 7 Jun 1981, coll. A. Cohen.

Description.—Male: Dorsal integument, especially of cephalon and pleon strongly pitted. Cephalon narrower than pereonites, line of fusion with pereonite 1 marked dorsally by impressed line; rostrum anteriorly rounded, about two-thirds middorsal length of rest of cephalon. Pereonites all of equal width; coxae in dorsal view becoming more elongate posteriorly, except for that of pereonite 7, latter shorter than preceding coxa. Pleon somewhat inflated, lateral margins convex, curled ventrally; posterior margin (apex of triangular pleon) narrowly truncate.

Antennule with basal peduncular article flexed at right angle, article 3 twice length of, but narrower than, article 2; flagellum of 12 articles, single aesthetasc on 7 distal articles. Antennal peduncular articles increasing in length distally, flagellum of 10 articles, numerous brush setae on anterior (medial) surfaces of peduncular and 4 proximal flagellar articles. Mandibular palp of 3 articles, article 2 about twice length of article 3, bearing 8 fringed spines; article 3

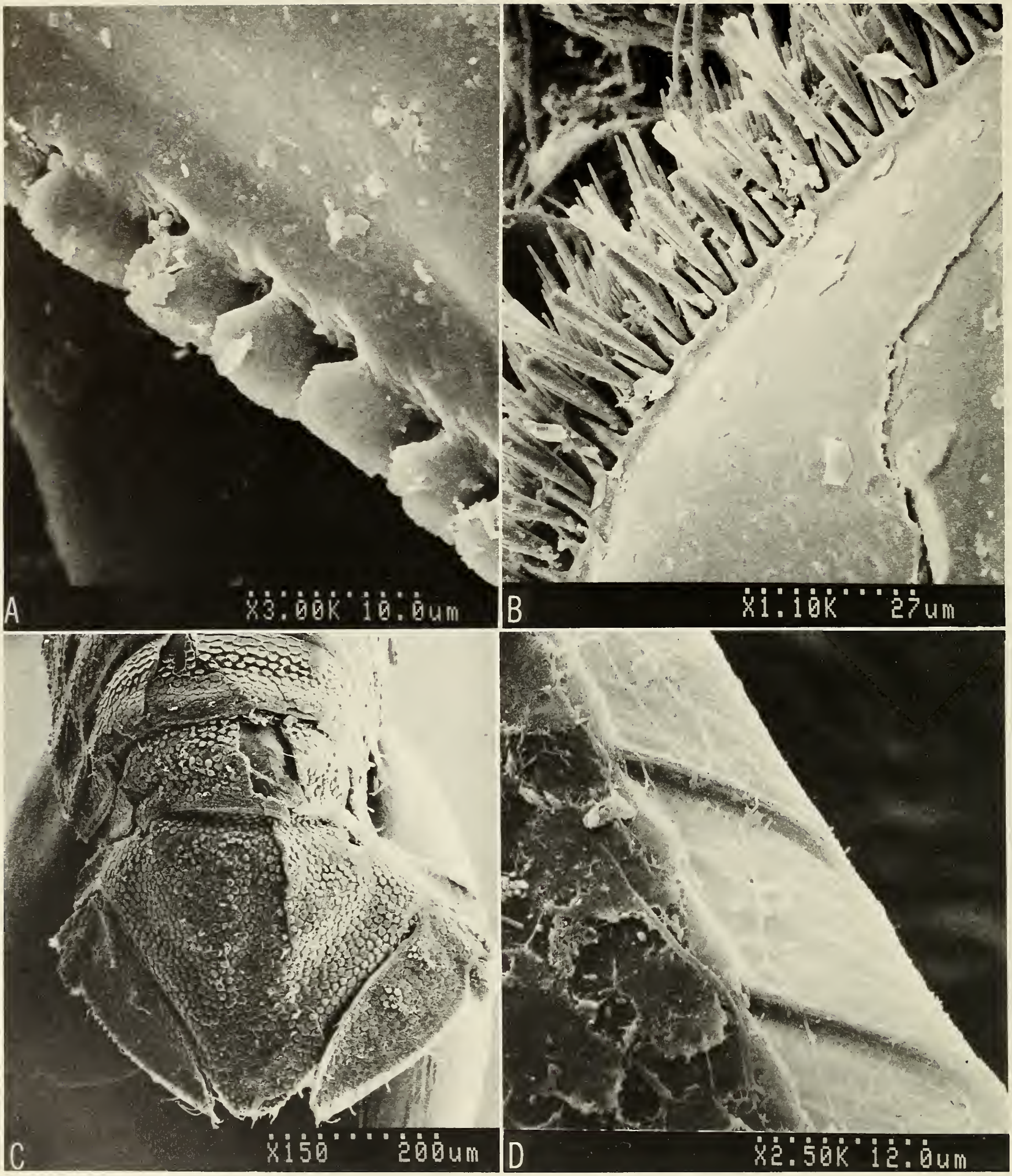

Fig. 17. *Ancinus belizensis*: A, Pereopod 1, tubercles of proximal cutting edge; B, Pereopod 1, spination of propodal margin. *Casidinidea mosaica*: C, Pleotelson in dorsal view; D, Fused setal fringe of uropod.

curved, bearing 5 fringed spines in distal half; left mandibular incisor of 3 sclerotized and 2 non-sclerotized cusps; lacinia mobilis non-sclerotized, with 2 distal cusps; spine row represented by single stout serrate spine. Right mandibular incisor as in left, lacinia mobilis with 2 sclerotized cusps; spine row with 2 serrate spines. Maxilla 1, outer ramus bearing 4 stout serrate spines and 8 smaller and more slender simple spines distally.

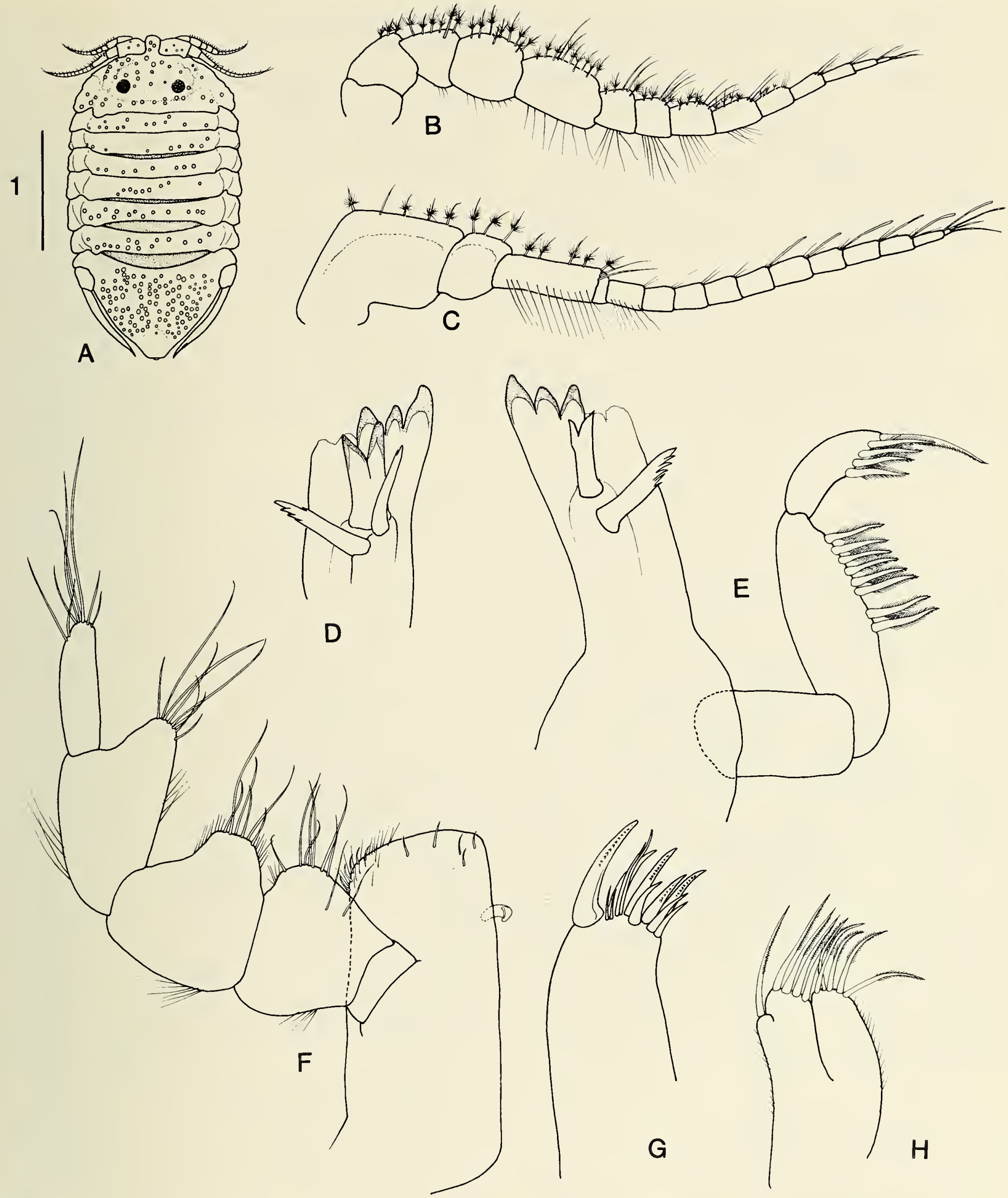

Fig. 18. *Ancinus belizensis*: A, Adult in dorsal view; B, Antenna; C, Antennule; D, Distal part of right mandible; E, Left mandible; F, Maxilliped; G, Maxilla 1; H, Maxilla 2.

Maxilla 2, inner ramus with 5 elongate fringed distal setae; outer ramus with 4 distal fringed setae, plus single setae on rudimentary outer lobe. Maxillipedal endite distally bluntly rounded to subtruncate; single retinaculum on medial margin; basal palp article short, 2½ times wider than long; articles 2–5 bearing elongate simple setae on anterior (medial) lobed margins; terminal article slender, 3½ times longer than broad.

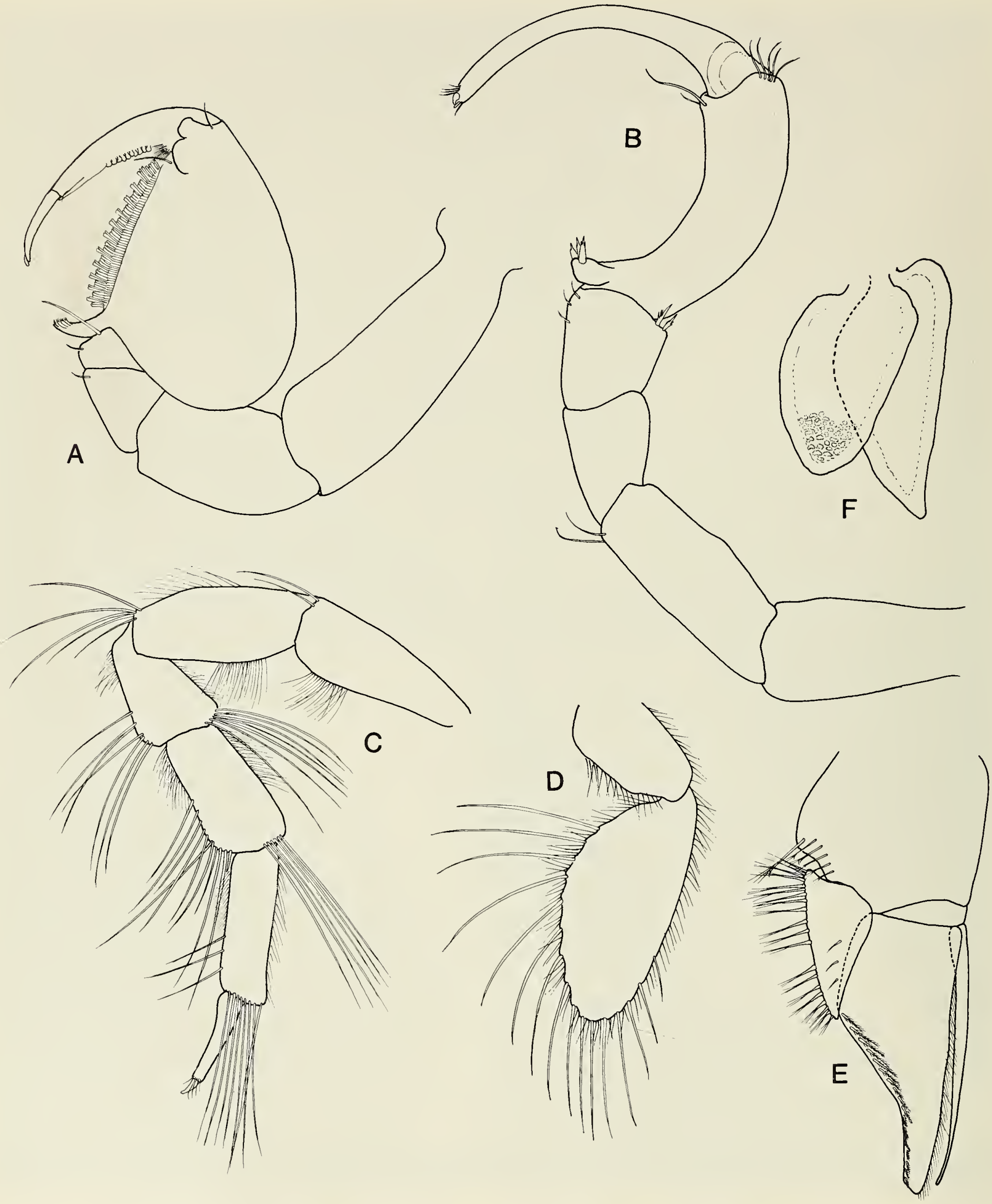

Fig. 19. *Ancinus belizensis* ♂: A, Pereopod 1; B, Pereopod 2; C, Pereopod 7; D, Pleopod 1; E, Pleopod 2; F, Pleopod 3.

Pereopod 1, unguis about half length of rest of dactyl, with elongate accessory spine at base; proximal half of dactyl bearing row of rounded scales on posterior margin; propodus proximally inflated; palm bearing series of densely-packed long and short distally widened setae; proximal digitiform process curved, reaching beyond carpus. Pereopod 2, dactyl elongate, curved, tip reaching proximal lobe of propodus, latter bearing 3 stubby spines; propodus strongly curved, palm strongly concave. Pereopod 7, dactyl ⅔ length of propodus; latter parallel-sided, with about 8 elongate setae on distal margin; carpus, merus, and ischium each bearing elongate setae on antero- and posterodistal margins.

Pleopod 2, exopod triangular, less than half length of distally tapered endopod; copulatory stylet elongate-slender, just falling short of apex of endopod. Pleopods 3–5 typical of genus. Uropodal ramus reaching to pleotelsonic apex, tapering, following lateral margin of pleotelson closely, with faint distal flexure.

Remarks.—The present species differs from the five species discussed by Glynn and Glynn (1974) in several features:

In *A. panamensis* Glynn & Glynn, 1974, from Pacific Panama and Colombia, the dactyl of pereopod 2 of the male is short and closes on the propodus; in *A. belizensis* the dactyl closes (i.e., the apex reaches) the carpus. The antennular flagellum has 13 articles, the antennal flagellum nine (*A. belizensis*: 12 and 10 articles, resp.). The proximal digitiform process of pereopod 1 in the male is short (relatively elongate in *A. belizensis*). The two distal articles of the mandibular palp bear 9 and 10 setae as against 8 and 5 in *A. belizensis.* The coarse and obvious integumental pitting of the latter species is distinctive; the pitting in *A. panamensis* is finer and less obvious (see Brusca and Iverson 1985).

In *A. brasiliensis* Lemos de Castro, 1959, the pleotelson is as long as its basal width, and apically narrowly truncate; in *A. belizensis* the pleotelson is wider than long, more broadly truncate, and the dactyl of pereopod 2 of the male is relatively longer, reaching to the midlength of the carpus; the antennular flagellum has 14–16 articles, the antennal flagellum 8–10 articles.

Ancinus granulatus Holmes & Gay, 1909, of California (with its synonym *S. seticornus* Frask, 1970), has a densely granulate integument.

Ancinus depressus (Say, 1818) of the east coast of the U.S.A. and Gulf of Mexico is a large species (at least three times longer than *A. belizensis*), having the uropodal ramus distinctly shorter than the pleotelson.

Etymology.—The specific name refers to the country of Belize, where the present species, as well as several others in this paper, was collected.

Cassidinidea mosaica, new species

Figs. 17C, D, 20, 21

Material.—HOLOTYPE, USNM 211403, ♂ tl 1.8 mm; sta CBC-K-158, Carrie Bow Cay, Belize, rubble and coarse sediments at base of spur and groove buttress, 8–10 m, 24 Nov 1985.

PARATYPES, USNM 211404, 10 specimens (incl. 1 ovig. ♀ tl 1.6 mm); same data as holotype.—USNM 211405, 15 specimens (incl. 3 ovig. ♀ tl 1.5 mm); sta CBC-AC-610-B, Carrie Bow Cay, Belize, silty sand from patch reefs, 1.5 m, 14 Jun 1981, coll. A. Cohen.

Description.—Body oval in outline, about twice longer than wide. Dorsal integument finely tuberculate. Lateral margins fringed with transparent setose flange. Cephalon embedded in pereonite 1; eyes dorsal, well pigmented. Pereonites 2–7 subequal in length and width. Pleonite 1 free, middorsally somewhat inflated, with free lateral margin. Pleotelson triangular, basally slightly inflated, posteriorly apex narrowly rounded. Frontal lamina visible between antennal bases.

Basal antennular peduncle article flexed, rest of appendage directed laterally; 2 distal peduncular articles becoming progressively shorter; flagellum of 3 articles, distal article bearing single aesthetasc. Antennal peduncular articles becoming progressively longer distally; flagellum of 7 setose articles. Mandible with strong dentate molar, 4 spines in spine-row, 3 cusps in incisor; palp of 3 articles, article 2 with 2 distal fringed spines, article 3 with 5 distal fringed spines. Maxilla 1, inner ramus with 4 fringed setae, outer

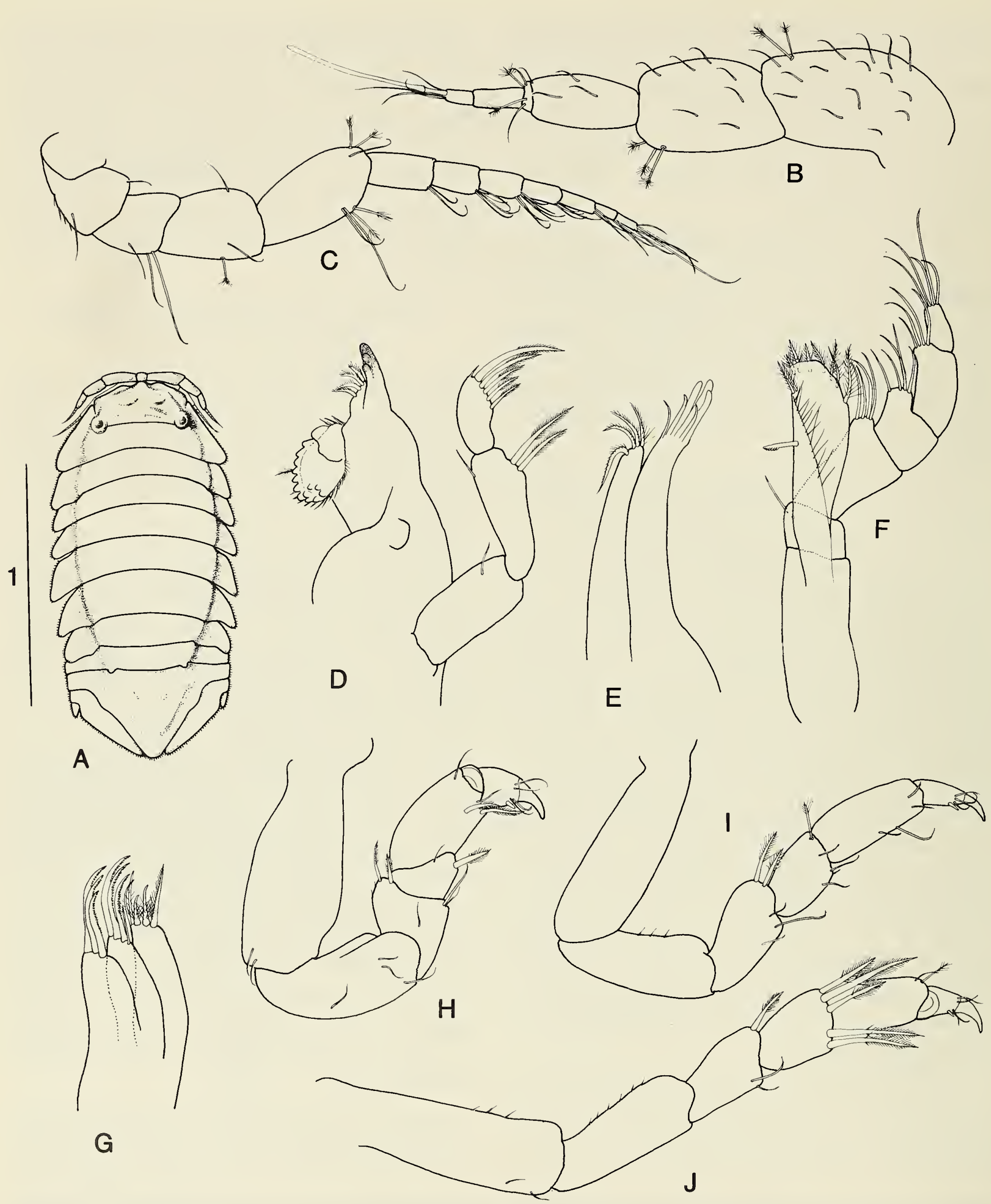

Fig. 20. *Cassidinidea mosaica*: A, Adult in dorsal view; B, Antennule; C, Antenna; D, Mandible; E, Maxilla 1; F, Maxilliped; G, Maxilla 2; H, Pereopod 1; I, Pereopod 2; J, Pereopod 7.

ramus with 3 broad and 3 slender distal spines. Maxilla 2, inner ramus with 5 distal fringed spines; inner lobe of outer ramus with 3 dentate spines and 1 simple spine, outer lobe with 3 dentate spines. Maxillipedal endite reaching to article 4 of palp, distally rounded, with single retinaculum on median margin, several short fringed spines distally; palp articles 2–5 with several simple setae on low inner distal lobe.

Pereopods becoming progressively longer posteriorly. Pereopod 1 with unguis equal

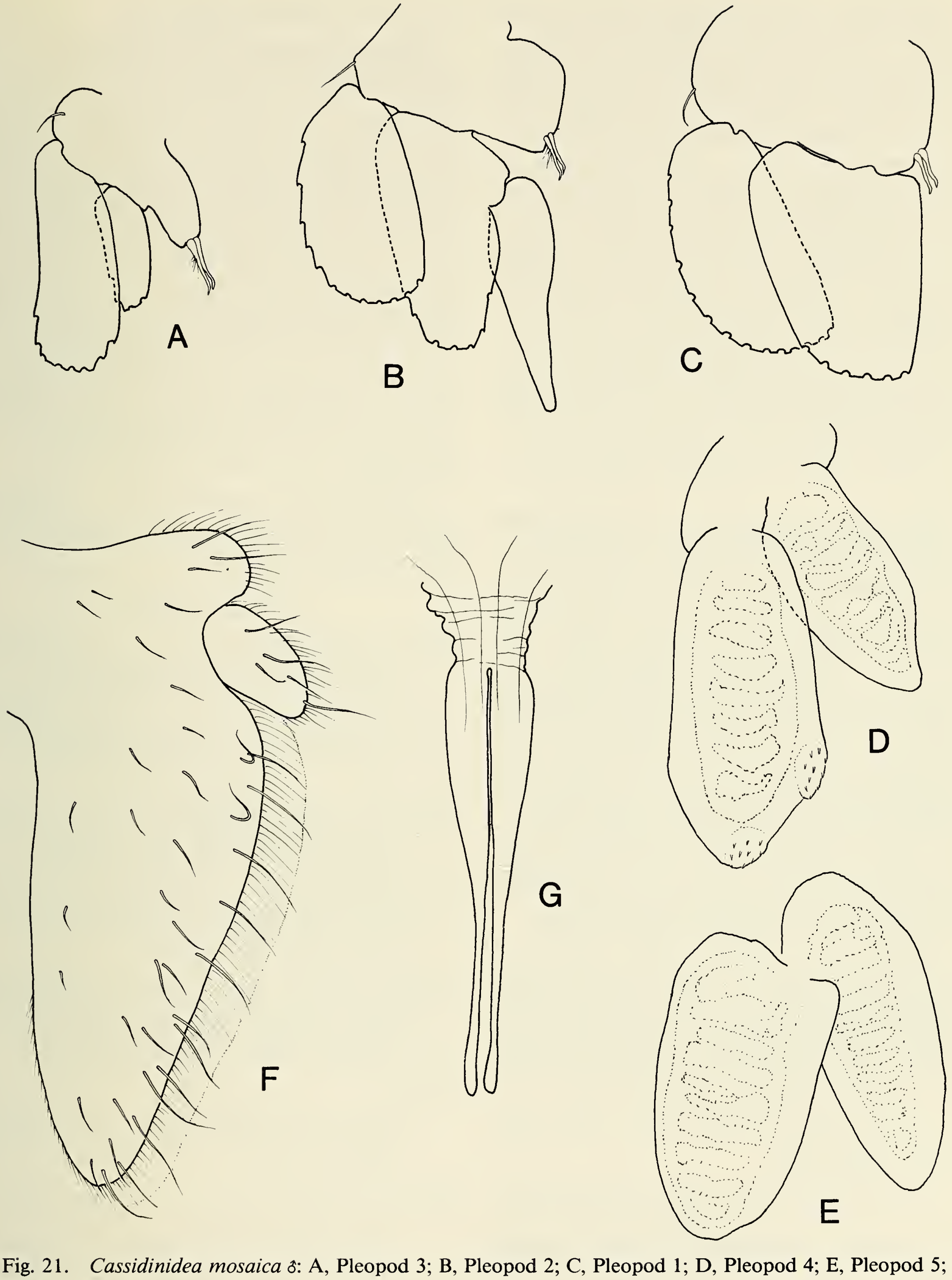

Fig. 21. *Cassidinidea mosaica* ♂: A, Pleopod 3; B, Pleopod 2; C, Pleopod 1; D, Pleopod 4; E, Pleopod 5; F, Uropod; G, Penis.

in length to rest of squat dactyl; propodus with 2 posterodistal spines; carpus triangular, with single posterodistal spine; merus with 2 anterodistal spines. Pereopod 2, dactyl less squat than that of pereopod 1, propodus and carpus lacking spines. Pereopod 7, carpus rectangular with 2 posterodistal, and 3 anterodistal stout fringed spines.

Penile rami basally fused, distally with 2 slender elongate rami. Pleopod 1 in male, basis broad, with 2 retinacula; endopod basally broad, distally tapering, longer than ovate and narrower exopod. Pleopod 2 in male, both rami ovate; copulatory stylet attached basally to endopod, basally broad, tapering distally, extending well beyond rami. Pleopod 3, basis produced mesially into lobe bearing 2 retinacula; endopod elongate-ovate, half length and width of exopod. Pleopod 4, both rami well developed, pleated. Pleopod 5, exopod ⅔ length of, and narrower than, exopod. Uropodal basis and endopod fused, almost reaching pleotelsonic apex, distally rounded; exopod short, ovate.

Remarks.—Menzies & Frankenberg (1966) regarded *Dies* and *Cassidinidea* as synonymous, but noted the single penis of the former and the double structure of the latter. Carvacho (1977) disagreed with Menzies & Frankenberg, maintaining that the genital structure required separation of the two genera. He further characterized *Dies* as being estuarine, *Cassidinidea* as truly marine. Heard (1982), however, recorded *C. ovalis* from the northeastern Gulf of Mexico, from salinities of <1‰-20‰, i.e., truly estuarine. Loyola e Silva (1960) also characterized *Dies* as having a single penis.

Cassidinidea mosaica differs from *C. ovalis* (Say, 1818) (=*C. lunifrons* (Richardson, 1905), see Schultz 1978, Heard 1982) known from New Jersey to Florida, in having a rounded posterior pleotelsonic margin, in being a smaller species (ovig. ♀ 1.5–1.6 mm), and in having a finely tuberculate dorsal integument.

Cassidinidea tuberculata Richardson, 1912, from Mexico, Brazil, Argentina (see Pires 1982), has a relatively larger uropodal exopod, a less ovate body outline, and a larger body-size (♀ tl 5.1 mm).

Etymology.—The specific name refers to the dorsal integument especially of the pleotelson, which resembles the closely-set tesserae of a mosaic (see Fig. 17).

Acknowledgments

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STEGOPHIURA PONDEROSA (LYMAN), NEW COMBINATION, AND *AMPHIOPHIURA VEMAE* AND *HOMOPHIURA NEXILA,* NEW SPECIES (ECHINODERMATA: OPHIUROIDEA) FROM THE R/V *VEMA* COLLECTIONS

Michael A. Kyte

Abstract.—*Amphiophiura ponderosa* Matsumoto is placed in the ophiurid genus *Stegophiura* and is redescribed. The geographic distribution of this species is extended to the Southern Hemisphere. *Amphiophiura vemae* and *Homophiura nexila* collected from the R/V *Vema* off the west coast of Central and South America are described as new species.

Between November 1958 and March 1961, benthic samples were collected from the R/V *Vema* of the Lamont-Dougherty Geological Observatory of Columbia University along the west coast of Central and South America between the latitudes of 13°N and 47°S. This sampling was a part of a long-term benthic exploration using the *Vema.* The collected echinoderm specimens were deposited in the American Museum of Natural History.

Among the specimens that were previously unidentified, two were new species. Also within these collections were three specimens of *Amphiophiura ponderosa* (Lyman), which after comparison with the descriptions by Lyman (1882) and Clark (1911), is assigned to the genus *Stegophiura.*

Order Ophiurida Muller & Troschel, 1840
Ophiuridae Lyman, 1865
Stegophiura ponderosa (Lyman), new combination
Fig. 1

Ophioglypha ponderosa Lyman, 1878:93, pl. 2, figs. 52–54.
Ophiura ponderosa.—Meissner, 1901: 925.—H. L. Clark, 1911:77.
Amphiophiura ponderosa.—Matsumoto, 1917:261.

Material examined.—R/V *Vema* samples: V-17-15, Golfo de Penas, Chile, 47°02'S, 75°36'W, 642 m, 24 Mar 1961, 3 individuals, 1 specimen deposited as paratype in American Museum of Natural History (AMNH 2758).

Description.—Disc diameter 32 mm, arms incomplete, length estimated at 100 mm.

Disc about 10 mm high, covered by about 130 irregular, angular, thick plates. Primary plates conspicuous, separating proximal ends of radial shields, high, prominent, forming low projections. Radial shields large, nearly as wide as long, contiguous distally along straight inner margin, widely separated proximally by primary plate. Radial shields and primary plates locked together with "dove-tail" notch arrangement at distal apices of primary plates.

Ventral interbrachial spaces covered by 9 to 13 plates. Plates immediately distal to oral shields irregularly elongate, remaining plates irregular, angular, similar to aboral disc plates.

Oral plates narrow, conspicuously swollen at proximal end forming a marked elevation on face of each jaw, tapering to points distally adjacent to adoral plates. Apical papillae 2, bluntly pointed. Oral papillae 4 to 7 on each side of jaw, varying from small, low, and truncate to large and elongate, distinct but continuous with oral tentacle pore papillae. Oral tentacle pores large, opening

Fig. 1. *Stegophiura ponderosa.* Dorsal view (top), lateral view (center), and ventral view (bottom).

partially into mouth slit, protected by 6 large oral papillae proximally and by 6 smaller papillae borne by peristomal plate distally.

Oral shields small, arrow-shaped, with distal rounded semicircular distal lobe between the genital slits. Adoral shields relatively large, rectangular, with projections at outer distal ends separating oral shields from first lateral arm plates. Each adoral shield bearing 3 to 4 papillae on distal outer corners similar to opposing genital papillae. Adoral shields unequal in length, one usually slightly longer, overriding other.

Genital slits long and narrow, continuing nearly halfway to aboral side of arms. Each slit bordered by 3 to 4 plates; small round plate adjoins oral shield, followed by long, rectangular plate continuing to aboral arm base where it fragments into 2 to 4 increasingly smaller angular plates meeting at arm aboral apex distal to radial shields. Each plate bearing series of low, rectangular, wider proximally, narrower distally, marginal papillae continuing aborally to arm apex forming arm comb.

Arms higher than wide, triangular in cross-section. Dorsal arm plates much wider than long, rectangular, becoming pentagonal and nearly equal, or slightly longer than wide, near arm tip. Dorsal arm plates appearing folded over apex of arm, broadly in contact throughout. First ventral arm plate pentagonal, wider than long, adjoining next plate. Succeeding arm plates trapezoidal to pentagonal to diamond-shaped, wider than long in distal parts of arm.

Lateral arm plates high, narrow, pointed at both ends and interlocking with oral and aboral plates, distal sides convex, proximal sides concave. First lateral arm plate bearing 16 arm spines, succeeding plates carrying approximately 10 spines. Arm spines dimorphic, 3 on proximal plate, 2 on succeeding plates, rounded, bead-like, becoming bluntly pointed distally. Second type low, truncate, first immediately above tentacle scales which are similar but disappear distally. Lowest rounded spine separated from tentacle scales by 1 truncate spine, those above separated by 4 to 5 spines.

Tentacle pores large, protected by as many as 8 tentacle scales on each side with outer set overlapping partially, or entirely hiding inner set. After third or fourth arm joint no distal tentacle scales, after sixth or seventh joint only 2 or 3 tentacle scales persisting with pores to arm tip.

Color (dried from alcohol): whitish tinged with light brown.

Distribution.—Western Pacific off Japan, Okhotsk Sea, eastern Pacific off Alaska, central California, and Chile; outer continental shelf to middle slope, 137 to 923 m. Previous to the collection from the R/V *Vema, Stegophiura* was known only from the Northern Hemisphere (D'yakonov 1954, Downey 1969). This collection extends the range of both genus and species to the Southern Hemisphere from the boreal North Pacific. The bathymetric distribution of the species is maintained.

Discussion.—This species has not been described in detail since Lyman (1882), who had only one specimen with which to work. Also, Lyman's description and figures were detailed and accurate in regards to disc features, but were not correct in depicting the arm spines, as was noted by H. L. Clark (1911). Because of this situation and the suggested transference of the species to another genus, the above detailed description is presented of the most complete and typical of the three specimens collected.

The genera *Amphiophiura* and *Stegophiura* were erected by Matsumoto (1915, 1917) while clarifying species relations within the genus *Ophiura.* The two genera were distinguished by Matsumoto on the basis of only the dimorphism of the arm spines and the relation between arm height and width. All other characters of the two genera were similar according to Matsumoto's discussion. However, the two genera differ also by the apparent degree of stoutness and inflation of the aboral disc scales with *Stegophiura* being the stouter.

Matsumoto (1917) listed *Ophioglypha ponderosa* as an *Amphiophiura* in his Group III containing species with the oral interradial disc covered with small plates, with quadrangular oral arm plates, and uniform arm spines. According to Lyman's (1878, 1882) description and figures, this was a correct generic placement even though Lyman described the oral arm plates as "broadly hexgonal." However, the *Vema* specimens and two individuals from *Albatross* station 5023 in the Okhotsk Sea were definitely *Stegophiura* while also fitting Lyman's description of *O. ponderosa* reasonably well. All specimens had a high and stout disc, higher than wide arms, and dimorphic arm spines. It is because of these characters that *O. ponderosa* is transferred here to *Stegophiura.* Matsumoto (1917:262) indicated that Group III, which contained *O. ponderosa,* approaches *Stegophiura.*

Amphiophiura vemae, new species
Fig. 2

Material examined.—R/V *Vema* samples: V-17-1, southeast of Punta Aguja, Peru, 7°10′S, 85°50′W, 4124 m, 26 Feb 1961, 1 individual; V-17-5, off Punta Morquilla, Chile, 38°15′S, 76°00′W, 3739 m, 15 Mar 1961, 7 individuals, holotype (AMNH 2759), 6 paratypes (AMNH 2760).

Etymology.—The specific name was chosen in honor of the R/V *Vema.*

Description.—Disc diameter 9 mm; arm length approximately 12 to 14 mm.

Disc stout, slightly convex, nearly 4 mm high. Dorsal side of disc covered by about 84 plates. Primaries and radial shield conspicuous, slightly swollen. Radial shields slightly longer than wide, with rounded outer edges and straight inner edges for distal two-thirds of their length; in contact for distal one-third, separated proximally by small, wedge-shaped plates and larger, rounded, slightly swollen plates.

Ventral interbrachial spaces covered by large oral shields and 14 to 16 small, irregular marginal and submarginal plates.

Oral papillae stoutly triangular, well separated, 3 to 5 on each side of jaw, 2 to 3 longer apical papillae.

Oral tentacle pores large, opening entirely outside mouth slit, protected by 1 long, low, flat scale on each side of pore.

Oral shields nearly oval with narrowed proximal end, lateral sides partially covering genital slits, separated from first oral arm plates by adoral shields. Adoral shields short, rectangular, broadly in contact.

Genital slits long, partially obscured distally by arm comb papillae. Each slit bordered by 2 plates, most ventral small, inconspicuous, carrying 2 or 3 wide, flat, adjoining truncate papillae. Second plate large, conspicuous from lateral view, carrying marginal series of 7 to 9 wide, flat papillae with rounded tips.

Arms stout, slightly rounded, bluntly triangular in cross-section proximally. First dorsal arm plate broadly triangular with convex distal edges. Subsequent dorsal arm plates tetragonal with convex distal margins and flaring sides, becoming pentagonal near middle of arms, triangular near tips, broadly in contact proximally but widely separated near arm tips.

First ventral arm plate hexagonal, wider than long, distal margin longer than proximal. Succeeding plates tetragonal, as long as wide with convex ends and concave sides, becoming more rounded and smaller distally with most distal nearly circular, broadly in contact until seventh to ninth joint, after which plates rapidly separate.

Lateral arm plates approximately as wide as high, rounded, meeting above and below only in distal part of arm. Each plate carrying 2 to 3 equally spaced, small, terete spines.

Tentacle pores large and protected by 2 long, low, flat scales. Distal scales often inconspicuous; tentacle pores and scales persist to arm tip. Color (dried from alcohol): ivory white.

Distribution.—Southeast Pacific upper abyssal regions off Peru and Chile, 3739 to 4124 m.

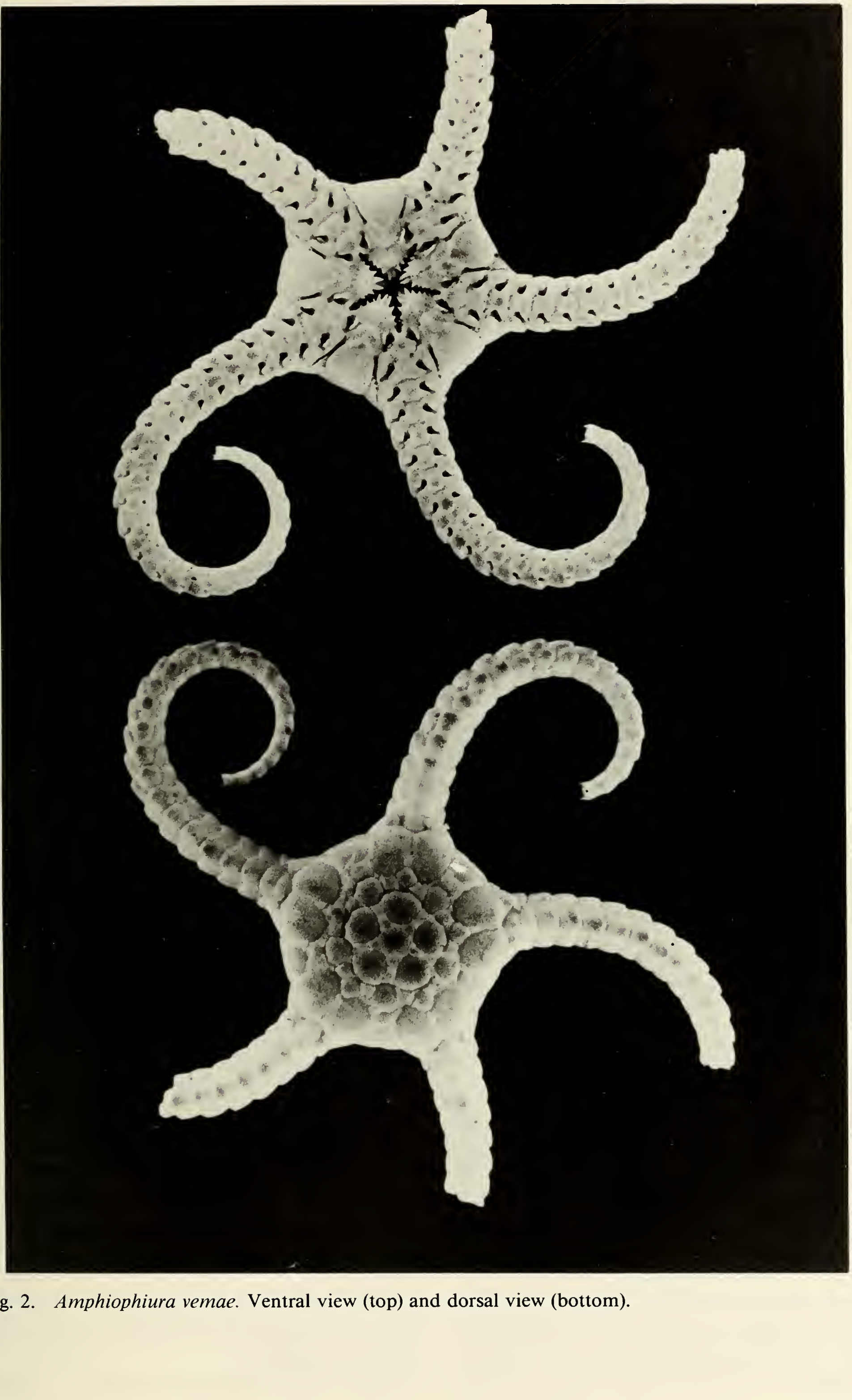

Fig. 2. *Amphiophiura vemae.* Ventral view (top) and dorsal view (bottom).

Discussion.—While these specimens definitely belong to the genus *Amphiophiura,* they are distinct from all other species presently in the genus. Distinctive features include the relation of the radial shields, the shape and number of the oral and genital papillae, and the number and appearance of the tentacle scales. Litvinova (1971) listed two other *Amphiophiura* species in the general region from which *A. vemae* was collected. These two, *A. undata* (Lyman) and *A. convexa* (Lyman), as described by Lyman (1878, 1882) differ from *A. vemae* in having more tentacle scales on each pore, and the arm comb papillae are pointed rather than flat and truncate. Also, the oral papillae are rectangular and truncate in *A. undata* rather than triangular and pointed as in *A. vemae.* The oral shield of *A. undata* is relatively much smaller than in *A. vemae.*

Litvinova (1971) also described a new subspecies from the Northwest Pacific, *Amphiophiura bullata* (Thompson) *pacifica* Litvinova, that was collected within the same abyssal depth range as *A. vemae.* However, in addition to the substantial geographical separation, the species differ in that *A. bullata pacifica* has six to eight tentacle scales where *A. vemae* has only one to two. Also, specimens of *A. bullata pacifica* collected from the same depths as *A. vemae* possessed relatively more dorsal disc scales than *A. vemae* between the primary plates.

The relatively large number of specimens and the variety of sizes present in the two samples from abyssal depths suggest that this zone is the normal habitat for the species.

Homophiura nexila, new species
Fig. 3

Material examined.—R/V *Vema* samples: V-15-37, Gulf of Panama, 7°25′N, 79°23′W, 1749 m, 14 Nov 1958, 3 individuals, holotype (AMNH 2761), 2 paratypes (AMNH 2762); V-15-42, off Costa Rica, 7°55′N, 86°00′W, 3087 m, 19 Nov 1958, 1 individual; V-15-58, off Costa Rica, 12°11′N, 89°34′W, 5690 m, 27 Nov 1958, 2 individuals.

Etymology.—From *nexila* (Latin), meaning tied together, referring to the tapering, jointed appearance of the arms.

Description.—Disc diameter 7 mm, arm length about 12 mm.

Disc stout, flat; dorsal side covered by approximately 90 plates. Primary plates conspicuous, convex. Radial shields conspicuous, flat, twice as long as wide, nearly oval, touching at a point one quarter of length from distal ends, diverging from this point. Radial shields separated distally by small, triangular plate in contact with first dorsal arm plates; proximally separated by 2 plates, more distal longer than wide and acutely triangular, second nearly tetragonal. Each radial shield bearing 2 minute, terete, opaque spines on most lateral interradial margins.

Oral plates of jaw nearly trapezoidal with extended proximal corners, each plate bearing 4 low, fused truncate oral papillae. Single, bluntly pointed apical papilla.

Oral shields small, with proximal angle, rounded distally, well separated from first ventral arm plates by adoral shields. Adoral shields large, narrower at proximal end, broadly in contact. Each plate bearing 1 large, opercular papilla protecting second oral tentacle pore.

Genital slits short, inconspicuous, guarded by 1 to 3 small, bead-like papillae. Each slit bordered by 2 plates, bar-shaped with rounded ends, distal plate approximately twice as long as proximal. Proximal plates bearing genital papillae, distal plates bare. No arm comb.

Arms rounded in cross-section, rapidly tapering, slender. First dorsal arm plate broad, wider than long, semicircular with straight proximal border adjoining disc plate separating radial shields distally. Dorsal arm plates after first small, inconspicuous, tetragonal, wider proximally, longer than wide, becoming equilateral distally, widely separated throughout.

First ventral arm plate rounded, approx-

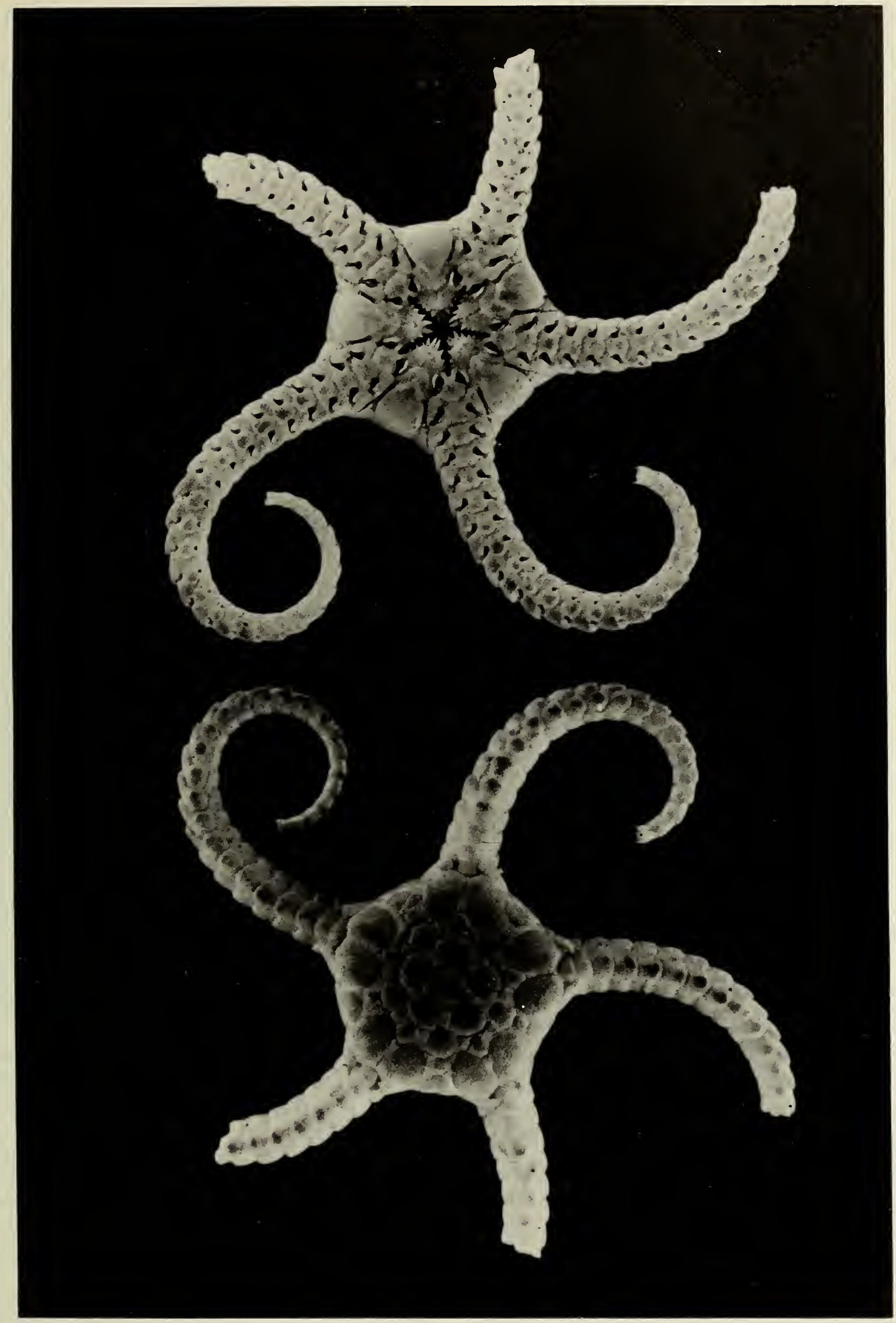

Fig. 3. *Homophiura nexila.* Ventral view (top) and dorsal view (bottom).

imately hexagonal, bearing 2 low, flat papillae pointed at inner ends and projecting into mouth slit giving plate notched appearance. Succeeding ventral arm plates triangular with concave sides, rapidly diminishing after fifth joint, absent after ninth, widely separated throughout.

Lateral arm plates wider than high, broadly in contact after first joint; each plate carrying 3 to 4 small, evenly spaced terete, translucent spines.

Oral tentacle pores small, inconspicuous, opening partly into mouth space, obscured by adoral papillae. Arm tentacle pores larger, protected by 2 low rounded scales on first pores only. After second joint only larger outer scales remain. Tentacle pores present only to fourth joint.

Color (dried from alcohol): ivory white.

Distribution.—Lower continental slope and abyssal regions of the Gulf of Panama and the eastern Pacific off Central America, 1749 to 5690 m.

Discussion.—Hubert Lyman Clark (1915) established this genus with *Ophioglypha inornata* Lyman as the type and included 19 species. Paterson (1985) revised *Homalophiura* and confirmed that the generic name is invalid. Paterson proceeded to place the species formerly assigned to *Homalophiura* into four groups; one of which was the new genus *Homophiura.* The above described specimen corresponds well with Clark's generic description and with generic characters in Lyman's (1878, 1882) description of *O. inornata.* The distinguishing specific characters including the restriction of the tentacle pores to the proximal four arm joints, the long genital slits, and the poorly developed arm combs place this species in Paterson's Group D or the new genus *Homophiura.* The small spines on some disc scales are unusual and differentiate *H. nexila* from other *Homophiura* species.

Acknowledgments

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TRACHELYOPTERICHTHYS ANDUZEI, A NEW SPECIES OF AUCHENIPTERID CATFISH FROM THE UPPER RÍO ORINOCO OF VENEZUELA WITH NOTES ON *T. TAENIATUS* (KNER)

Carl J. Ferraris, Jr. and Justa Fernandez

Abstract.—A new catfish species of the Neotropical siluriform family Auchenipteridae is given the name *Trachelyopterichthys anduzei.* This species can be distinguished from all other auchenipterids by the irregularly distributed brown spots on the dorsal and lateral surfaces of the body and by a unique combination of vertebral and fin ray meristics. Sexual dimorphism of the anal fin and dorsal fin spine is documented in *Trachelyopterichthys taeniatus.*

The auchenipterid catfish genus *Trachelyopterichthys* was created by Bleeker (1862) to accommodate Kner's (1858) *Trachelyopterus taeniatus,* a species then known only from its holotype. *Trachelyopterichthys taeniatus* remains a poorly known fish, being represented by only a handful of specimens in museums. Little has been written about this species due to the dearth of material available for anatomical studies.

Recent collecting in the Río Orinoco system of Venezuela has uncovered another species of this genus, again from a unique specimen. Studies associated with the description of this new species and the recent importation of specimens of *T. taeniatus* into the U.S. aquarium fish trade led to the discovery of previously unknown sexually dimorphic characters in *Trachelyopterichthys.*

Materials and methods.—Vertebral counts include all rib-bearing centra but do not include any of the anterior, complex-centrum elements without ribs.

The following institutional abbreviations are used below: AMNH, American Museum of Natural History; NMW, Naturhistorisches Museum, Vienna; MCZ, Museum of Comparative Zoology, Harvard University; MZUSP, Museu de Zoologia da Universidade de São Paulo, Brazil; MBUCV, Museo de Biologia, Instituto de Zoología Tropical, Universidad Central de Venezuela, Caracas.

Trachelyopterichthys anduzei, new species
Fig. 1

Holotype.—MBUCV V-14627, 139.5 mm standard length, male; Venezuela: Territorio Federal Amazonas; Río Orinoco, Laguna de Carida, at the mouth of Caño Carida, Justa Fernandez and Edgar Armas, 28 Apr 1981.

Diagnosis.—A species of *Trachelyopterichthys* most readily distinguishable from the only other species in the genus, *T. taeniatus,* by a pigmentation pattern consisting of an irregular series of dark spots scattered over the body and caudal fin. Additional characters which distinguish these two species are noted under "Remarks."

Description.—Meristic values of the holotype are presented in Table 1. Head depressed, broad; depth at pectoral-fin base half of its width; fontanelle ovoid, completely contained within frontals. Nostrils widely separated, anterior nostril tubular, posterior with an opercular flap on anterior margin, above eye. Eye obscure, completely covered with skin, less than snout length. Barbels in three pairs, maxillaries extending to dorsal-fin origin, inner mentals short, reaching only to more posteriorly placed

Fig. 1. *Trachelyopterichthys anduzei,* new species, holotype MBUCV V-14627.

outer mentals, outer mentals reach posteriorly to pectoral-fin base. Teeth in both jaws conical, in bands of seven to eight irregular rows. No teeth on vomer or palatines. Lower jaw protruding slightly.

Dorsal fin with narrow base, base one-third of head length; fin spine pungent, with single row of feeble denticles along anterior midline; posterior and lateral margins smooth, except for fine grooves running parallel to long axis. First branched dorsal ray extending beyond spine, fin margin rounded; tip of appressed spine just reaches to vertical line through pelvic-fin origin. Adipose dorsal fin absent.

Pectoral fin with pungent spine, spine length equals distance from snout tip to pectoral-spine origin, spine with approximately equal numbers of serrae on both margins. Anterior serrae antrorse, progressively larger distally; posterior serrae retrorse, all of approximately equal length. Dorsal and ventral surfaces of spines with fine parallel grooves, without granulations, first branched ray slightly longer than spine, rays becoming progressively shorter posteriorly.

Pelvic fins broadly rounded, branched rays 3 to 5 longest; appressed fin rays reaching past anal-fin origin.

Anal fin with branched rays of approximately equal length, posterior three shorter. Posterior margin rounded; appressed fin rays not reaching to caudal fin base.

Caudal fin emarginate, middle rays only a little shorter than lateral principal rays; lobes broadly rounded, dorsal lobe slightly longer than ventral.

Cleithral spine long, acutely pointed; reaching to beneath dorsal-fin origin; directed posterodorsally; lateral surface covered with rows of fine rounded nodules of uniform size.

Lateral line canal undulating posteriorly from beneath dorsal fin, becoming less wavy posteriorly; cephalic lateral line canal ossifications of the preopercular and infraorbital series wholly contained beneath skin and lack granulations.

Pigmentation in ethanol.—Head brown dorsally, white on underside, except for brown lower jaw margin. Body dark brown dorsally, progressively lighter ventrally, abdomen white. Fins brown except for dorsal and posterior margins of dorsal fin, posterior half of pectoral fins, unbranched pelvic ray and anterior and distal margins of anal fin white; brown areas of caudal fin, ventral and anal fin bases, and dorsal and lateral surfaces of body, with scattered dark brown spots 3 mm or less in diameter; spots largest and most concentrated on dorsal half of lateral body surface.

Etymology.—The patronymic species epithet is for Dr. Pablo Anduze, former governor of the Territorio Federal Amazonas, Venezuela, for his continued interest in the natural history of the Amazonian region of Venezuela.

Remarks.—*Trachelyopterichthys anduzei* differs from its congener in quite a number of characters. The pigment pattern of *T. taeniatus* consists primarily of a series of alternating black and white stripes running the length of the body. All fin ray counts except the caudal differ between the two species (Table 1). The dorsal fin origin is proportionally further posteriorly in *T. anduzei* than in *T. taeniatus* (29 vs. 23% of standard length (SL), respectively).

The dorsal spine of *T. anduzei* has but a single anterior row of feeble serrae, whereas in *T. taeniatus* several rows of stout, blunt tubercles cover the anterior and lateral surfaces. The pectoral spine of *T. taeniatus* is also more heavily ornamented, with an irregular patch of small rounded serrae proximally on its ventral surface, and an accessory row of pointed serrae both dorsal and ventral to the anterior edge of the spine. In larger individuals, serrae are more prominent and more widely distributed on the dorsal and ventral surfaces.

The cleithral process of *Trachelyopterichthys anduzei* has shorter, more uniformly-sized tubercles and is more acutely pointed than in *T. taeniatus.* The enlarged series of tubercles along the dorsal surface of the cleithral process of *T. taeniatus* is unlike that of any other auchenipterid species.

Relationships.—The genus *Trachelyopterichthys* belongs to a subgroup of the family Auchenipteridae defined by several derived characters, among which are an expanded lateral ethmoid and an accessory basibranchial cartilage (Ferraris, pers. obs.). Within this group, *T. anduzei* shares three additional derived characters with *T. taeniatus*: an elongate anal fin with greater than 38 rays, a high vertebral count, and the absence of an adipose fin. The first two characters are unique within the aforementioned subgroup of the Auchenipteridae. The absence of an adipose fin occurs in a number of auchenipterid species, including all known species of *Trachelyichthys, Epapterus,* and *Trachelyopterus.* Indeed, this character was the basis for the inclusion of *T. taeniatus* in *Trachelyopterus* by Kner (1858). The hypothesis that an adipose dorsal fin is primitively present in catfishes and lost several times within this group has been supported recently by Vari and Ortega (1986). Pending the outcome of a broader study of the relationships among auchenipterid catfishes (Ferraris, in prep.), it is assumed that the absence of an adipose fin in *Trachelyopterichthys* is not a shared derived character of a larger group but is, instead, a synapomorphy for these two species.

Table 1.—Meristics of *Trachelyopterichthys anduzei* holotype and *T. taeniatus.* Number of specimens examined is listed in parentheses.

	T. anduzei holotype	*T. taeniatus*
Dorsal-fin rays	II,5	II,4 (6)
Pectoral-fin rays	I,8	I,8 (6)
Ventral-fin rays	i,10	i,12–14 (6)
Anal-fin rays	iii,36	iii,49–55 (5)
Caudal-fin rays	i,7,8,i	i,7,8,i (5)
Vertebrae (rib bearing/total)	11/46	7–9/47–50 (5)

Sexual dimorphism in Trachelyopterichthys taeniatus.—Britski (1972) noted sexual dimorphism in the anal fin and the placement of the urogenital pore in *Trachelyopterichthys.* Anterior anal-fin rays of females are of the same length and thickness as those following. In males, the last unbranched ray and the first two branched rays are both longer and slightly thicker than those immediately posterior. There is, however, no evidence of modification of the rays or their supporting elements as was found in *Epapterus blomhi* (Vari et al. 1984), *Entomacorus gameroi* (Mago-Leccia 1984), and a number of other auchenipterid species. In most adult male auchenipterid species, including *T. taeniatus,* the urogenital pore is located at the distal tip of the anterior margin of the anal fin in contrast to the enlarged pore anterior to the anal fin base in females.

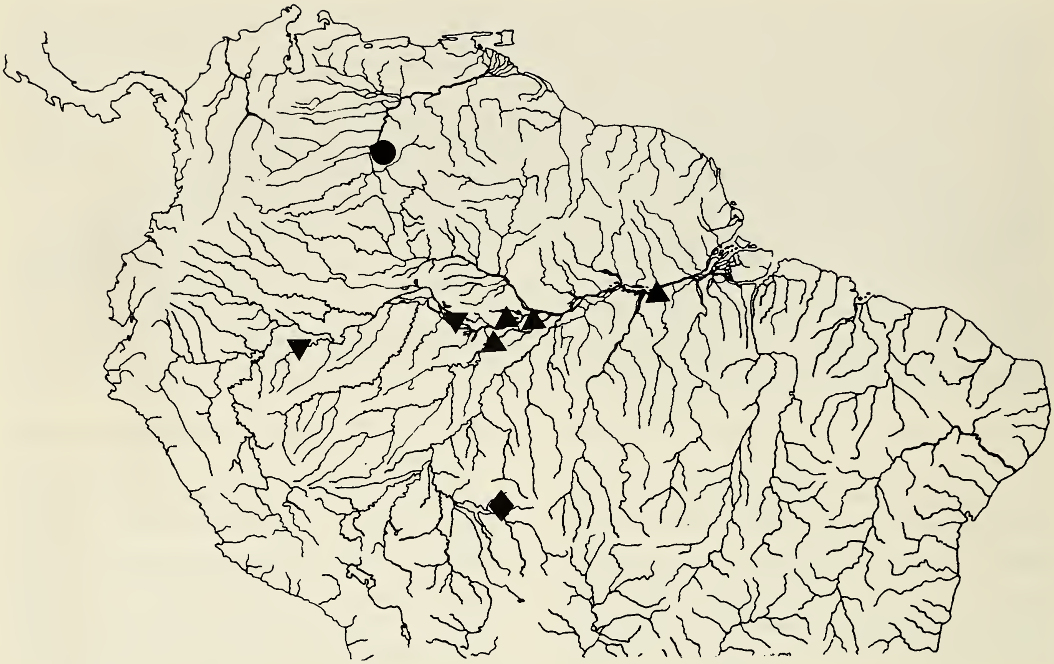

Fig. 2. Geographic distribution of *Trachelyopterichthys anduzei* (●) and *T. taeniatus*: holotype (◆), examined specimens (▼), and literature records (Britski 1972) (▲).

In *Trachelyopterichthys taeniatus* there is, in addition, a clear difference in the length and serration pattern of the dorsal spine. The spine in females and immature males is between 35% and 43% of the predorsal length and it lacks serrations on the posterior margin. Substantially longer (60–69%) spines with a single series of strong, recurved serrae on the distal half of the posterior margin were observed in two males.

Distribution.—Trachelyopterichthys anduzei was collected in the Río Orinoco, and is therefore, the first record of this genus outside of the Río Amazonas basin. *Trachelyopterichthys taeniatus* was described from a specimen from the Río Guaporé (Kner 1858). Additional material collected from the Thayer expedition (Eigenmann and Eigenmann 1890), and specimens housed at MZUSP (Britski 1972) all originate from the Río Amazonas and Río Solimões (Fig. 2).

Relevant material examined.—Trachelyopterichthys taeniatus: NMW 43346, holotype, Río Guaporé; MCZ 36189, 1 male, Lake Hyanuary; MCZ 8132, 1 female, Teffé; MCZ 7731, 1 female, Teffé; AMNH uncat., 3 aquarium specimens.

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SOME CYCLOPOID AND HARPACTICOID COPEPODS FROM COLOMBIA, INCLUDING DESCRIPTIONS OF THREE NEW SPECIES

Janet W. Reid

Abstract.—The cyclopoid copepods *Paracyclops andinus* Kiefer, *P. novenarius,* new species, *Eucyclops serrulatus* (Fischer), *Mesocyclops aspericornis* (Daday), and the harpacticoid copepods *Elaphoidella suarezi,* new species, and *E. radkei,* new species, are recorded from outdoor artificial cultures of *Aedes aegypti* in Colombia. Descriptions of *P. novenarius, E. suarezi* and *E. radkei* are furnished.

Copepods collected from artificial containers in the municipalities of Anapoima and Agua de Dios (Cundinamarca) and Buenaventura (Valle), Colombia, in 1983 and 1985 were sent to me for determination by Dr. Marco F. Suarez of the Servicio Nacional de Erradicación de la Malaria, Bogotá. These outdoor artificial containers, used to rear larvae of *Aedes aegypti,* included asbestos-cement tanks (capacity 250 l), metal drums (200 l) and tires (4 l). Water was supplied to the containers from larger rainwater cisterns. Several species of cyclopoid and harpacticoid copepods were present in the containers. The 1983 finding of *Mesocyclops aspericornis* was reported by Suarez et al. (1984); all records are summarized below and the new species are described.

Locality and date	Species recorded
Anapoima, Cundinamarca:	
8 Nov. 1983	*Mesocyclops aspericornis* (Daday), 18 ♀
Agua de Dios, Cundinamarca:	
20 Aug 1985	*Eucyclops serrulatus* (Fischer), 15 ♀, 2 ♂ *M. aspericornis,* 1 ♀
24 Sep 1985	*E. serrulatus,* 2 ♀ *M. aspericornis,* 2 ♀, 1 ♂
Buenaventura, Valle:	
29 Aug 1985	*Paracyclops andinus* Kiefer, 1 copepodite V ♂ *Elaphoidella suarezi,* new species, 16 ♀
5 Sep 1985	*Paracyclops novenarius,* new species, 12 ♀, 10 ♂, 7 copepodites
18 Sep 1985	*Paracyclops novenarius,* 1 ♀, 4 copepodites *Elaphoidella radkei,* new species, 1 ♂

Paracyclops novenarius, new species
Figs. 1–20

Material.—1 ♀, holotype, National Museum of Natural History, USNM 231096, 5 Sep 1985. Paratypes: 1 ♀, dissected on 1 slide, USNM 231097, 5 Sep 1985; 1 ♂, dissected on 1 slide, USNM 231098, 5 Sep 1985; 10 ♀, 9 ♂, 7 copepodites, USNM 231099, 5 Sep 1985; 1 ♀, 4 copepodites, USNM 231100, 18 Sep 1985; all from Buenaventura, Valle, Colombia. All undissected specimens alcohol-preserved.

Description.—Female: Length of holotype excluding caudal setae 0.67 mm; range of lengths of 11 paratypes 0.57–0.88 mm (median = 0.63 mm). Prosome (Fig. 1) depressed; posterior margins of 2 anterior prosomal somites smooth, posterolateral margins of 2 posterior prosomal somites with hairs. Dorsolateral margin of first urosomal somite with spines, remaining urosomal somites with toothed hyaline membranes on posterior margins and few rows of fine spinules; posterior margin of anal somite with spinules. Genital segment (Figs. 2, 3) slightly expanded anteriorly and tapering posteriorly, broader than long; shape of seminal receptacle normal for genus. Caudal rami (Fig. 2) about 4 × longer than broad, slightly divergent, separated at anal somite by a distance slightly less than breadth of ramus. Length of lateral seta about equal to width of ramus; length of dorsal seta about ¾ length of ramus. Ratios of lengths of inner to outer apical setae 1:6.8:3.5:0.7. Medial apical setae set with fine setules proximally, grading to coarser setules distally.

Antennule (Figs. 4–7) of 9 articles in most specimens; article 4 with partial suture on anterodorsal surface. Article 6 with 2 setae and 1 narrow esthetasc. In one female, articles 3 and 4 of the right antennule are fused posteriorly and divided anteriorly (Fig. 6); while in the left antennule (Fig. 7) these articles are distinct posteriorly, article 3 appearing telescoped under article 2 anteriorly. Antenna, labrum and mouthparts as in Figs. 8–12. Swimming legs 1–4 (Figs. 13–16) each with rami of 3 articles and spine formula 3,4,4,3. Terminal article of endopod of leg 4, 1.5 × longer than broad; inner apical spine 2.1 × longer than outer. Basal lamellae of legs 1–3 each with crescentic row of fine spinules on each side of anterior surface and long hairs on margins; lamella of leg 4 with short hairs near margin.

Medial spine of leg 5 (Fig. 3) reaching midlength of genital segment when depressed. Ratios of lengths of medial to lateral spine and setae of leg 5, 1:1.5:1.2. Leg 6 (Fig. 2) consisting of 1 seta and 1 spinule inserted somewhat dorsally.

Male: Lengths of 10 specimens 0.54–0.64 mm (median = 0.60 mm). Ornamentation of somites (Figs. 17, 18) similar to female. Caudal rami (Fig. 19) about 2.7 × longer than broad; setae similar to those of female. Antennules geniculate (Fig. 20). Lateral seta of leg 5 (Fig. 18) long, slender; medial spine of leg 6 not reaching posterior margin of next somite; middle seta spiniform, short and stout.

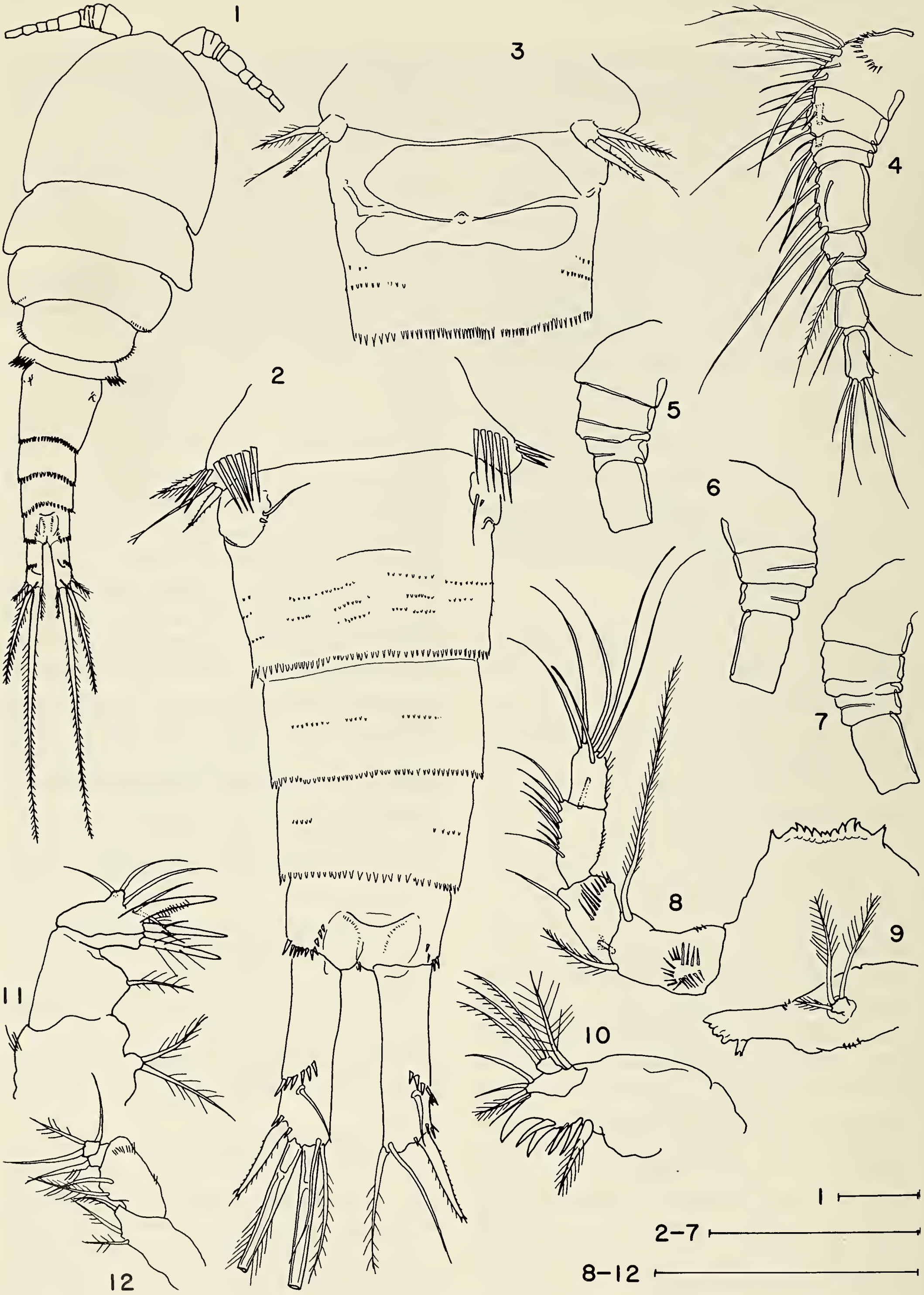
Etymology.—From Latin "consisting of nine," to describe the number of articles in the antennule.

Remarks.—Species of the genus *Paracyclops,* particularly *P. fimbriatus* are notoriously variable in such features as the proportions of the caudal rami and of the terminal article of the endopod of leg 4 (Gurney 1933, Lindberg 1958). However, to my knowledge no population with antennules of 9 articles has been found; all other species in South America possess antennules of 8 articles (Lindberg 1958, Reid 1985). *Paracyclops novenarius* otherwise keys to *P. fimbriatus chiltoni* in the keys of Lindberg (1958) and Reid (1985), but differs in that the inner apical seta on the caudal ramus is relatively longer than that of *P. f. chiltoni;* the basal lamella of leg 4 lacks spinules on its anterior surface; and in the male, the medial spine of leg 6 does not reach the posterior margin of the succeeding somite.

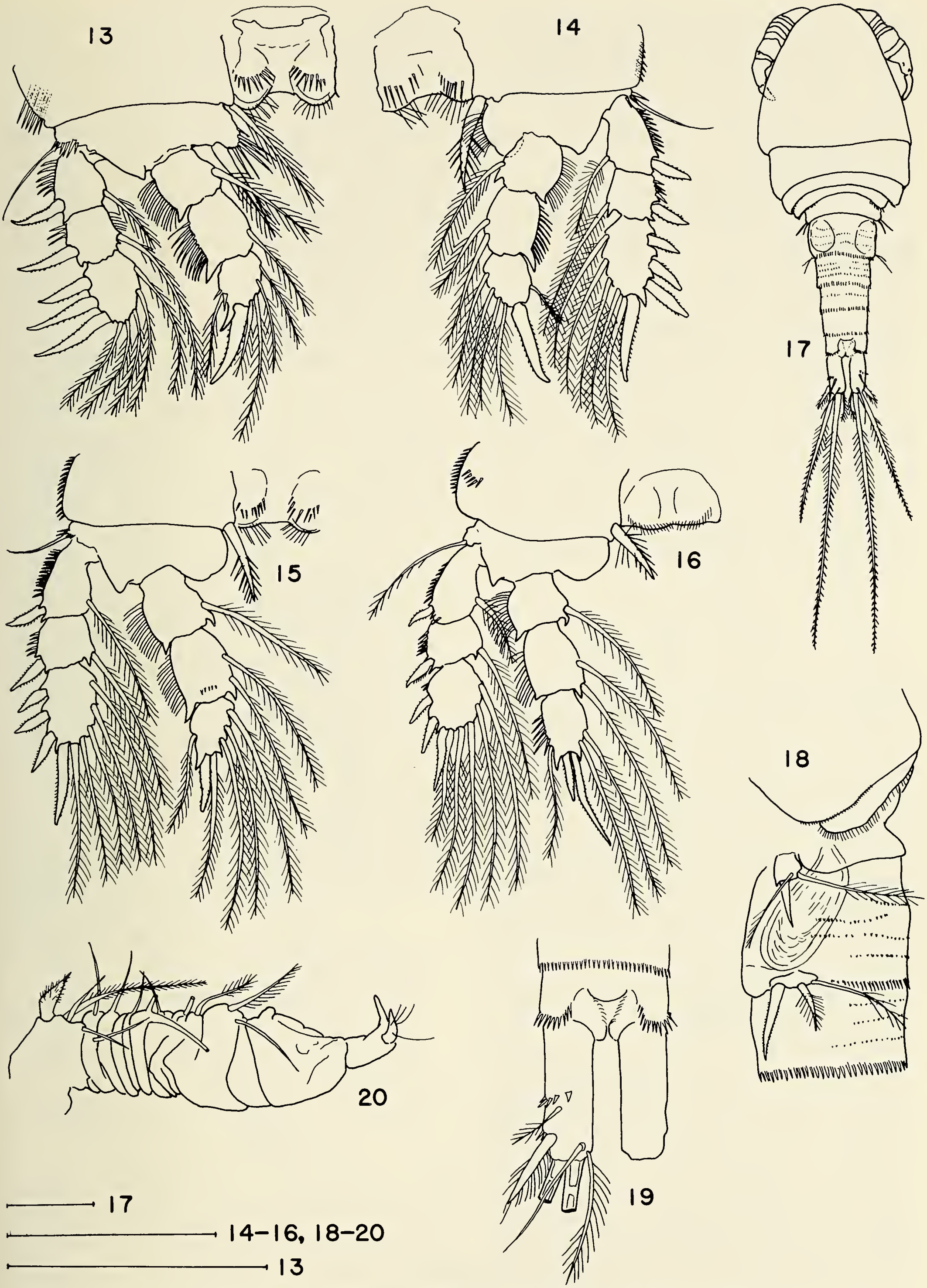
Elaphoidella suarezi, new species
Figs. 21–33

Material.—1 ♀, holotype, USNM 231093, partly dissected on 1 slide. Paratypes: 15 ♀, USNM 231094, alcohol-preserved; all from Buenaventura, Valle, Colombia, 29 Aug 1985.

Description.—Female: Length of holotype 0.37 mm; range of lengths of 10 paratypes 0.35–0.41 mm (median = 0.38 mm). Prosomal and urosomal somites with lateral rows of tiny hairs and toothed posterior margins. Genital segment (Figs. 21, 22) with posterolateral row of 8 large spinules on each side and discontinuous posterodorsal and

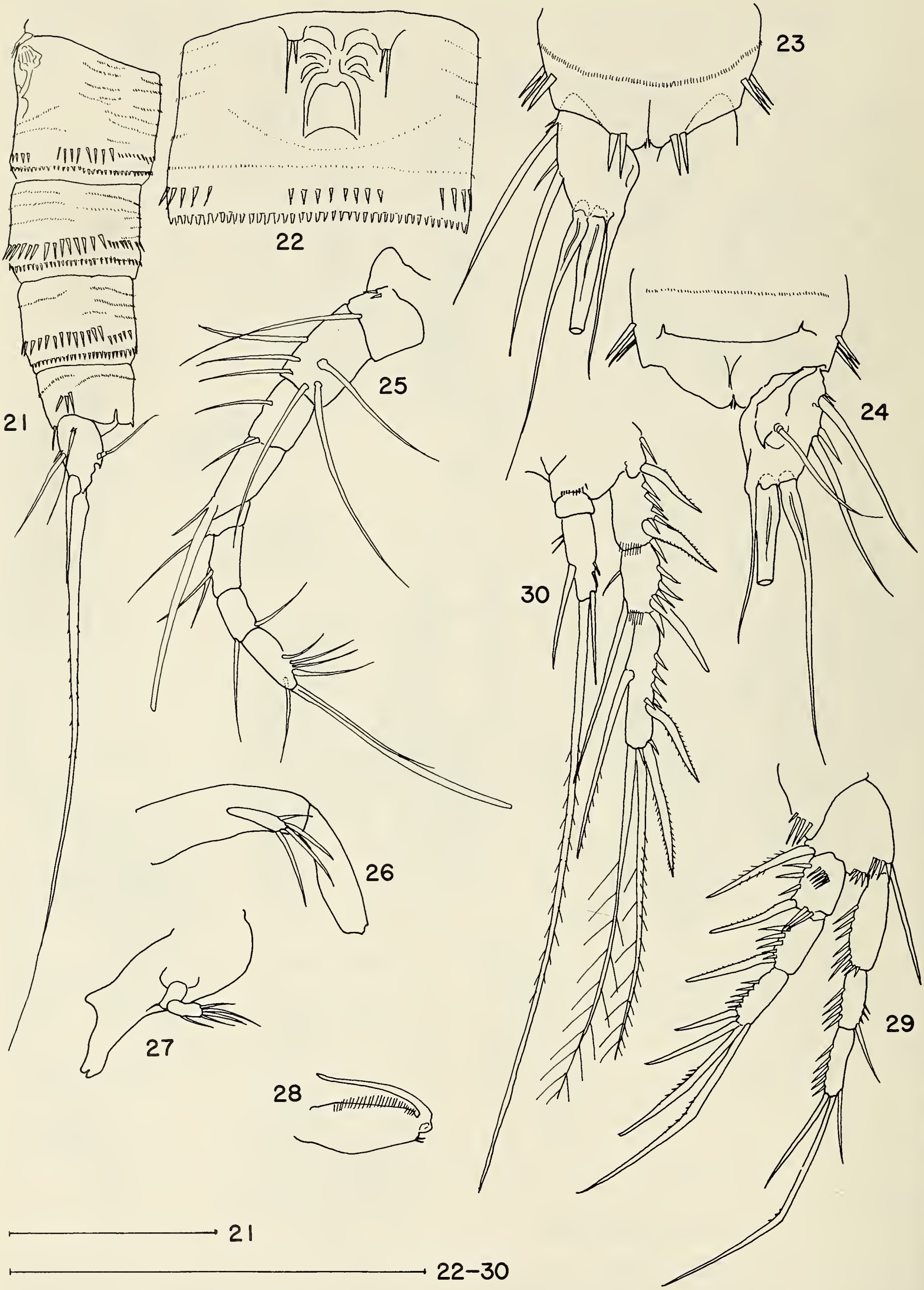


Figs. 1–12. *Paracyclops novenarius,* female: 1, Habitus; 2, Urosome, dorsal; 3, Genital segment, ventral; 4, Right antennule, ventral; 5, Left antennule articles 1–5, dorsal; 6, Right antennule articles 1–4, dorsal, of a second female; 7, Left antennule articles 1–5, ventral, of same female; 8, Antenna and labrum; 9, Mandible; 10, Maxillula; 11, Maxilla; 12, Maxilliped. Scales = 100 μm.



Figs. 13–16. *Paracyclops novenarius,* female: 13, Leg 1; 14, Leg 2; 15, Leg 3; 16, Leg 4.

Figs. 17–20. *P. novenarius,* male: 17, Habitus; 18, Legs 5 and 6; 19, Caudal rami, dorsal; 20, Antennule. Scales = 100 μm.



Figs. 21–30. *Elaphoidella suarezi,* female: 21, Urosome, lateral; 22, Genital segment, ventral; 23, Anal somite and caudal ramus, ventral; 24, Anal somite and caudal ramus, dorsal; 25, Antennule and rostrum; 26, Antenna (setation omitted) and exopod; 27, Mandible; 28, Maxilliped; 29, Leg 1; 30, Leg 2. Scales = 100 μm.

posteroventral rows of smaller spinules. Genital field extending to midlength of segment. Urosomal somites 2–3 each with row of large spinules ventrally and laterally and smaller spinules dorsally along posterior margins. Anal somite with group of 3 long spinules on each side and 2 long spinules extending posteroventrally over each caudal ramus (Figs. 21, 23). Operculum smooth, slightly convex (Figs. 21, 24). Caudal rami about 1.5× longer than broad, with dorsal keel ending in posteriorly directed "tooth" at midlength of ramus and lateral to base of tooth bearing 1 seta with 2 basal articulations. Inner margin of each ramus smooth; outer margin with 2 setae and some spines. Middle apical seta about 1.3× longer than urosome; outer apical seta nearly twice as long as inner apical seta, each of these setae swollen at base.

Rostrum (Fig. 25) reaching distal margin of antennule article 1. Antennule (Fig. 25) of 8 articles, articles 4 and 8 each with 1 long esthetasc. Antenna (Fig. 26) with allobasis; single article of exopod bearing 4 setae. Remaining mouthparts not completely dissected; exopod of mandible of 1 article (Fig. 27); maxilliped prehensile (Fig. 8).

Swimming legs 1–4 (Figs. 29–32) each with exopod of 3 articles; endopod of leg 1 of 3 articles, endopods of remaining legs each of 2 articles. Setation formula for major armature as follows:

Leg 1	basis 1-1	exp 0-1; 0-1; 1,2,1
		enp 0-0; 1-0; 1,2,0
Leg 2	basis 0-1	exp 0-1; 1-1; 1,2,2
		enp 0-0; 1,1,1
Leg 3	basis 0-1	exp 0-1; 1-1; 2,2,2
		enp 0-0; 2,2,1
Leg 4	basis 0-1	exp 0-1; 1-1; 2,2,2
		enp 0-0; 1,1,1

Leg 5 (Fig. 33) with inner expansion of basipod reaching past midlength of exopod and bearing 4 setae of which next innermost is longest. Oval exopod with 4 setae of which innermost is longest.

Etymology.—Named in honor of the collector, Dr. Marco E. Suarez.

Remarks.—*Elaphoidella suarezi* is clearly a member of *Elaphoidella* Group VIII of Lang (1948), but differs from other members of this group recorded from the neotropics in possessing both an unarmed operculum and only two ventral spines on the anal somite above each caudal ramus (Table 1). Among species lacking teeth on the operculum, *E. humboldti* is known only from male specimens, but males of this species have five ventral spines above each caudal ramus, and the operculum is fringed with fine hairs (Löffler 1963). Chappuis (1928) described *E. malayica* as possessing four to seven spinules on each side of the anal somite above the caudal ramus; *E. malayica* is further distinguished by caudal rami which are quadrate in dorsal view and the possession of a short seta on the inner surface of the proximal article of the endopod of leg 3.

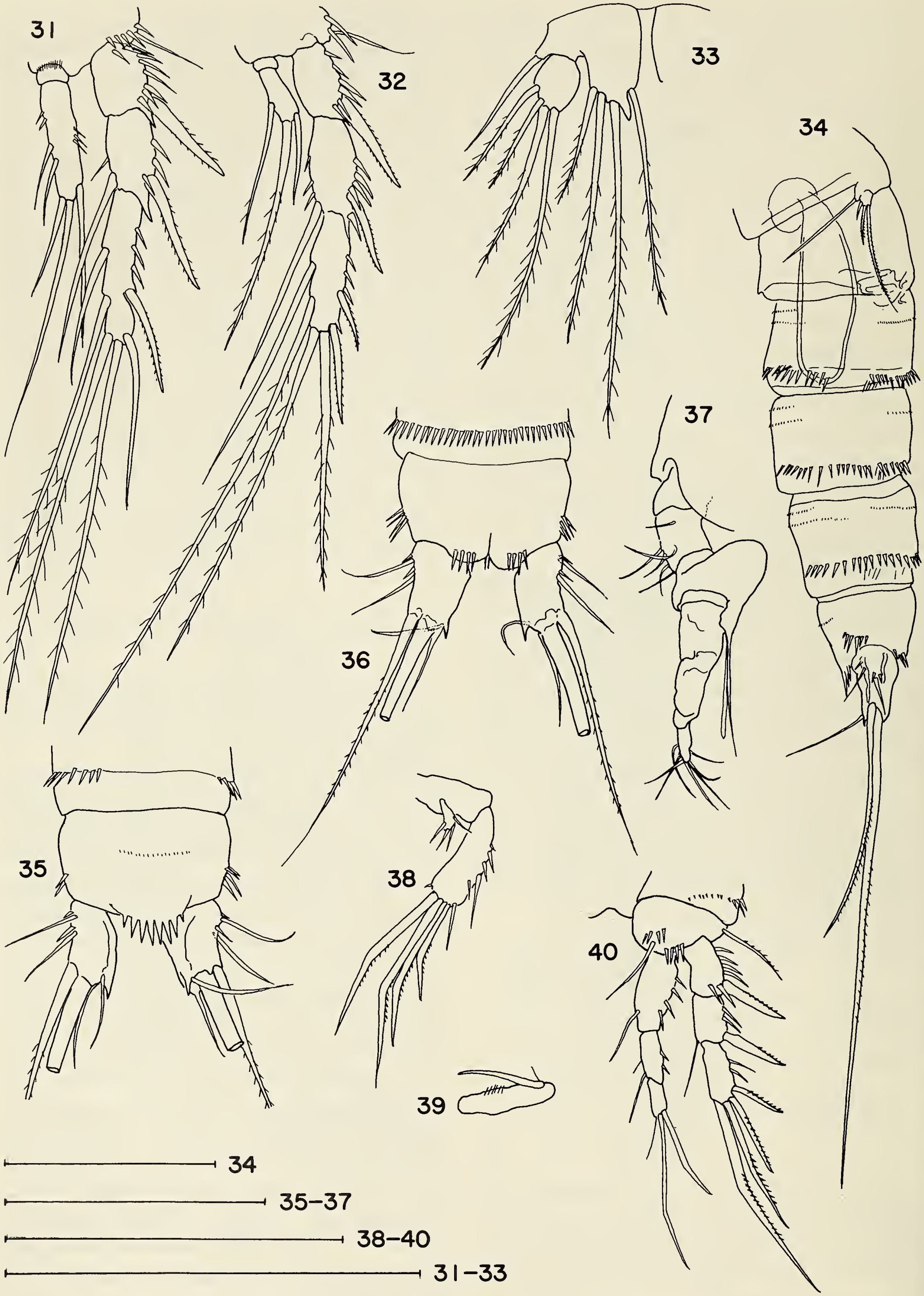
Elaphoidella radkei, new species

Figs. 34–44

Material.—1 ♂, holotype, USNM 231095, alcohol-preserved; from Buenaventura, Valle, Colombia, 18 Sep 1985.

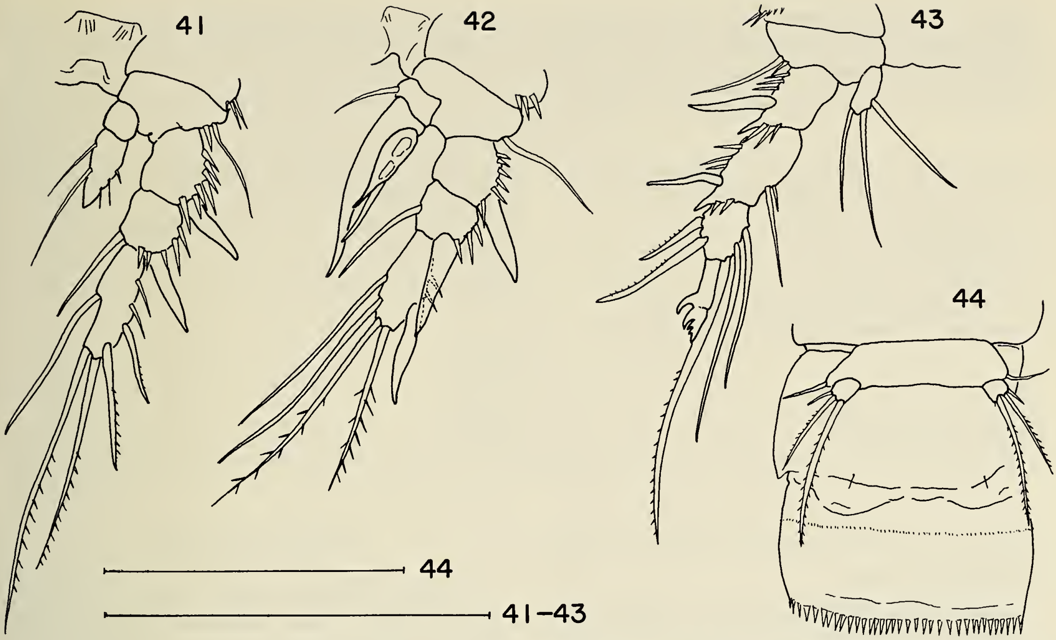
Description.—Male: Length 0.51 mm. Prosomal somites unornamented; urosomal somites 2–4 (Fig. 34) each with few dorsal and ventral rows of tiny hairs and row of spinules along posterior lateral and ventral margins, each spinule row discontinuous dorsally. Anal somite (Figs. 34–36) with row of 6 spinules on each side and 4 ventral spinules extending over each caudal ramus; operculum convex, with 8 teeth of which 2 outermost are shortest. Caudal rami about 1.5× longer than broad, with dorsal keel extending past end of ramus and ending in posteriorly directed tooth; 1 seta inserted lateral to base of tooth. Inner margins of rami smooth; outer margins each with 2 setae and few spinules. Middle apical seta about 1.2× longer than urosome; outer apical seta about 3.7× longer than slender inner apical seta.

Rostrum (Fig. 37) about half length of article 1 of antennule; antennule geniculate,



Figs. 31–33. *Elaphoidella suarezi,* female: 31, Leg 3; 32, Leg 4; 33, Leg 5.

Figs. 34–40. *E. radkei,* male: 34, Urosome, lateral; 35, Anal somite and caudal rami, dorsal; 36, Anal somite and caudal rami, ventral; 37, Antennule; 38, Antenna; 39, Maxilliped; 40, Leg 1. Scales = 100 μm.



Figs. 41–44. *Elaphoidella radkei,* male: 41, Leg 2; 42, Leg 3; 43, Leg 4; 44, Leg 5 and anterior portion of urosome. Scales = 100 μm.

with 1 long esthetasc on expanded article 4. Antenna (Fig. 38) with allobasis and exopod of 1 article bearing 4 setae. Mouthparts not examined except mandible which is prehensile (Fig. 39).

Swimming legs 1–4 (Figs. 40–43) each with exopod of 3 articles; endopods composed respectively of 3, 2, 3 and 1 articles. Setation formula for major armature as follows:

Leg 1	basis 1-1	exp 0-1; 1-1; 0,2,2
		enp 1-0; 1-0; 0,2,1
Leg 2	basis 0-1	exp 0-1; 1-1; 1,2,2
		enp 0-0; 2,0,0
Leg 3	basis 0-1	exp 0-1; 1-1; 2,2,1
		enp 1-0; –; –
Leg 4	basis 0-1	exp 0-1; 1-1; 2,2,2
		enp 1,2,0

Basal lamellae of legs 2 and 3 each with few hairs on anterior surface. Outer spines of articles 1 and 2 of exopod of leg 2 and of each article of exopod of leg 3 enlarged. Endopod of leg 3 modified, apophysis on article 2 reaching past midlength of article 3 of exopod, and article 3 with stout terminal seta and acute terminal projection. Terminal article of exopod of leg 4 short and bent inwards; outer terminal seta short and stout, with clawlike teeth on outer distal margin.

Basipods of legs 5 (Figs. 34, 44) continuous and unornamented; exopods each with 3 setae of which innermost is longest. Posteroventral margin of first urosomal somite convolute; leg 6 consisting of 1 tiny hair.

Etymology.—Named in memory of Myron G. Radke, parasitologist and friend.

Remarks.—*Elaphoidella radkei* most resembles the Group VIII male tentatively assigned to *E. malayica* by Chappuis (1928). Chappuis' description of the endopod of leg 3 of this male says that it is similar to that of the previous species described (*E. bromeliaecola*), which implies that the first article lacks a seta. In addition to this possible difference in setation, *E. radkei* differs from the putative male of *E. malayica* in the number of teeth on the operculum and in possessing a total of five, not six spines and setae on the terminal article of the endopod of leg 2. Females of *E. malayica,* originally described from Java, have been reported

Table 1.—Some morphological features of neotropical species of the genus *Elaphoidella* belonging to Group VIII of Lang (1948); only one sex of several species has been described. VS, number of ventral spines on anal somite above each caudal ramus; IS, number of setae on inner surface of proximal article of endopod of leg 3.

Species	Feature		
	Operculum	VS	IS
E. sewelli americana (Chappuis, 1933), ♀	about 18 small teeth	3	0
E. negroensis Keifer, 1967, ♀	10–11 small teeth	3	0
E. paraplesia Keifer, 1967, ♀	9–14 small teeth	3	0
E. humboldti Löffler, 1963, ♂	fringed with fine hairs	5	0
E. surinamensis (Delachaux, 1924), ♀ and ♂	smooth	4	?
E. malayica (Chappuis, 1928)			
♀	smooth	4–7	1
♂	6 teeth	4–7	0?
E. suarezi, new species, ♀	smooth	2	0
E. radkei, new species, ♂	8 teeth	4	1

recently from Martinique, French Antilles by Dussart (1982).

There is some ambiguity in Lang's diagnosis of Group VIII; the principal difference between this and the diagnosis of Group VII, which also includes several neotropical species, is that species of Group VIII are defined as having opercula which are smooth or with numerous short teeth, and that in males, the outer apical seta of the terminal article of the exopod of leg 4 is modified as a strong clawlike structure. In species of Group VII the opercula have several long, strong teeth, and in males, two outer distal setae of the terminal article of the exopod of leg 4 are modified. Apparently Lang ignored the long opercular teeth of the male of *E. malayica* in composing his diagnosis of Group VIII, with good reason since its identification with the female is tentative. I have placed *E. radkei* in Group VIII on the basis of the modification of only one exopodite seta on leg 4, as well as the presence of two, not three setae on the distal article of the endopod of leg 2. Unfortunately the extent and nature of sexual dimorphism in Group VIII are no better understood than in Lang's time, since only one sex of most species is known (Table 1). The opercula of males and females of *E. surinamensis* are similar.

Acknowledgments

I extend thanks to Dr. Marco F. Suarez for the gift of these specimens, and to Dr. Thomas E. Bowman for his comments on the manuscript.

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RECORDS OF *LIMNODRILOIDES* (OLIGOCHAETA: TUBIFICIDAE) FROM VENEZUELA

Christer Erséus

Abstract.—*Limnodriloides claviger* Erséus, 1982, *L. rubicundus* Erséus, 1982, and *L. monothecus* Cook, 1974, are reported from Bahía de Amuay in Venezuela. These records support the view that the South Caribbean marine Tubificidae largely comprise elements present throughout the Caribbean area and along the southeast coast of USA.

The published records of marine Oligochaeta from the Caribbean coast of South America are sparse. Only one species, *Tectidrilus verrucosus* (Cook), has been reported from Venezuela (Erséus 1982), but Righi and Kanner (1979) described *T. bori* (as *Limnodriloides bori*), *Marcusaedrilus hummelincki, Thalassodrilides gurwitschi* (Hrabě) (as *Curacaodrilus sinus*), *Kaketio ineri,* and *Bathydrilus adriaticus* (Hrabě) (as *Phallodrilus adriaticus caraibicus* (for nomenclature, see Erséus 1981, 1982, 1985) from Aruba, Curaçao and Bonaire, islands situated just off Venezuela. *Thalassodrilides belli* (Cook) was recorded from Trinidad by Erséus (1981).

In 1981, marine biological impact studies for an oil refinery were performed in Bahía de Amuay near Punto Fijo (11°42′N, 70°13′W) on the Paraguana Peninsula, Falcon, Venezuela, by AWARE, Inc., Nashville, Tennessee, USA. During the work a few tubificid oligochaetes were collected. The material represents at least three species of *Limnodriloides* Pierantoni; some sexually immature individuals could not be identified. The species are accounted for in the present note.

Materials and Methods

The material was first given to the late Dr. H. R. Baker (University of Victoria, Victoria, B.C., Canada), who stained and mounted the specimens in Canada balsam, but who never started to work on the collection. By the courtesy of Ms. R. D. Kathman (E.V.S. Consultants, Sidney, B.C.) and Dr. R. O. Brinkhurst (Institute of Ocean Sciences, Sidney, B.C.) Baker's slides were transferred to the present author's collection.

Limnodriloides claviger Erséus, 1982
Fig. 1

Limnodriloides claviger Erséus, 1982:221–222, fig. 6, tables 1, 4.

New material.—One specimen from off Punta Piedras, S of mouth of Bahía de Amuay, about 15 m, mud.

Remarks.—This species was originally described on the basis of five specimens from Barbados and Bermuda. It is characterized by its small, club-shaped atria, with poorly developed prostate glands (cf. Fig. 1). The worm from Venezuela conforms in most features with the original material, but a few differences should be noted.

The new specimen is 5.6 mm long and consists of 52 segments, which is longer than any of the old individuals (only complete specimen was 3.2 mm, 29 segments). Its setae are, however, smaller; only 25–35 μm long, about 1.5 μm thick, as opposed to 40–50 μm long, about 2 μm thick for the type series. The atria (Fig. 1) are about 145 μm long (about 125 μm in original material), and the spermathecae have slender ampul-

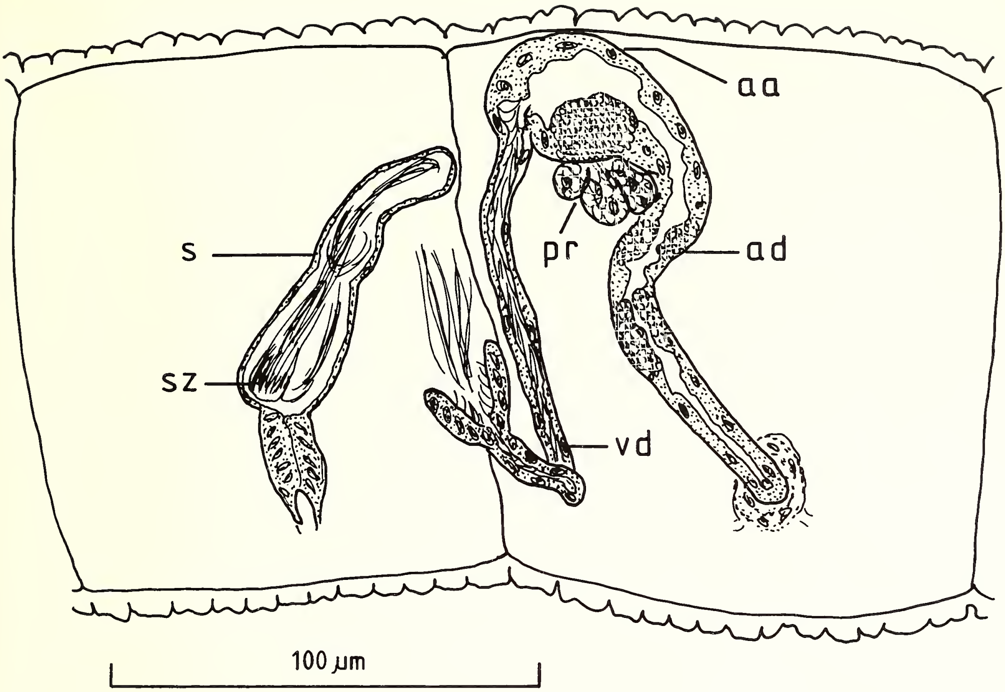

Fig. 1. *Limnodriloides claviger* Erséus, 1982; specimen from Bahía de Amuay, Venezuela. Lateral view of spermatheca and male duct. aa, atrial ampulla; ad, atrial duct; pr, prostate gland; s, spermatheca; sz, spermatozeugma?; vd, vas deferens.

lae, up to about 75 µm long (up to 55 µm in original material). All these dimensional differences can be regarded as intraspecific and are not even necessarily true geographic variation; they may be caused by different nutritional or other ecological circumstances. A more qualitative difference, which may reflect geographic variation, is the fact that some posterior 'bundles' of the new worm are unisetal (all posterior bundles bisetal in type series).

According to the original description the walls of the spermathecal ampullae consist of "large (vacuolized?) cells," and the sperm is arranged in "narrow bundles" within the ampullae. In the new individual the 'vacuoles' of the wall appear to be absent, possibly indicating that the ampullae are more fully developed ('stretched'), and at least one of the sperm bundles has a torch-shaped end, which characterizes the simple kind of spermatozeugmata found in many species of the subfamily Limnodriloidinae (cf. Erséus 1982:265). Previously, the absence of spermatozeugmata was regarded as a distinguishing feature of *L. claviger,* particularly for its separation from the closely related, European, *L. pierantonii* (Hrabě). Still, however, the small, round atrial ampullae, the minute prostate glands, and the very simple pseudopenes make *L. claviger* a distinct species.

Distribution and habitat.—Bermuda, Barbados and Venezuela. Subtidal muddy sediments, 5–15 m depth.

Limnodriloides rubicundus Erséus, 1982

Limnodriloides rubicundus Erséus, 1982: 226–228, fig. 10, tables 1–2.

New material.—Four specimens from S part of Bahía de Amuay, about 3 m, mud.

Remarks.—The new specimens, which conform well with the original description, represent a considerable range extension of the species. *Limnodriloides rubicundus* was previously known from Bahamas, Bermuda and the SE coast of USA (Florida through Delaware). It occurs in muddy bottoms down to at least 74 m depth.

Limnodriloides monothecus Cook, 1974

Limnodriloides monothecus Cook, 1974: 131–132, fig. 3.—Erséus 1982:250–253, figs. 28–29, tables 1, 3.

New material.—One specimen from NE part of Bahía de Amuay, about 4 m, mud with seagrass.

Remarks.—As currently delimited, *L. monothecus* is a very widely distributed species, recorded from the Pacific coasts of Canada, USA and Mexico, Atlantic coast of USA (Gulf of Mexico, Florida through New Jersey), Bermuda, Barbados, and the Mediterranean Sea (Yugoslavia). It was noted by Erséus (1982), however, that the worms from Barbados had spermatozeugmata which were stouter than those from specimens available from other areas, and that this may indicate that a separate (tropical) species is involved. The worm from Venezuela is, with regard to this character, very similar to the specimens from Barbados.

Like the preceding species, *L. monothecus* is a subtidal species, and it has been found down to 370 m depth. It also appears to prefer muddy sediments.

Discussion

The previous, scanty records from the southern Caribbean indicated that the marine tubificid fauna of this area basically is a pan-Caribbean one, with links also to the fauna of the east coast of North America. The additional information represented here strongly supports this. *Limnodriloides claviger, L. rubicundus* and *L. monothecus* now can be regarded as present through the Caribbean area, possibly with the reservation that *L. monothecus,* as noted above, may be a composite taxon actually including more than one species.

Acknowledgments

I am indebted to R. Deedee Kathman and Ralph O. Brinkhurst for making the material available for study.

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THE EUPHAUSIACEA OF EASTERN FLORIDA (CRUSTACEA: MALACOSTRACA)

Paula M. Mikkelsen

Abstract.—Twenty-eight species of euphausiacean crustaceans are recorded from off the eastern Florida coast, from collections by the University of Miami and Harbor Branch Foundation, Fort Pierce. *Thysanopoda cristata, T. pectinata, Nematobrachion sexspinosus,* and *Stylocheiron robustum* are newly recorded for the area. Species bibliographies and a key to adult specimens are presented, along with taxonomic and ecological notes.

Twenty-seven species of euphausiacean crustaceans have been previously recorded from off the eastern Florida coast (Table 1). Of the five previous reports, three (Hansen 1915; Tattersall 1926; James 1970, 1971) were large geographical surveys which included parts of the eastern Florida area. The remaining two reports (Lewis 1954, Stepien 1980) were non-taxonomic works within the study area. Three of the 27 species (*Thysanopoda subaequalis, Stylocheiron affine, S. longicorne*) have since been synonymized with other species (Brinton 1975, Mikkelsen 1981), reducing the number of species to 24.

A comprehensive faunal survey of the Indian River coastal zone on the central eastern Florida coast was conducted during 1973–1974 by Harbor Branch Foundation and Smithsonian Institution's Fort Pierce Bureau. Eight stations from this survey, plus one subsequent Harbor Branch collection, yielded a total of 11,080 euphausiids. An additional 12,259 specimens from 84 stations by University of Miami's R/V *Gerda* were subsequently located in the Invertebrate Museum at the Rosenstiel School of Marine and Atmospheric Science. Together these two collections provided a total of 23,339 specimens in 28 species, including four species (*Thysanopoda cristata, T. pectinata, Nematobrachion sexspinosus, Stylocheiron robustum*) newly recorded for the area. This report documents the eastern Florida euphausiacean fauna found in this material, and comments on taxonomic and ecologic findings.

Materials and Methods

The study area is defined as the region off eastern Florida which is south of the Georgian-Floridan geopolitical boundary, west of the Bahama Bank, north of 24°N latitude, and east of Key West (see Fig. 1).

Station positions for the 93 stations are shown in Fig. 1. University of Miami's 84 R/V *Gerda* stations were taken during 1962–1965 and ranged in depth from surface to 820 m ($\bar{x}$ = 274.3 m). The remaining nine stations by Harbor Branch Foundation (eight by R/V *Gosnold* in 1974; one by R/V *Johnson* in 1981) ranged in depth from 50–750 m ($\bar{x}$ = 208.3 m). Bottom depths ranged from 73–1222 m. Twenty-three stations were classified as daytime samples, defined as including any portion of the hours between 0600 and 1800; 70 stations were night samples. Detailed station data may be obtained from the author or from the Rosenstiel School of Marine and Atmospheric Science, University of Miami.

The history of the samples (e.g., sorting, sub-sampling, etc.) was unknown; 50 of the 93 samples contained less than 100 total

Table 1.—Summary of records of eastern Florida Euphausiacea: Hansen 1915 [one station off St. Augustine (481.3 m)]; Tattersall 1926 [three stations off Miami (150, 700, 800 m), three stations off Fort Pierce/Jupiter (250, 500, 700 m)]; Lewis 1954 (11 stations off Miami, all at 732–823.5 m); James 1970, 1971 [one station off the Florida Keys (400 m)]; Stepien 1980 [one station off Miami (600–750 m)]. * = new records by the present study.

Species	Hansen	Tattersall	Lewis	James	Stepien	Present study
Bentheuphausia amblyops	—	—	—	—	X	X
Thysanopoda aequalis	—	X	X	X	—	X
*_T. cristata_	—	—	—	—	—	X
T. monacantha	X	X	X	X	—	X
T. obtusifrons	—	—	—	—	X	X
T. orientalis	X	—	—	X	—	X
*_T. pectinata_	—	—	—	—	—	X
T. tricuspida	—	X	X	—	—	X
Euphausia americana	—	X	X	X	X	X
E. brevis	—	X	X	X	—	X
E. gibboides	—	X	X	—	—	X
E. hemigibba	—	X	X	X	X	X
E. mutica	—	X	X	—	X	X
E. pseudogibba	—	—	—	X	X	X
E. tenera	—	X	X	X	X	X
Nematobrachion boopis	—	—	X	X	X	X
Nb. flexipes	—	X	—	—	X	X
*_Nb. sexspinosus_	—	—	—	—	—	X
Nematoscelis atlantica	—	—	X	—	X	X
Ns. megalops	—	—	X	—	—	—
Ns. microps	—	X	X	X	X	X
Ns. tenella	—	X	X	X	X	X
Stylocheiron abbreviatum	—	X	X	X	X	X
S. carinatum	—	X	X	X	X	X
S. elongatum	—	X	X	X	X	X
S. maximum	—	X	X	—	—	X
*_S. robustum_	—	—	—	—	—	X
S. suhmii	—	X	X	X	—	X

specimens (including 13 with less than 10), and were suspected of being unrepresentative of the original collection. For this reason, samples with 100 or more total individuals (hereafter referred to as "100+" stations) were treated separately for analyses of species frequency and relative abundance. No further attempts were made to treat these collections quantitatively.

To confirm adult identifications, specimens were compared to type or other identified material obtained from several museums. All such material is listed in the "Material examined" sections of the species accounts. Cited repositories are as follows:

IRCZM—Indian River Coastal Zone Museum, Harbor Branch Foundation, Inc., Fort Pierce, Florida.
UMML—Invertebrate Museum, Rosenstiel School of Marine and Atmospheric Science, University of Miami, Florida.
USNM—Division of Crustacea, National Museum of Natural History, Smithsonian Institution, Washington, D.C.

The structure of the male copulatory structure, the petasma, is of taxonomic value in euphauseacean, and was used in final verification of species determinations. Following clearing of the isolated appendage, using the method of Mikkelsen (1981), the species-specific arrangement of processes on the petasma could be observed without obstruction or further manipulation. The female copulatory structure, the thelycum, is believed equal to the petasma in diagnostic value (Einarsson 1942, Costanzo and Guglielmo 1976a). However, because thelyca are more difficult to prepare and observe, they were examined only when somatic characters of females were inconclusive.

Larvae were encountered but are not considered in this study (all are deposited in the IRCZM).

Synonymies are restricted to the original description, previous names, petasma and thelycum descriptions, and one or two useful recent descriptions. All body lengths are total lengths in millimeters, measured along the dorsal midline from the tip of the rostrum (or frontal plate) to the tip of the telson.

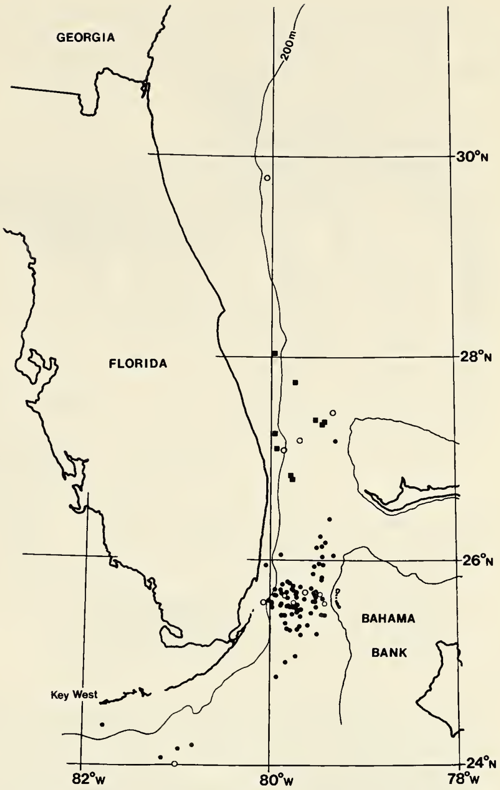


Fig. 1. Map of eastern Florida, showing stations utilized in this study. Open circles = previous records; solid circles = R/V *Gerda* stations; solid squares = R/V *Gosnold* and R/V *Johnson* stations (both HBF).

Taxonomic Section

The following artificial key is designed for identifying adult specimens, and relies heavily on structures most easily recognized in the often imperfect specimens commonly found in plankton tows. Previous keys (e.g., Boden et al. 1955, Lomakina 1978) depend on fragile structures, such as the thoracic appendages, which frequently suffer damage or loss during collection. Acronyms in brackets refer to those used in Fig. 2.

1. Eyes with few ommatidia, surrounded by homogeneous organic matrix ....
   Family BENTHEUPHAUSIIDAE,
   .... *Bentheuphausia amblyops*

– Eyes with numerous, densely-packed ommatidia ....
   .... Family EUPHAUSIIDAE ... 2

2. Eyes round, or nearly so [eyr], without division into two lobes; no thoracic endopods greatly elongated ..(*Euphausia, Thysanopoda*) .. 3

– Eyes oblong and divided into two lobes [eyb]; second or third pair of thoracic endopods greatly elongated [ene] ......(*Nematobrachion, Nematoscelis, Stylocheiron*) 16

3. Rostrum with secondary dorsal spine [rss] of varying length 4

– Rostrum simple, with no secondary spine 5

4. Dorsal process of first segment of antennular peduncle expanded as a "hood" ..... *Thysanopoda cristata*

– Dorsal process spine-like ....
   .... *Thysanopoda tricuspida*

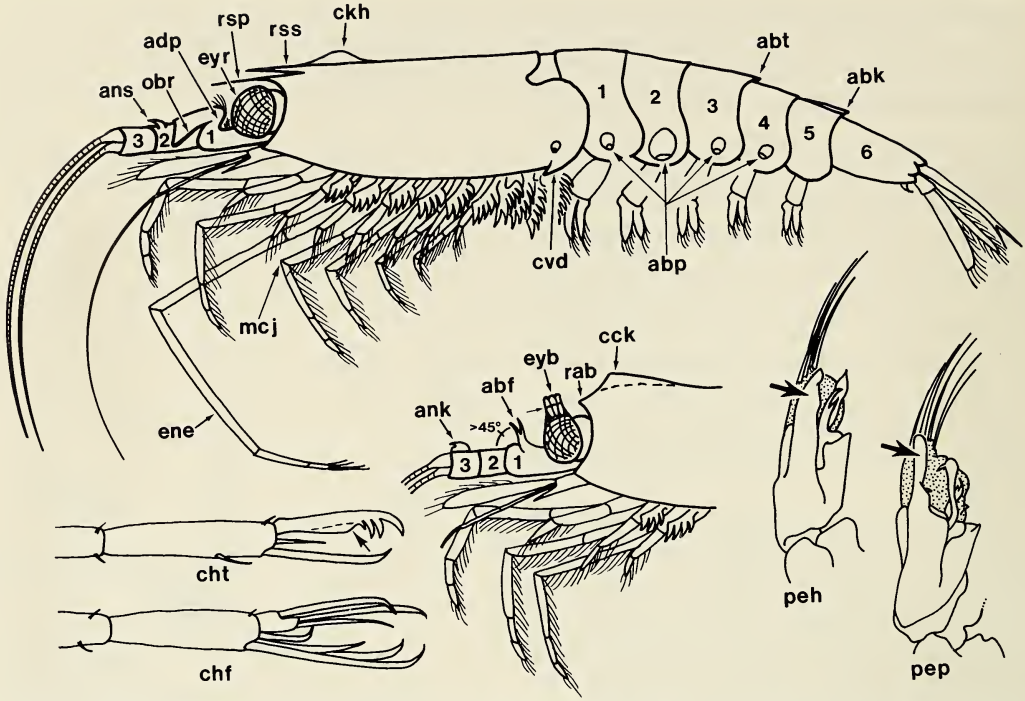


Fig. 2. Diagrammatic euphausiid to accompany artificial key. Segments (1, 2, 3) of antennular (=first antennal) peduncle and those (1 through 6) of abdomen are numbered for use with text. abf = antennular bifid process (first antennular segment); abk = abdominal keel (fifth segment); abp = abdominal photophores (that of second segment enlarged); abt = abdominal tooth (third segment); adp = antennular dorsal prominence (first segment); ank = antennular keel (tooth, third segment); ans = antennular spine (second segment); cck = crested carapace keel; ckh = carapace with humped keel; chf = false chela; cht = true chela; cvd = carapace with ventral denticle; ene = elongated thoracic endopod (third); eyb = bilobed eye (arrow indicates crystalline cones); eyr = round eye; mcj = mero-carpal joint (fourth thoracic endopod); obr = oblique ridge (process of first antennular segment); peh = petasma of *Euphausia hemigibba* (arrow indicates median lobe); pep = petasma of *Euphausia pseudogibba* (arrow indicates median lobe); rab = absent rostrum; rsp = spiniform rostrum; rss = rostral secondary spine.

5. Dorsal prominence ("hump") [adp] on first segment of antennular peduncle, directly anterior to eye . . . . (*Thysanopoda,* in part) 6
– Prominence absent . . . . (*Euphausia*) . . 10
6. Middorsal tooth [abt] on third abdominal segment . . . . *Thysanopoda monacantha*
– Tooth absent 7
7. Dorsal process of first segment of antennular peduncle pectinate . . . . *Thysanopoda pectinata*
– Process not pectinate 8
8. Dorsal process of first segment of antennular peduncle expanded distally, forming a conspicuous oblique lateral ridge [obr] . . . . *Thysanopoda aequalis*
– Dorsal process tapered distally in lateral view; ridge absent 9
9. Dorsal process of first segment of antennular peduncle truncate in dorsal view; small denticle [cvd] on postero-lateral margin of carapace . . . . . . *Thysanopoda obtusifrons*
– Dorsal process acute in dorsal view; lateral denticle absent . . . . *Thysanopoda orientalis*
10. Dorsal process of first segment of

antennular peduncle pectinate .. .. *Euphausia americana*

– Process not pectinate 11

11. Middorsal tooth [abt] on third abdominal segment 12

– Tooth absent 14

12. Middorsal keel on third segment of antennular peduncle [ank] prominent and distally toothed . ... *Euphausia gibboides*

– Keel low and untoothed 13

13. Median lobe of male petasma [pep, arrow] ending in a blunt, finger-shaped process; coxal lobes of female thelycum meeting at midventral line . *Euphausia pseudogibba*

– Median lobe of male petasma [peh, arrow] with a tapered end; coxal lobes of thelycum not meeting at midventral line .... *Euphausia hemigibba*

14. Dorsal process of first segment of antennular peduncle bifid [abf] .. 15

– Dorsal process very small and triangular (female), or absent (male) .... *Euphausia tenera*

15. Bifid process pointing dorsally at angle greater than 45° [abf]; dorsal spine [ans] on second segment of antennular peduncle .... *Euphausia brevis*

– Bifid process pointing anteriorly at angle less than 45°; dorsal spine absent .... *Euphausia mutica*

16. Ventral photophores [abp] present on more than one abdominal segment ....(*Nematobrachion, Nematoscelis*) 17

– Ventral abdominal photophores on first segment only ....(*Stylocheiron*) .. 23

17. Upper lobe of eye conspicuously wider than lower lobe 18

– Upper lobe nearly equal in width or narrower than lower lobe 21

18. Middorsal tooth [abt] on at least two abdominal segments 19

– Middorsal teeth absent 20

19. Three teeth on posterior margins of fourth and fifth abdominal segments .. *Nematobrachion sexspinosus*

– Single teeth only on above segments ..... *Nematobrachion flexipes*

20. Rostrum present and spiniform [rsp] .... *Nematoscelis tenella*

– Rostrum absent [rab] .... *Nematobrachion boopis*

21. Long spines extending from dactylus and from terminal end of propodus of elongated second endopod; three segments distal to mero-carpal joint [mcj] of third to sixth thoracic endopods; adult body length to 26 mm .... *Nematoscelis megalops*

– Long spines from dactylus only of elongated endopod; one or two segments distal to mero-carpal joint of third to sixth endopods; adult body length to 20 mm 22

22. Strong keels on carapace and fourth and fifth abdominal segments [abk]; conspicuous "hump" [ckh] on carapace keel; upper eye lobe equal or slightly less in width to lower lobe .... *Nematoscelis microps*

– Above keels and "hump" weak or absent; upper eye lobe conspicuously narrower than lower .... *Nematoscelis atlantica*

23. Length of sixth abdominal segment greater than sum of lengths of fourth and fifth abdominal segments ...... *Stylocheiron elongatum*

– Length not greater than sum 24

24. Toothed middorsal keels [abk] on fourth and fifth abdominal segments .....*Stylocheiron abbreviatum*

– Keels absent 25

25. Middorsal "crested" keel [cck] on carapace .....*Stylocheiron carinatum*

– Keel not "crested" or absent 26

26. False chela [chf] at end of elongated third thoracic endopod; upper lobe of eye with conspicuous crys-

Table 2.—Species abundance and relative frequencies in all stations and 100+ stations. "Av. % of sp." is the mean relative abundance of the species in the 100+ stations in which it was found.

	All Stations (n = 93)		100+ Stations (n = 43)		
Species	Total no. (%)	No. (%) of sta. containing sp.	Total no. (%)	Av. % of sp.	No. (%) of sta. containing sp.
S. carinatum	4116 (17.6)	56 (60.2)	4032 (18.6)	12.6	37 (86.0)
Ns. microps	3303 (14.2)	64 (68.8)	2973 (13.7)	19.5	37 (86.0)
S. abbreviatum	2971 (12.7)	71 (76.3)	2704 (12.5)	16.7	37 (86.0)
E. tenera	2498 (10.7)	32 (37.6)	2477 (11.5)	10.2	24 (55.8)
E. americana	2245 (9.6)	46 (49.4)	2208 (10.2)	5.4	38 (88.4)
T. aequalis	1778 (7.6)	55 (59.1)	1647 (7.6)	11.4	36 (83.7)
T. tricuspida	943 (4.0)	60 (64.5)	854 (3.9)	9.0	39 (90.7)
E. hemigibba	864 (3.7)	51 (54.8)	812 (3.7)	6.8	36 (83.7)
T. monacantha	761 (3.3)	63 (67.7)	702 (3.2)	5.3	41 (95.3)
S. suhmii	534 (2.3)	49 (52.7)	493 (2.3)	2.0	32 (74.4)
E. gibboides	435 (1.9)	59 (63.4)	287 (1.3)	2.2	35 (81.4)
Ns. atlantica	433 (1.8)	44 (47.3)	374 (1.7)	3.7	29 (67.4)
Ns. tenella	350 (1.5)	52 (55.9)	301 (1.4)	2.2	34 (79.1)
Nb. flexipes	335 (1.4)	45 (48.4)	271 (1.2)	2.4	31 (72.1)
E. pseudogibba	322 (1.4)	47 (50.5)	288 (1.3)	2.5	33 (76.7)
E. brevis	303 (1.3)	24 (25.8)	292 (1.3)	3.6	20 (46.5)
S. elongatum	273 (1.2)	33 (35.5)	202 (0.9)	3.0	21 (48.8)
E. mutica	239 (1.0)	42 (45.2)	208 (1.0)	1.7	28 (65.1)
Nb. boopis	179 (0.8)	20 (21.5)	129 (0.6)	4.1	9 (20.9)
T. obtusifrons	166 (0.7)	20 (21.5)	165 (0.8)	2.4	19 (44.2)
T. orientalis	92 (0.4)	16 (17.2)	70 (0.3)	2.1	11 (25.6)
Nb. sexspinosus	72 (0.3)	25 (26.9)	49 (0.2)	1.0	16 (37.2)
S. robustum	56 (0.2)	19 (20.4)	42 (0.2)	1.2	13 (30.2)
S. maximum	41 (0.2)	14 (15.0)	29 (0.1)	1.3	9 (20.9)
T. pectinata	3 (<0.1)	3 (3.2)	2 (<0.1)	0.2	2 (4.6)
B. amblyops	3 (<0.1)	2 (2.1)	0 (0.0)	0.0	0 (0.0)
T. cristata	1 (<0.1)	1 (1.1)	1 (<0.1)	0.1	1 (2.3)
	23,316 (99.8)		21,612 (99.5)		

talline cones [eyb, arrow] of varying number ..... *Stylocheiron suhmii*

– True chela [cht] at end of elongated third thoracic endopod; eye bilobed but without conspicuous crystalline cones in upper lobe .. 27

27. Upper lobe of eye approximately equal in width to lower lobe; dactylus of true chela expanded [cht, arrow] proximal to secondary spines ...... *Stylocheiron maximum*

– Upper lobe of eye narrower than lower lobe; dactylus of equal width proximal and distal to secondary spines .... *Stylocheiron robustum*

Order Euphausiacea Boas, 1883
Family Bentheuphausiidae Colosi, 1917
Genus *Bentheuphausia* G. O. Sars, 1885

Bentheuphausia amblyops (G.O. Sars, 1883)

Thysanopoda (?) *amblyops* G. O. Sars, 1883: 23.

Bentheuphausia amblyops.—G. O. Sars, 1885:109–114, fig. 4, pl. XIX.—Einarsson, 1942:278–284, figs. 13–16 [modified first male pleopod].—Lomakina, 1978: 75–77, fig. 40.—Guglielmo and Costanzo, 1983:278–279, fig. 1(a–b) [thelycum].

Material examined.—ATLANTIC: Bermuda-Bahamas line: 1 spm, *Bache* Sta 10182, USNM 62247.—Gulf of Mexico: 3 ♀, *Oregon* Sta 841, USNM 95999; 2 ♂, *Alaminos* Sta 65-A-14-7, USNM 135308.—PACIFIC: Galapagos Islands: 1 ♂, 1 ♀, *Albatross* Sta 4707, USNM 45353.

Vouchers: 1 ♂, GER-091, IRCZM 089:05873; 2 juv., GER-358, UMML 32:5761.

Family Euphausiidae Dana, 1850
Genus *Thysanopoda* Latreille, 1831
Thysanopoda aequalis Hansen, 1905

Thysanopoda aequalis Hansen, 1905:18–20.—Boden et al., 1955:303–305, fig. 9(a–d) [petasma].—Brinton, 1975:165–167, figs. 89(a–c), 119(l–m).—Costanzo and Guglielmo, 1976a:46–47, text-fig. 1, pl. 1, fig. 1 [thelycum].

Thysanopoda subaequalis Boden, 1954:190–192, fig. 5.

Material examined.—ATLANTIC: Bahama Bank: 20+ spms, *Bache* Sta 10208, USNM 62258.—Gulf of Mexico: 22 ♂, 27 ♀, *Alaminos* Sta 65-A-9-6, USNM 135323.—Caribbean Sea: 1 ♂, 1 ♀, *Gerda* Sta CARIB-15, UMML 32:1482; 1 ♂, 2 ♀, *Gerda* Sta CARIB-18, UMML 32:1487.—Western Atlantic: 1 ♂, *Bache* Sta 62252 (in part).

Vouchers: 87 ♂, 124 ♀, GER-356, IRCZM 089:05874; 11 ♂, 22 ♀, GOS-173, IRCZM 089:05959; 37 ♂, 43 ♀, 1 spm, GER-200, UMML 32:5754; 10 ♂, 10 ♀, GOS-144, UMML 32:5753; 23 ♂, 19 ♀, 4 juv., 1 spm, GER-352, USNM 228239; 10 ♂, 10 ♀, GOS-144, USNM 228238.

Thysanopoda cristata G. O. Sars, 1883

Thysanopoda cristata G. O. Sars, 1883:22.—Boden et al., 1955:300–301, fig. 7(a–b) [petasma].—Guglielmo and Costanzo, 1977:275, text-fig. 2, pl. 1c [thelycum].—Lomakina, 1978:82–83, fig. 42.

Material examined.—ATLANTIC: Gulf of Mexico: 1 ♂, *Alaminos* Sta 65-A-14-5, USNM 135318; 1 ♀, *Alaminos* Sta 69-A-13-13, USNM 135317.

Vouchers: 1 ♂, GER-072, UMML 32:5752.

Remarks.—This species has not been previously reported from the study area. A single male was collected off Miami at 458 m. The nearest previous record was in the Gulf of Mexico, west southwest of Key West (James 1970, 1971).

Thysanopoda monacantha Ortmann, 1893

Thysanopoda monacantha Ortmann, 1893:9, pl. 1, fig. 2.—Boden et al., 1955:298–300, fig. 6(a–b) [petasma].—Guglielmo and Costanzo, 1977:275, text-fig. 1, pl. 1(a–b) [thelycum].—Lomakina, 1978:80–82, fig. 41.

Material examined.—ATLANTIC: eastern Florida: 1 ♂, *Albatross* Sta 2665, USNM 47510; 1 juv., *Gerda* Sta, UMML 32:1503.—north of Bahama Bank: 1 ♂, *Bache* Sta 10211, USNM 62254.—Gulf of Mexico: 1 ♂, 1 ♀, *Alaminos* Sta 69-A-11-91, USNM 135319.—Caribbean Sea: 1 juv., *Gerda* Sta CARIB-18, UMML 32:1486 (in part); 1 ♂, 1 ♀, *Gerda* Sta CARIB-18, UMML 32:1488; 2 ♂, 13 ♀, 25 juv., *Gerda* Sta CARIB-21, UMML 32:1491 (in part); 1 ♂, 3 ♀, *Gerda* Sta CARIB-21, UMML 32:1493 (in part); 1 ♂, *Gerda* Sta CARIB-9, UMML 32:1497 (in part).—Western Atlantic: 10 spms, *Bache* Sta, USNM 62252 (in part).

Vouchers: 14 ♂, 18 ♀, 1 juv., GER-326, IRCZM 089:05872; 3 ♂, 19 ♀, 10 juv., GOS-144, IRCZM 089:05958; 10 ♂, 35 ♀, 54 juv., GER-099, UMML 32:5750; 1 ♂, 4 ♀, GOS-173, UMML 32:5751; 17 ♂, 16 ♀, 2 juv., GER-327, USNM 228241; 1 ♂, 12 ♀, 23 juv., GOS-160, USNM 228240.

Thysanopoda obtusifrons G. O. Sars, 1883

Thysanopoda obtusifrons G. O. Sars, 1883:21.—Boden et al., 1955:305–307, fig. 10(a–c) [petasma].—Guglielmo and Costanzo, 1977:278, text-fig. 4, pl. le [thelycum].—Lomakina, 1978:88–89, fig. 45.

Material examined.—ATLANTIC: Bermuda-Bahamas line: 3 ♀, *Bache* Sta 10182, USNM 62285.—Gulf of Mexico: 1 ♂, 3 ♀, *Alaminos* Sta 69-A-13-7, USNM 135320.—Western Atlantic: 1 juv. ♂, 2 ♀, 4 juv. ♀, *Bache* Sta, USNM 181671.—PACIFIC: Callao, Peru, to Easter Island: 12 spms, *Albatross* Sta 4685, USNM 45218.

Vouchers: 1 ♂, 8 ♀, GER-072, IRCZM 089:05870; 1 ♂, GER-107, IRCZM 089:05869; 3 ♂, 1 ♀, GOS-144, IRCZM 089:05960; 3 ♂, 4 ♀, GER-058, UMML 32:5756; 3 juv., GOS-159, UMML 32:5755; 1 ♂, 7 ♀, 3 juv., GER-346, USNM 228243; 1 ♂, GOS-172, USNM 228242.

Thysanopoda orientalis Hansen, 1910

Thysanopoda orientalis Hansen, 1910:85–87, pl. 13, fig. 2(a–i).—Boden et al., 1955:309–311, fig. 12(a–b) [petasma].—Guglielmo and Costanzo, 1977:278, text-fig. 6, pl. 2(a–b) [thelycum].—Lomakina, 1978:93–94, fig. 48.

Material examined.—ATLANTIC: eastern Florida: 1 spm, *Albatross* Sta 2665, USNM 47519.—Gulf of Mexico: 1 ♂, 1 ♀, *Oregon* Sta 841, USNM 96002; 1 spm, *Albatross* Sta 2382, USNM 47518.—PACIFIC: Easter Island to Galapagos Islands: 1 ♂, 1 ♀, *Albatross* Sta 4709, USNM 45213.

Vouchers: 1 ♀, GER-130, IRCZM 089:05883; 8 ♂, 6 ♀, 10 juv., GER-285, IRCZM 089:05871; 1 ♀, GOS-144, IRCZM 089:05961; 4 ♂, 6 ♀, 1 juv., GER-341, UMML 32:5757; 4 ♂, 2 ♀, 1 juv., GER-356, USNM 228244.

Thysanopoda pectinata Ortmann, 1893

Thysanopoda pectinata Ortmann, 1893:10, pl. 1, fig. 4.—Boden et al., 1955:307–309, fig. 11(a–c) [petasma].—Guglielmo and Costanzo, 1977:278, text-fig. 5, pl. 1f [thelycum].—Lomakina, 1978:91–93, fig. 47.

Material examined.—ATLANTIC: Gulf of Mexico: 2 ♀, *Alaminos* Sta 66-A-9-15, USNM 135322; 1 ♂, *Albatross* Sta 2393, USNM 47505.

Vouchers: 1 juv. ♂, GER-332, IRCZM 089:05868; 1 juv. ♂, GER-072, UMML 32:5758; 1 ♀, GER-196, USNM 228245.

Remarks.—*Thysanopoda pectinata* has not been previously reported from the study area. Three specimens were collected in this study, all from off Miami, in depths ranging from 256–458 m. The species was also previously collected in the northern and western Gulf of Mexico (Hansen 1915; Springer and Bullis 1956; James 1970, 1971).

Thysanopoda tricuspida
H. Milne Edwards, 1837

"Thysanopode tricuspide" H. Milne Edwards, 1830:454, pl. 19, figs. 1–9 [Note: Milne Edwards' "fig. 5" is applied to two different illustrated appendages, and should read as numbers 5 and 6; those labelled figs. 6–9 should therefore be figs. 7–10, as reflected in the figure captions, p. 410.].

Thysanopoda tricuspida H. Milne Edwards, 1837:466, pl. 26, figs. 1–6.—Lucas, 1840:205.—Desmarest, 1852:43.

Thysanopodus tricuspidatus Guérin Méneville, 1829–1844: pl. 23, figs. 4, 4(a–l).—Lucas, 1840: pl. 17, fig. 2.

Thysanopoda tricuspidata.—G. O. Sars, 1883:20–21; 1885:98–102, pl. 17, figs. 1–25, larvae 165–169, pl. 31, figs. 1–22.—Hansen, 1910:82–84, pl. 12, fig. 3(a–b) [petasma].—Guglielmo and Costanzo, 1977:275, 278, text-fig. 3, pl. 1d [thelycum].—Lomakina, 1978:83–85, fig. 43.

Cyrtopia rostrata Dana, 1852:648; 1855: pl. 43, fig. 2(a–b) [fide G. O. Sars, 1885:165; larvae].

Material examined.—ATLANTIC: Gulf of Mexico: 1 ♂, 1 ♀, *Alaminos* Sta 69-A-11-91, USNM 135324.—Caribbean Sea: 1 ♀, *Gerda* Sta CARIB-10, UMML 32:1476; 2 ♀, *Gerda* Sta CARIB-23, UMML 32:1478;

7 ♂, 21 ♀, 16 juv., *Gerda* Sta CARIB-15, UMML 32:1483 (in part); 2 ♂, 3 ♀, *Gerda* Sta CARIB-18, UMML 32:1485; 2 ♂, 2 ♀, *Gerda* Sta CARIB-21, UMML 32:1491 (in part); 2 ♂, 2 ♀, *Gerda* Sta CARIB-21, UMML 32:1492 (in part); 50 ♂, 126 ♀, 5 juv., 3 spms, *Gerda* Sta CARIB-21, UMML 32:1493 (in part); 1 ♂, *Gerda* Sta CARIB-22, UMML 32:1495; 1 ♂, *Gerda* Sta CARIB-9, UMML 32.1497 (in part); 1 ♂, 1 ♀, *Gerda* Sta CARIB-9, UMML 32:1499.—Western Atlantic: 22 spms, *Bache* Sta, USNM 62248.

Vouchers: 71 ♂, 62 ♀, 48 juv., GER-286, IRCZM 089:05867; 10 ♂, 15 ♀, 2 juv., GOS-173, IRCZM 089:05962; 27 ♂, 53 ♀, 18 juv., GER-351, UMML 32:5759; 5 ♂, 12 ♀, 5 juv., GOS-172, UMML 32:5760; 26 ♂, 18 ♀, 17 juv., GER-098, USNM 228247; 5 ♂, 7 ♀, 1 juv., GOS-160, USNM 228246.

Remarks.—A correction is made here to the spelling of this species name. The first description and illustration of this species, under the French vernacular "Thysanopode triscupide," was read before the Académie des Sciences by H. Milne Edwards in 1830. Latreille (1831) was first to latinize Milne Edwards' genus "Thysanopode" to *Thysanopoda,* without reference to the specific epithet "tricuspide." The latter was latinized to *tricuspida* by H. Milne Edwards (1837). Because vernacular names have no status in zoological nomenclature, they cannot be emended. These latinizations are therefore first appearances and thus take authorship from those first appearances, i.e., *Thysanopoda* Latreille, 1831, and *T. tricuspida* H. Milne Edwards, 1837.

Dr. L. B. Holthuis (in litt. 1980) noted that Milne Edwards may not have been first to latinize the specific epithet "tricuspide." Plate 23 of Guérin Méneville's (1829–1844) "Iconographie du Règne Animal de Cuvier" illustrates Milne Edwards' species under the name "*Thysanopodus tricuspidatus* Edw." The exact publication date of this plate, and thus of *Thysanopodus tricuspidatus,* is unknown, except that it fell between 1829 and December 1837, when the last plate was published (Cowan 1971). According to Cowan (in litt. to L. B. Holthuis 1976), plate 23 most likely appeared with one of the livraisons between livr. 23 (September 1832) and livr. 41 (December 1835). If this should prove to be true, Guérin Méneville's specific name would precede that of Milne Edwards (1837). However, without further evidence, Cowan's suggested dates cannot be proven at this time. Therefore, the earliest date which can be accepted for plate 23 must be December 1837, the date by which all of the plates had been published. Because Milne Edwards' name appeared in July 1837, *Thysanopoda tricuspida* has priority.

Desmarest (1852) was the last to apply the valid name to this species, but without citation of any of the earlier authors. In summary, then, the name *Thysanopoda tricuspida* has been a nomen oblitum for over 130 years. G. O. Sars' (1883, 1885) form of the species name, *T. tricuspidata,* has been used by virtually every author since 1883, being attributed variously to Milne Edwards, 1830, or 1837. Such usage might provide sufficient reason to petition the International Commission on Zoological Nomenclature to suppress the unused senior synonym. However, I concur with Dr. L. B. Holthuis (in litt. 1980), who considered *T. tricuspida* "not a common species and . . . only known to taxonomists," in that nomenclatural stability of the Euphausiacea will not be seriously disturbed by reinstating the original spelling.

G. O. Sars (1883, 1885) was first to note the prominent dorsal spine on the carapace, just posterior to the rostrum. Although this character was neither noted nor illustrated in any work prior to 1883, other anatomical characters of this euphausiid illustrated by Milne Edwards (1830, 1837) and Sars (1885) compare favorably and leave little doubt that both authors were dealing with the same species. However, because Milne Edwards had overlooked or neglected to mention the very prominent post-rostral spine, examination of type material was desirable. Regrettably, the collections of the Muséum National d'Histoire Naturelle (Paris), believed to contain the existing specimens of H. Milne Edwards, yielded only one lot (MNHN Eu 29) under the name *Thysanopoda tricuspida.* Completely lacking locality data, the lot included the label "A. Milne Edwards, 4-99," indicating only that it was in the collection which A. Milne Edwards had in his cabinet in 1899 (J. Forest in litt. 1980). That this was part of a syntypic series of the elder Milne Edwards seems doubtful. Moreover, the single intact and seven fragmented specimens in the lot proved to be representatives of *Meganyctiphanes norvegica* (M. Sars, 1857), a species bearing little or no resemblance to *T. tricuspida.* Beyond these, no other specimens apparently exist which could be construed as type material for *T. tricuspida.* However, the identity of this species is well understood, principally through the work of G. O. Sars (1885), so no neotype need be designated.

Genus *Euphausia* Dana, 1850

Euphausia americana Hansen, 1911

Euphausia americana Hansen, 1911:23–24, fig. 6 [petasma].—Guglielmo and Costanzo, 1978:145, pl. 1(a–b) [thelycum].—Lomakina, 1978:128–129, fig. 69.

Material examined.—ATLANTIC: Caribbean Sea: 11 spms, *Albatross* Sta 138, USNM 9122; 1 ♂, *Gerda* Sta CARIB-23, UMML 32:1480; 1 ♀, *Gerda* Sta CARIB-15, UMML 32:1483 (in part); 2 ♂, 3 ♀, *Gerda* Sta CARIB-15, UMML 32:1484 (in part); 1 ♂, 1 ♀, *Gerda* Sta CARIB-18, UMML 32:1486 (in part).

Vouchers: 17 ♂, 25 ♀, 1 spm, GER-286, IRCZM 089:05863; 20 ♂, 20 ♀, GOS-130, IRCZM 089:05951; 5 ♂, 5 ♀, 12 juv., GER-740, UMML 32:5763; 20 ♂, 20 ♀, GOS-130, UMML 32:5762; 8 ♂, 9 ♀, GER-195, USNM 228201; 20 ♂, 20 ♀, GOS-130, USNM 228200.

Euphausia brevis Hansen, 1905

Euphausia brevis Hansen, 1905:15–16.—Boden et al., 1955:328–330, fig. 21(a–d) [petasma].—Costanzo and Guglielmo, 1976a:50, text-fig. 4, pl. 2, fig. 2 [thelycum].—Lomakina, 1978:124–125, fig. 66.

Material examined.—ATLANTIC: Bermuda-Bahamas line: "many," *Bache* Sta 10186, USNM 62271.

Vouchers: 1 ♂, 2 ♀, GER-286, IRCZM 089:05864; 1 ♂, GER-314, IRCZM 089:05866; 2 ♀, GER-345, IRCZM 089:05865; 7 ♂, 8 ♀, GOS-173, IRCZM 089:05952; 3 ♂, 1 ♀, GER-338, UMML 32:5765; 6 ♂, 8 ♀, GOS-173, UMML 32:5764; 2 ♂, 5 ♀, 1 juv., GER-717, USNM 228203; 6 ♂, 9 ♀, GOS-173, USNM 228202.

Euphausia gibboides Ortmann, 1893

Euphausia gibboides Ortmann, 1893:12, pl. 1, fig. 5.—Boden et al., 1955:347–349, fig. 32(a–b) [petasma].—James, 1970:209 [key], fig. 7-4.—Guglielmo and Costanzo, 1978:150, pl. 23(a–b) [thelycum].

Material examined.—ATLANTIC: Caribbean Sea: 2 ♀, *Gerda* Sta CARIB-10, UMML 32.1477; 25 ♂, 22 ♀, *Gerda* Sta CARIB-23, UMML 32.1479; 53 ♂, 49 ♀, 2 spms, *Gerda* Sta CARIB-18, UMML 32:1486 (in part); 1 ♀, *Gerda* Sta CARIB-21, UMML 32:1491 (in part); 22 ♂, 29 ♀, *Gerda* Sta CARIB-21, UMML 32:1492 (in part); 4 ♂, 2 ♀, *Gerda* Sta CARIB-14, UMML 32:1494; 1 ♂, 3 ♀, 1 juv., *Gerda* Sta CARIB-9, UMML 32:1500; 2 ♀, *Gerda* Sta CARIB-13, UMML 32:1505.—Western Atlantic: 10+ spms, *Bache* Sta, USNM 62278.

Vouchers: 30 ♂, 21 ♀, 1 juv., GER-011, IRCZM 089:05862; 6 ♂, 15 ♀, 19 juv., GOS-160, IRCZM 089:05953; 14 ♂, 14 ♀, 2 juv., GER-321, UMML 32:5767; 4 ♂, 3 ♀, 6 juv., GOS-159, UMML 32:5766; 8 ♂, 11 ♀, GER-084, USNM 228205; 4 ♂, 4 ♀, 6 juv., GOS-159, USNM 228204.

Euphausia hemigibba Hansen, 1910

Euphausia hemigibba Hansen, 1910:100, pl. 14, fig. 5(a–f).—Boden et al., 1955:342–344, fig. 29(a–e) [petasma].—James, 1977: 1039–1040, fig. 1 [thelycum].—Lomakina, 1978:149–150, fig. 86.

Material examined.—ATLANTIC: Caribbean Sea: 1 ♀, *Gerda* Sta CARIB-18, UMML 32:1486 (in part); 1 ♂, *Gerda* Sta CARIB-21, UMML 32:1492 (in part).—Western Atlantic: 200+ spms, *Bache* Sta, USNM 62277.

Vouchers: 17 ♂, 29 ♀, GER-011, IRCZM 089:05858; 10 ♂, 17 ♀, GOS-144, IRCZM 089:05954; 6 ♂, 10 ♀, GER-327, UMML 32: 5769; 10 ♂, 16 ♀, GOS-144, UMML 32:5768; 6 ♂, 6 ♀, GER-107, USNM 228207; 10 ♂, 17 ♀, GOS-144, USNM 228206.

Remarks.—Separation of this species from *Euphausia pseudogibba* was not possible using somatic characters alone. The dorsal spine on the third abdominal segment was variable in length and was thus unreliable as a diagnostic feature in these collections. Therefore, petasmal and thelycal structures were used, unfortunately excluding subadult specimens from identification to the species level. In mature individuals, the shape of the median lobe of the petasma (Fig. 2, pep, peh) or that of the sixth coxal lobes of the thelycum (see James 1977) were readily observable without dissection, allowing fairly rapid separation of the two species.

Euphausia mutica Hansen, 1905

Euphausia mutica Hansen, 1905:14–15; 1910:93–94, pl. 14, fig. 1(a–d) [petasma].—Guglielmo and Costanzo, 1978: 145, pl. 3(a–b) [thelycum].—Lomakina, 1978:123–124, fig. 65.

Material examined.—ATLANTIC: Caribbean Sea: 8 spms, *Albatross* Sta surf. 138, USNM 47615; 1 ♂, 1 ♀, *Gerda* Sta CARIB-22, UMML 32:1496.—West Indies: 1 spm, *Albatross* Sta, USNM 47618.—Western Atlantic: 30+ spms, *Bache* Sta, USNM 62272.

Vouchers: 10 ♂, 9 ♀, GER-286, IRCZM 089:05859; 16 ♂, 20 ♀, GOS-160, IRCZM 089:05955; 4 ♂, 9 ♀, 2 juv., GER-338, UMML 32:5771; 10 ♂, 6 ♀, GOS-144, UMML 32:5770; 7 ♂, 4 ♀, GER-351, USNM 228209; 9 ♂, 5 ♀, 3 juv., GOS-144, USNM 228208.

Euphausia pseudogibba Ortmann, 1893

Euphausia pseudogibba Ortmann, 1893:12–13, pl. 1, fig. 6.—Boden et al., 1955:340–342, fig. 28(a–d) [petasma].—James, 1977: 1040, fig. 2 [thelycum].—Lomakina, 1978: 151–153, fig. 88.

Material examined.—ATLANTIC: Caribbean Sea: 1 ♂, *Gerda* Sta CARIB-18, UMML 32:1486 (in part); 1 ♂, *Gerda* Sta CARIB-21, UMML 32:1491 (in part); 2 ♂, *Gerda* Sta CARIB-21, UMML 32:1492 (in part).—PACIFIC: Philippine Islands: 50+ spms, *Albatross* Sta 5649, USNM 49451.

Vouchers: 11 ♂, 16 ♀, GER-072, IRCZM 089:05860; 21 ♂, 7 ♀, GOS-160, IRCZM 089:05956; 13 ♂, 14♀, GER-351, UMML 32:5773; 3 ♂, 5 ♀, GOS-144, UMML 32: 5772; 7 ♂, 9 ♀, GER-326, USNM 228211; 3 ♂, 4 ♀, GOS-144, USNM 228210.

Remarks.—See remarks under *Euphausia hemigibba.*

Euphausia tenera Hansen, 1905

Euphausia tenera Hansen, 1905:9.—Boden et al., 1955:335–337, fig. 25(a–c) [petasma].—Guglielmo and Costanzo, 1978: 148, pl. 15(a–b) [thelycum].—Lomakina, 1978:162–164, fig. 98.

Material examined.—ATLANTIC: Caribbean Sea: 1 ♀, *Gerda* Sta CARIB-15, UMML 32:1484 (in part).—Western Atlantic: 30 + spms, *Bache* Sta, USNM 62273.

Vouchers: 29 ♂, 29 ♀, 7 juv., GER-740, IRCZM 089:05861; 20 ♂, 20 ♀, GOS-130, IRCZM 089:05957; 3 ♂, 4 ♀, GER-717,

UMML 32:5775; 20 ♂, 20 ♀, GOS-130, UMML 32:5774; 10 ♂, 12 ♀, GER-286, USNM 228213; 20 ♂, 20 ♀, GOS-130, USNM 228212.

Genus *Nematobrachion* Calman, 1905

Nematobrachion boopis (Calman, 1896)

Nematodactylus boopis Calman, 1896:16–19, pl. 2, figs. 19–28.

Nematobrachion boopis.—Calman, 1905: 153–154, pl. 26.—Boden et al., 1955:377–379, fig. 47(a–b) [petasma].—Lomakina, 1978:104–105, fig. 55.—Guglielmo and Costanzo, 1983:290, fig. 11(a–b) [thelycum].

Material examined.—ATLANTIC: Gulf of Mexico: 4 spms, *Alaminos* Sta 69-A-13-19, USNM 135309.

Vouchers: 19 ♂, 22 ♀, GER-072, IRCZM 089:05856; 2 ♂, 2 ♀, GOS-159, IRCZM 089:05964; 4 ♂, 5 ♀, 2 juv., GER-352, UMML 32:5777; 3 ♀, GOS-172, UMML 32:5776; 10 ♂, 9 ♀, 1 juv., GER-285, USNM 228215; 1 ♂, 1 ♀, GOS-172, USNM 228214.

Remarks.—No pattern of abdominal photophore reduction was noted for *Nematobrachion boopis*; males and females of all sizes possessed the full complement of photophores. In view of the patterns of reduction noted in the other species of this genus (see below), this "non-reduction" is in fact a species-specific characteristic.

Nematobrachion flexipes (Ortmann, 1893)

Stylocheiron flexipes Ortmann, 1893:18–19, pl. 1, fig. 7.

Nematodactylus flexipes.—Calman, 1896: 16.

Nematobrachion flexipes.—Calman, 1905: 153.—Boden et al., 1955:373–376, fig. 45(a–c) [petasma].—Lomakina, 1978: 101–102, fig. 53.—Guglielmo and Costanzo, 1983:287, fig. 9(a–b) [thelycum].

Material examined.—ATLANTIC: Gulf of Mexico: 3 ♀, *Alaminos* Sta 65-A-9-6, USNM 135310.—Western Atlantic: 51 ♂, 45 ♀, 37 juv., USNM 62288 (in part).

Vouchers: 37 ♂, 42 ♀, 2 juv., GER-286, IRCZM 089:05857; 4 ♂, 2 ♀, 6 juv., GOS-144, IRCZM 089:05940; 2 ♂, 5 ♀, 3 juv., GER-100, UMML 32:5779; 3 ♂, 2 ♀, 4 juv., GOS-144, UMML 32:5778; 5 ♂, 4 ♀, GER-327, USNM 228217; 3 ♂, 2 ♀, 4 juv., GOS-144, USNM 228216.

Remarks.—P. T. James (quoted by Herring and Locket 1978) noted sexual dimorphism in the abdominal photophores of this species in the eastern Atlantic; males lacked the third photophore, and females lacked both the second and third photophores. This same pattern of photophore reduction was noted in all specimens examined in this study. However, a further observation was made: Whereas large males (ca. 15 mm in length) lacked only the third photophore, small males (ca. 11 mm in length) with underdeveloped, but recognizable, petasmata, lacked both the second and third. Males of an intermediate length (ca. 13 mm) possessed the second photophore, although it was smaller in diameter than the first and fourth. All subadults (<10 mm in length, with underdeveloped reproductive structures) lacked both the second and third photophores. Thus while females of any size lacked both the second and third photophores, males appeared to acquire the second with maturity.

Nematobrachion sexspinosus Hansen, 1911

Nematobrachion sexspinosus Hansen, 1911: 50–51.—Boden et al., 1955:376–377, fig. 46(a–d) [petasma].—Lomakina, 1978: 102–103, fig. 54.

Nematobrachion sexspinosum Mauchline and Fisher, 1969:92, fig. 31 [unjustified emendation].—Guglielmo and Costanzo, 1983:288, 290, fig. 10(a–b) [thelycum].

Material examined.—ATLANTIC: Gulf of Mexico: 1 ♂, 1 ♀, *Alaminos* Sta 66-A-5-3, USNM 135311.—Western Atlantic: 1 ♂, 1 ♀, *Bache* Sta, USNM 62289.—PACIFIC: Easter Island to Galapagos Islands: 1 ♂ (HOLOTYPE), *Albatross* Sta 4699, USNM 45374.

Vouchers: 4 ♂, GER-286, IRCZM 089:05852; 1 ♀, GER-353, IRCZM 089:05854; 1 ♀, GER-358, IRCZM 089:05853; 1 ♂, 3 ♀, GOS-144, IRCZM 089:05963; 2 ♂, 3 ♀, GER-339, UMML 32:5780; 2 ♂, 7 ♀, GER-341, USNM 228218; 1 ♀ with parasitic isopods, GER-346, USNM 228219.

Remarks.—Mauchline and Fisher (1969) and some subsequent authors have used the specific epithet *sexspinosum* for this species. Although Mauchline and Fisher (1969) did not comment on the change in spelling, it is most logically interpreted as a change in ending from masculine to neuter, to agree in gender with the genus name. The Greek stem, "brachion," of the genus, however, is masculine, rendering the emendation unjustified. It is unlikely that *sexspinosum* was an unintentional subsequent spelling because the original spelling was cited and the change was used consistently throughout Mauchline and Fisher's 1969 review and Mauchline's 1980 revision.

A previously unknown pattern of abdominal photophore reduction was noted in this species; all males examined possessed the full complement of four photophores, however, all females lacked the third.

Parasitic isopods were found attached to one specimen (1 ♀, GER-346, USNM 228219).

This is the first record of *Nematobrachion sexspinosus* from eastern Florida. James (1970, 1971) collected a single specimen from 24°00'N, 83°11'W, west of the area presently under consideration, plus 24 other specimens from various locations throughout the Gulf of Mexico.

Genus *Nematoscelis* G. O. Sars, 1883
Nematoscelis atlantica Hansen, 1910

Nematoscelis atlantica Hansen, 1910:106–107.—Gopalakrishnan, 1975:799–808, figs. 1a, 4Ab, 4Bb, 5d, 6b, 8d [petasma].—Costanzo and Guglielmo, 1976a:51–52, text-fig. 7, pl. 4 [thelycum].

Material examined.—ATLANTIC: Martha's Vineyard, Mass.: 2 ♀, *Albatross* Sta 2210, USNM 8404; 3 spms, *Albatross* Sta 2565, USNM 35239.

Vouchers: 4 ♂, 27 ♀, 1 ovig. ♀, GER-072, IRCZM 089:05855; 2 ♂, 6 ♀, GOS-144, IRCZM 089:05941; 1 ♂, 6 ♀, 1 ovig. ♀, GER-285, UMML 32:5782; 3 ♂, 4 ♀, GOS-144, UMML 32:5781; 5 ♂, 15 ♀, GER-352, USNM 228221; 2 ♂, 4 ♀, GOS-144, USNM 228220.

Remarks.—*Nematoscelis atlantica* is extremely difficult to distinguish from *N. microps.* Gopalakrishnan's (1975) study, although thorough, cited diagnostic characters subsequently found to be ambiguous in eastern Florida material. Specimens of *N. atlantica* differed from *N. microps* in having generally narrower upper eye lobes, a weaker carapace keel with a lower "hump," and weaker or absent keels on the fourth and fifth abdominal segments. Adult females usually retained the juvenile lateral denticles on the edge of the carapace, although the largest had lost them as in *N. microps* (see remarks under *N. microps*). Males were present in two forms as described by Gopalakrishnan (1975), viz., either unmodified or with enlarged abdominal photophores on the second and third segments plus dorsal prominences on the first and second segments. Immature males of the latter category showed some photophore enlargement, with further enlargement and development of the dorsal prominences occurring with increasing body length.

Two females with external ova were collected, one each in September and April.

Of the 30 stations containing males of *Nematoscelis atlantica,* 16 (53%) stations had males with enlarged photophores on the second and third abdominal segments as described by Gopalakrishnan (1975). Of a total of 143 male specimens, 35 (24.5%) were males with enlarged photophores (=MEP's). Numbers of males per station were too low to provide a meaningful indication of percent of the population possessing this feature. All of the MEP's occurred in stations containing other *Nematoscelis* species.

Nematoscelis megalops G. O. Sars, 1883

Nematoscelis megalops G. O. Sars, 1883: 27.—Gopalakrishnan, 1975:802–807, figs. 4Af, 4Bf, 5g, 6f, 7a [petasma].—Costanzo and Guglielmo, 1976a:50, text-fig. 6, pl. 3, fig. 2 [thelycum].

Material examined.—ATLANTIC: off Chesapeake Bay: 300+ spms, *Bache* Sta 10158, USNM 62281.—off Nantucket Shoals, Mass.: 1 ♀, *Albatross* Sta 2044, USNM 35451.

Remarks.—*Nematoscelis megalops* was not represented in the collections analyzed here. The only previous record for the species in Floridan waters is a single specimen from the Florida Straits off Miami (Lewis 1954). Unfortunately, the specimen could not be located either at the Rosenstiel Invertebrate Museum nor through communication with Mr. Lewis (in litt. 1980), therefore the record remains unverified.

Nematoscelis microps G. O. Sars, 1883

Nematoscelis microps G. O. Sars, 1883:28.—Gopalakrishnan, 1975:799–808, figs. 1b, 4Ac, 4Bc, 5c, 6a, 8b [petasma].—Costanzo and Guglielmo, 1980:315, figs. 7–9 [thelycum].

Material examined.—ATLANTIC: Caribbean Sea: 1 ♂, *Albatross* Sta 2151, USNM 47387; 1 ♂, *Gerda* Sta CARIB-23, UMML 32:1481 (in part).—Western Atlantic: 25+ spms, *Bache* Sta, USNM 62283; 1 juv., *Bache* Sta, USNM 62288 (in part).

Vouchers: 41 ♂, 282 ♀, 33 ovig. ♀, GER-072, IRCZM 089:05876; 13 ♂, 10 ♀, 3 ovig. ♀, GOS-159, IRCZM 089:05942; 65 ♂, 16 ♀, 4 ovig. ♀, 15 juv., GER-326, UMML 32:5784; 13 ♂, 10 ♀, 3 ovig. ♀, GOS-159, UMML 32:5783; 45 ♂, 119 ♀, 1 ovig. ♀, GER-327, USNM 228223; 13 ♂, 10 ♀, 3 ovig. ♀, GOS-159, USNM 228222.

Remarks.—See remarks under *Nematoscelis atlantica.* Subadult females possessed a lateral denticle on the rear edge of the carapace, a feature which gradually decreased in size with increasing body length. Adult females lacked the denticle completely, in agreement with Gopalakrishnan (1975). Parasitic isopods were encountered on three specimens (1 ♂, GER-286; 1 ♀, GER-338; 1 ♀, GOS-144); these specimens, with their euphausiid hosts, are now housed at the USNM. Males corresponding to Gopalakrishnan's (1975) two forms were encountered: those with an enlarged photophore on the second abdominal segment plus a dorsal prominence on the first segment, and those without these features. As with *N. atlantica,* enlarged photophores and prominences were more fully developed in larger males.

Females carrying external ova were collected in January, March, April, June, July, August, September, and December.

Of the 53 stations containing males of *Nematoscelis microps,* 32 (60%) contained males with enlarged photophores on the first abdominal segment as described by Gopalakrishnan (1975). A total of 909 males yielded 330 (36%) MEP's. Percentage of MEP's per station [calculated using only those stations ($n = 22$) with 10 or more total males] ranged from 0–100% ($\bar{x} = 41.6\%$); 93% of the MEP's occurred in stations containing other *Nematoscelis* species.

Nematoscelis microps was the second most abundant species in the present study (Table 2).

Nematoscelis tenella G. O. Sars, 1883

Nematoscelis tenella G. O. Sars, 1883:28.—Gopalakrishnan, 1975:802–808, figs. 4Ad, 4Bd, 5e, 6d, 8a [petasma].—Costanzo and Guglielmo, 1980:312–313, figs. 3A, 4A [thelycum].

Material examined.—ATLANTIC: Gulf of Mexico: 6 spms, *Alaminos* Sta 66-A-5-3, USNM 135312.—Caribbean Sea: 2 ♂, *Gerda* Sta CARIB-23, UMML 32:1481 (in part); 1 ♀, *Gerda* Sta CARIB-18, UMML 32:1490.—Western Atlantic: 15+ spms, *Bache* Sta, USNM 62286; 1 juv., *Bache* Sta, USNM 62288 (in part).

Vouchers: 5 ♂, 18 ♀, 1 ovig. ♀, GER-072, IRCZM 089:05875; 5 ♂, 15 ♀, 12 juv., GOS-144, IRCZM 089:05949; 2 ♂, 10 ♀, 7 ovig. ♀, GER-285, UMML 32:5786; 5 ♂, 7 ♀, 1 ovig. ♀, 5 juv., GOS-159, UMML 32:5785; 4 ♂, 12 ♀, GER-346, USNM 228227; 4 ♂, 8 ♀, 6 juv., GOS-159, USNM 228226.

Remarks.—Females carrying external ova were collected in April, September, and January.

Of the 34 stations containing males of *Nematoscelis tenella,* only 2 stations (6%) contained males with enlarged photophores on the second and third abdominal segments as described by Gopalakrishnan (1975); only 2 (2%) of the 87 males encountered possessed this feature. As with *N. atlantica,* numbers per station were too low to calculate a meaningful figure for percent of the population exhibiting this feature. Both MEP's were found in samples containing other species of *Nematoscelis.*

Genus *Stylocheiron* G. O. Sars, 1883

A previous paper (Mikkelsen 1981) reported on *Stylocheiron elongatum* and *S. suhmii* [=*S. affine, S. longicorne, S. microphthalma*] from this study. Outside material examined and R/V *Gosnold* vouchers have already been given for these species and are not repeated here.

Stylocheiron abbreviatum G. O. Sars, 1883

Stylocheiron abbreviatum G. O. Sars, 1883: 33.—Boden et al., 1955:390–391, fig. 54(a–c) [petasma].—Costanzo and Guglielmo, 1976b:180, text-fig. 5, pl. 3, fig. 1 [thelycum].—Lomakina, 1978:215–216, fig. 131.

Material examined.—ATLANTIC: Miami: 2 ♀, *Gerda* Sta, UMML 32:1498; 6 ♂, 9 ♀, *Gerda* Sta, UMML 32.1502; 2 ♀, *Gerda* Sta, UMML 32:1504.—Caribbean Sea: 1 ♂, 1 ♀, *Gerda* Sta CARIB-7, UMML 32:1506; 2 ♂, 1 ♀, *Gerda* Sta CARIB-22, UMML 32.1507; 1 ♂, *Gerda* Sta CARIB-19, UMML 32:1508.—Western Atlantic: 30+ spms, *Bache* Sta, USNM 62296.

Vouchers: 158 ♂, 338 ♀, 1 ovig. ♀, GER-333, IRCZM 089:05877; 18 ♂, 29 ♀, 4 ovig. ♀, 56 juv., GOS-144, IRCZM 089:06021; 35 ♂, 92 ♀, 1 juv., GER-338, UMML 32:5788; 5 ♂, 12 ♀, 7 juv., GOS-173, UMML 32:5787; 26 ♂, 37 ♀, 6 juv., GER-326, USNM 228229; 4 ♂, 12 ♀, 7 juv., GOS-173, USNM 228228.

Remarks.—Females carrying external ova were collected in January, May, June, and July.

Stylocheiron carinatum G. O. Sars, 1883

Stylocheiron carinatum G. O. Sars, 1883: 31.—Hansen, 1910:113–115, pl. 16, fig. 1(a–h) [petasma].—Lomakina, 1978:203–205, fig. 123.

Material examined.—ATLANTIC: Chesapeake Bay-Bermuda line: 50+ spms, *Bache* Sta 10169, USNM 62290.—Caribbean Sea: 1 ♀, *Gerda* Sta CARIB-18, UMML 32:1489.

Vouchers: 13 ♂, 9 ♀, 4 juv., GER-746, IRCZM 089:05878; 20 ♂, 21 ♀, 5 ovig. ♀, GOS-173, IRCZM 089:05950; 158 ♂, 366 ♀, 3 ovig. ♀, GER-740, UMML 32:5790; 20 ♂, 20 ♀, 5 ovig. ♀, GOS-173, UMML 32:5789; 2 ♂, 6 ♀, GER-104, USNM 228231; 20 ♂, 20 ♀, 5 ovig. ♀, GOS-173, USNM 228230.

Remarks.—The thelycum of *Stylocheiron carinatum* is undescribed, and is presently being studied by L. Guglielmo and G. Costanzo (pers. comm.). Females carrying external ova were collected in January, February, May, August, and September.

This was the most abundant species in the collections analyzed here (Table 2).

Stylocheiron elongatum G. O. Sars, 1883

Stylocheiron elongatum G. O. Sars, 1883: 32.—Lomakina, 1978:212–214, fig. 129.—Mikkelsen, 1981:1177, figs. 1a, 3a [thelycum and petasma].

Vouchers: 3 ♂, 22 ♀, 1 juv., GER-349, IRCZM 089:05880; 2 ♂, 7 ♀, GER-199, UMML 32:5792; 4 ♂, 4 ♀, GOS-144, UMML 32:5791; 1 ♂, 14 ♀, 2 juv., GER-058, USNM 228232.

Remarks.—R/V *Gosnold* material of this species was thoroughly examined in a previous study (Mikkelsen 1981) which included material examined and petasmal and thelycal structures.

Females with external ova were collected in January.

Stylocheiron maximum Hansen, 1908

Stylocheiron maximum Hansen, 1908:92.—Boden et al., 1955:391–393, fig. 55(a–d) [petasma].—Costanzo and Guglielmo, 1976b:180, text-fig. 6, pl. 3, fig. 2 [thelycum].—Lomakina, 1978:217–219, fig. 133.

Material examined.—ATLANTIC: Gulf of Mexico: 1 ♂, 1 ♀, *Alaminos* Sta 65-A-96, USNM 135314.—Western Atlantic: 1 ♂, 17 ♀, *Bache* Sta, USNM 62297.

Vouchers: 2 ♂, 3 ♀, 1 juv., GER-309, IRCZM 089:05882; 1 ♂, 3 ♀, GER-339, IRCZM 089:05881; 3 ♂, 1 ♀, GER-353, UMML 32:5793; 2 ♂, 3 ♀, GER-286, USNM 228233.

Remarks.—No females with external ova were collected.

Stylocheiron robustum Brinton, 1962

Stylocheiron robustum Brinton, 1962:174–178, figs. 4–5, table 3 [petasma].—Lomakina, 1978:217, fig. 132.

Material examined.—PACIFIC: south of Japan: 1 ♂ (HOLOTYPE), "Norpac" Sta 141, USNM 107830.—off eastern Australia: 1 ♀ (ALLOTYPE), "Monsoon" Exped. Sta 19, USNM 107831.

Vouchers: 2 ♂, 4 ♀, GER-071, IRCZM 089:05836; 2 ♀, GOS-144, IRCZM 089:05948; 2 ♂, 2 ♀, GER-339, UMML 32:5794; 2 ♂, 2 ♀, GER-326, USNM 228234.

Remarks.—This is the first record of this species from the study area, although James (1970, 1971) collected 26 specimens in the Gulf of Mexico, including a single specimen from just west of the study area, off western Cuba. *Stylocheiron robustum* is somatically very similar to *S. abbreviatum,* except that it lacks dorsal keels on the fourth and fifth abdominal segments, and the upper eye lobe is only slightly narrower than the lower lobe. It differs from *S. maximum* mainly in the relative sizes of the eye lobes, which in *S. maximum* are more nearly equal in width. In addition, the dactyl of the "true chela" in *S. robustum* (see Brinton 1962, fig. 4C) is narrower proximal to the secondary spines than that of *S. abbreviatum* (see James 1970, figs. 7–9) or *S. maximum* (see Hansen 1910, pl. 16, fig. 6b).

The thelycum of *Stylocheiron robustum* is undescribed, and is presently being studied by L. Guglielmo and G. Costanzo (pers. comm.). No females with external ova were collected.

Stylocheiron suhmii G. O. Sars, 1883

Stylocheiron suhmii G. O. Sars, 1883:31.—Mikkelsen, 1981:1196–1199, figs. 2, 3B, 5, 8 [petasma and thelycum].

Stylocheiron affine Hansen, 1910:118–120, pl. 16, fig. 4(a–d).

Stylocheiron longicorne G. O. Sars, 1883: 32.

Stylocheiron microphthalma Hansen, 1910: 117–118, pl. 16, fig. 3(a–d).

Vouchers: 1 ♂, 2 ♀, GER-339, IRCZM 089:05835; 7 ♂, 23 ♀, GER-740, IRCZM 089:05879; 1 ♂, 2 ♀, GER-195, UMML 32:5799; 3 ♂, 9 ♀, GER-338, UMML 32:5797; 1 ♂, 2 ♀, GER-339, UMML 32:5798; 1 ♂, 3

Table 3.—Recorded day/night occurrence for species in all stations. All cited depths are maximum limits of open net hauls. Daytime defined as any time period either partially or completely included in the period from 0600 to 1800 hrs. Frequency defined as percentage of the day or night hauls, respectively, which contained the species. ND = no data.

	Day		Night	
	(23 sta.; 35–805 m; $\bar{x}$ = 324.4 m)		(70 sta.; 0–820 m; $\bar{x}$ = 249.4 m)	
Species	Depth range (m)	Frequency (%)	Depth range (m)	Frequency (%)
B. amblyops	ND	0	520–648	3
T. aequalis	157–805	43	26–820	64
T. cristata	458	4	ND	0
T. monacantha	35–805	52	26–820	74
T. obtusifrons	250–596	22	130–750	21
T. orientalis	250–596	26	256–820	14
T. pectinata	458	4	256–342	3
T. tricuspida	78–805	52	0–820	68
E. americana	157–596	48	0–750	53
E. brevis	250–595	17	0–750	28
E. gibboides	157–596	52	45–750	67
E. hemigibba	91–596	39	26–750	60
E. mutica	250–596	30	0–750	50
E. pseudogibba	78–596	39	38–520	54
E. tenera	35–596	30	0–750	36
Ns. atlantica	174–596	35	38–750	48
Ns. microps	157–805	56	38–820	73
Ns. tenella	157–805	48	38–820	58
Nb. boopis	300–596	26	200–820	20
Nb. flexipes	157–596	48	26–750	48
Nb. sexspinosus	250–596	30	181–520	26
S. abbreviatum	91–805	78	38–750	76
S. carinatum	35–595	52	0–820	63
S. elongatum	250–596	43	181–820	33
S. maximum	300–805	30	256–520	10
S. robustum	250–805	30	181–500	17
S. suhmii	78–596	61	38–750	50

♀, 3 juv., GOS-159, UMML 32:5796; 6 ♂, 8 ♀, 2 juv., GOS-160, UMML 32:5795; 3 ♀, GER-324, USNM 228236; 2 ♂, 4 ♀, GER-331, USNM 228235; 3 ♀, GER-339, USNM 228237.

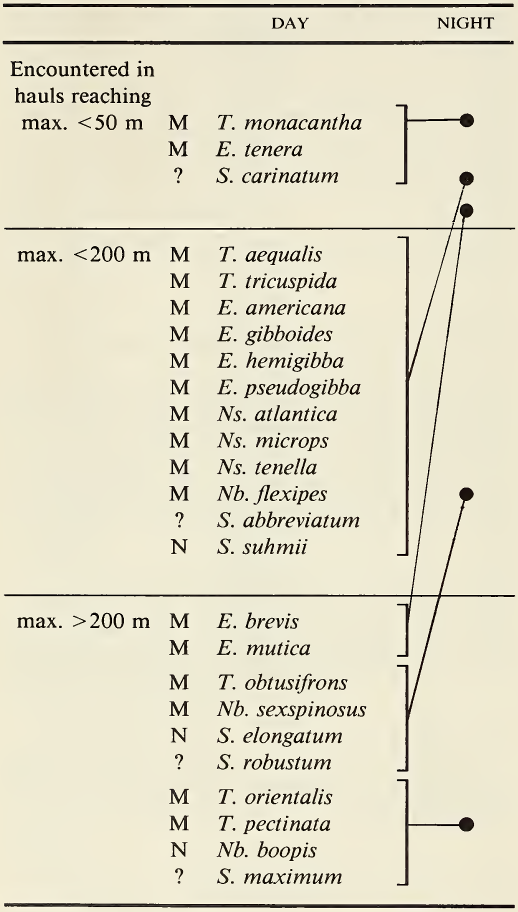
Remarks.—This species and its synonyms were thoroughly investigated in a previous paper (Mikkelsen 1981), which included a redescription, synonymy, material examined, and petasmal and thelycal structures. Specimens corresponding to the descriptions (Brinton 1975, and authors) of *Stylocheiron suhmii* s.s., *S. affine,* and *S. longicorne* were encountered.

Females with external ova were collected in January.

Discussion

The eastern Florida euphausiacean fauna may be characterized as predominantly warm-temperate to tropical, with 17 (71%) of the 24 species encountered categorized as such according to Western Atlantic distributional data from Lomakina (1978). Although four species (*Thysanopoda cristata, T. pectinata, Nematobrachion sexspinosus, Stylocheiron robustum*) are recorded for the

Table 4.—Comparison of day/night composition in hauls reaching various depth maxima. List indicates first appearance and is cumulative, that is, those species listed in the <50 m category are also components of the two succeeding categories, etc. Lines indicate night depth locations of each day group, and do not mean to imply migratory pathways. M = migrator; N = nonmigrator; ? = unknown or conflicting reports on migratory behavior (Mauchline and Fisher 1969; Mauchline 1980).



		DAY	NIGHT
Encountered in hauls reaching max. <50 m	M	*T. monacantha*	
	M	*E. tenera*	
	?	*S. carinatum*	
max. <200 m	M	*T. aequalis*	
	M	*T. tricuspida*	
	M	*E. americana*	
	M	*E. gibboides*	
	M	*E. hemigibba*	
	M	*E. pseudogibba*	
	M	*Ns. atlantica*	
	M	*Ns. microps*	
	M	*Ns. tenella*	
	M	*Nb. flexipes*	
	?	*S. abbreviatum*	
	N	*S. suhmii*	
max. >200 m	M	*E. brevis*	
	M	*E. mutica*	
	M	*T. obtusifrons*	
	M	*Nb. sexspinosus*	
	N	*S. elongatum*	
	?	*S. robustum*	
	M	*T. orientalis*	
	M	*T. pectinata*	
	N	*Nb. boopis*	
	?	*S. maximum*	

first time off eastern Florida in the present study, all have been previously collected in the Gulf of Mexico and so do not reflect dramatic range extensions for circumglobal, pelagic species such as these.

In an analysis of species abundance and relative frequencies (Table 2), the six top-ranking species comprised over 70% of the entire collection. Species ranking in this category was not significantly altered when only "100+ stations" were analyzed, unlike ranking by relative frequency which showed noticeable change. The figures generated by analysis of "100+ stations" thus probably represent a more accurate description of the eastern Florida euphausiacean community than those from analysis of the entire collection.

Because all collections analyzed here were made with open nets, few positive statements may be made about the vertical distribution or migration of the various species. However, some information may be obtained by examining species lists from shallow (<50 m), medium (<200 m), and deep (>200 m) hauls. Table 4 shows that 14 (82%) of the 17 species in the top 50 m at night were not found in day hauls to the same depth, suggesting vertical migration on the part of those species. The list also shows three shallow-water species (*Thysanopoda monacantha, Euphausia tenera, Stylocheiron carinatum*) and four deep-water species (*T. orientalis, T. pectinata, Nematobrachion boopis, S. maximum*) which did not change depth category, suggesting the absence of marked vertical migration. Most of these observations are consistent with the current categorizations of these species as migratory or nonmigratory (Table 4).

Gopalakrishnan (1975) discussed the occurrence of patterns of enlarged abdominal photophores in the genus *Nematoscelis*. Sixty-nine stations analyzed here contained one or more *Nematoscelis* species, with 58 stations containing males. Of these 58, 35 stations contained at least one male with enlarged photophores (=MEP). Fifteen stations yielded only one species of *Nematoscelis*; of these, two stations contained MEP's. Seventeen stations yielded two species of *Nematoscelis*, with 10 stations containing one MEP species, and 1 station containing both species with MEP's. The remaining 37 stations contained all three species of *Nematoscelis*; 14 stations contained no MEP's, 11 contained one MEP species, 11 contained two MEP species, and one station contained all three species with MEP's. These data indicate that MEP's are more frequently encountered in populations containing more than one species of *Nematoscelis,* lending support to Gopalakrishnan's (1975) suggestion that enlarged photophores may play a role in species recognition. The observation of more fully enlarged photophores in larger males of *N. atlantica* and *N. microps* further supports this hypothesis.

Species recognition may also apply as explanation for the species-, sex-, and size-dependent patterns of abdominal photophore reduction shown here for the three species of *Nematobrachion.*

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HETEROMYSINI FROM GRAND BAHAMA ISLAND: DESCRIPTION OF *HETEROMYSIS AGELAS*, NEW SPECIES, FIRST DESCRIPTION OF MALE *H. FLORIDENSIS*, AND NOTES ON *H. GUITARTI* (CRUSTACEA: MYSIDACEA)

Richard F. Modlin

Abstract.—*Heteromysis agelas* is described from waters near Freeport, Grand Bahama Island. The first description of the male of *H. floridensis*, known previously from a single female specimen, is presented. Additional ecological information on *H. guitarti* is provided.

Species in the tribe Heteromysini, because of their cryptic mode of existence, are rarely obtained when usual collecting techniques are employed. The species described and discussed herein were obtained by SCUBA divers when they examined or collected substrates (hosts) on the sea bottom that contained heteromysids. Although about 22 species in this tribe have been reported from the western Atlantic Ocean, only *Heteromysoides dennisi* Bowman (1985) has previously been reported from waters off Grand Bahama Island. Two other heteromysids are known from the Bahama Islands. Clarke (1955) described *Heteromysis actiniae* from waters off Bimini and discussed its commensal relationship with the sea anemone *Bartholomea annulata.* This species has since been reported from Lyford Cay and Paradise Island (Brattegard 1970). Brattegard (1970) obtained two specimens of *H. guitarti* from a sponge collected off Andros Island. Herein is described a new species of *Heteromysis* and the male of *H. floridensis,* and some additional ecological information is presented for *H. guitarti.*

Type specimens of the new species and the collection that contained *H. floridensis* have been deposited in the U.S. Museum of Natural History (USNM). The remaining specimens are in the museum of the Marine Environmental Sciences Consortium at the Dauphin Island Sea Lab, Dauphin Island, Alabama (MESC).

Heteromysis agelas, new species
Fig. 1

Material examined.—Male, 4.7 mm, holotype (USNM 228745); 5.2 mm male, 5.0 mm female, paratypes (USNM 228746); and 3 males (4.0–5.2 mm), 4 females (4.0–5.1 mm), 3 ovigerous females (4.6–5.5 mm), and 6 juveniles (2.4–3.0 mm) taken from 8 different specimens of the sponge *Agelas dispar* collected by J. Uebelacker near the November 1975 Hydro-Lab habitat location off Freeport, Grand Bahama Island, at depths from 15–17 m.

Description.—Body robust. Carapace with anterior margin produced into triangular rostrum, posterior margin deeply emarginate, partly exposing thoracic segment 7 and all of 8, anterolateral lobes rounded. Eyes large, oval, distinctly stalked and directed laterally; cornea large, oval, medial margin slightly scalloped with strong ocular tooth on anterosuperior edge.

Antennular peduncle 3-segmented; segment 1 about as long as segment 3; segment 2 compressed, with small spine on medial surface; segment 3 with plumose seta on medial surface, robust blade-like spine with subterminal flagellum, 2 plumose setae and

Fig. 1. *Heteromysis agelas*: A, Carapace, dorsal; B, Carapace, lateral; C, Antennular peduncle; D, Antennal peduncle and scale; E, Mandible, right; F, Mandible, left; G, Mandibular palp; H, Thoracic endopod 3; I, Thoracic endopod 3, carpopropodus and dactylus; J, Pleopod 3; K, Pleopod 4; L, Uropod; M, Telson. A–B = male, 5.2 mm, USNM 228746; C–I, L–M, = female, 5.1 mm; J–K = male, 5.0 mm.

1 naked seta distomedially, 2 small plumose setae mid-dorsally, male lobe ventrally with few long hair-like setae.

Antennal scale blade-like, about 0.8 times length of peduncle, medial margin strongly convex, lateral margin slightly convex, setose all around, apical segment about 0.06 times length of scale. Antennal peduncle 3-segmented, segment 1 inconspicuous; segment 2 1.2 times longer than 3, short robust plumose seta near distolateral edge, 4 naked setae distomedially; segment 3 with 4 naked setae distomedially.

Mandibles and palp: Right and left mandibles with blade-like incisors, right incisor with large anterior cusp, left with anterior and posterior cusp; right lacinia mobilis with 5 cusps, left with 4 cusps; each mandible with 3 strong setose accessory blades in spine row; left molar region more strongly developed than right. Mandibular palp 3-segmented; segment 1 small, inconspicuous; segment 2 expanded, medial margin with 16 naked setae, lateral margin with 10 naked setae; segment 3 medial margin sinuous, proximal half with 2 long naked setae and 3 robust spined setae, distal half with about 5 short spines and 1 long plumose seta, apex with 2 long robust spine setae, 4 long simple setae on lateral surface.

Labrum, maxillule, maxillae, and paragnaths typical of genus.

Thoracic endopods 1 and 2 typical of genus. Thoracic endopod 3, ischium about 1.4 times longer than carpopropodus, medial margin with 3 long and 4 short simple setae, small protuberance distomedially, lateral margin with 1 simple seta proximally and 1 simple seta distolaterally; medial margin of carpopropodus with 5 robust flagellated spines arranged as 2 pairs of equal-length spines distal to single short spine, 3 long simple setae submarginal to spinal groups, 2 short simple setae proximally, 1 simple seta distally; dactylus inconspicuous with 2 simple setae distolaterally, terminating in long robust claw with 3 simple setae at mid-length. Carpopropodus 3-segmented in thoracic endopod 4; 6-segmented in thoracic endopods 5–8. Thoracic exopod 1 with 9 segments; exopods 2–8 each with 10 segments.

Pleopods unsegmented; male pleopods 1, 2, and 5 not differentiated. Pleopod 3 with 8 robust plumose setae along anterior surface, 4 flagellated spines along distal margin and 1 naked long robust seta distolaterally, 2 short robust plumose setae proximally on posterior surface, distal margin of pseudobranchial lobe with 4 long and 1 short plumose setae. Pleopod 4 with 8 robust plumose setae along anterior surface, 5 flagellated spines on distal margin and 1 simple long robust seta distolaterally, 2 short robust plumose setae proximally on posterior surface, distal margin of pseudobranchial lobe with 4 long and 1 short plumose setae. Female pleopods rudimentary.

Uropods: Exopod about 1.1 times longer than endopod, lateral margin straight, medial margin slightly convex, setose all around. Endopod linguiform with 2 small spines on medial margin in region of statocyst, setose all around.

Telson 0.8 times length of exopod of uropod, lateral margins slightly concave, completely spined with 15–16 spines per margin (apical spines included), marginal spines in distal half slightly longer than proximal group, outer apical spine 2.5 times longer than inner, cleft completely spined with 12 spines, 0.2 times length of telson.

Remarks.—*Heteromysis agelas* appears to be intermediate between *H. bredini* Brattegard, 1970, and *H. guitarti* Bacescu, 1968; (Brattegard 1970). It differs from *H. bredini* by having the antennal scale shorter than the antennal peduncle, 5 rather than 10 flagellated spines on the carpopropodus of thoracic endopod 3, 2 short rather than 5 long spines in the region of the statocyst, and a telson with 15–16 instead of 19–20 spines on each lateral margin and 12 rather than 31 spines in the telsonal cleft. Similarily, *H. guitarti* has 7 flagellated spines on the medial margin of the carpopropodus of thoracic endopod 3, 4 long spines on the endopod of the uropod in the vicinity of the statocyst, 9–10 spines on each lateral margin of the telson and 16–21 spines in the cleft of the telson. Males of *H. guitarti* and *H. agelas* have pleopods 3 and 4 modified. Pleopods 3 and 4 of the latter have, respectively, 4 and 5 flagellated spines on the distal margins rather than 2 and 9 as does the former. Males of *H. bredini* have not been described.

Ecological notes.—Eight of the 19 specimens of *Agelas dispar* examined contained *H. agelas.* The average number of individuals taken from a sponge was two, range one to five. The three ovigerous females each carried two eggs. Modlin (1984) obtained specimens of *H. beetoni* from *A. dispar* collected on the Florida Middle Grounds in the Gulf of Mexico.

Etymology.—Named for the sponge, *Agelas dispar,* with which this mysid was found associated.

Heteromysis floridensis Brattegard, 1969

Fig. 2

Heteromysis floridensis was described from a single female specimen collected in Biscayne Bay, Florida (Brattegard 1969). No other specimens of this species have since been reported. This report describes the male of the species for the first time and extends the range of *H. floridensis* to include the northern end of the Bahama Islands, specifically Little Bahama Bank.

Only those morphological features of *H. floridensis* that have not been described and that differ from Brattegard's (1969) original description are discussed.

Material examined.—Male (3.7 mm), 25 Oct 1982, voucher (USNM 228747); 2 females (3.2, 3.5 mm), 2 ovigerous females (4.5 mm), 11 Nov 1983, voucher (USNM 228748); all collected near entrance to Cemetery Cave, Grand Bahama Island, an oceanic blue hole about 100 m off the south coast of the island, depth 3–4 m, collected by Jill Yager. The actual substrate from which the specimens were taken is unknown.

Description.—Antennular peduncle of male like that of female, but with prominent male lobe on ventral surface of segment 3 that contains many long hair-like setae.

Mandibles and palp: Right and left mandible incisor blade-like with single cusp, right lacinia mobilis with 2 prominent cusps, left lacinia mobilis with 2 slightly curved cusps, both mandibles with 2 robust serrate accessory blades, molar surface well developed on right mandible, weakly developed on left mandible. Mandibular palp segment 2 expanded, medial margin straight, armed with 12–13 simple setae, lateral margin convex, armed with 4 simple setae; distal segment medial margin sinuous, armed proximally to distally with 5 robust spined setae, about 5 small serrate setae, 2 long spined setae and terminal claw-like spine, lateral margin convex armed with 2 long and 2 short submarginal setae distally.

Thoracic endopod 3, merus without barbed spines on lateral surface described by Brattegard (1969); carpopropodus with 6 rather than 5 strong flagellate spines on medial margin, distal 4 arranged in 2 paired sets, proximal 2 slightly longer and arranged singly.

Pleopod 4 of male modified, lateral margin armed with 5 long submarginal plumose setae proximally, 26 closely-spaced flagellate denticles along distal margin, slightly longer simple seta distomedially, medial margin with 2 plumose setae proximally; pseudobranchial lobe with 4 long and 1 short plumose setae.

Uropod endopod with 14, rather than 19, subequal spines along medial margin.

Telson with 8 spines on distal half of each lateral margin (apical spines included) increasing in length distally, cleft with 10–11 spinule in apical half rather than 9.

Ecological note.—The two 4.5 mm ovigerous females carried three and five stage IV larvae, respectively.

Fig. 2. *Heteromysis floridensis*: A, Mandible, right; B, Mandible, left; C, Mandibular palp; D, Thoracic endopod 3; E, Pleopod 4; F, Uropod; G, Telson. A–G = male, 3.2 mm.

Comments.—The characters of the male *H. floridensis* strengthen the phylogenetic relationship suggested by Brattegard (1969) between *H. bermudensis, H. b. cesari, H. actiniae,* and *H. floridensis.* Among other similarities, all four species have about the same number (6–12) of spines on the lateral margins of the telson and in the telsonal cleft (9–20), and all males have pleopod 4 modified. Assuming that a reduction in spines suggests evolutionary advancement, *H. bermudensis* would be the plesiomorph because it has the most spines on key morphological features. For example, its male pleopod 4 has 35 flagellated spines on the distal margin (Bowman 1981) and its telson has 18–20 spinules in its cleft. Distal margins of the fourth pleopod of *H. b. cesari, H. actiniae,* and *H. floridensis* have, respectively, 26, 17, and 26 flagellate spines, while the clefts of their telsons contain 14, 9–13, and 9–11 spines (Brattegard 1969, Bowman 1981).

Heteromysis guitarti Bacescu, 1968

Material examined.—8 males (3.3–3.7 mm), 6 females (2.9–3.7 mm), 2 ovigerous (4.0, 4.1 mm), 3 juveniles (2.2–2.4 mm) taken with 12 specimens of the sponge *Agelas dispar* collected during November 1975 by J. Uebelacker near the Hydro-Lab habitat location off Freeport, Grand Bahama Island at depths from 15–17 m.

Geographic distribution.—Originally collected in waters off northern Cuba (Bacescu 1968), also reported from waters off Andros Island, Bahama Islands (Brattegard 1970), Lesser Antilles (Brattegard 1975), and Gulf of Mexico (Modlin 1984).

Ecological notes.—*Heteromysis guitarti* appears to be a true spongicolous species. It was found in 12 of the 19 specimens of *Agelas dispar* examined. An average of about two individuals were taken in each sponge, range one to four. It occurred together with *H. agelas* in three sponges. Modlin (1984) obtained specimens from the sponge *Ircinia campana.* Likewise, Bascescu (1968) found specimens inhabiting *I. fasciculata.* Specimens collected by Brattegard (1970, 1975) were taken from unidentified sponges.

The two ovigerous females collected each carried two stage I larvae.

Acknowledgments

The Uebelacker and Yager collections were kindly provided for inspection by Mr. Michael Dardeau (MESC) and Dr. Thomas E. Bowman (USNM), respectively. This is Contribution 109 from the Marine Environmental Sciences Consortium, Dauphin Island, Alabama 36528.

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CRYPTOCORYNETES HAPTODISCUS, NEW GENUS, NEW SPECIES, AND *SPELEONECTES BENJAMINI,* NEW SPECIES, OF REMIPEDE CRUSTACEANS FROM ANCHIALINE CAVES IN THE BAHAMAS, WITH REMARKS ON DISTRIBUTION AND ECOLOGY

Jill Yager

Abstract.—Two additional members of the crustacean class Remipedia, *Speleonectes benjamini* n. sp., and *Cryptocorynetes haptodiscus* n. gen., n. sp., are described from anchialine caves on the Little Bahama Bank in the northern part of the Bahamas. The Bahamian anchialine caves in which remipedes are found represent a low oxygen environment.

Since the discovery in Lucayan Cavern, Grand Bahama Island, of the first representative of the crustacean class Remipedia, *Speleonectes lucayensis* Yager (1981), additional members of the class have been found in the low oxygen waters of anchialine caves throughout the Bahamian archipelago. Outside of the Bahamas, undescribed remipedes were collected in 1986 from an anchialine cenote on the Yucatan Peninsula, and in addition, *Speleonectes ondinae* (Garcia-Valdecasas), the second species of the genus *Speleonectes,* was discovered in a submerged lava tube in the Canary Islands (see Garcia-Valdecasas 1984, Iliffe et al. 1984, Schram et al. 1986). Remipedes appear to be common components of low oxygen anchialine cave communities in the north Atlantic Ocean, especially in the West Indies region (Table 1).

In the summer of 1984, a joint British-USA-Bahamian cave diving expedition surveyed many anchialine caves on and near Sweeting's Cay at the east end of Grand Bahama Island. Two of the caves explored, Sagittarius and Asgard, were inhabited by *Speleonectes benjamini,* described below, the third species of the genus *Speleonectes* to be described. Also in 1984 the biological survey of several previously unexplored caves on Grand Bahama and Abaco Islands resulted in the collection of an unusual new genus and species of remipede, *Cryptocorynetes haptodiscus,* described below.

Speleonectes benjamini, new species
Figs. 1–6

Material examined.—BAHAMAS: Grand Bahama Island, Sweeting's Cay, Asgard Cave, holotype, adult, 16.8 mm, USNM 228199, 27 Jul 1984, R. Palmer, S. Cunliffe.—Sagittarius Cave, 1 adult, 5 Jul 1984, R. Palmer; 1 adult, 25 Jul 1984, D. Williams.—Abaco Island, Dan's Cave, 2 adults, 26 Jul 1985, D. Williams, J. Yager. Nontype material retained in the collection of the author.

Diagnosis.—Antenna 1 very long, extending from one-half to two-thirds length of body. First maxilla with long, slender distal fang; segment 1 with narrow endite bearing 1 moderately long apical spine and at least 10 accessory spines. Trunk sternites developed as cuticular plates with posterolateral projections. Sternal bars of trunk segments 1–13 with concave posterior margins, 14th triangular, remaining bars concave to triangular until anal segment. Trunk appendages with many small, serrate, spine-like comb setae along distal margins of predistal segments.

Table 1.—List of known remipedes from anchialine caves of the West Indies region.

- Grand Bahama Island:
  - *Speleonectes lucayensis*
  - *Speleonectes benjamini*
  - *Cryptocorynetes haptodiscus*
  - Undescribed "juvenile-like"
- Abaco Island:
  - *Speleonectes* cf. *lucayensis*
  - *Speleonectes benjamini*
  - *Cryptocorynetes haptodiscus*
  - *Godzillius* cf. *robustus*
  - Undescribed godzilliid
  - Undescribed "juvenile-like" species
- Andros Island:
  - *Speleonectes* cf. *lucayensis*
- Cat Island:
  - *Speleonectes* cf. *lucayensis*
  - *Godzillius* cf. *robustus*
- Providenciales Island:
  - *Lasionectes entrichoma*
- North Caicos Island:
  - *Lasionectes entrichoma*
  - Undescribed species with discoid organs
  - *Godzillius robustus*
- Yucatan Peninsula:
  - Undescribed speleonectid

Description.—Body elongate, slender, with tiny setae dispersed over surface, without pigment or eyes; maximum length of specimens examined 16.8 mm. Cephalic shield small, tapered slightly at anterior end. Trunk segment numbers varying with age, maximum number in material examined 27. First trunk segment reduced and covered by cephalic shield; pleura from second segment posteriad projecting laterally. Sternites (Fig. 3C) developed as cuticular plates with triangular posterolateral projections. Transverse cuticular sternal bars posterior to each plate, with concave posterior margins on trunk segments 1–13 (Fig. 3C), triangular on segment 14, concave on several segments posterior to 14th segment, then triangular in shape until anal segment.

Frontal filaments long, slender, cylindrical, with short, tapered medial process. Antenna 1 (Fig. 1A) biramous, very long, slender, extending well beyond cephalon, about two-thirds length of body. Peduncle 2-segmented; proximal segment enlarged, bearing several rows of densely packed, fine esthetascs (Fig. 5A, B) draping over second antenna toward mouth; distal segment bifurcate. Dorsal ramus long, with at least 15 slender, elongate segments. Ventral ramus short, less than ½ length of dorsal ramus, with 10 to 14 segments; segments near base of ventral ramus indistinctly divided by partial sutures. Segments of both rami with short, simple setae along ventral margins, clusters of forked esthetasc-like setae (Fig. 3B) on distoventral margins, and at least 4 terminal setae on apical segments. Antenna 2 (Fig. 1B) biramous, smaller than antenna 1, not extending beyond cephalon. Protopod 2-segmented, with moderately long setae on medial margins. Exopod a single, large, oval article, extending laterally from distal segment of protopod, bearing about 54 long, finely plumose setae along entire margin. Endopod 3-segmented, curving laterally; first segment with moderately long setae on anterior margin; second segment with row of moderate to long anterior setae becoming a double row distally, and several short setae on posterior margin; third segment with row of about 30 setae, becoming a double row along anterior and distal margins; all setae plumose.

Labrum a prominent, fleshy lobe, with distinct transverse groove; anterior half triangular and slightly raised at apex; posterior half with dense array of fine setae along margin of fossa. Mandibles well developed, asymmetrical. Right mandible with 3-cusped incisor process and 3-cusped lacinia mobilis. Left mandible (Fig. 1C) with 4-cusped incisor process and crescent-

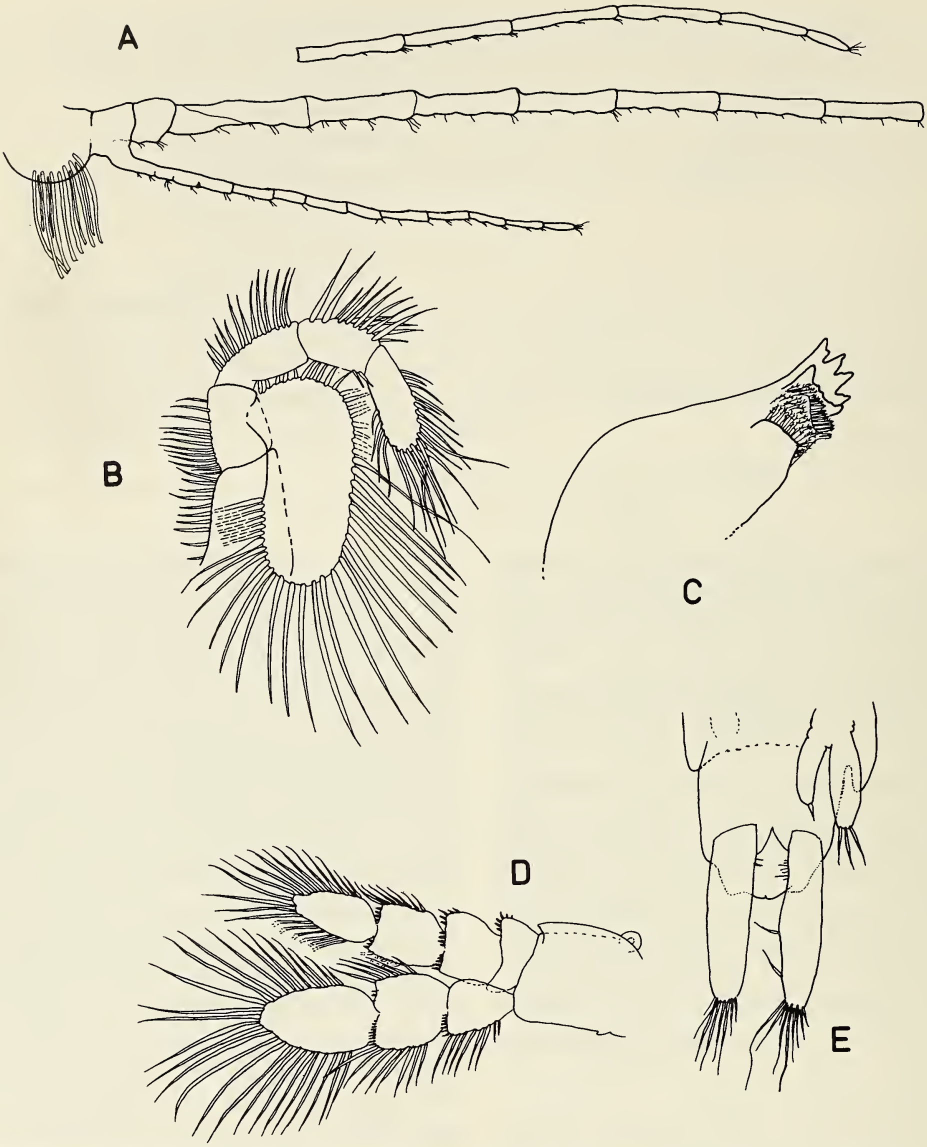

Fig. 1. *Speleonectes benjamini,* new species. A, Antenna 1; B, Antenna 2; C, Left mandible; D, 14th trunk appendage with gonopore; E, Anal segment with caudal rami and one terminal trunk appendage.

shaped lacinia mobilis. Molar process of both broad, bearing long, thick, multitipped setae. Paragnath (Fig. 4A) a round, flattened lobe with dense covering of fine, hair-like setae along margin.

First maxilla (Fig. 2A) 7-segmented, uniramous, prehensile, robust. Segment 1 (Figs. 2B, 4A) with long, narrow endite terminating in 1 long spine and up to 10 shorter, stout subterminal spines arranged in opposing pairs. Segment 2 (Fig. 4A) with endite as broad, plate-like flap lying over paragnath and bearing at least 8 short spines on terminal margin, flanked by parallel row of many short, simple setae; a row of long setae on anterolateral margin, and a few

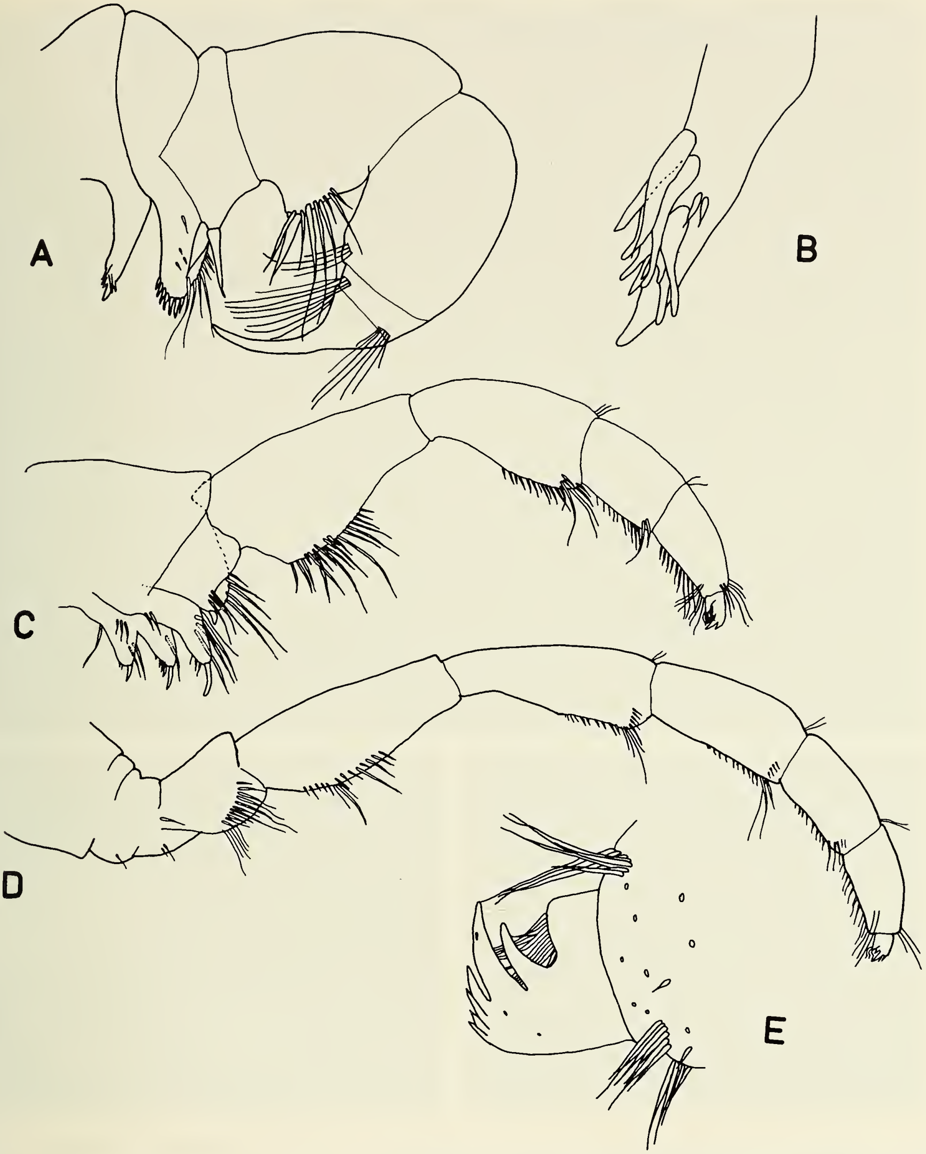

Fig. 2. *Speleonectes benjamini,* new species. A, Maxilla 1; B, Maxilla 1, endite of first segment; C, Maxilla 2; D, Maxilliped; E, Claw complex of maxilliped.

short to long setae near base of endite. Segment 3 with conical medial endite (see Fig. 4A) terminating in 2 robust, conical setae with fine serrations on distal halves, flanked posteriorly by cluster of several short to moderate setae. Segment 4 longer than segment 3, medial margin rounded, with 1 robust, serrate proximal seta and 2 rows of setae; setae of anterior row long, serrate, setae of posterior row less robust than those of anterior row, short to long, simple. Principle flexure of appendage between segments 4 and 5. Segment 5 about as long and wide as segment 4, with cluster of setae on anterior and posterior distomedial margins. Segment 6 very short, with cluster of long

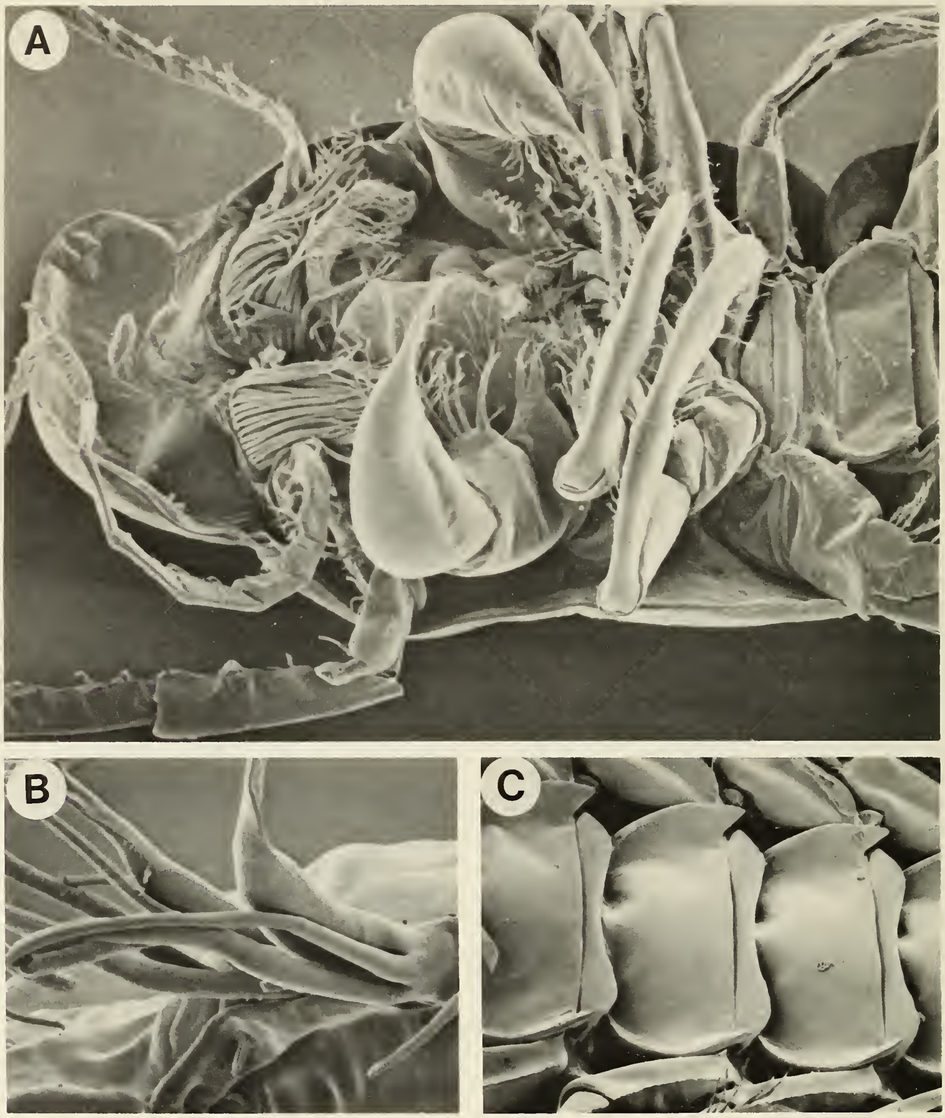

Fig. 3. *Speleonectes benjamini,* new species. A, Head appendages (29×); B, Antenna 1, branching, esthetasc-like setae (1330×); C, Sternal plates with cuticular bars (56×).

simple setae on anterior and posterior distomedial margins and cluster of moderate to long setae on anterior and posterior distolateral margins. Segment 7 a single long, slender fang (Fig. 3A) about 3 times as long as segment 6, with terminal pore and tuft of long, fine, simple setae at base medially.

Second maxilla (Fig. 2C) 7-segmented, uniramous, prehensile, longer than maxilla 1. Segment 1 with 2 small, weakly developed lobes posteriorly, bearing a few short setae each; 3 anteriorly-directed digitiform endites, progressively larger distally; each endite with single, curved terminal spine-like seta, several small subterminal spine-like setae, and several moderately long setae anterolaterally. Segment 2 shorter than segment 1, with small, rounded endite bearing

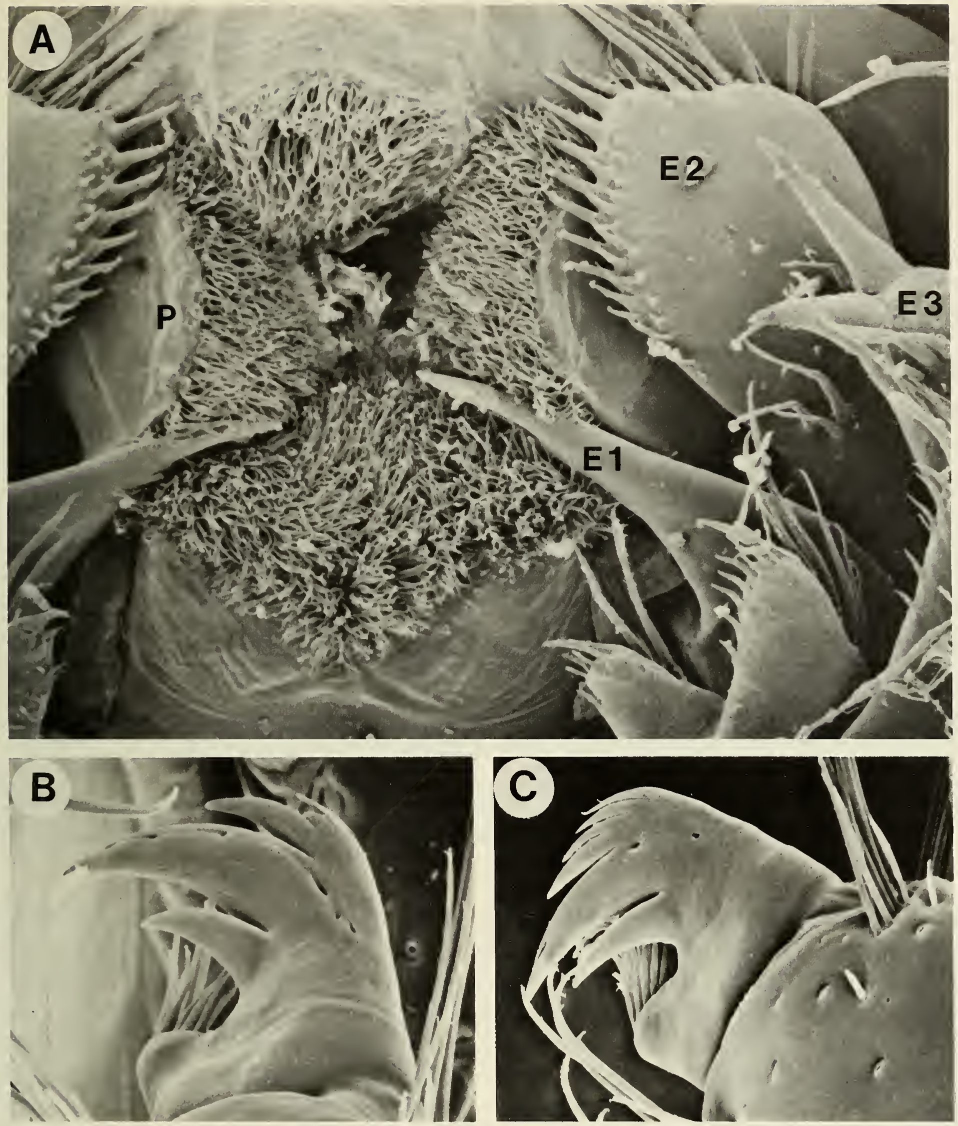

Fig. 4. *Speleonectes benjamini,* new species. A, Mouth area (117×), P—paragnath, E1—maxilla 1, endite of first segment, E2—maxilla 1, endite of second segment, E3—maxilla 1, endite of third segment; B, Maxilla 2, claw complex of terminal segment (650×); C, Maxilliped, claw complex of terminal segment (527×).

1 short, stout, apical spine-like seta and 2 rows of setae, setae of anterior row long, serrate, setae of posterior row short to moderately long. Segment 3 long, with proximomedial rounded bulge bearing 2 rows of setae; anterior row with many moderate to long serrate setae, posterior with fewer short to moderate setae. Principle flexure of appendage between segments 3 and 4. Segment 4 about as long as segment 3, with row of many moderate to long setae along distomedial margin, cluster of moderately long setae on anterior and posterior distomedial margins, and several small setae on distolateral margin. Segment 5 shorter than segment 4, with row of many moderate to long

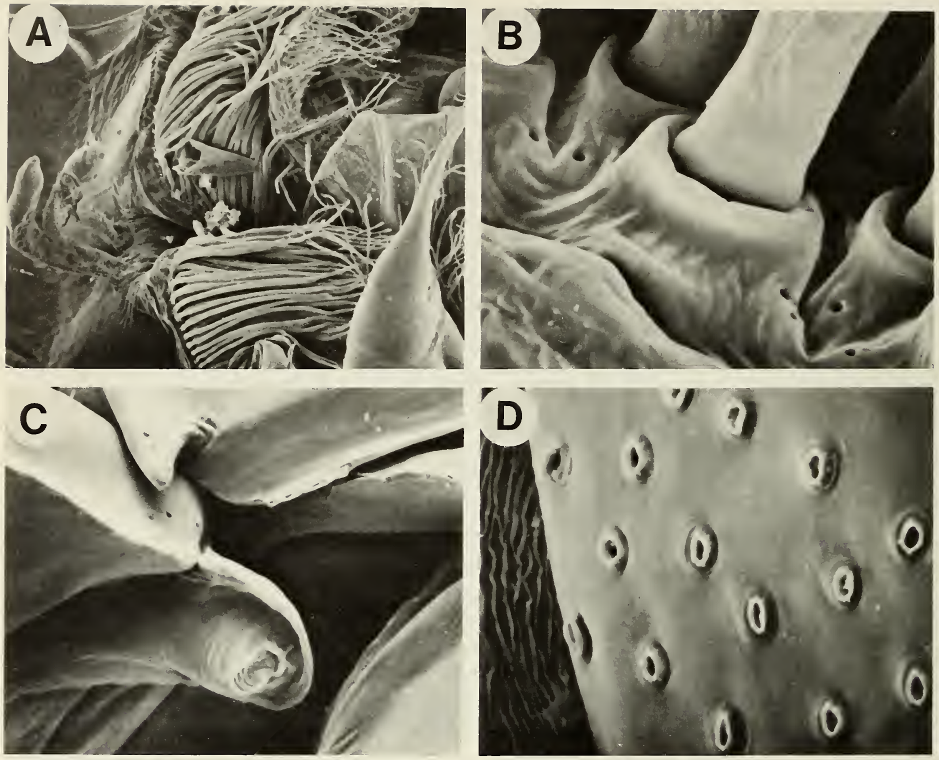

Fig. 5. *Speleonectes benjamini,* new species. A, Antenna 1, esthetascs (85×); B, Antenna 1, closeup of base of esthetascs (2200×); C, Gonopore (136×); D, Porous plate adjacent to gonopore (1710×).

setae along entire medial margin; cluster of several small to moderate setae on anterior and posterior distomedial margins, several small setae on distolateral margin. Segment 6 about as long as segment 5, with row of moderate to long simple setae along medial margin; cluster of moderate to long setae on anterior and posterior distomedial margins, and several moderate to long setae on anterior and posterior distolateral margins. Segment 7 (Fig. 4B) with claw complex consisting of 1 long, stout, anterior claw, flanked subterminally by smaller, stout claw, and posterior horseshoe-shaped arrangement of smaller spines; pores on surface of claw complex. Thumb-like pad bearing many long, simple, esthetasc-like setae opposing claw complex.

Maxilliped (Fig. 2D) similar in form but longer than maxilla 2, having 1 more segment beyond point of flexure; 8-segmented, uniramous, prehensile. Segment 1 indistinctly subdivided with several weakly developed lobes bearing a few short medial setae. Segment 2 with medial lobe bearing anterior row of long, serrate setae and posterior row of short to moderate simple setae. Segment 3 moderately rounded, with 2 rows of setae, anterior setae longer and more numerous than those of posterior row. Principle flexure between segments 3 and 4. Segments 4, 5, and 6 with medial row of short to moderate setae, clusters of several long anterior and posterior distomedial setae, and several setae on distolateral margins. Segment 8 (Figs. 2E, 4C) with claw complex and opposable pad similar to maxilla 2.

Trunk appendages (Fig. 1D) biramous, paddle-like swimming appendages becoming smaller and less setose near anal seg-

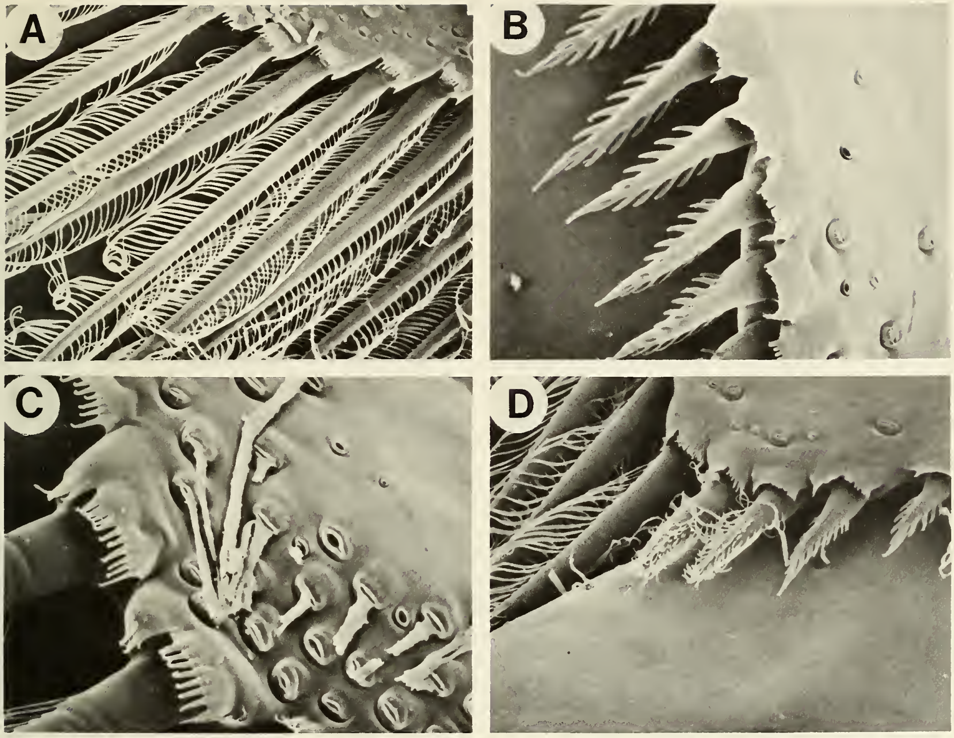

Fig. 6. *Speleonectes benjamini,* new species. A, Plumose setae of trunk appendage (308 ×); B, Short, serrate comb setae of trunk appendage (893 ×); C, Closeup of trunk segment showing porous nature and cuticular fringe of setal sockets (932 ×); D, Trunk appendage showing three types of setae (591 ×).

ment; three distinct setal types: short comb setae bearing well-developed serrations (Fig. 6B); short, with fine serrations dispersed on surface (Fig. 6D); long, plumose (Fig. 6A). Protopod large, subrectangular; cuticle on ventral side of medial margin forming lateral flap-like extension or ridge. Endopod 4-segmented; proximal segment short, rectangular, with several distomedial, short setae; segment 2 subrectangular, with many comb setae along distal margin of segment and several circumserrate setae medially; segment 3 subrectangular with moderate to long plumose setae (Fig. 6A) on lateral and medial margins and many comb setae along distal margin; segment 4 oval with long, plumose setae along entire margin. Exopod 3-segmented; segment 1 subrectangular with short to moderate, lateral, plumose setae and many comb setae along distal margin; segment 2 with moderately long plumose setae on lateral and medial margins and many comb setae along distolateral margin and a few on distomedial margin; segment 3 oblong, with long, plumose setae along entire margin. All three setal types arising from well-developed sockets, each with a fine cuticular fringe (see Fig. 6C). Distal part of segments with many small pores, some with visible secretion (Fig. 6C). Gonopore (Fig. 5C) on 14th trunk appendage at base of protopod, protected by small triangular cuticular flap. Genital plate (Fig. 5D) proximal to gonopore, bearing many pores; not found in all specimens. Anal segment (Fig. 1E) about as long as wide; caudal rami cylindrical, slightly longer than anal segment, with about 10 short to moderate terminal setae, several medial setae, and about 6 short setae basomedially, near anus.

Etymology.—This species is named in honor of the pioneer of Bahamian cave diving, Dr. George Benjamin, in recognition of his enthusiastic exploration of Bahamian ocean blueholes as well as his innovative design of safe cave diving equipment.

Habitat.—Asgard (type locality) and Sagittarius Caves are anchialine caves which formed beneath the small island of Sweeting's Cay off the eastern end of Grand Bahama Island (see Cunliffe 1985). The remipedes were collected beneath the density interface in low oxygen, polyhaline (18–30 ppt) water. Other animals collected from the water column include two species of Remipedia (*Speleonectes* cf. *lucayensis* and an undetermined "juvenile-like" species which also occurs in Dan's Cave, Abaco), the amphipod *Bahadzia williamsi,* the isopod *Bahalana geracei,* undescribed species of thermosbaenaceans, two species of ostracodes (*Deeveya* sp. and another new species), the mysid *Stygiomysis holthuisi,* and the blind cave fish *Lucifuga spelaeotes.*

Relationships.—*Speleonectes benjamini* is morphologically similar to the other two speleonectids, *S. lucayensis* and *S. ondinae.* The most obvious distinguishing characters of *S. benjamini* are the very long first antenna and the long, slender fang of the first maxilla. The genus *Speleonectes* is characterized by the morphology of the three prehensile feeding appendages. The first maxilla is the most robust due to the wide third and fourth segments. In contrast, the second maxilla and maxilliped are narrower and more elongate. The third segment of those appendages is rounded, with a rounded medial bulge bearing parallel rows of moderate to long setae. The second segment of the first maxilla in all three species bears two robust, conical setae, the distal part of which is finely serrate. The first maxilla has several characters which differ at the species level. For example, the third segment of this appendage bears a single robust, multiserrate, proximal seta on *S. benjamini,* but five in *S. ondinae. S. ondinae* and *S. lucayensis* bear a distal fang approximately the same length while the fang of *S. benjamini* is more than twice as long. Another difference in the first maxilla is the first or proximal endite on segment 1: this endite on *S. benjamini* bears one long spine and at least nine shorter, stout, accessory spines, whereas in the other two species it bears one long spine and only six stout accessory spines. The second maxilla and maxilliped of the three known speleonectids are very similar, differing slightly in the shape of the distal claw complex; the maxilliped of *S. benjamini* is more slender than that of *S. lucayensis.*

Cryptocorynetes, new genus

Diagnosis.—Maxilla 2 and maxilliped with inflated distal segments bearing many stalked discoid organs. Sternites of trunk segments developed as plates, with small triangular posterolateral projections. Transverse sternal bar along posterior edge of sternite narrow rectangle on segments 1–13, a triangular flap from segment 14 to anal segment. First segment of maxilla 1 bearing elongate proximal endite with 1 long spine and 9 smaller spines.

Type species.—*Cryptocorynetes haptodiscus* n. sp. by monotypy.

Etymology.—The name is derived from the Greek *cryptos* meaning "hidden," and *corynetes* meaning "club-bearer." It refers to the cryptic habitat and to the inflated club-like segments on the second maxilla and maxilliped. The gender is masculine.

Cryptocorynetes haptodiscus, new species
Figs. 7–10

Material examined.—BAHAMAS: Abaco Island, Dan's Cave, holotype, 9.8 mm, USNM 228198, 7 Jun 1984, D. Williams.—Abaco Island, Dan's Cave, 1 adult, 24 Dec 1984, and 4 subadult specimens, 26 Jul 1985, D. Williams and J. Yager.—Grand Bahama Island, Mermaid's Lair, Old Freetown Cave System, 1 adult, 30 Apr 1984, D. Williams and J. Yager. Non-type material retained in collection of the author.

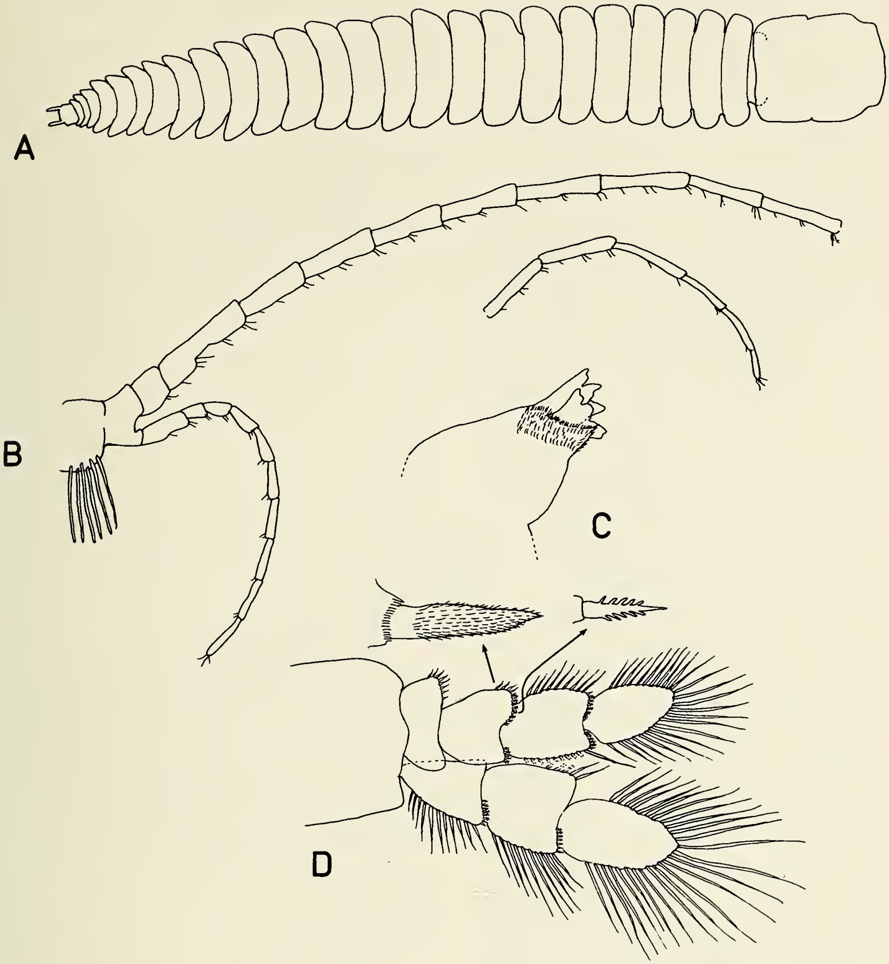

Fig. 7. *Cryptocorynetes haptodiscus,* new genus, new species. A, Dorsal view, appendages omitted; B, Antenna 1; C, Right mandible; D, Trunk appendage showing small circumserrate seta and comb seta.

Description.—Body elongate (Fig. 7A), slender, without pigment or eyes, maximum length of specimens examined 16.3 mm. Cephalic shield small, tapered slightly at anterior end. Numbers of trunk segments varying with age; maximum number in specimens examined, 32. Trunk (Fig. 7A) with rounded tergites and lateral pleura. First trunk segment reduced in length and width, partly covered by posterior edge of cephalic shield. Sternites developed as plates with small triangular projection at posterolateral corners, similar to those of *S. benjamini.* Cuticular bar on posterior edge of sternal plate, extending between bases of trunk appendages; bars on segments 1–13 narrow rectangular to slightly convex posteriorly, changing to triangular flap from segment 14 and beyond.

Frontal filaments small, broad-based, with slender, thumb-like ventromedial process. Antenna 1 (Fig. 7B) biramous, long, slender, extending beyond cephalon. Peduncle 2-segmented; proximal segment enlarged, bearing several rows of long, lash-like esthetascs extending posteriorly over antenna 2; distal peduncular segment bifurcate. Dorsal ramus with 16–18 segments; ventral ramus with 10–12 segments, less than one-third length of dorsal ramus. Segments of both rami with short, simple setae and several tufts of forked esthetascs along distomedial margins similar to those of *Speleonectes benjamini* (see Fig. 3B); 2–4 terminal setae on apical segments. Antenna 2 biramous, smaller than antenna 1, not extending beyond cephalon, similar to that of *S. benjamini* (see Fig. 1B). Protopod 2-segmented, with setae on medial margins. Exopod a large, single oval article, extending laterally from distal protopod segment and bearing at least 35 long, finely plumose setae along margin. Endopod 3-segmented, curving laterally; first and second segments with setae along margins, distolateral setae arranged in double rows; third segment with at least 20 setae, becoming a double row of 8–10 along distal margin. All setae plumose.

Labrum (Fig. 9A) a prominent lobe with triangular anterior apex, posterior half broad, with finely setose fossa along posterior margin. Mandibles slightly asymmetrical; right mandible (Fig. 7C) incisor process with 3 large, dentate cusps, lacinia mobilis 3-cusped; incisor process of left mandible with 4 dentate cusps, lacinia mobilis small, crescent-shaped. Molar processes broad, well developed, covered with long, dense, multitipped setae. Paragnath round, plate-like, densely covered with fine setae along margin; partly covered by broad endite of first segment of maxilla 1.

First maxilla (Fig. 8A) 7-segmented, uniramous, prehensile. Segment 1 (Fig. 8B) with long, narrow endite terminating in 1 long tooth-like spine and at least 6 shorter, stout spines. Segment 2 endite as broad, plate-like flap overlying paragnath and terminating in at least 6 short spines flanked by parallel row of smaller, fine setae; anterolateral margin of endite with row of moderate to long simple setae. Articulation between segments 2 and 3 oblique. Segment 3 short, with truncate endite bearing at least 3 robust setae with long, finely circumserrate setae (Fig. 8A) and several moderately long, simple setae on anterior and posterior margins. Segment 4 longer than segment 3, produced medially into rounded lobe, bearing at least 1 relatively large, proximal seta with relatively long, fine serrations on distal half, and rows of short to long setae, setae of anterior row large, circumserrate, similar to apical seta, setae of posterior row smaller. Segment 5 about as long as segment 4, narrower, with several fine, simple setae on anterior and posterior distomedial margins and several setae distolaterally. Segment 6 short, with cluster of moderately long, fine, simple setae on anterior and posterior distomedial margins and cluster of moderately long, simple setae on both anterior and posterior distolateral margins. Segment 7 a single fang, only slightly longer than segment 6, with terminal pore and tuft of long, fine, simple setae at medial base.

Second maxilla (Fig. 8C) 7-segmented, uniramous, prehensile, longer and slightly more robust than maxilla 1. Segment 1 with 3 obliquely anteriorly directed digitiform endites increasing in size distally. Each endite with single terminal, curved spine, several short subterminal setae, and several moderately long setae on anterolateral margin. Segment 2 short, rounded medially, bearing 1 short spine-like proximal seta and 2 parallel rows of moderately long setae, anterior row with several large serrate setae and several smaller ones; posterior row with several short to moderately long setae and several discoid organs. Segment 3 long, expanded medially, anterior margin with at least 4 long setae, posterior margin with cluster of discoid organs. Segment 4 shorter than segment 3; distomedial margin slightly inflated, bearing several simple setae and a cluster of discoid organs, 1–2 small simple setae on distolateral margin. Segment 5 about as long as segment 4, distomedial surface inflated, bearing many discoid organs and several small, simple setae; several small setae on distolateral margins. Segment 6 inflated; medial surface covered with discoid organs (Fig. 8C); cluster of long, simple setae

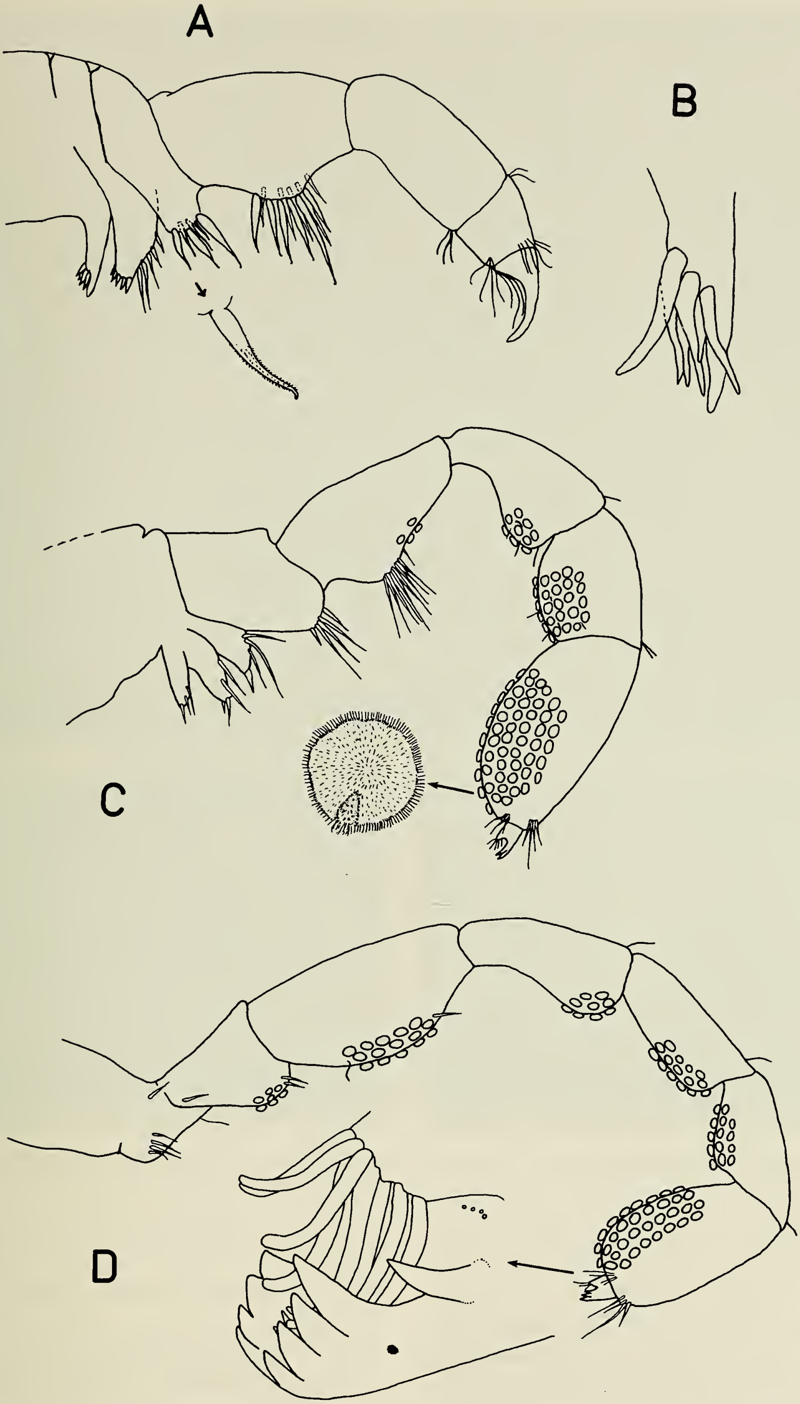

Fig. 8. *Cryptocorynetes haptodiscus,* new genus, new species. A, Maxilla 1, with serrate seta; B, Maxilla 1, endite of first segment; C, Maxilla 2, with enlarged discoid organ; D, Maxilliped, with enlarged claw complex.

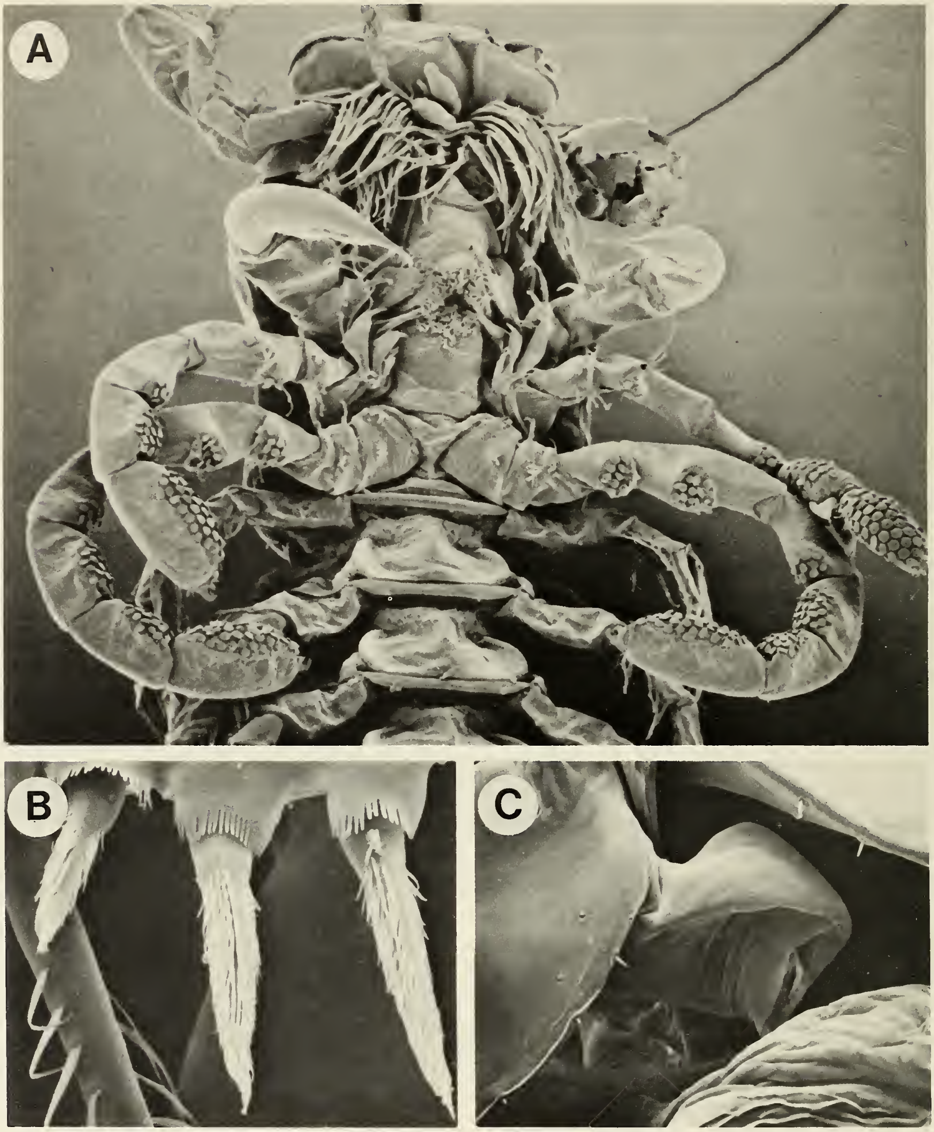

Fig. 9. *Cryptocorynetes haptodiscus,* new genus, new species. A, Head appendages, trunk segments 1–3, with sternal bars (54×); B, Small, finely circumserrate setae of trunk appendage (1230×); C, Gonopore (276×).

on anterior and posterior distomedial and distolateral margins. Segment 7 (Fig. 10B, C, D) terminating in claw complex consisting of 1 separate, anterior, subterminal claw and horseshoe-shaped arrangement of 1 robust anterior proximal claw and about 8 smaller spines fused at bases; one or more pores on surface of claw complex. Opposable, subterminal thumb-like pad bearing many long, simple, setae; row of small pores between pad and anterior single spine (see Fig. 10D).

Maxilliped (Fig. 8D) 8-segmented, uniramous, prehensile. Similar in appearance to maxilla 2, but longer, having 1 more segment beyond point of flexure. Proximal segment indistinctly subdivided, with very weak development of several medial lobes

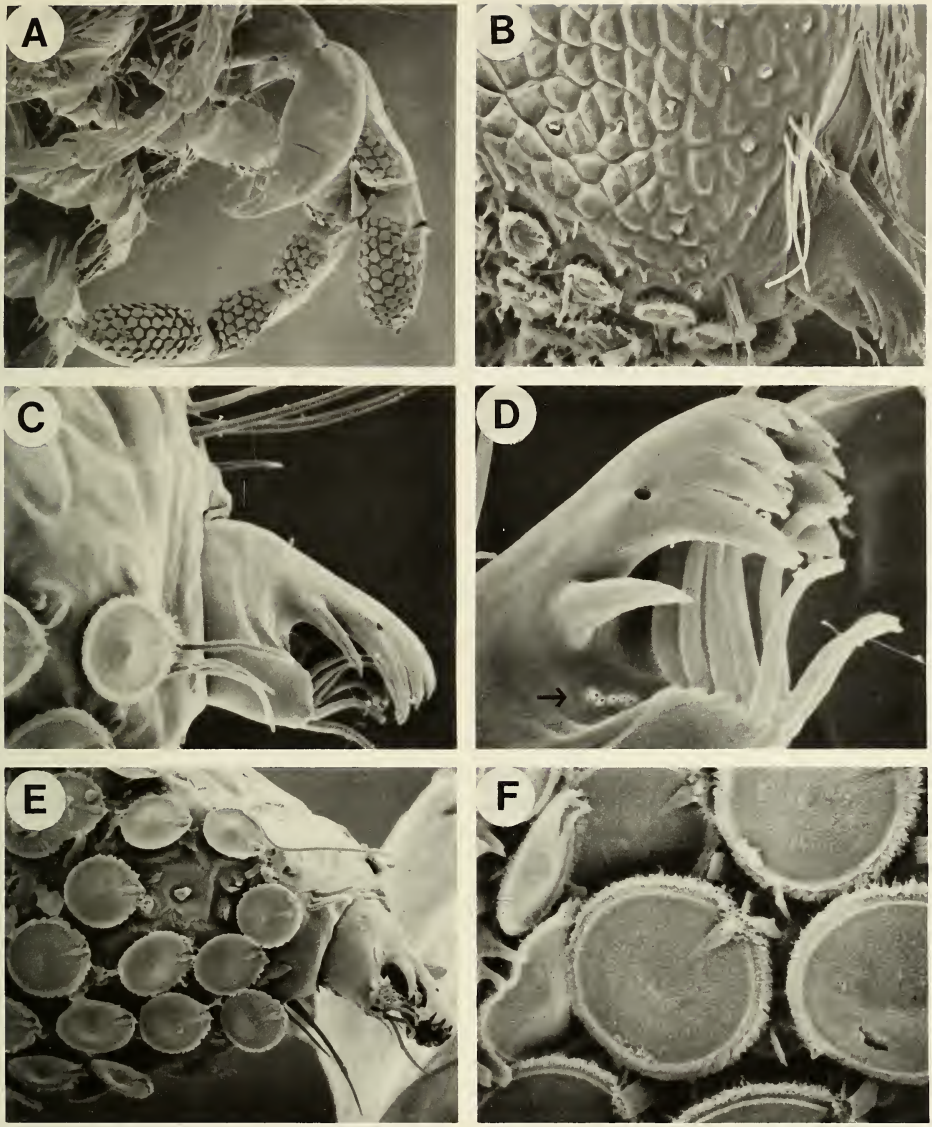

Fig. 10. *Cryptocorynetes haptodiscus,* new genus, new species. A, Raptorial head appendages (106×); B, Maxilla 2, terminal segments, closeup of raised polygonal microsculpture and discoid sensillae (261×); C, Maxilla 2, terminal segments (917×); D, Maxilla 2, terminal claw complex with setose pad, arrow indicates small pores (2450×); E, Maxilliped, terminal segments (713×); F, Discoid organs and ribbon-like structures (853×).

bearing a few medial setae. Segment 2 short, with rounded, medial lobe bearing several discoid organs and several short, simple setae distally. Segment 3 rounded medially, bearing many discoid organs and several simple setae. Segment 4 slightly shorter than segment 3, inflated distomedially, with discoid organs and 1 or more distolateral setae. Segments 5 and 6 about as long as segment 4, with medial inflation covered with discoid organs, distolateral margin with several small setae. Segment 7 long and greatly inflated, medial surface covered with many discoid organs and several simple setae;

cluster of short to long setae on anterior and posterior distomedial and distolateral margins. Segment 8 (Figs. 8D, 10E) with claw complex and opposable setose thumb-like pad similar to that of maxilla 2. Discoid organs (Fig. 10F) stalked; surface slightly raised in center, covered with fine setules and a single wedge-shaped ridge; outer margin of disc with fringe of very fine, densely packed setae; ribbon-like structures, or possibly secretions, coming from pores interspersed between discs.

Trunk appendages (Fig. 7D) biramous, obliquely laterally-directed, paddle-like swimming appendages decreasing in size and number of setae near anal segment; 3 types of setae as in *S. benjamini.* Protopod large, subrectangular, lacking setae. Endopod 4-segmented; proximal segment short, rectangular, with 1 or more small, circumserrate setae (Fig. 9B); segment 2 subrectangular, with small circumserrate setae along distolateral margin and several small comb setae (see Fig. 7D) along distal margin; segment 3 subrectangular with moderately long, plumose setae along sides and comb setae along distal margin; segment 4 oval. Exopod 3-segmented; first segment subrectangular, with moderate, lateral, plumose setae and comb setae on distal margin; segment 2 similar to segment 1, with additional setae along mediolateral margin; distal segment oval. Oval segments of both rami bearing very long, finely plumose setae. Endopod of trunk appendages 1–4 with moderate setae on distomedial margins decreasing in size posteriorly, until appendage 4 when they become short, circumserrate setae as described above. Gonopore (Fig. 9C) at base of protopod of 14th trunk appendage. Anal segment slightly broader than long, with cylindrical caudal rami about same length as segment; both rami with a few short medial setae and 8–10 moderately long, terminal setae.

Etymology.—The name is formed from a combination of the Greek words *haptos,* meaning "grasping," and *diskos,* meaning "disc" or "plate," in reference to the discoid organs.

Habitat.—The two caves in which *Cryptocorynetes* is found are typical of Bahamian anchialine caves (see Discussion). Dan's Cave (type locality) on Abaco Island is about 3 km from the sea. The entrance is through a small freshwater pool at the base of a cliff along a limestone ridge. The surface vegetation consists of pine forest with palmetto and poison wood. Other animals found in the aphotic zone with *Cryptocorynetes* include five apparently distinct species of Remipedia: *Speleonectes* sp. cf. *S. lucayensis, Speleonectes benjamini, Godzillius* sp. cf. *G. robustus* Schram, Yager, and Emerson (1986), an undescribed new genus of the family Godzilliidae, and the undescribed small, "juvenile-like" species found also in Asgard and Sagittarius Caves. Other inhabitants are the amphipods *Spelaeonicippe* sp. cf. *S. provo* and *Bahadzia williamsi,* the ostracod *Deeveya spiralis,* the cirolanid isopod *Bahalana geracei,* undescribed thermosbaenaceans, the blind cave fish *Lucifuga spelaeotes,* and the epigean spiny cheek sleeper fish *Eleotris pisonis.* The remipedes were collected in the water column below the density interface approximately 300 m from the surface entrance in polyhaline to euhaline water.

Mermaid's Lair, on Grand Bahama Island, is part of the Old Freetown Cave System, about 100 m inland from the ocean. This cave system has a freshwater lens to approximately 18-m depth, with deeper euhaline waters. The specimen of *Cryptocorynetes* from this cave was collected beneath the density interface.

Remarks.—The discoid organs of *Cryptocorynetes* appear to be unique within the Crustacea. Preliminary investigation with transmission electron microscopy indicates that they are innervated. In addition to the setose fringe, the surface of each disc is covered with tiny hair-like projections. The discs may serve as "nonskid" pads which facilitate the grasping and holding of a slippery or highly mobile prey item. Another remipede with similar discs on the second maxilla and maxilliped has been collected from a cave in the Turks and Caicos. Although it appears to be a new species, only one specimen was collected and additional material is necessary for taxonomic consideration. Several *Cryptocorynetes* specimens appear to have a raised polygonal microsculpture on the dorsal surface of the raptorial head appendages. This is especially evident in Fig. 10B.

Discussion

Several distinguishing characters are to be found in the structure of the raptorial first and second maxilla and maxilliped of remipedes. First is the relative size ratio of these appendages. In the three *Speleonectes* species, the first maxilla is robust with segments 3 and 4 about as broad as long. The second maxilla and maxilliped, though more elongate, are less robust and segments 3 and 4 are slender in comparison. In contrast, the first maxilla of *Lasionectes entrichoma* Yager and Schram (1986) is less robust than its second maxilla and maxilliped. The third segments of those two appendages are massive structures. The two long, robust, subchelate appendages of the 31-mm *Lasionectes* may enable the manipulation of its apparent prey item, a large (up to 15 mm) atyid shrimp found in great abundance in the type locality. In its type locality, the 24-mm *Speleonectes lucayensis* is found associated almost solely with abundant populations of thermosbaenaceans averaging about 5 mm in length. With enlarged distal segments and discoid organs, the second maxilla and maxilliped of *Cryptocorynetes* represent yet another kind of apparent feeding modification. It is likely that the enlarged surface area and presumed "nonskid" pads facilitate the capture and manipulation of a prey item quite different from that eaten by species of *Speleonectes*.

Another distinguishing feature of raptorial feeding appendages in remipede is the morphology of the first maxilla. For example, in *Speleonectes lucayensis,* the terminal fang is stout and short, only about twice as long as the segment proximal to it. The fang of *S. benjamini* is quite long and slender, about four times as long as the segment proximal to it. The third segment of the first maxilla of *Godzillius robustus* bears a long, stout fang and a long, club-like endite. Often several species of remipedes occur together in the same cave, and are collected within meters of each other, so it is unlikely that they are competing for space. The comparative morphology of the raptorial feeding appendages suggests that remipedians may avoid competition by prey selectivity.

The fourteenth trunk segment of each species bears the gonopore or genital opening. Some individuals have a small plate (see Fig. 5D) overhanging the gonopore. The plate is covered with pores which appear to be secretory in function. It is possible that this plate serves as a place for egg attachment. While sectioning the fourteenth trunk appendage of *Speleonectes benjamini,* sperm was discovered in the protopod. It was contained within a cell-lined pouch, possibly a seminal receptacle. While ovaries with immature oocytes and paired oviducts have been found, little is known about the reproductive biology of remipedes. I have not found mature eggs or testicular tissue, and it is not known whether they are dioecious or hermaphroditic.

The Bahamian archipelago consists of a long chain of limestone islands situated off of the east coast of Florida and extending 1000 km to the southeast. The archipelago is hypothesized to have originated as a continuous platform or megabank which began by shallow water carbonate deposition about 150 million years ago (Schlager and Ginsburg 1981). The Bahama Platform was subsequently divided up into smaller, disjunct banks by the development of deep water channels sometime during the Cretaceous (Schlager and Ginsburg 1981). The islands

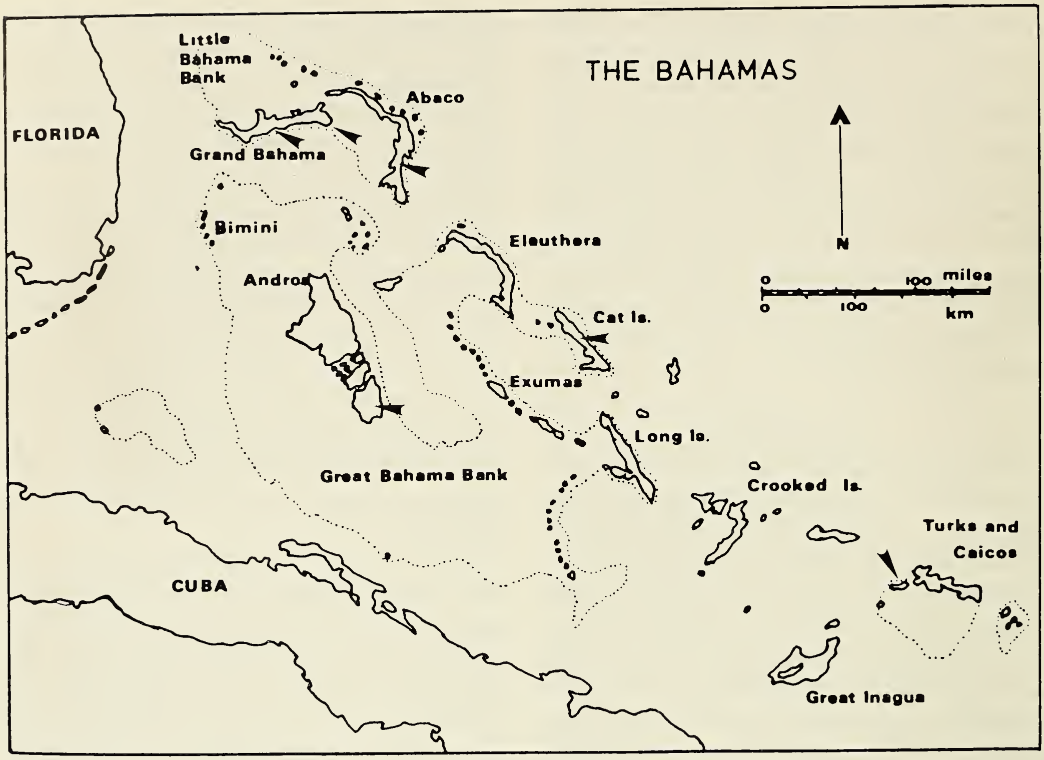

Fig. 11. Map of the Bahamian archipelago. Arrows indicate locations where remipedes have been collected.

that now make up the Bahamas and the Turks and Caicos are the tops of those banks (Fig. 11). The geographic distribution of remipedians known from the Bahamian archipelago is shown on Fig. 11.

Bahamian anchialine caves inhabited by remipedians are characterized by layers of increasingly haline water (Fig. 12). Water at the surface ranges from limnetic to polyhaline. There is a distinct density interface between waters of different salinities, and several haloclines may exist as depth increases. For example, on Grand Bahama Island, the location of the first density interface is at the bottom of the freshwater lens found on the island and has a maximum depth of about 20 m. The deeper aphotic passages have polyhaline to euhaline waters and can extend horizontally for many kilometers through the porous limestone. The distinguishing feature of the cave water beneath the first density interface is a significant drop in dissolved oxygen content. In contrast to a dissolved oxygen content of about 4 ppm or greater in the surface waters, some caves have a dissolved oxygen of less than 0.1 ppm in the water beneath the density interface. Remipedes have not been collected in cave water with a dissolved oxygen greater than 1 ppm. The processes by which the freshwater lens and density interfaces control the amount of oxygen in the water are poorly understood. However, the importance of this low oxygen for the ecology of remipedes cannot be ignored.

Anchialine environments in Bermuda have yielded a diverse cavernicolous marine fauna (Sket and Iliffe 1980). However, to date, remipedians have not been collected from Bermuda caves. The anchialine caves of Bermuda lack the overlying freshwater lens and density interfaces, and con-

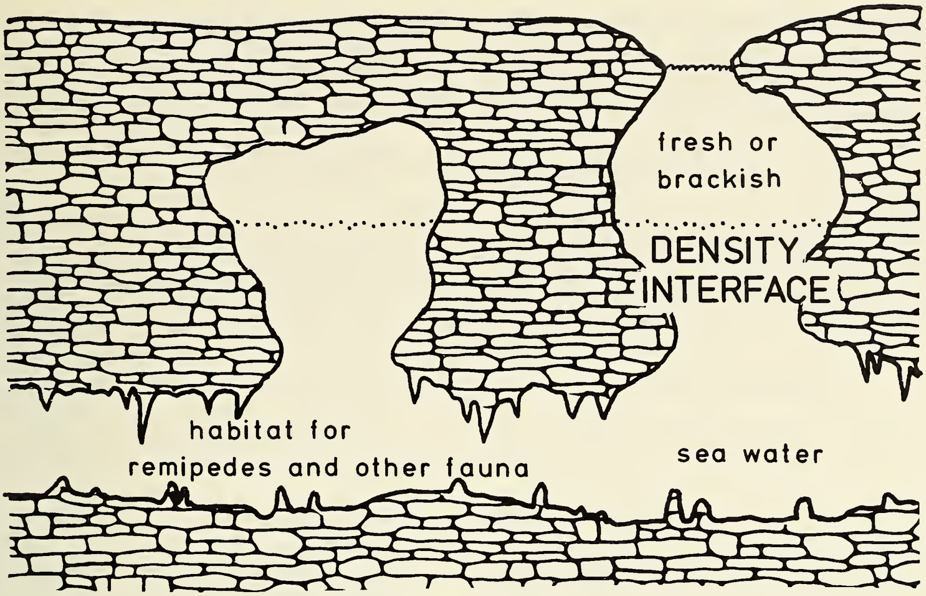

Fig. 12. Diagram of typical anchialine cave of the West Indies.

tain waters with dissolved oxygen values higher than 1 ppm (T. M. Iliffe, pers. comm.).

The low oxygen anchialine ecosystem can be considered a refugium because it represents a "stable" habitat. Although the caves accessible to divers today are geologically young, the Bahama Banks contain numerous caves at greater depths, providing a crevicular habitat that has been available for colonization throughout the 150 million year history of the Bahamas Platform. The low oxygen anchialine fauna may be descendants of taxa that have inhabited this environment for millions of years relatively unaffected by surface climatic changes, and the low oxygen ecosystem may have served as a refugium for species that were able to survive oceanic anoxic events (Degens and Stoffers 1976, Arthur and Schlanger 1979).

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A REVIEW OF RECENTLY DISCOVERED TYPE SPECIMENS OF BERMUDA AMPHIPODA (CRUSTACEA: PERACARIDA) DESCRIBED BY B. W. KUNKEL (1882–1969)

Eric A. Lazo-Wasem and Michael F. Gable

Abstract.—Type specimens of six of the seventeen species of Bermuda amphipods described by Kunkel (1910) are reviewed: *Maera tinkerensis, Melita planaterga, Parhyalella batesoni, Eurystheus* [=*Gammaropsis*] *lina, Isaea longipalpus,* and *Caprella bermudia.* The first four listed species are redescribed and refigured. The lectotype and recently collected specimens of *Melita planaterga* are compared with Karaman's (1981) redescription of the species. The authors conclude that the specimen used by Karaman represents a new species. *Caprella bermudia* is synonymized with *C. equilibra.*

In 1898 and 1901 A. E. Verrill conducted scientific expeditions to the Bermuda islands and amassed large collections of terrestrial and marine invertebrates. Verrill himself reviewed some of the crustaceans, mostly decapods, in several papers. To one of his students, Beverly Waugh Kunkel, Verrill gave the task of elucidating the status of the Bermuda amphipod fauna. Verrill's collections, along with those of G. Brown Goode and others, formed the basis of Kunkel's (1910) monograph on the Bermuda amphipods. Prior to this publication, the amphipods of Bermuda were virtually unknown and, to date, Kunkel's paper remains the only significant study of its kind. Johnson's (1986) eclectic summary of the Bermuda amphipods provides little additional information and leaves most of the longstanding taxonomic questions untouched.

Kunkel described 17 new species, 16 gammaridean and 1 caprellidean, and erected three new genera in his monograph. Unfortunately, he did not clearly designate type specimens, a fact that made their recovery from the general collections difficult and at times serendipitous. E. L. Mills (1964) reviewed the status of six of Kunkel's type specimens. The present paper reviews six additional species for which the type specimens have been found. Because the first author has culled all the amphipods from YPM's crustacean collection, including all unidentified specimens, virtually no possibility exists for finding type material of the remaining species described by Kunkel. This situation is unfortunate as one species, *Insula antennuella,* may have been incorrectly figured (Barnard 1969) and was the basis for a new genus.

In general, the descriptions of Kunkel (especially the figures) were not executed with sufficient detail to facilitate contemporary comparison with other known species. Revised descriptions of the recently discovered type specimens are desirable, therefore, before the description of new taxa complicates the already confused state of the Bermuda amphipod fauna.

Systematics

The family categories used herein follow Bowman and Abele (1982). Legend: Body parts marked by abbreviation beginning with uppercase letters, and lowercase letters separated from body part indications read as follows: A, antenna; Gn, gnathopod; Hd, head; LL, lower lip; Md, mandible; Mx, maxilla; Mxpd, maxilliped; T, telson; U, uropod; dm, damaged; plp, palp; s, setae missing.

Melitidae Bousfield, 1973
Maera tinkerensis Kunkel
Figs. 1–2

Maera tinkerensis Kunkel, 1910:49–51, fig. 18.—Barnard, 1962:100.

Description.—Male: Dorsal surface of body finely setose, pleonal epimera 1–3 each with small ventroposterior tooth, epimeron 1 with 1 ventral spine, epimera 2–3 with 3–4 ventral spines.

Head subequal to combined length of pereonites 1 and 2, lateral lobe broadly rounded, eye weakly pigmented in alcohol-preserved specimens, ocelli separated.

Antenna 1 longer than antenna 2, nearly 50% body length, peduncular article 1 somewhat shorter than article 2, posterior margin with a few spines, article 3 20% article 2, primary flagellum composed of at least 10–13 articles (terminal article(s?) missing), accessory flagellum 6-articulate, terminus minute. Antenna 2, peduncle extending nearly to length of peduncle of antenna 1, flagellum short, composed of 6 articles.

Left mandible with cuspate lacinia, proximal spine row with 1 large cuspate spine followed by 8 smaller, plumose spines; palp slender, article 1 with distal tooth, 33% length article 2, posterior margin article 2 setose, longer than article 3. Maxilla 1, inner plate distally with 1 short spine and 2 long plumose setae, outer plate with 8 stout, recurved, bifid spines; palp 2-articulate. Maxilla 2, inner plate less broad than outer plate.

Gnathopod 1, ventroanterior corner of coxal plate acutely produced, posterior margin of basis with long setae, article 3 with plumose setae on posterior margin, article 5 triangular, longer than article 6, posterior margin and inner facial surface densely setose, article 6 oval, palm oblique, margin lined with small spines, dactyl slender, tip bearing small spatulate process. Gnathopod 2 much larger than gnathopod 1, coxa square, corners rounded, posterior margin of basis with 2 spines and a few setae, article 5 30% length article 6, posterior lobe densely setose, article 6 oval, much longer than broad, palm oblique, elongate, sinusoidal and distally serrate, posteriorly defined by sharp tooth bearing spine at base, posterior margin lined with submarginal spines and a few setae, inner facial surface with long, stout spine, dactyl stout, with 4 setae on anterior margin, tip bearing small spatulate process, dactyl closing between palmar tooth and inner facial spine.

Pereopods 3–4 similar, normal, coxa 4 not posteriorly excavate; pereopod 5 shorter than pereopods 6–7; pereopods 6–7 similar, subequal in length, pereopod 7, proximoposterior corner of basis produced into rounded lobe; all dactyls singly annulate.

Uropod 1 extending slightly beyond uropod 2, dorsal surface of peduncle with row of short and row of long spines, distal spines of both rows longest and very stout, ventral surface with large proximal spine, rami shorter than peduncle, spinose, outer ramus shorter than inner. Uropod 2, peduncle stout, shorter than rami, with 2 rows of spines, rami spinose, outer ramus shorter than inner. Uropod 3 missing from specimen.

Telson longer than broad, deeply excavate, lobe apices pointed, outer margins notched, stout spines submarginally at base of each notch.

Remarks.—Kunkel's original description agrees fairly well with the type specimens but lacks considerable detail, most notably in uropod spination, the details of the gnathopods, and in precise length of specimens. The uropods are much more spinose than as figured by Kunkel, and the lengths of the terminal spines on uropod 2 were exaggerated. Kunkel drew the palm of gnathopod 2 crenulate along its entire length, whereas in the type material the crenulation extends only ⅓ the length beginning at the distal end.

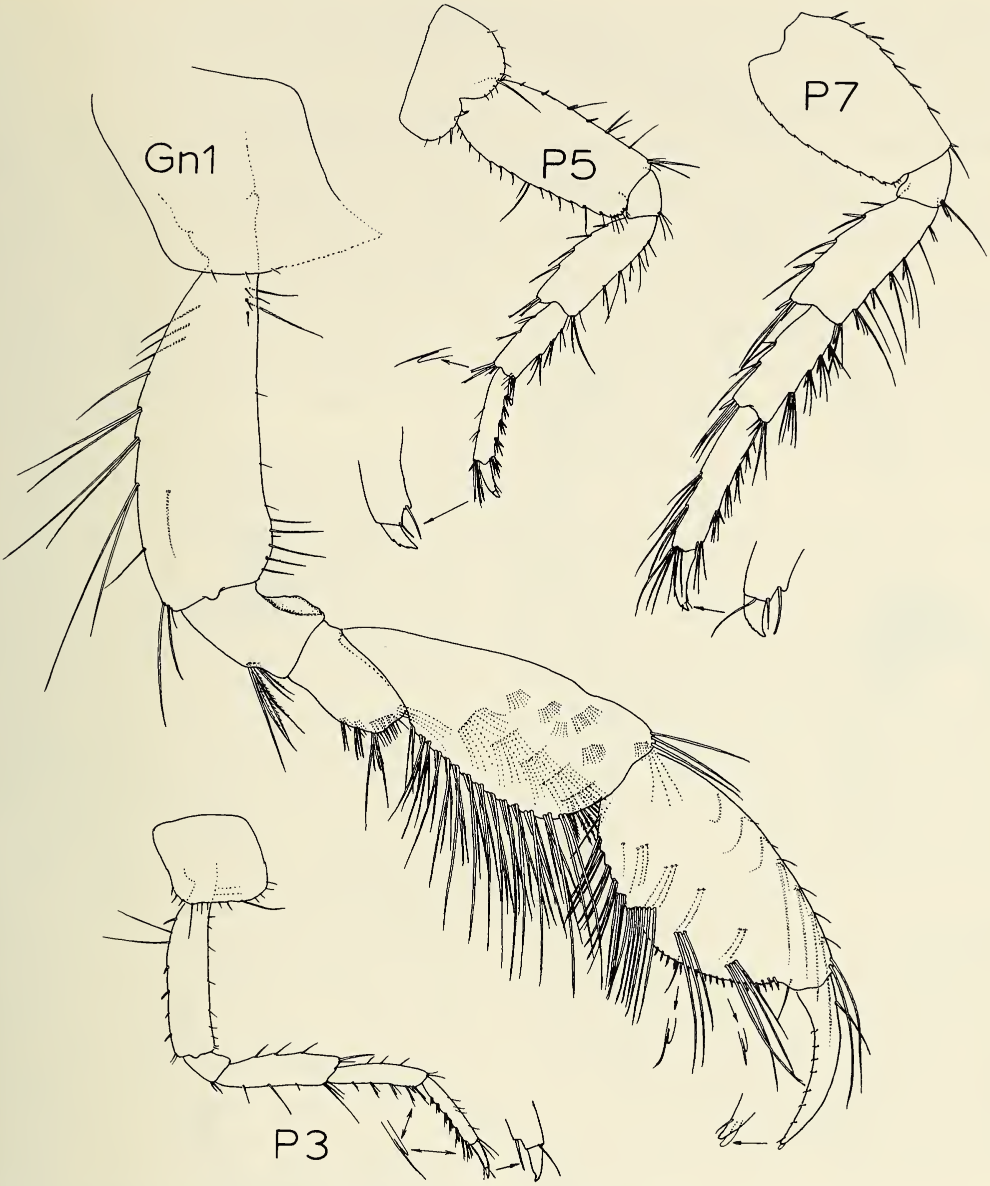

Fig. 1. *Maera tinkerensis* Kunkel: YPM 8220, male syntype, 8.4 mm.

Material examined.—YPM 8220, male, 6.7 mm, syntype, Harrington Sound, Bermuda, collector and date unknown.—YPM 8221, male, 8.4 mm, syntype, Harrington Sound, Bermuda, collector and date unknown.—YPM 8222, male, 6.3 mm, syntype, Harrington Sound, Bermuda, collector and date unknown.

Melita planaterga Kunkel
Figs. 3–4

Melita planaterga Kunkel, 1910:34–37, fig. 12.—Barnard, 1962:107–108.
Melita planaterga (?): Karaman, 1981:29–50.

Description.—Male: Head, lateral lobes

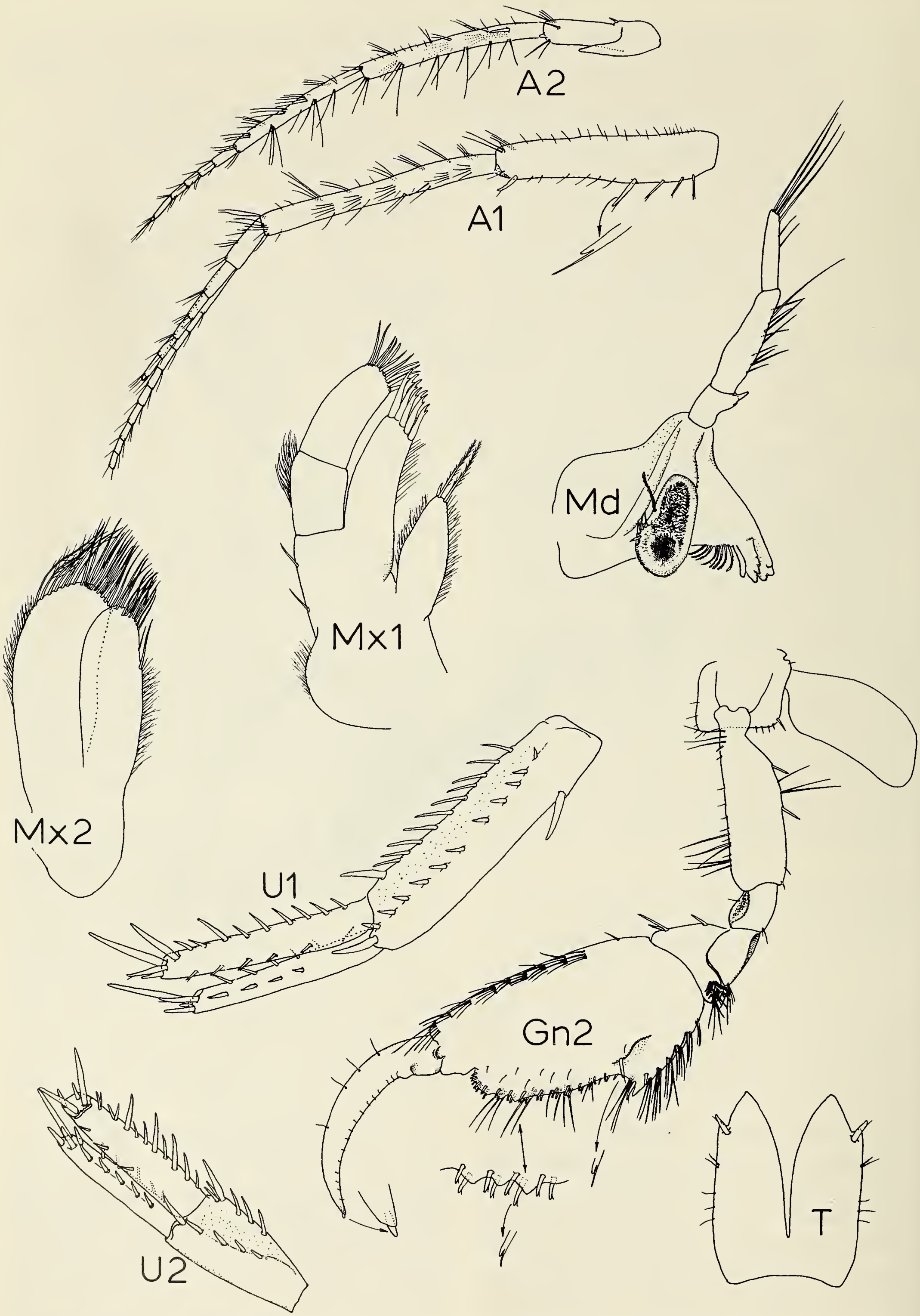

Fig. 2. *Maera tinkerensis* Kunkel: YPM 8220, male syntype, 8.4 mm: A1, A2, Gn2, Md, T, U1 and U2. YPM 8221, male syntype, 6.7 mm: Mxl, Mx2.

rounded, eyes not distinct in alcohol-preserved specimens. Pleon dorsally smooth, epimeron 3 produced behind to form large tooth, urosome segment 1 with short medial mucronation on posterior margin, urosome segment 2 with lateroposterior spine.

Antenna 1 greater than 50% body length, peduncular article 1 stout, with 2 proximal and 1 distal spines on posterior margin, article 2 120% length article 1, article 3 33% length article 2; flagellum longer than peduncle, accessory flagellum 3-articulate, terminus minute. Antenna 2 slightly shorter than antenna 1.

Mandible with 4-cuspate lacinia, molar moderately strong; mandibular palp article 1 60% article 2, article 2 30% longer than article 3. Maxilla 1, inner plate truncate, with distal setae; outer plate with 7 stout, recurved, bifid spines; palp 2-articulate, distally moderately serrate, with stout spines and a few setae. Maxilla 2, inner plate as broad as outer plate, inner marginal setae extending proximally ⅔ the distance of medial margin, outer plate distally setose, a few setae plumose.

Gnathopod 1, basis with 2 long setae on anterior margin near base, distal half anterior margin with dense groups of long, exceptionally fine setae, article 4, distal portion extended into distinct, slightly excavate margin with setae, article 5 much longer than broad, anterior margin lined with groups of setae, posterior margin with 8 or 9 fascicles of long setae, inner facial margin with 4 groups of setae, article 6 shorter than article 5, distoposterior corner produced into rounded lobe with setae, palm incised near base of article 7, base of dactyl inflated, anterior margin with small distal spine. Gnathopod 2, anterior margin of basis with groups of long setae, articles 3 and 4 subrectangular, article 4, distoposterior corner produced into small tooth, article 5, anterior and posterior margins densely lined with fascicles of setae, setae on posterior margin serrate, inner facial margin with several groups of long setae, article 6, length 170% width, anterior and posterior margins densely lined with long setae, palm oblique, excavated margin result of damage, lined with plumose setae, inner facial surface adjacent to palm forming depression, article 7 longer than palm, closing against facial depression of article 6.

Pereopods 5–7, bases of anterior and posterior margins finely serrate, serrations defined by small spines.

Uropod 1 extending slightly beyond uropod 2, peduncle spinose, slightly longer than rami, ventral margin with 1 stout spine, rami spinose, rami equal, uropod 2, peduncle and rami spinous, rami equal to each other and to peduncle, uropod 3 missing from specimen.

Telson split nearly to base, each lobe bearing 1–3 terminal spines and 0–1 spines along inner margin.

Remarks.—Kunkel described the palm of gnathopod 2 as slightly concave. The dactyl in his figure, however, obscures the margin of the palm. Our redescribed gnathopod 2 of the lectotype shows a concavity (Fig. 3). Examination of recent material from Bermuda, however, suggests that the normal condition of the palmar margin is entire, not concave, and of the palmar setae, long and plumose, not short.

Karaman (1981) redescribed this species from a single male specimen collected at Castle Harbour, Bermuda, noting many differences between his specimen and Kunkel's. The type material of Kunkel, however, confirms many points of his original description and brings to light more differences from the specimen described by Karaman.

The dorsal mucronation on urosome segment 1, as figured by Karaman, is much more prominent than on the type specimen; its mucronation extends approximately ⅕ the length of urosome segment 2 whereas Karaman's figure shows it extending nearly ½ the length of urosome segment 2. Moreover, on Kunkel's specimen we find no notch at the insertion of the dorsolateral spine on the posterior margin of urosome segment 2.

Karaman figured a strongly dentate palp

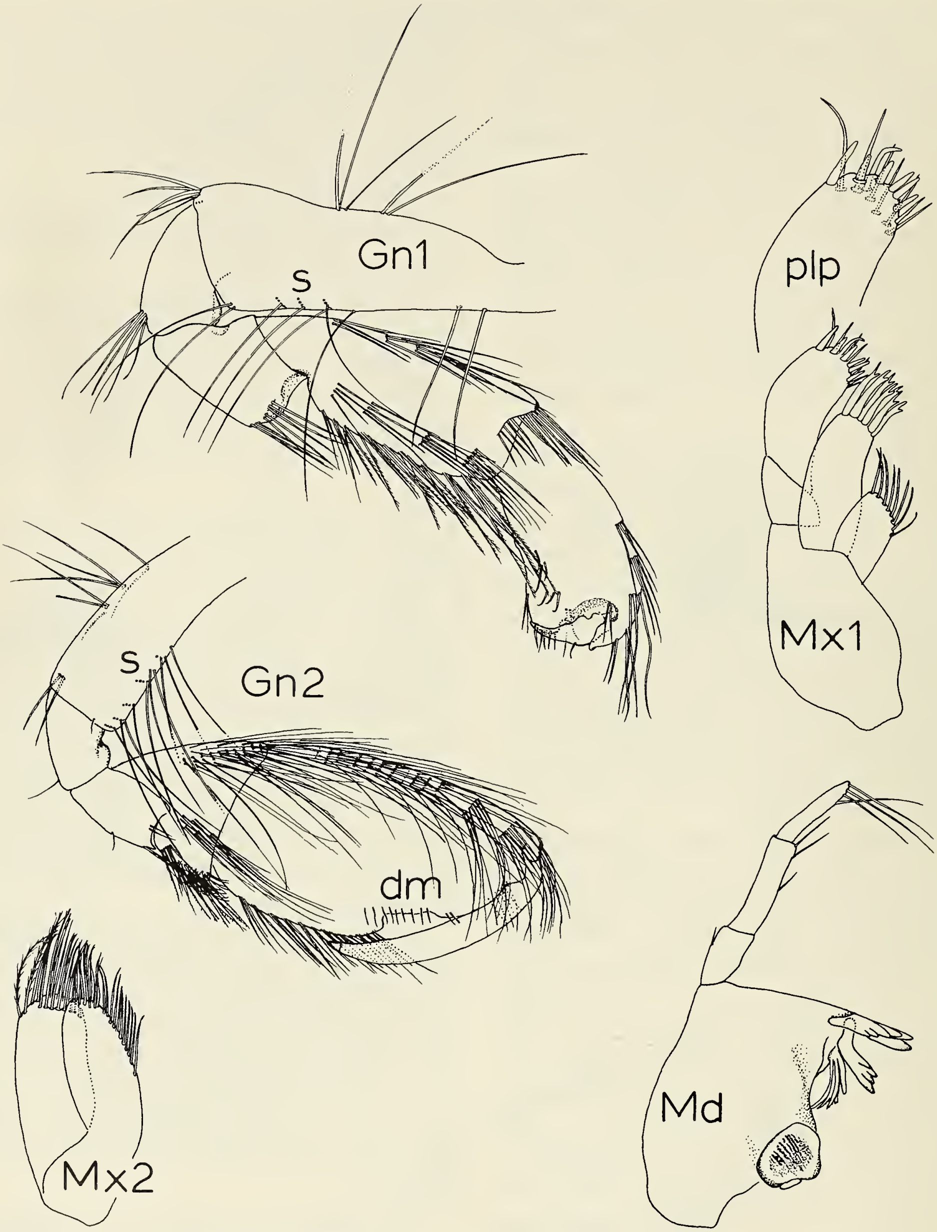

Fig. 3. *Melita planaterga* Kunkel: YPM 8227, male lectotype, 5.4 mm.

article 2 on maxilla 1. In the lectotype the distal margin of the maxilla 1 palp is only moderately dentate; the teeth are acutely rounded and not pointed as in Karaman's specimen.

Kunkel stated that the accessory flagellum of antenna 1 is 2-segmented. Careful examination of the type revealed that the accessory flagellum is actually 3-segmented; the terminus is miniscule and was certainly overlooked by Kunkel. Karaman, however, clearly figured a 4-segmented accessory fla-

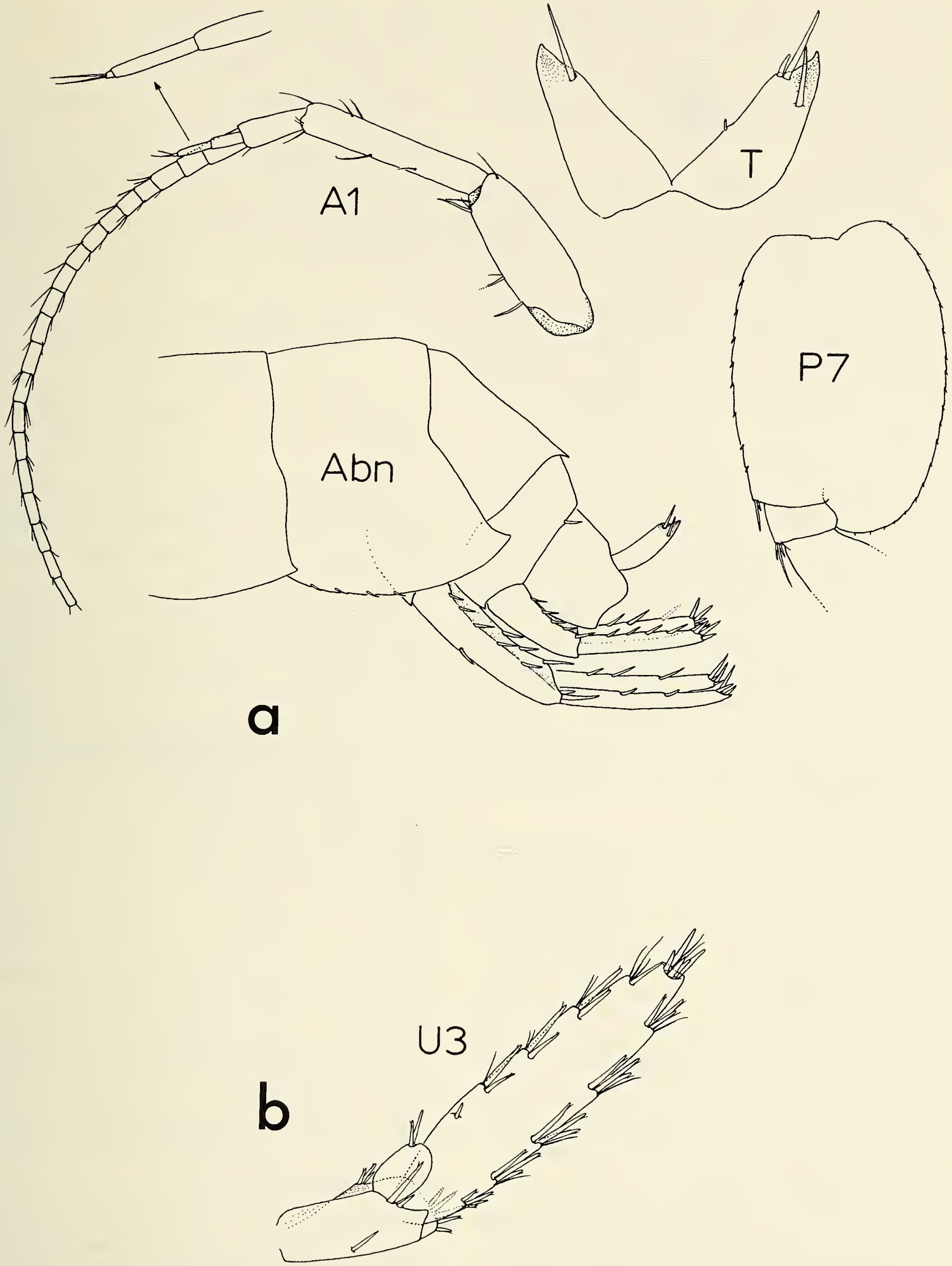

Fig. 4. *Melita planaterga* Kunkel: a: YPM 8227, male lectotype, 5.4 mm; b: YPM 8229, male, 4.5 mm.

gellum with a large terminal segment. In specimens examined from material recently collected at several localities in Bermuda, all had an accessory flagellum as we have figured; none had 4 segments as stated by Karaman.

Examination of these recently collected specimens supports the differences between Kunkel's and Karaman's specimens in other aspects. The posterior spination of the first peduncular segment of antenna 1 is invariably as Kunkel illustrated as is the inner marginal spination of the telson. Furthermore, the spines on the peduncle and rami of uropods 1 and 2, although variable in number, are always significantly less than the number shown by Karaman and again agree with Kunkel's figure. Kunkel did not figure uropod 3 and his description is vague, but the third uropods of recent specimens (Fig. 4b) differ from those of Karaman's specimen; the peduncle in his specimen is less spinose and the rami more spinose than in the recent material. Finally, the serrate margin of the basis on pereopods 5–7 mentioned by Kunkel but not seen by Karaman is always present and distinct in all specimens we examined.

Karaman's specimen, which differs in so many characteristics, undoubtedly represents a new species; without seeing his specimen, however, we feel it prudent not to erect a new taxon.

Material examined.—YPM 8227, Flatts Village, Bermuda, collector and date unknown, 1 lectotype male (5.4 mm).—YPM 8229. Whalebone Bay, St. George's, Bermuda, M. F. Gable and class, 22 May 1985, intertidal, among rocks and vegetation, 1 male [uropod 3 figured].—YPM 8230, Whalebone Bay, St. George's, Bermuda, M.F. Gable and class, 22 May 1985, intertidal, among rocks and vegetation, 2 males, 2 females (ovigerous).—YPM 8231, Ferry Reach, Bermuda, north of Long Bird Bridge, M.F. Gable, 29 May 1985, intertidal to subtidal, 1 male, 1 female, 3 juveniles.—YPM 8232, Devonshire Bay, Bermuda, M.F. Gable, 29 May 1985, under rocks, shallow subtidal, 2 males, 2 females, 2 ?? [damaged specimens].—YPM 8233, Gravelly Bay, Bermuda, M.F. Gable, 31 May 1985, under rocks in subtidal honeycombed substrate, 2 females (1 ovigerous).—USNM Acc. No. 346847, Hungry Bay, Bermuda, M.L. Jones, 5 Sep 1981, from transect collection along length of bay, West Seawall, associated with rocks, 1 male, 1 female (ovigerous).

Hyalellidae Bulycheva, 1957
Parhyalella batesoni Kunkel
Figs. 5–6

Parhyalella batesoni Kunkel, 1910:74–76, fig. 28.

Description.—Male: Body dorsally smooth, coxa deep, anterior margins rounded. Pleonal epimera subquadrate, posterior corners not produced.

Head, lateral lobes rounded; eyes moderately large, oblong. Antenna 1 25% of body length, slightly longer than antenna 2, flagellum 110% length of peduncle, consisting of 11 to 15 articles; peduncular segments subequal in length, accessory flagellum lacking. Antenna 2 nearly 25% of body length, peduncular segments much broader than those of antenna 1, gland cone hidden, segment 3 short and stout, as long as broad, segment 4 as broad as 3, length of segment 4 to 5, 1:0.5, segment 5 narrower than 3 and 4; flagellum short, 25% length of peduncle, 3-articulate, basal article conjointed.

Maxilla 1, inner plate narrow, with short medial setules and 2 stout plumose terminal spines; outer plate with 8 stout, serrate spines, lateral margin distinctly excavate, pre-ecdysial serrate spines visible through facial surface; palp absent.

Gnathopod 1 subchelate, much smaller than gnathopod 2, posterior margin of article 2 produced, broadest point with 3 large and 1 small setae; article 5 nearly as broad and as long as article 6, posterior lobe with ridge of small spines, article 6 rectangular, posterior corner of transverse palm with small to medium spines and a few setae, dactyl short, stout, congruent with palm.

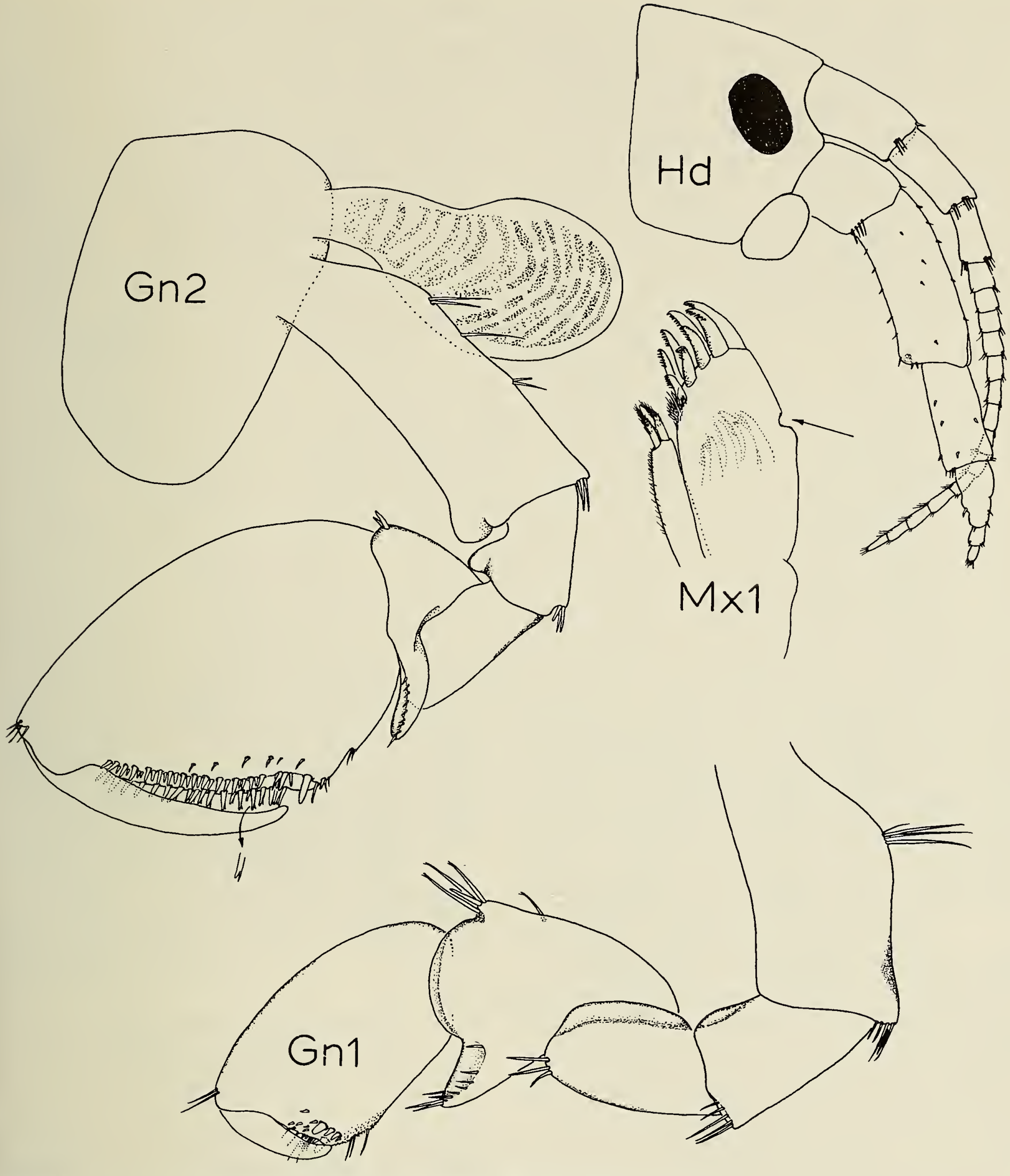

Fig. 5. *Parhyalella batesoni* Kunkel: YPM 8188, male holotype, 6.8 mm.

Gnathopod 2, powerful, subchelate, article 2 with anterodistal lobe; articles 3 and 4 normal, 3 with mammilliform anterior lobe; article 5 less than 20% length article 6, posterior lobe strong, distally produced between articles 4 and 6, lined with row of spines, article 6 equal to width of article 5, oval, palm oblique, margin incised, submarginally lined with stout spines, larger spine at proximoposterior corner, dactyl congruent with palm.

Pereopods 3 and 4 normal, dactyls 1-annulate. Pereopods 5–7 similar, length increasing consecutively; article 2 expanded in all.

Uropod 1 extending beyond uropod 2, peduncle spinose, rami subequal, each with spines along dorsal margin and four ter-

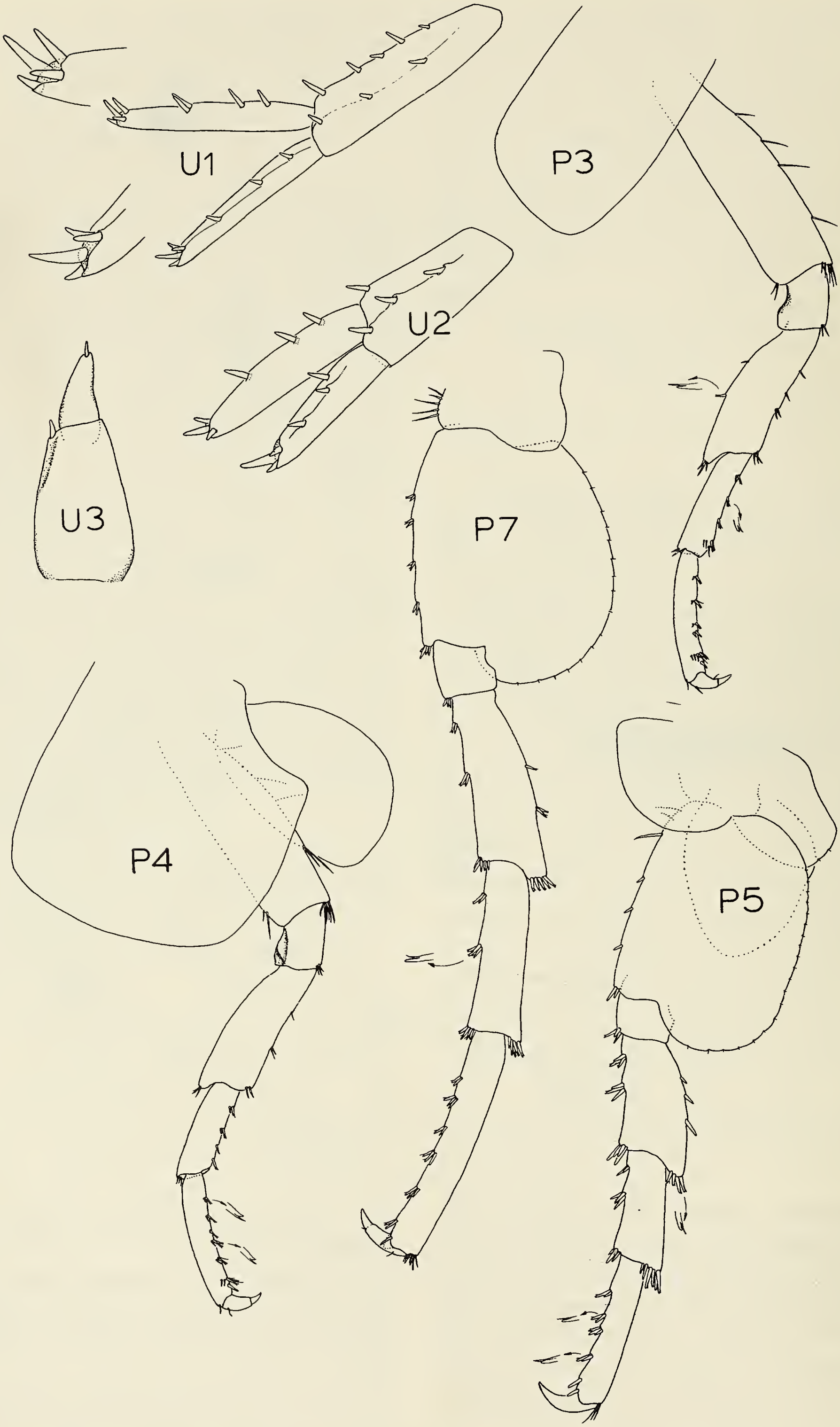

Fig. 6. *Parhyalella batesoni* Kunkel: YPM 8188, male holotype, 6.8 mm.

minal spines. Uropod 2 75% length uropod 1, peduncle with row of spines; outer ramus shorter than inner, both with marginal and terminal spines. Uropod 3, peduncle with 1 prominent spine at inner posterior corner, inner ramus absent, outer ramus stout, 40% length of peduncle, with 1 terminal spine.

Remarks.—The genus *Parhyalella* is diagnosed in part by the absence of a palp on maxilla 1. The type specimen lacked nearly all the mouthparts but fortunately still retained a single maxilla 1 so its form could be confirmed. Several species assigned to this genus, however, have been clearly described as having a palp, albeit vestigial, on maxilla 1. It is apparent that the species of *Parhyalella* need to be re-examined and the generic diagnosis re-evaluated.

Recent shallow water collections made in Bermuda by one of us (MFG) failed to turn up any additional specimens of *P. batesoni.* As the type specimen had no collection data, one can only speculate upon the habitat of this species. Several individuals of *Parhyalella* were recently collected at 20 m from Taiwan (in prep.); it is possible that *P. batesoni* also inhabits deeper water and may only rarely be collected in shallow water.

Material examined.—YPM 8188, Bermuda, collector and date unknown, 1 holotype male (6.8 mm).

Corophiidae Dana, 1849
Gammaropsis lina (Kunkel)
Figs. 7–9

Eurystheus lina Kunkel, 1910:81–83, fig. 31.
Eurystheus = *Gammaropsis* [in part], Barnard, 1969:271.

Description.—Male: Coxae moderately deep, overlapping. Pleon segments 1–3 each with one pair dorsolateral setae on posterior margin; posterior margin pleonal epimera broadly rounded, hind corner produced into small tooth. Urosome segment 1 with pair of 1 long and 1 short dorsolateral setae; urosome segment 2 with pair of 1 long and 2 short, dorsolateral setae.

Eye oval, situated in head lobe; head lobe acute. Antenna 1 50% body length, peduncular segment length ratio 1:1.4:1; peduncular segment 1 twice as broad as segments 2 and 3, posterior margin of segments 2 and 3 densely setose; flagellum composed of 12 articles, 30% length of peduncle; accessory flagellum 5 articulate, terminus minute. Antenna 2 slightly shorter than antenna 1; peduncular segment 4 shorter than 5, posterior margin of both articles strongly setose; flagellum 40% length of peduncle, flattened, 1st article elongate.

Right mandible with serrate lacinia, 9 spines proximal to incisor, molar strong, ridged, with plumose accessory seta; palp 3-articulate, 1st article 25% length article 2, article 2 stout, subequal in length to article 3, posterior margin slightly excavate and setose, anterior margin article 3 with 3 long setae, distal margin armed with long, plumose setae. Lower lip with inner lobes well developed, outer lobes with pointed lateral projections. Maxilla 1, inner plate with plumose marginal setae, outer plate with about 9 stout, bifid spines; palp 2-articulate, distal margin of second article with short, stout spines. Maxilla 2, outer plate a little broader than inner, inner plate with row of facial setae. Maxilliped normal, palp 4-articulate, terminus bearing long distal setae.

Gnathopod 1 subchelate, smaller than gnathopod 2, article 4 distally rounded with long posterior setae, article 5 slightly longer than article 6, posterior margin and medial face with fascicles of long setae, article 6 ovate, fascicles of setae on posterior and anterior margins, palm oblique, with stout spines at proximoposterior corner. Gnathopod 2, article 5 33% article 6, posterior lobe prominent, article 6 elongate, 2.5 times longer than wide, rectangular, posterior margin densely lined with curly setae, palm transverse, convex, distoposterior corner produced into strong thumb, article 7 stout, with posterior tubercle hidden by long setae of article 6.

Pereopod 4 (pereopod 3 missing), coxal plate with long seta at distoanterior corner, basis with long seta on posterior margin;

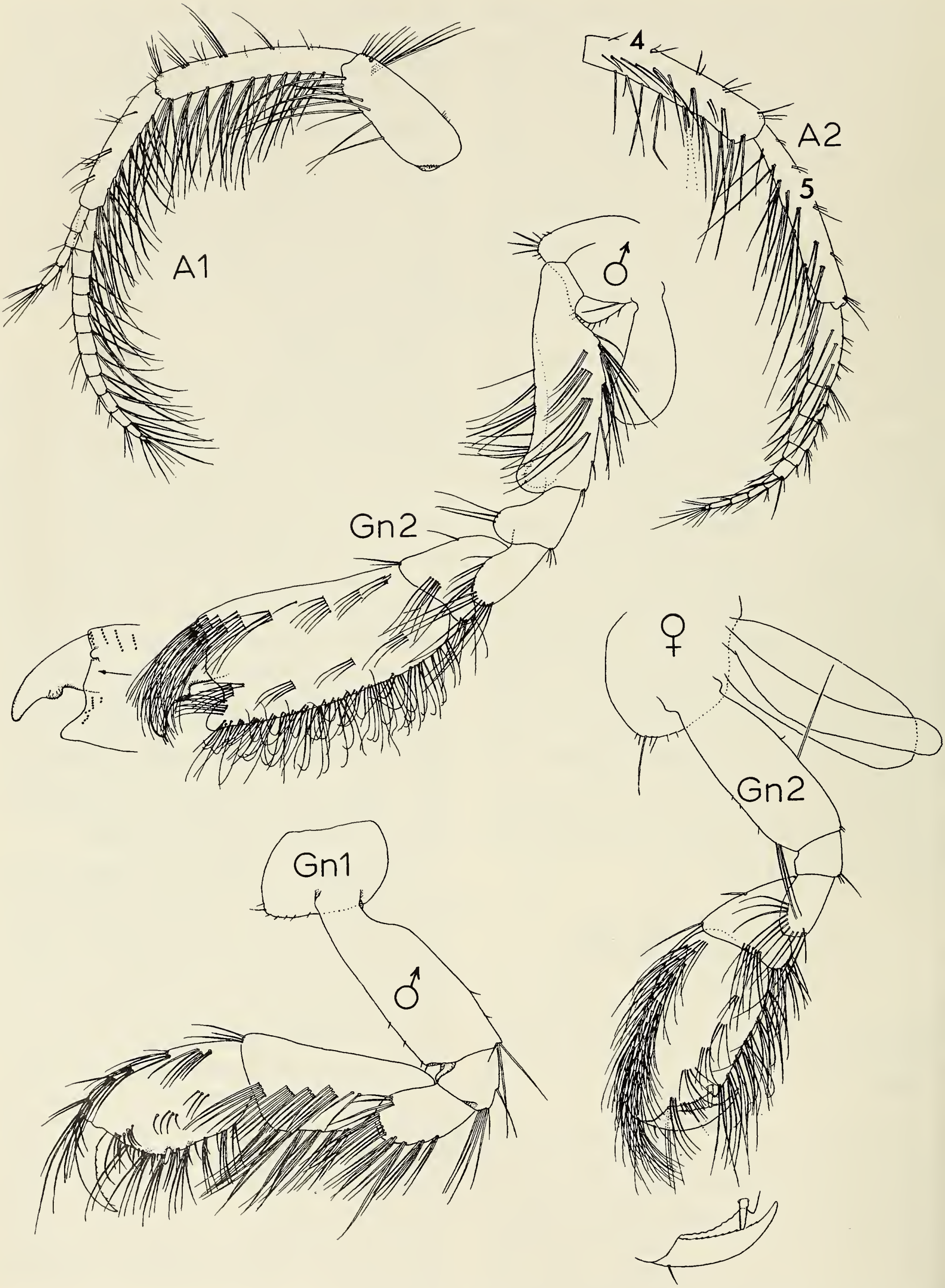

Fig. 7. *Gammaropsis lina* (Kunkel): YPM 8189, male syntype, 6.1 mm: Al, Gnl, Gn2; A2 from unattributed specimen. YPM8224, female syntype, 5.1 mm: Gn2.

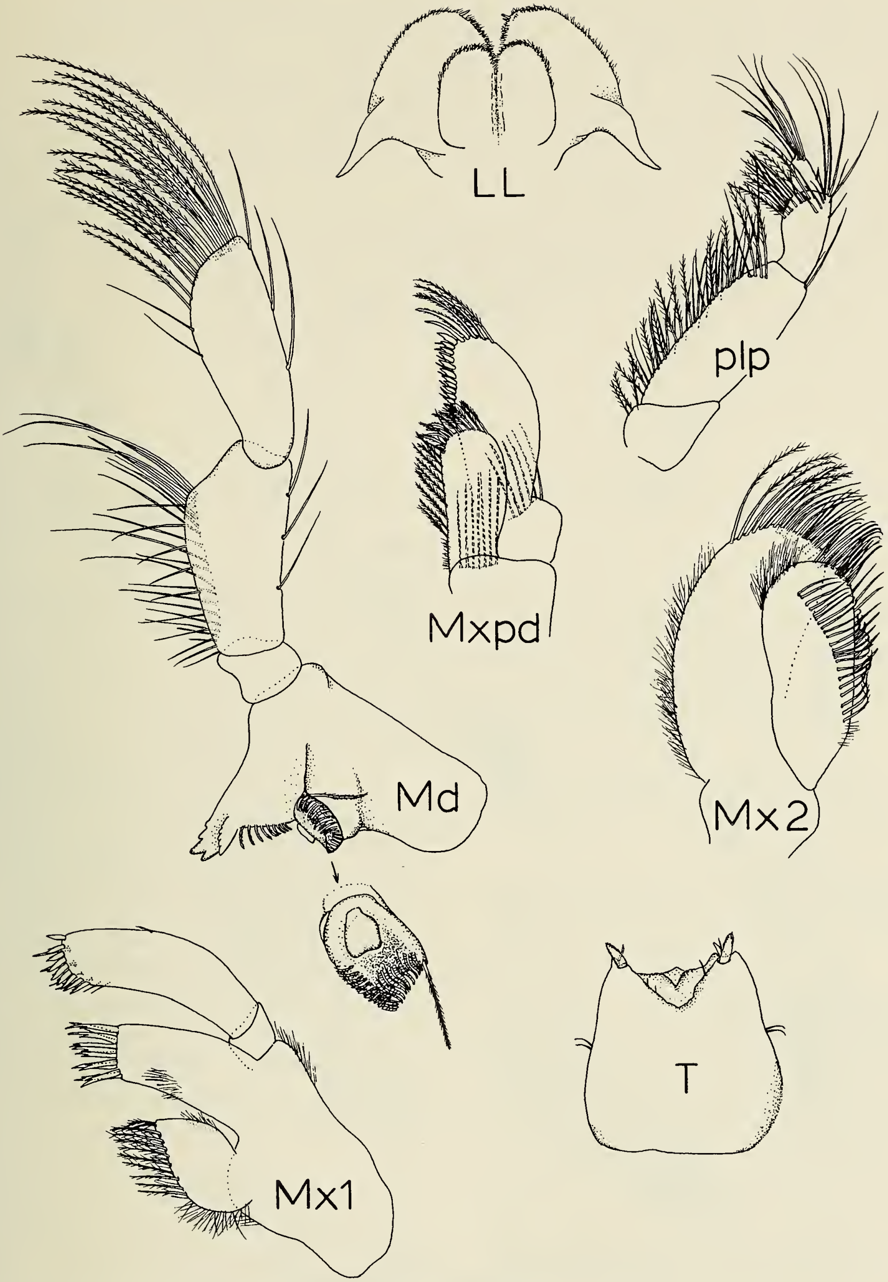

Fig. 8. *Gammaropsis lina* (Kunkel): YPM 8189, male syntype, 6.1 mm.

pereopod 5, basis somewhat expanded, articles 6 and 7 appearing antero-facing because of limb splaying; pereopod 6, coxa with spine at distoposterior corner, dactyl bifid; pereopod 7, proximoposterior corner of basis produced acutely, articles 6 and 7 appearing antero-facing because of limb splaying.

Uropods extended behind subequally; uropod 1, interramal spine extending nearly

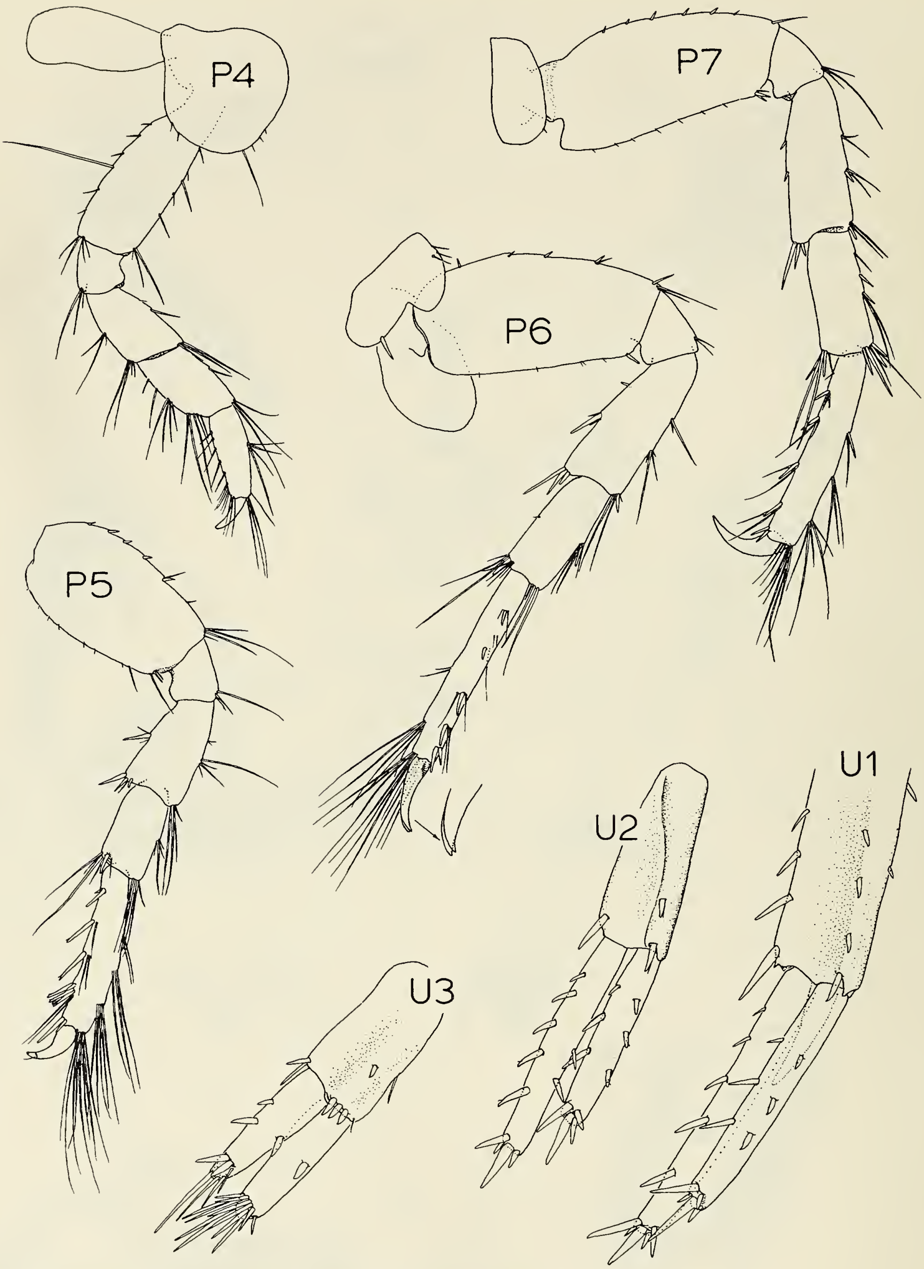

Fig. 9. *Gammaropsis lina* (Kunkel): YPM 8189, male syntype, 6.1 mm.

½ length outer ramus, rami longer than peduncle, outer ramus 80% inner ramus, both spinose; uropod 2 spinose, outer ramus 80% inner ramus; uropod 3, peduncle and rami subequal, rami with long distal spines.

Telson emarginate, apices separated, with 1–2 short distal spines.

Female: Syntypic female very similar to male except in form of gnathopods. Gnathopod 1 smaller than gnathopod 2, anterior margin moderately setose, posterior margin with fascicles of setae, palm oblique, lined with setae, distoposterior corner with stout spine, posterior margin article 7 ser-

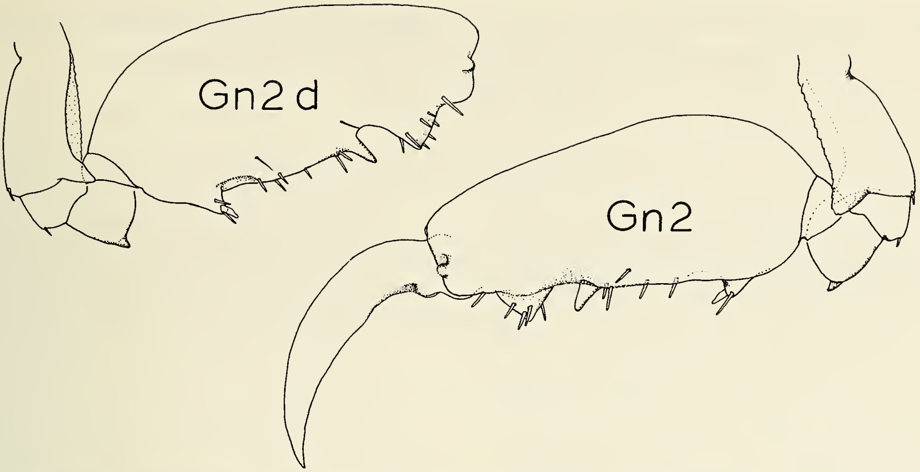

Fig. 10. *Caprella bermudia* Kunkel: YPM 8223, male lectotype, 6.3 mm: outer view (dactyl removed) and inner view.

rate. Gnathopod 2, article 6 subrectangular, anterior margin densely lined with setae, posterior margin lined with fascicles of curly setae; palm oblique, moderately crenulate, distoposterior corner produced into weak thumb, and armed with stout spine, article 7 serrate posteriorly.

Remarks.—The type material agrees closely with Kunkel's description in major diagnostic features; Kunkel's figures, however, lacked detail, particularly those of the mouthparts and the gnathopods. He also did not figure any of the pereopods or uropods. In the type material there are three specimens and not two as he stated; none of the specimens retained an intact antenna 2, and, therefore, one antenna for figuring was selected from several found loose inside the original vial.

Material examined.—YPM 8189, Bermuda, Dr. J. L. Cole, 1903, 1 syntype male, 6.1 mm.—YPM 8224, Bermuda, J. L. Cole, 1903, 1 syntype female, 5.1 mm.—YPM 8225, Bermuda, J. L. Cole, 1903, 1 syntype male [damaged, lacking head].

Isaea longipalpus Kunkel

Isaea longipalpus Kunkel, 1910:85–87, fig. 33.

Remarks.—The type material consists of only a few rehydrated fragments (YPM 8226) from Bailey Bay, Bermuda; their poor condition is not satisfactory for redescription so Kunkel's description must stand until new material can be evaluated.

Caprellidae White, 1847

Caprella bermudia Kunkel

Fig. 10

Caprella bermudia Kunkel, 1910:108–110, fig. 42.—McCain, 1968:22; McCain and Steinberg, 1970:13.

Remarks.—Although authenticated type material of *C. bermudia* was originally not found, one lot of *C. equilibra* Say, obviously examined by Kunkel, contained an individual matching his description and figures for *C. bermudia* precisely. This specimen consisted of a dissected head and first pereon segment and a matching carcass complete with gnathopod 2. The gnathopod 2 described and figured by Kunkel for *C. bermudia* is identical to gnathopod 2 of this specimen (Fig. 10). Furthermore, the dissection cleavage, directly posterior to the suture between the head and pereon segment 1 is identical with Kunkel's figure.

It is not readily apparent what characters Kunkel used to diagnose *C. bermudia.* He averred that the diagnostic character of *C.*

equilibra is the strong spine projecting ventrally between the gnathopods on pereonite 2. The specimen mentioned above has only a very small ventral spine between the gnathopods on pereonite 2 whereas the specimens called *C. equilibra* by Kunkel possess a very large, prominent ventral spine. On both a specimen recently collected from Bermuda and a specimen found in the USNM collections there was also a very large ventral spine on pereonite 2 even though the specimens were extremely small. It is conceivable, therefore, that Kunkel separated the two species by the appearance of the ventral spine, as no other distinctions are apparent. McCain (1968) mentioned that a variant of *C. equilibra* from North Carolina lacks the prominent ventral spine on pereonite 2; obviously, Kunkel was not aware of variants.

Kunkel apparently figured a female *C. equilibra* and a male caprellid, calling it *C. bermudia.* McCain (1968) concluded there is no way to separate *C. bermudia* from *C. equilibra.* Kunkel's figured specimen of *C. bermudia* is clearly indistinguishable from *C. equilibra* (*C. equilibra* in McCain 1968, Laubitz 1970). We believe, therefore, that the synonymy of the two is warranted.

Material examined.—YPM 8223, Bermuda, Dr. J. L. Cole, 15 Jul 1903, lectotype male (6.3 mm).—YPM 8208, *Caprella equilibra* (Say), Flatts Village, Bermuda, collector unknown, 4 Jul 1898, 2 males, 1 female.—YPM 8265, *C. equilibra,* Shelly Bay, Bermuda, M. F. Gable, 3 Jun 1985, among hydroids, 1 male.—USNM collection, *C. equilibra,* Bermuda, G. Brown Goode, 1876–1877, 1 ovigerous female.

Acknowledgments

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TWO NEW SPECIES OF *ELEUTHERODACTYLUS* (AMPHIBIA: ANURA: LEPTODACTYLIDAE) FROM BOLIVIA

John D. Lynch and Roy W. McDiarmid

Abstract.—*Eleutherodactylus fraudator,* new species, *E. mercedesae,* new species, and *E. rhabdolaemus* are reported from cloud forests in Departamento Cochabamba, Bolivia. *Eleutherodactylus pharangobates* Duellman is placed as a synonym of *E. rhabdolaemus* Duellman.

Although the genus *Eleutherodactylus* is extraordinarily speciose in many areas of northern South America and especially on the Andean slopes, it is poorly known in southern South America. Presently, the southern terminus of the genus is in northern Argentina (Lynch 1971, Cei 1980) where only a single species, *Eleutherodactylus discoidalis,* is recognized. Three species have been reported from Andean Bolivia in contrast to ten species recorded from adjacent areas in Peru. While such a gradient is consistent with the geographic pattern of diversity characteristic of many groups of tropical organisms, with frogs (especially *Eleutherodactylus*) this gradient is partially a reflection of collecting efforts. Thus, a series of small collections made by Mercedes S. Foster in 1979 as she travelled down the eastern versant of the Bolivian Andes along the road from Cochambamba to Villa Tunari (Cannatella [1980] presented a useful map of the area) are especially noteworthy for the frogs they contain. Her collections, when added to material collected in 1959 from the same area, provide us with some important additions to the Bolivian herpetofauna particularly within the genus *Eleutherodactylus.*

The three species previously reported from Bolivia are *E. cruralis* (Boulenger), *E. fenestratus* (Steindachner), and *E. pharangobates* Duellman. The cloud forests of adjacent Peru (Departamentos Ayacucho, Cuzco, and Huánuco) harbor ten species: *E. cosnipatae* Duellman, *E. danae* Duellman, *E. granulosus* (Boulenger), *E. lindae* Duellman, *E. mendax* Duellman, *E. pharangobates* Duellman, *E. platydactylus* (Boulenger), *E. rhabdolaemus* Duellman, *E. salaputium* Duellman, and *E. scitulus* Duellman.

In addition to the two new species of *Eleutherodactylus* (described below) and *E. rhabdolaemus,* Foster obtained one specimen of *E. fenestratus* (USNM 257849, Miguelito, ca. 99 km from Cochabamba on Cochabamba to Villa Tunari road, Provincia Chapare, Departamento Cochabamba, 1770 m). This record is from the southern edge of the distribution of *E. fenestratus,* a wide-ranging species recorded from several localities in the southern Amazon Basin (Lynch 1980).

Our use of abbreviations and terminology follows Lynch (1980) and Lynch and Myers (1983).

Eleutherodactylus fraudator, new species

Figs. 1, 2A

Holotype.—USNM 257847, adult male, taken 73.5 km from Cochabamba on Cochabamba to Villa Tunari road, Provincia Chapare, Departamento Cochabamba, Bolivia, ca. 2690 m, on 23 Sep 1979, Mercedes S. Foster collector.

Paratopotype.—USNM 257846, adult male, taken with holotype.

Diagnosis.—A species of *Eleutherodactylus* distinguished from others by the following combination of characteristics: (1) skin of dorsum shagreened, that of venter smooth; low dorsolateral folds present; (2) tympanum prominent, round, ⅖ eye length; (3) snout outline from dorsal view rounded to obtuse, round in lateral profile; canthus rostralis sharp in cross section; (4) upper eyelid broader than IOD; no cranial crests; (5) vomerine odontophores oval; (6) males with vocal slits; males with non-spinous nuptial pads; (7) first finger slightly longer than second; tips of two outer fingers truncate with expanded pads, those of inner fingers more rounded; (8) lateral fringes on fingers weakly defined or absent; (9) no ulnar tubercles; (10) no tubercles or folds on heel or tarsus; (11) inner metatarsal tubercle oval and elevated, outer low and indistinct; no supernumerary plantar tubercles; (12) toes with weak lateral keels; toe tips rounded to truncate; (13) brown with darker brown stripes; dark brown canthal-supratympanic and labial stripes; venter cream stippled with brown, heaviest on throat; (14) two adult males 28.1–28.3 mm SVL.

Eleutherodactylus fraudator tentatively is assigned to the *conspicillatus* group. However, the plesiomorphic nature of that group (Lynch 1986) prevents final determination of relationships at this time. *Eleutherodactylus fraudator* is readily distinguished from all others species in the group by having a continuous brown labial stripe instead of labial bars or spots. Additionally, the oval vomerine odontophores are distinctive.

Description.—Statements expressed in full in diagnosis are not repeated here. Head as wide as body, wider than long; HW 40.3–40.6% SVL; nostrils protuberant, directed laterally; snout obtuse, sloping abruptly anterior of nostrils, rounded below tip; canthus rostralis sharp, slightly concave to straight; loreal region concave, sloping abruptly to lips; lips not flared; E-N 75.0–82.0% eye length; low tubercles on upper eyelid; upper eyelid width 112.0–119.2% IOD; relatively large frontoparietal fontanelle present, possibly indicating that these are young, albeit adult, males; supratympanic fold low, barely touching tympanum; tympanum low on head, length 40.0–46.2% of eye length, separated from eye by distance equal to its length; choanae ovoid, moderate-sized, about equal to tip of first finger, well separated from palatal shelf of maxillary arch; vomerine odontophores oval in outline, medial and posterior to choanae, separated by distance about equal to width of odontophore, bearing two to four teeth; tongue longer than wide, oval, posterior edge with shallow notch, posterior ⅓ free from floor of mouth; vocal slits long, posterolateral to tongue; vocal sac subgular.

Skin of dorsum shagreened but with scattered low tubercles; dorsolateral folds extend from above tympanum to above groin; skin on flanks not areolate but with scattered tubercles; distinct glandular area in groin; no ventral discoidal folds; skin posteroventral to vent areolate; no anal sheath; palmar tubercle much larger than oval thenar, both low; subarticular tubercles low, longer than wide; fringes indistinct (presence at some points along margins of some fingers may be artifact of preservation); tips of fingers III–IV (Fig. 2) expanded, truncate, with enlarged pads, tips of II–IV with circumferential grooves; finger tip of III less than ½ size of tympanum; finger lengths, shortest to longest, 2, 1, 4, 3; males with large (covers more than half length of digit), white and glandular nuptial pad on top of thumb; outer metatarsal tubercle low, ½ to ⅓ size of inner; subarticular tubercles longer than wide, sub-conical; toes lack fringes and webbing; lateral keels weakly developed; all toes bear pads on ventral surfaces; heels broadly overlap when flexed hind legs held at right angles to sagittal plane; shank 57.9–60.8% SVL.

The paratype, dissected to determine the condition of the *m. adductor mandibulae,* has the "S" condition (Lynch 1986).

Coloration in preservative.—Brown above

Fig. 1. *Eleutherodactylus fraudator,* left: holotype, USNM 257847; right: paratype, USNM 257846.

with darker brown interorbital triangle continuing posteriorly as a pair of stripes vaguely recalling scapular and sacral chevrons (Fig. 1); lateral margin of dorsolateral fold very dark brown delineating a brown flank band bordered ventrally by paler coloration; irregular dark brown marks forming broken stripe beginning above forelimbs and extending ventrally on anterior ¼ of flank; canthal stripe broad, dark brown, extending posteriorly above and below eye to join supratympanic stripe; supratympanic stripe expanded ventrally to form blotch, edged ventrally by cream line; tympanum dark, continuous with supratympanic stripe, annulus only slightly lighter; brown stripe on margin of upper lip; limbs irregularly barred (bars wider or narrower than interspaces, darkest marginally); top of thigh barred; posterior surface of thigh essentially dark brown with some traces of lighter mottling; groin pigmentless except in glandular area that is ochre in one specimen; ventral surfaces cream dusted with brown, heaviest on throat and chest.

Coloration in life.—Dorsally and laterally mottled with tan, light and dark brown, pattern edged in black in some places; eye, lip, and lateral stripes dark brown to black; ventrally creamy gold, more or less iridescent, intermixed with brown; iris gold (from field notes of M. S. Foster).

Measurements of holotype (*and paratype*) *in mm.*—SVL 28.3 (28.1), shank 16.3 (17.1), HW 11.4 (11.4), head length 10.3 (10.1), chord of head length 11.4 (11.1), upper eyelid width 3.1 (2.8), IOD 2.6 (2.5), tympanum 1.8 (1.6), eye 3.9 (4.0), E-N 3.2 (3.0), hind leg (vent to tip of fourth toe) 53.8 (53.8).

Etymology.—Latin, meaning cheat or deceiver; used because these frogs look very much like *Gastrotheca marsupiata.*

Referred specimen.—In addition to the types, we are aware of one additional specimen of *E. fraudator.* USNM 146568, a juvenile female 14.3 mm SVL, was taken at Incachaca, Provincia Chapare, Departamento Cochabamba, 2100 m, on 27 Oct 1959, R. B. Cumming. We prefer not to include it in the type series because of its juvenile nature.

Remarks.—These frogs were calling from a road-cut in the late afternoon from under rocks or in heavy "moss." The road-cut, a sheer face, was very rocky and covered with vegetation 3 to 5 cm tall interspersed with many bare areas. Males, completely hidden, gave single note, high pitched calls.

We considered the possibility that this species might be identical with that named *Leptodactylus* (*Plectromantis*) *andicola* by Boettger (1891) from Sorata, Bolivia, a locality east of Lago Titicaca at about 2650 m on the eastern Andean slopes of Departamento La Paz. Heyer (1978:33) reported that the type had been destroyed but placed the species in the genus *Eleutherodactylus.* Our comparison of the published description also indicates that several features are in agreement with *Eleutherodactylus,* and *E. fraudator.* However, the description is somewhat general and the following points are at variance (states for *fraudator* in parentheses): snout almost 1½ times as long as eye (about equal); IOD as wide as upper eyelid (narrower); first finger as long as second (longer); narrow fringes on fingers and toes (indistinct or absent); fold on distal ⅓ of tarsus (no tarsal fold); upper lip blotched (brown labial stripe); limbs indistinctly banded (bands prominent). Additionally, Boettger (1891) made no mention of dorsolateral folds; given that such folds are important in the taxonomy of *Leptodactylus,* the omission suggests that the type of *andicola* lacked such folds. We conclude that *if andicola* is an *Eleutherodactylus,* it is distinct from *E. fraudator.*

In reading the description of *L. andicola* we were struck by its agreement with that of *Gastrotheca marsupiata.* Although Heyer (1978:33) placed *andicola* in *Eleutherodactylus,* we think it equally likely that it might be a *Gastrotheca marsupiata.* Although the type is reported to be 48 mm SVL, somewhat large for a *G. marsupiata* (Duellman and Fritts 1972:17), Sorata is within the range of *G. marsupiata.* Also many other traits, as described by Boettger (1891) for *andicola,* are similar to those found in *Gastrotheca.*

Eleutherodactylus mercedesae, new species
Figs. 2B, C, 3

Holotype.—USNM 257848, adult male, ca. 3.3 km N of Cochabamba to Villa Tunari road on road to San Onofre, at a point 97.5 km from Cochabamba on Cochabamba to Villa Tunari road, Provincia Chapare, Departamento Cochabamba, Bolivia, ca. 1690 m, taken 29 Oct 1979, Mercedes S. Foster collector.

Paratype.—USNM 165753, Limbo, Provincia Chapare, Departamento Cochabamba, Bolivia, 1950 m, probably collected 25 Oct 1959, Robert B. Cumming.

Diagnosis.—A species of *Eleutherodactylus* distinguished from others by the following combination of characters: (1) skin of dorsum finely granular, that of venter areolate; irregular, indistinct dorsolateral folds; (2) tympanum prominent, superficial, ⅓ eye length; (3) snout subacuminate in dorsal view, round in lateral profile; canthus rostralis sharp; (4) IOD about equal to width of upper eyelid; no cranial crests; (5) vomerine dentigerous processes large, nearly triangular, just medial and posterior to choanae; (6) males with vocal slits; males lack nuptial pads; (7) first finger slightly shorter than second; fingers long, tips truncate, pads large; (8) lateral fringes on fingers; (9) no ulnar tubercles; (10) fold along distal ⅓ of inner edge of tarsus; no heel or tarsal tubercles; (11) two metatarsal tubercles, inner large, oval, about four times size of low outer; three small supernumerary plantar tubercles; (12) toes with narrow lateral fringes, basal webbing; toe tips truncate with broad pads; (13) dorsum brown with lichenose pattern of cream (green in life); throat streaked and mottled with cream and brown; posterior surfaces of thighs brown with many cream flecks and mottling; (14) adults large, two males 40.1–49.5 mm SVL.

By virtue of its color pattern, *E. merce-*

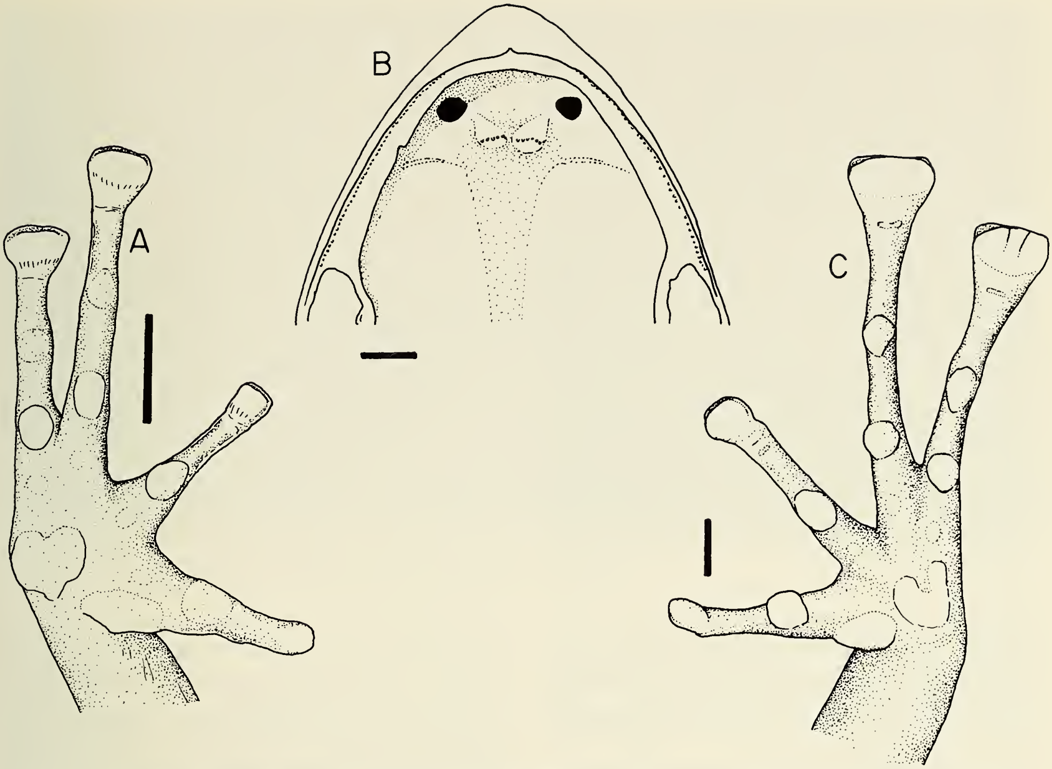

Fig. 2. (A) Hand of *Eleutherodactylus fraudator* (USNM 257847), (B) palate and (C) hand of *E. mercedesae* (USNM 257848). (A) is a composite of the left and right hands of the holotype to remove distortions caused by encysted parasites. Scales equal 2 mm.

desae is distinguished from every other species in the genus. Although it has characteristics of Lynch's (1976) *unistrigatus* group, we are unable to suggest any relatives at this time.

Description.—Statements expressed in full in diagnosis not repeated here. Head equal to or wider than body, wider than long; HW 36.4–39.7% SVL; snout deep and lacking tubercles at tip; nostrils moderately protuberant, directed laterally, much nearer tip of snout than to eye; canthus rostralis straight or weakly sinuous; E-N 90.4–93.5% eye length; loreal region concave, especially anteriorly, sloping abruptly to lip; small tubercle in center of loreal region; lips not flared; upper eyelids with few small tubercles; upper eyelid width 118.2–120.0% IOD; supratympanic fold distinct, contacting upper edge of tympanum, extending posteroventrally to above arm insertion; tympanum round, its length 36.5–37.1% eye length, separated from eye by distance equal to or slightly more than its diameter; two, low to moderate postrictal tubercles posteroventral to tympanum; scattered tubercles on head (three or four on upper eyelid, one between eyes, two preinterocular, one on loreal surface, two behind eyes on a line between tympana), but none on margin of lower jaw; choanae relatively large, about equal to subarticular tubercle width, ovoid, not concealed by palatal shelf of maxillary arch; vomerine odontophores between and slightly posterior to choanae (Fig. 2B), narrowly separated, slightly larger than choana, approximately triangular in outline, much elevated, bearing slanted row of six or seven teeth; tongue longer than wide, somewhat cordate, posterior border with shallow notch, posterior ¼ free from floor of mouth; moderately long vocal slits lateral to posterior half of tongue, slit covered posteriorly by distinct labial flap.

Skin of dorsum finely granular, bearing some enlarged warts (more distinct in paratype); a series in the area where dorsolateral folds might occur, a pair in scapular region, a series forming a fold high on flanks; skin of flanks coarsely granular with few enlarged warts; throat smooth; ventral discoidal folds prominent; no anal sheath. In USNM 165753, several strigiid parasites have encysted beneath the skin just above the anus and three more below and to the right. The resulting structures (not on the holotype) superficially resemble specialized anal warts. A single strigiid cyst occurs on the underside of the left shank near the heel, and another on the left heel.

Skin of arm smooth except for some rugosity on outer surface of forearm; palmar tubercle distinctly bifid (Fig. 2C), larger than thenar; thenar tubercle oval, distinctly elevated; supernumerary palmar tubercles present, subconical; subarticular tubercles raised, round to oval, basal on III subconical, others non-conical; fringes along edges of fingers, least developed along outside of IV, palm, and I; fingers very long and slender (Fig. 2C); toe tip on I scarcely expanded, on II expanded but smaller than tympanum, on III and IV expanded, larger than tympanum, weakly emarginate; circumferential grooves present on all fingers (least evident on thumb).

Upper surface of thigh smooth (lower and posterior proximal surfaces areolate); outer surface of shanks feebly granular; one or two minute outer tarsal tubercles; inner metatarsal tubercle 2.5 times as long as wide; supernumerary plantar tubercles low, at bases of toes II–IV; subarticular tubercles moderate-sized, mostly subconical, longer than wide; toe tips truncate, smaller than those of outer fingers, weakly emarginate; heels of flexed hind legs broadly overlap (⅓ length of leg) when limbs held at right angles to sagittal plane; heel of adpressed hind leg reaching well beyond snout; shank 69.3–70.1% SVL.

The paratype was dissected to record the condition of the *m. adductor mandibulae* ("S"). A moderate-sized frontoparietal fontanelle, slightly larger than that illustrated by Lynch (1971:147) for *E. palmeri* (=*E. nyctophylax*), is found in adult males of *E. mercedesae.*

Coloration in preservative.—Brown above with cream blotches in complex lichenose pattern; light areas include a ⊥-shaped mark on snout (bordered posteriorly by dark interocular bar that forms anterior edge of brown interocular triangle, irregular in shape), two irregular paired blotches on anterior half of trunk, more diffuse cream blotches posteriorly (Fig. 3); canthal stripe dark brown; two or three dark brown subocular spots; dark brown supratympanic fold, separated from eye; tympanum dark brown, annulus cream except dorsally where dark color of tympanum is continuous with that of supratympanic fold; pair of dark brown spots on each side in scapular region; lips incompletely barred (three bars consisting of dark half-moons); flanks pale brown, reticulated with cream; limbs cream with brown bars, bars about equal to interspaces, transverse on shank; lower lip with two or three irregular shaped, light brown marks; center of throat with cream, ♦-shaped mark edged in brown, posterior sides longer than anterior ones (Fig. 3); throat darker than belly, belly cream with brown reticulation; undersides of limbs cream with brown spots; posterior surfaces of thighs dark brown with many irregular, small cream spots and lines; anal triangle diffuse.

Coloration in life.—Medium brown dor-

Fig. 3. *Eleutherodactylus mercedesae,* holotype, USNM 257848.

sally with irregular, light green splotches (spots look like moss) and few black marks; black eyestripe (canthal plus supratympanic stripe) and lip marks; limbs iridescent coppery with green marks; thighs and sides of body speckled cream, green, and brownish black; ventrally pearly yellow, mottled brown; iris gold (from field notes of M. S. Foster).

Measurements of holotype (*and paratype*) *in mm.*—SVL 40.1 (49.5), shank 28.1 (34.3), HW 15.9 (18.0), head length 13.5 (17.1), chord of head length 16.5 (19.7), upper eyelid width 3.9 (4.8), IOD 3.3 (4.0), tympanum 1.9 (2.3), eye 5.2 (6.2), E-N 4.7 (5.8).

Etymology.—This strikingly beautiful frog is named for Mercedes S. Foster whose herpetological collecting efforts in Latin America have added significantly to our knowledge of the fauna of that region.

Remarks.—The type locality is in forest adjacent to the road to San Onofre. The holotype was found active on the forest floor during the day.

The throat pattern in *E. mercedesae* is somewhat similar to that in *E. rhabdolaemus* (see below and Fig. 4). However, we do not believe that this feature is a synapomorphy. Several species of *Eleutherodactylus* in the Andes of Colombia and Ecuador have similar throat markings.

Eleutherodactylus rhabdolaemus Duellman

Eleutherodactylus rhabdolaemus Duellman, 1978a:65 (holotype, LSUMZ 26150, Huanhuachayocc, on trail from Tambo to Valle del Apurimac, Departamento Ayacucho, Peru, 1650 m).

Eleutherodactylus pharangobates Duellman, 1978b:426 (Holotype, KU 173236, Buenos Aires, Departamento Cuzco, Peru, 2400 m). NEW SYNONYMY.

Although Duellman (1978a) compared *rhabdolaemus* with *pharangobates* (as "*E.* sp. [Buenos Aires]"), he (1978b) did not compare *pharangobates* with *rhabdolaemus* (but did compare it with *E. cosnipatae, E. danae,* and *E. granulosus,* three other species from the vicinity of the type locality). The two species are purported to differ in several respects (Table 1).

One of us (JDL) has examined all known specimens of the two taxa. The following

Table 1.—Purported differences between two nominal species of *Eleutherodactylus* (from Duellman 1978a, b). Cited differences marked with asterisk.

	rhabdolaemus	*pharangobates*
Scapular tubercles	Present	Not mentioned
Snout shape	Narrowly rounded	Acuminate
Vomerine odontophores	Present, both sexes	Absent in males*
Digital pads	Rounded	Truncate*
Heel, tarsal tubercles	Small	Absent*
Throat coloration	Longitudinal stripes	Brown with cream flecks*
Labial stripe	Absent	Present*

point-by-point analyses are based on direct comparisons of the type series (KU 173236–54) of *E. pharangobates* with the KU paratypes of *rhabdolaemus* (138877, 175082–84), the USNM Bolivian series, and notes on the holotype (LSUMZ 26150). The skin of the dorsum is finely shagreened in all specimens of each species; all specimens we examined have a pair of scapular warts. Although not mentioned in the description of *E. pharangobates,* scapular warts are obvious in the photograph (Duellman 1978b, Fig. 2e) of the paratype (KU 173237). These warts (indistinct in some specimens), often bordered with darker pigment to form scapular marks, are more prominent in paler individuals because the dark scapular marks show up better against the ground color. Duellman (1978a, b) described the snout shapes in the diagnoses of the two species as distinct but direct comparison belies these differences (which were not cited in the comparison of *E. rhabdolaemus* to *pharangobates* by Duellman [1978a] as distinguishing characteristics). Both species have long snouts with sharp canthi rostrali and subelliptical to somewhat pointed snouts (in contrast to all other forms except *E. scitulus* in the cloud forests of adjacent Bolivia and Peru). Duellman (1978b) reported that male *E. pharangobates* lack vomerine odontophores. In both sexes of both nominate species, including type material, low vomerine odontophores are evident. We find no difference in position, size, shape, or tooth number. Duellman (1978a) distinguished *pharangobates* from *rhabdolaemus* in having truncate digital discs. Inspection of specimens under magnification fails to confirm a shape difference. Casual inspection (without magnification or direct comparison) does give the impression of truncate finger tips in the type series of *E. pharangobates.* However, in those specimens having had the fingers laid out in a fixing pan, one gets the impression of truncateness whereas in those preserved by Richard Thomas (collector of most of Duellman's [1978a] specimens of *rhabdolaemus*), the hands were not laid flat in a fixing tray and the tips appear less truncate (more rounded). We consider the tips of the outer fingers of all specimens to be weakly truncate owing to slight emargination of the ungual flap. The two species were reported (Duellman 1978a) to differ in tuberculation of the heel and tarsus. Both have a low inner tarsal fold which usually has a tubercle on it. Both have small, nonconical tubercles on the heels and each has smaller tubercles along the outer edge of the tarsus.

Duellman (1978a) contrasted *rhabdolaemus* and *pharangobates* in two aspects of coloration: throat pattern and labial stripe. The type series of *E. pharangobates* includes a single female and 12 males. The males have semi-inflated vocal sacs and the throat pattern is obscure. In the female, the throat pattern is identical to that of paratypes of *E. rhabdolaemus* (Fig. 4) except that it is paler. The pattern of a dark central streak with narrower lateral streaks is evident in all specimens from the type series

Fig. 4. Venters of *Eleutherodactylus rhabdolaemus.* Intensity of throat patterns declines to right. Paratype of *E. rhabdolaemus,* KU 175083; female paratype of *E. pharangobates,* KU 173246; and male paratype of *E. pharangobates,* KU 173250.

examined. The same general throat patterns are repeated in several of the Bolivian specimens except that a streaked throat is obvious in several males as well.

Darker specimens have dark faces. The labial stripe recorded by Duellman (1978a, b) for *pharangobates* is produced by a paler face edged by the dark canthal stripe and the partial labial bars; the clear area evident between these dark markings was termed a labial stripe (see Duellman 1978b, fig. 2e). The pattern evident in dark specimens is identical to that seen in pale specimens. The difference in intensity is consistent in the type series of *pharangobates* but is bridged within the series of paratypes of *rhabdolaemus.* This difference appears to be the result of metachrosis. This interpretation is supported by Foster's observation (unpublished field notes) that a specimen of *E. rhabdolaemus* (USNM 257854) varied from "very dark to light brown—changes color."

In the absence of sustained differences, we combine the two taxa. *Eleutherodactylus pharangobates* was described on 29 August 1978, slightly more than two months after the description of *E. rhabdolaemus* appeared (27 June 1978). Duellman (1978a, b) reported specimens from the Peruvian Departamentos Ayacucho, Cuzco, and Huánuco from localities between 1020 and 2650 m. He also reported one specimen (USNM 146587, as *pharangobates*) from Departamento Cochabamba, Bolivia. We have seen the following material of *E. rhabdolaemus* from Bolivia (all Provincia Chapare, Departamento Cochabamba): Limbo, on mule trail to "Mino Porro," 1950 m, USNM 146592–93; 10 km N Limbo, 1800 m, USNM 146587–91; Miguelito, ca. 99 km from Cochambamba on Cochabamba to Villa Tunari road, 1770 m, USNM 257850–51; Paracti, 83 km from Cochabamba on Cochabamba to Villa Tunari road, 2040 m, USNM 257856–57; road to San Onofre, ca. 3.3 km N of Cochabamba to Villa Tunari road at point 97 km from Cochabamba, 1695 m, USNM 257855.

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ANOPSILANA LINGUA, A NEW FRESHWATER TROGLOBITIC ISOPOD FROM THE PALAU ISLANDS (FLABELLIFERA: CIROLANIDAE)

Thomas E. Bowman and Thomas M. Iliffe

Abstract.—*Anopsilana lingua,* a blind, unpigmented cirolanid isopod, is described from a natural well on Peleliu Island. It is distinguished from the nine known species of *Anopsilana* by the shape of the telson, which is very broadly rounded, in contrast to the triangular, pointed or angular telsons of the other species. *Anopsilana lingua* is the first troglobitic cirolanid reported from a Pacific Ocean locality.

Explorations of caves on Atlantic Ocean islands in recent years have revealed the presence of rich and diverse faunas of aquatic troglobites (Sket and Iliffe 1980; Iliffe et al. 1983, 1984). A summary of the species in these faunas and those of other troglobitic aquatic faunas of the world is given in the recent volume edited by Botosaneanu (1986). In contrast, the number of known troglobites from caves of Pacific Ocean islands is small. Collecting effort in Pacific caves has been much less than in Atlantic caves, and to remedy this situation, the second author led an expedition to explore and collect in Pacific island caves in 1985. One of the discoveries of this expedition was the isopod described below.

Anopsilana lingua, new species
Figs. 1–3

Material.—Palau, Peleliu Island, Airport Well, 26 Feb 1985, leg. Thomas M. Iliffe, Jeff Bozanic, and Dennis Williams, holotype (USNM 232000) and 16 paratypes (USNM 232001); 2 Apr 1985, leg. Dennis Williams and Jeff Bozanic, 25 paratypes (USNM 232002).

Etymology.—From the Latin "lingua" (tongue), referring to the shape of the pleotelson.

Description.—Blind, unpigmented. Length of largest specimen 11 mm. Body length/width 2.48–3.25, tending to be greater in longer specimens (Fig. 1). Head subtriangular, about 2× as wide as long, produced into small triangular rostrum between bases of antennae, rostrum not reflexed ventrally. Frontal lamina about 2× as long as wide, widening anteriorly, anterior margin rounded, posterior margin overlapped by clypeus. Clypeus short, about 0.7× length of labrum.

Pereonite 1 about 1.5× as long as each of subequal pereonites 2–4, slightly longer than each of subequal pereonites 5–7. Posterior corners of coxae 2–3 rounded, of coxae 4–7 angular; all coxae with oblique carinae.

Pleonites subequal in length; pleonite 5 overlapped laterally by pleonite 4; epimera of pleonites 1–3 pointed, of pleonite 4 rounded. Telson slightly wider than long, linguiform, posterior margin broadly rounded, armed with 10 spines between which, 3–5 plumose setae only slightly longer than spines.

Antenna 1 reaching slightly beyond posterior margin of pereonite 1; flagellum of about 12 segments, last 7 segments with 1-2-2-2-2-1-0 esthetes (counting distally). Antenna 2 reaching posterior margin of pereonite 5; peduncle segment 5 about 1.2× longer than segment 4; flagellum with 22 segments.

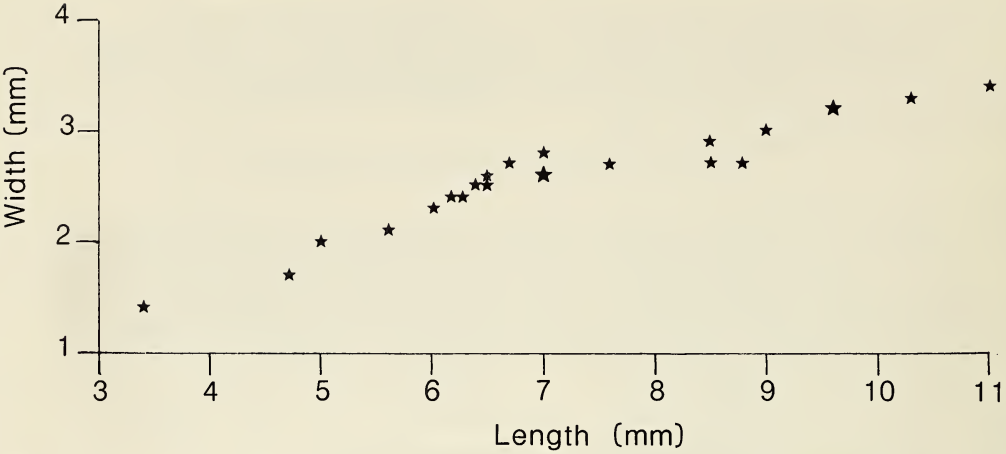

Fig. 1. Length-width relationships in *Anopsilana lingua.* Each of the larger stars represents 2 specimens with identical measurements.

Incisor of right mandible with 3 well separated cusps, incisor of left mandible with well developed anterior and posterior cusps and 3 rudimentary cusps between them; right lacinia with 11 spines; right molar with 18 spines. Exopod of maxilla 1 with 11 spines and 1 seta; endopod with 3 circumplumose spines. Maxilla 2 with 6 and 7 setae on palp and exopod, respectively; endopod with 11 setae. Maxilliped endite with 2 retinacula and 4 plumose apical setae.

Pereopod 1 merus with 3 short setulose spines on posterior margin and long setulose spine at posterodistal corner.

Pereopods 1–3 more robust than pereopods 4–7, apparently prehensile although not subchelate. Pereopod 1 shortest; merus with 3 short setulose spines on posterior margin and long setulose spine at posterodistal corner. Pereopod 2 merus posterior margin slightly concave, with group of 4 spines at proximal third and 3 longer spines at posterodistal corner. Pereopod 3 more slender; merus with proximal group of 4 spines, distal group of 3 spines, and single seta proximal to distal group. Pereopods 4–7 slender, progressively longer; bases with 2–3 broom setae; other segments except dactyl with clusters of spines at distal corners.

Pleopod 1 endopod with slightly concave lateral margin. Pleopod 2 endopod with straight cylindrical appendix masculina extending slightly beyond apex of endopod; tip of appendix with slight subapical bulge medially and groove medial to bulge. Apex of endopods of pleopods 3–5 with medial shoulder and lateral rounded process.

Uropods reaching apex of telson; exopod slightly shorter and about half as wide as endopod; lateral margin with 7 spines, medial margin with 2 spines; apical notch symmetrical. Endopod triangular; lateral margin with 3 spines, medial margin with 4 spines; apical notch with slightly longer medial side.

Comparisons.—Nine species of *Anopsilana* have been described, and several other species are known and await description. Of these nine species, four have well developed eyes and need not be considered further. None of the five eyeless species has a telson that is broadly rounded posteriorly like that of *A. lingua.* The species include *A. acanthura* (Notenboom, 1981) and *A. radicicola* (Notenboom, 1981), both transferred from *Haitilana* by Botosaneanu et al. (1986), *A. poissoni* Paulian and Delamare Deboutteville, 1956, *A. crenata* Bowman and Franz, 1982, and *A. cubensis* (Hay, 1903), the last transferred from *Troglocirolana* by Botosaneanu et al. (1986). In these five species the telson is pointed or angular. In *A. cu-*

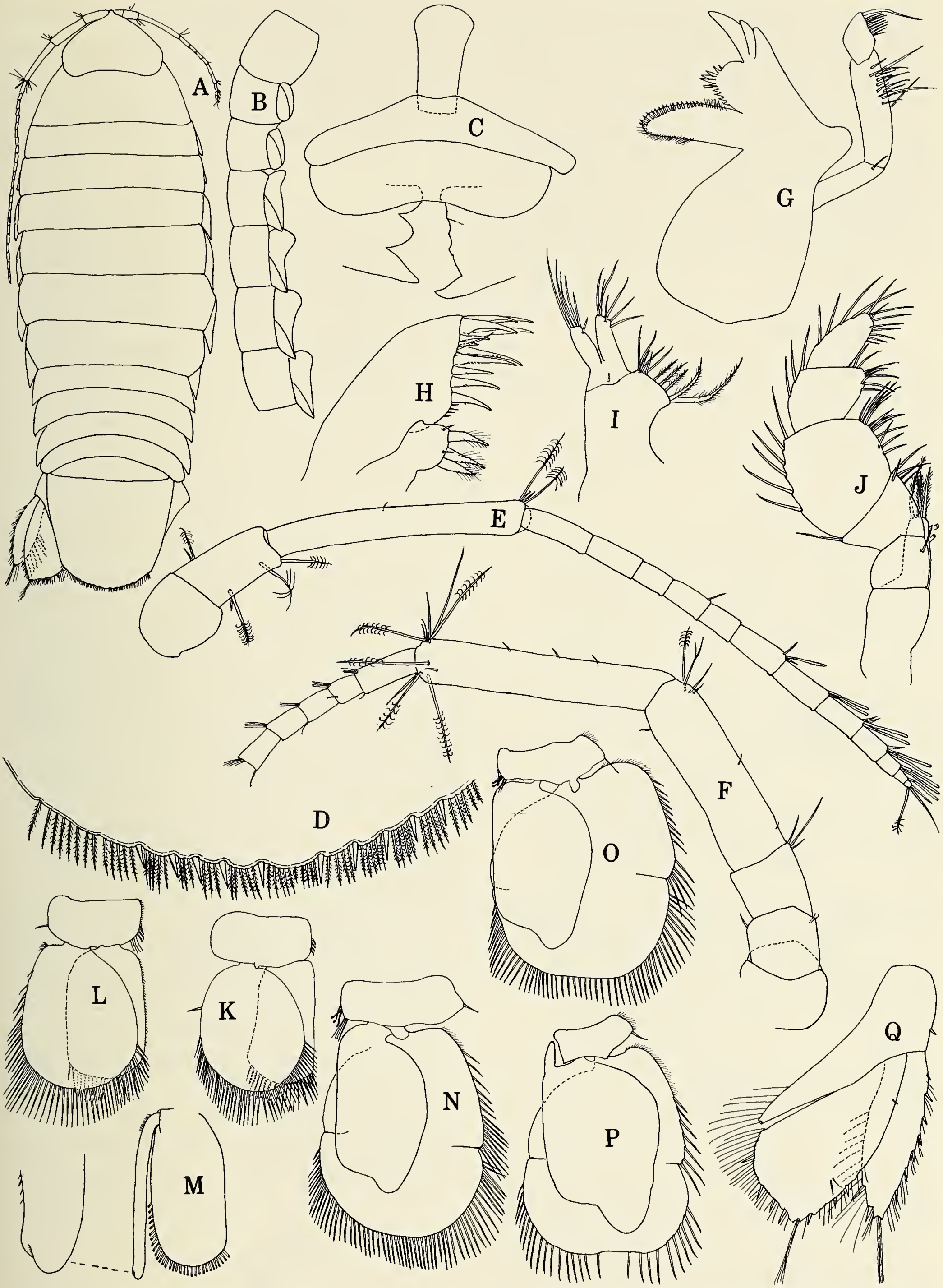

Fig. 2. *Anopsilana lingua*: A, Habitus, dorsal; B, Pereon, lateral; C, Anteroclypeal region of head, ventral; D, Posterior margin of telson, dorsal; E, Antenna 1; F, Antenna 2, peduncle and proximal segments of flagellum; G, Right mandible; H, Maxilla 1; I, Maxilla 2; J, Maxilliped; K, Pleopod 1; L, Pleopod 2 ♀; M, Pleopod 2 ♂; N, Pleopod 3; O, Pleopod 4; P, Pleopod 5; Q, Uropod.

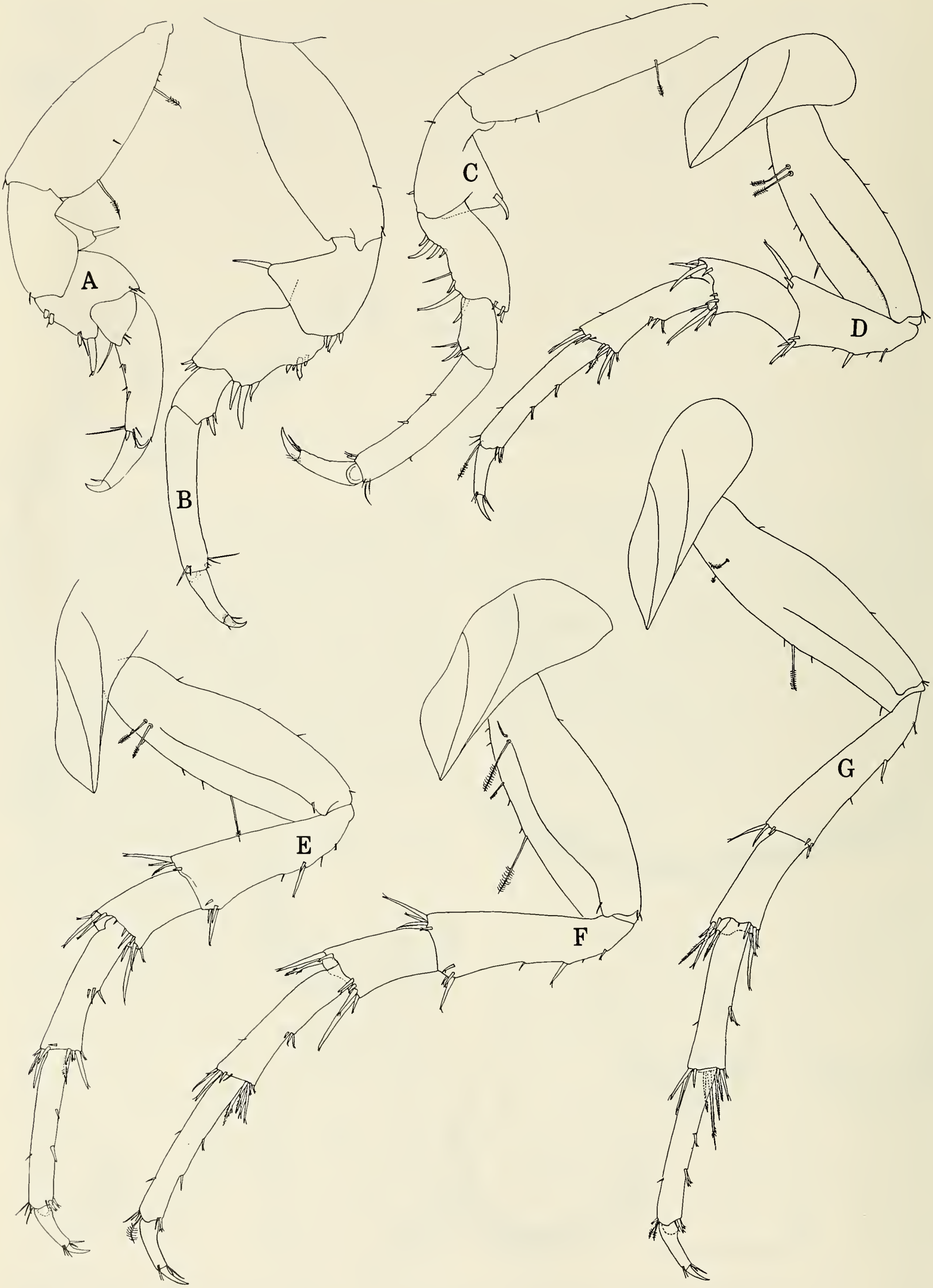

Fig. 3. *Anopsilana lingua*: A–G, Pereopods 1–7.

bensis it is only slightly angular, but, as in the other four species, it differs from *A. lingua* in that the marginal setae are much longer than the marginal spines, whereas in *A. lingua* they are only slightly longer.

Habitat

Peleliu (Beliliou), located at 7°00′N, 134°15′E, is one of the major islands of the Palau Archipelago. It is composed of late Tertiary andesitic volcanics completely capped by an uplifted and karstified coral reef platform. The island has a limestone ridge along its northwest side with elevations to 75 m, but is otherwise low flat ground. Airport Well is located in the flat southcentral part of the island, 1 km inland. It is a natural well from which freshwater is pumped and is covered by a tin roof. The cenote-like entrance is a hole 2 m in diameter which flares out to a larger, water table pool 2.5 m below. The pool, several meters deep, is floored with breakdown material, and clumps of roots extend through cracks in the roof into the water. The water is very clear and receives no direct surface runoff. The cave extends out underwater along the sides of the pool to a depth of 10 m before ending in collapse.

The ispods obtained in February were collected in two ways. Six specimens were collected with a suction bottle by a diver using scuba in 3–10 m water depths where the isopods were seen swimming in the open water. The other 11 specimens were caught in a plastic bottle trap (Manning 1986) baited with a crushed hermit crab and left overnight at a depth of 5 m. Other animals collected in Airport Well included cyclopoid copepods and a blind troglobitic amphipod of the genus *Tegano,* now under study by Dr. John R. Holsinger.

Acknowledgments

Biological collections from caves in Palau were supported by a National Science Foundation grant (BSR 8417494) to Thomas M. Iliffe. We thank Jeff Bozanic and Dennis Williams for assistance with field collections in Palau. We also appreciate the assistance of Toshiro Paulis and the Micronesian Mariculture Demonstration Center, Koror, Palau, for logistical support during the expedition. This paper is contribution No. 1102 of the Bermuda Biological Station for Research.

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FOSSIL EVIDENCE OF A TAPACULO IN THE QUATERNARY OF CUBA (AVES: PASSERIFORMES: SCYTALOPODIDAE)

Storrs L. Olson and Evgeny N. Kurochkin

Abstract.—Two bones from Quaternary cave deposits in the Isle of Pines and Camagüey Province, Cuba, are from a small species of tapaculo (Scytalopodidae = auct.) that was similar in size and morphology to modern species of *Scytalopus.* This is the only record of the family outside of South America, Panama, and Costa Rica, and the only record of the entire superfamily Furnarioidea in the West Indies. It presents a great zoogeographical anomaly because the species of *Scytalopus* are nearly flightless and appear to have little capability for dispersal over water.

When Olson was confronted with a humerus from cave deposits on the Isle of Pines (Isla de Juventud) that seemingly could have come from nothing other than a species of Scytalopodidae (=Rhinocryptidae auct., but see Brodkorb 1978:147, Feduccia and Olson 1982:3), he set the specimen aside in disbelief. Some five years later, Kurochkin visited the Smithsonian Institution and brought with him a tibiotarsus from a cave in Camagüey Province, Cuba, that he had at first tentatively identified as belonging to the Furnariidae, a related family also unknown in the Antilles. Recalling the humerus from the Isle of Pines, Olson suggested that the tibiotarsus be compared with the Scytalopodidae, with the result that it was found to match the corresponding element of *Scytalopus* very closely. The improbable reality of an Antillean tapaculo became too difficult to deny any longer. Here we present our evidence for the occurrence of the South America family Scytalopodidae in a zoogeographical subregion where no member of the superfamily Furnarioidea has hitherto ever been recorded, either living or fossil.

Order Passeriformes Linnaeus, 1758
Superfamily Furnarioidea Ames, 1971
Family Scytalopodidae Müller, 1846
?*Scytalopus* sp.
Fig. 1

Material examined.—Paleontological collections of the National Museum of Natural History, Smithsonian Institution, USNM 336505, proximal half of right humerus (proximal width, 3.9 mm). Caballos Mountains, Isle of Pines, Cuba. This specimen (Fig. 1a, c) was part of a fairly large lot of bird and mammal remains found among the collections of West Indian cave fossils in the Department of Paleobiology, National Museum of Natural History, Smithsonian Institution. These bore only locality data and as yet we know nothing more concerning their acquisition, although they were almost certainly obtained during the first three decades of this century, when Gerrit Miller was actively studying West Indian cave fossils.

Institute of Geology and Paleontology of the Academy of Sciences of Cuba, IGP 406-39, proximal third of left tibiotarsus (proximal width through cnemial crest, 4.1 mm; proximal depth, 3.0 mm) (Fig. 1e). Collected at "Cueva de Los Fosiles," 28.5 km NE of Camagüey, Camagüey Province, Cuba, by E. N. Kurochkin and B. W. Woloszyn. This locality has previously been mentioned by Olson (1985a).

Age of the localities.—Nothing is known of the exact age of the humerus from the Isle of Pines. However, no cave deposits have been found anywhere in the West Indies that are known to be older than late Pleistocene and all are assumed to be Quaternary. The specimen appears to be unmineralized and the collections associated with it contained an abundance of *Rattus,* indicating that at least some of the deposition was post-Columbian. In all likelihood this specimen is Holocene in age and it could be very recent.

The tibiotarsus from Camagüey is definitely older, being from a bone breccia containing thousands of bones of the rodent *Geocapromeys columbianus,* as well as isolated remains of *Capromys pilorides, C. nana, Solenodon cubanus,* and Edentata. *Rattus* and *Mus* were absent in these deposits, which date from the first two (of three) pluvial periods of the Upper Pleistocene.

Comparative skeletal material of Scytalopodidae examined.—(Number of individuals in parentheses): *Scytalopus unicolor* (2, USNM), *S. femoralis* (1, USNM), *S. magellanicus* (1, USNM), *S. argentifrons* (3 partial, USNM), *Scelorchilus albicollis* (1, USNM; 1, AMNH), *Melanopareia elegans* (2, USNM), *Pteroptochus megapodius* (2, USNM), *P. tarnii* (1, USNM), *Rhinocrypta lanceolata* (2, AMNH).

Comparisons.—Both the humerus and the tibiotarsus in the Scytalopodidae are distinctive and easily separable from those of most other passerine birds (Feduccia and Olson 1982), being quite unlike any passerine known from Cuba. The fossil humerus from the Isle of Pines agrees with that in the Scytalopodidae in having the pectoral crest reduced, curved, and decidedly incised in palmar view (Fig. 1c). It is virtually identical to the humerus in *Scytalopus,* the only differences noted being that in ventral view the ventral tubercle is more pronounced and the edge of the bicipital crest runs slightly more perpendicular to the shaft. These differences would probably not prove to be of generic value if sufficient comparative material of the various species of *Scytalopus* were available.

The fossil tibiotarsus from Camagüey agrees with that in the Scytalopodidae in having the proximal end distinctly offset medially from the midline of the shaft and in having a distinct proximally situated crest on the medial side of the shaft, opposite the fibular crest, that is an extension of the inner cnemial crest. There is a deep fossa retrocristalis on the proximal articular surface and a deep fossa flexoria on the most proximal part of the caudal portion of the tibial head. This specimen, too, is very close in size and morphology to *Scytalopus,* but differs in the following respects: fibular crest longer, medial crest somewhat more distinct, inner cnemial crest with less prominent excavation on the anterior tip, ridge on the lateral side of the outer cnemial crest lacking, and inner cnemial crest not as narrow at the base. These differences are somewhat greater than between the fossil humerus and *Scytalopus* but might still fall within the range of variation in that genus. The specimen also shows some similarity to *Melanopareia.* Without more fossil and recent material we are hesitant to make a positive identification of the Cuban material as *Scytalopus.*

Discussion.—A tapaculo in Cuba presents an almost insurmountable zoogeographical anomaly. The family Scytalopodidae (containing 11 genera and 17 species) appears to be the most primitive group in the superfamily Furnarioidea (Feduccia and Olson 1982) and is restricted to South America, except for two species of *Scytalopus,* one found in eastern Panama and the other in western Panama and Costa Rica. The

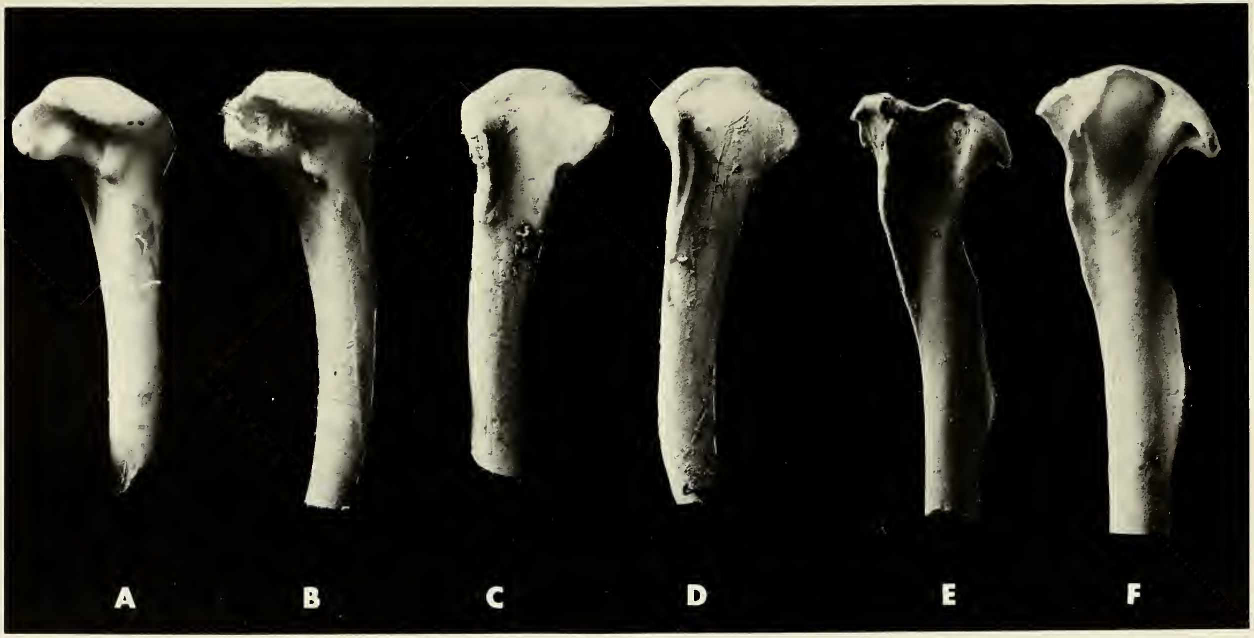

Fig. 1. Fossil specimens of ?*Scytalopus* sp. from Cuba and the Isle of Pines, compared with *Scytalopus unicolor* USNM 428900 (B, D, F): A, Proximal end of right humerus from Isle of Pines in anconal view (USNM 336505); C, Same, palmar view; E, Proximal end of left tibiotarsus from Camagüey Province, Cuba, in anterior view (IGP 406-39). The figures are ca. 5.5×.

family is most diverse in southern South America, with the more northern species tending to be montane in distribution.

The suboscine passerines (suborder Eurylaimi or Tyranni auct.), which includes the furnarioidea, and probably the entire order passeriformes, are believed to have originated in the Southern Hemisphere (Olson 1985b). There is no reason to believe that the Scytalopodidae would ever have been present in North or Middle America prior to the closing of the Panamanian seaway at the end of the Pliocene. (A supposed tapaculo from the Eocene of Wyoming does not even belong in the Passeriformes, much less to the Scytalopodidae [Feduccia 1976].) Thus, any tapaculo found in Cuba would probably have had to get there directly from South America.

As a group, the tapaculos are terrestrially adapted, with strong legs, reduced wings, and weak powers of flight. The species of *Scytalopus* are the smallest members of the family, being tiny, skulking, wren-like birds that are practically flightless. The pectoral apparatus in *Scytalopus* is very reduced, the sternum has only a vestigial keel, and the clavicles are unfused (Feduccia and Olson 1982). In short, of all the thousands of species of passerine birds in the world, the species of *Scytalopus* would seem to be among the very least capable of overwater dispersal. Furthermore, the Scytalopodidae belong to a large superfamily (or suborder, depending on one's views), Furnarioidea (Ames 1971), no member of which occurs anywhere in the West Indies.

The geological history of the Antillean region is extremely complex but there is still no convincing evidence of a former direct land connection between any of the Antilles and the mainland of either North or South America (Pregill 1981). Although various models propose the existence of a "proto-Antilles" in the position of present day Middle America (Rosen 1976, MacFadden 1980, Savage 1982), these have been projected as islands that received their fauna in stepping-stone fashion from continental areas. Even if this were the case, the avifauna of the Greater Antilles is preponderantly of North and Central American derivation, a point repeatedly emphasized by Bond (e.g. Bond 1934, 1948, 1963, 1978), whereas the Scytalopodidae are South American. Besides which, it would be just as difficult for a species of *Scytalopus* to get to a conjectural island and then to Cuba as to go there directly from the mainland of South America. Although drifting land masses have been proposed on an ad hoc basis to explain the occurrence of certain taxa in the Antilles, such as the Insectivora (MacFadden 1980), to have pieces of land randomly hurtling the odd taxon hither and yon about the Caribbean hardly seems an advance over the days when landbridges were constructed over most of the surface of the ocean for the same purposes.

Yet how did a tapaculo get to Cuba? We are left with the old hypothesis of rafting, which is an improvement over hypotheses of drifting land masses or of landbridges at least in that rafts of floating vegetation would surely be of more frequent occurrence than rafting land masses. Ground sloths evidently swam or were rafted directly from South America to the Greater Antilles, as the West Indian taxa are more closely related to Miocene sloths of South America than to the Plio-Pleistocene taxa of North and Central America (Paula Couto 1967). The fact that ground sloths did not colonize Jamaica is probably a result of that island's having been located farther west and having been submerged from the middle Eocene to the early Miocene (Buskirk 1985), a fact that provides some indirect evidence corroborating the probable time of arrival of ground sloths in the Greater Antilles. Presumably any factors that may have facilitated the dispersal of ground sloths at this time could have aided a tapaculo as well.

No species similar to *Scytalopus* has ever been reported historically in Cuba and it would seem likely that any such bird must now be extinct. Given the possibly quite recent age of the specimen from the Isle of Pines, it is conceivable that the species existed into the historic period, only to fall prey to introduced predators such as rats, cats, and mongooses. However, because the two localities from which the Cuban tapaculo is known are nearly 500 km apart, it must once have been widespread and possibly may still exist in some remote mountainous area of the island.

Acknowledgments

We thank Rafael Alvarez, who first undertook to sort the material from the Isle of Pines and originally recognized the familial affinities of the humerus described above. Kurochkin's visit was supported in part by the American Museum of Natural History (AMNH) and the Smithsonian Institution. We are grateful to David W. Steadman for commenting on the manuscript. The photographs are by Victor E. Krantz, Smithsonian Institution.

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ADDITIONAL MATERIAL OF *ANHINGA GRANDIS* MARTIN AND MENGEL (AVES: ANHINGIDAE) FROM THE LATE MIOCENE OF FLORIDA

Jonathan J. Becker

Abstract.—An associated partial skeleton and other previously unknown skeletal elements of *Anhinga grandis* Martin and Mengel, 1975, are described from three late Miocene (latest Clarendonian and early Hemphillian) localities in Florida. Derived osteological characters of the tarsometatarsus show *A. grandis* to be more closely related to the New World *A. anhinga* than to the Old World *A. rufa, A. melanogaster,* and *A. novaehollandiae.* The wing of *Anhinga grandis* was larger than that of the largest living species, *Anhinga novaehollandiae,* but the pelvic limb was comparable to that species in size.

Anhinga grandis was originally described from a single distal end of a humerus from the late Miocene Cambridge (=Ft.-40) local fauna, "Kimball" formation, Frontier County, Nebraska (Martin and Mengel 1975). The associated mammalian fauna, along with that from several other local faunas in western Nebraska, were used to typify a discrete post-Hemphillian, pre-Blancan Land Mammal Age, termed the "Kimballian" (Schultz et al. 1970). Subsequent work (Breyer 1981, Voorhies 1984) has demonstrated that no stratigraphic nor biochronologic evidence exists to support this proposal. The Cambridge local fauna is now considered to originate in the Ash Hollow Formation and to be early Hemphillian in age, about 8.5 MYBP (=million years before present) (Tedford et al., in press).

This paper describes new material referable to *Anhinga grandis* from three late Miocene localities that extends the range of the species to Florida and provides additional data on its morphology and systematic relationships to other species in the genus *Anhinga.*

Materials and Methods

Fossil specimens included in this study are housed in the Vertebrate Paleontology collections of the Florida State Museum (UF) and the University of Nebraska State Museum (UNSM). Modern comparative material came from the collections of Pierce Brodkorb; Florida State Museum (UF); National Museum of Natural History, Smithsonian Institution (USNM); American Museum of Natural History (AMNH); and Royal Ontario Museum (ROM). Modern species and number of specimens examined are as follows: *Anhinga anhinga* (17), *A. rufa* (10), *A. melanogaster* (1), *A. novaehollandiae* (1). Anatomical terminology follows Baumel et al. (1979) and Howard (1929).

Measurements given in Tables 1 and 2 are defined below.

HUMERUS: LENGTH—Greatest length from the head of the humerus through the midpoint of the lateral condyle. LATIS—Greatest length from the proximal-most extension of the tuberculum for the attachment of the posterior head of the latissimus dorsi through the midpoint of the lateral condyle. W-SHAFT—Transverse width of midshaft. D-SHAFT—Depth of midshaft. W-DIST—Transverse width of distal end from the entepicondylar prominence to the ectepicondylar prominence. D-DIST—Depth of distal end from cranial face of external condyle through ridge slightly mediad from external tricipital groove, measured at right angles to the long axis of the shaft. D-ENTEP—Depth from attachment of the pronator brevis through entepicondyle, measured at right angles to the long axis of the shaft.

CARPOMETACARPUS: LENGTH—Greatest length from most proximal portion of the carpal trochlea through facet for digit III. W-CARPAL—Transverse width carpal trochlea measured at the proximal edge of the articular facet. L-MCI—Length metacarpal I from process of metacarpal I to pollical facet. D-SHAFT—Depth of midshaft of metacarpal II. W-SHAFT—Transverse width of midshaft of metacarpal II. D-DIST—Greatest depth of distal end, measured across dorsal edge of facet for digit II. W-DIST—Transverse width distal end from edge of facet for digit II through facet for digit III.

TIBIOTARSUS: W-SHAFT—Transverse width of midshaft. D-SHAFT—Depth of midshaft. W-DIST-CR—Transverse width of distal end, measured across cranial portion of condyles. D-MCON—Greatest depth of medial condyle. D-LCON—Greatest depth of lateral condyle.

TARSOMETATARSUS: LENGTH—Greatest length from intercondylar eminence through trochlea for digit III. W-SHAFT—Transverse width of midshaft. D-SHAFT—Depth of midshaft. W-PROX—Greatest transverse width proximal articular surface, measured across dorsal surface. D-PROX-M—Depth of proximal end, measured from dorsal edge of the proximal articular surface through the medial hypotarsal crest. W-DIST—Greatest transverse width of distal end.

SYSTEMATICS

Family Anhingidae Ridgway, 1887

Genus *Anhinga* Brisson, 1760

Anhinga grandis Martin and Mengel, 1975

Fig. 1A–H

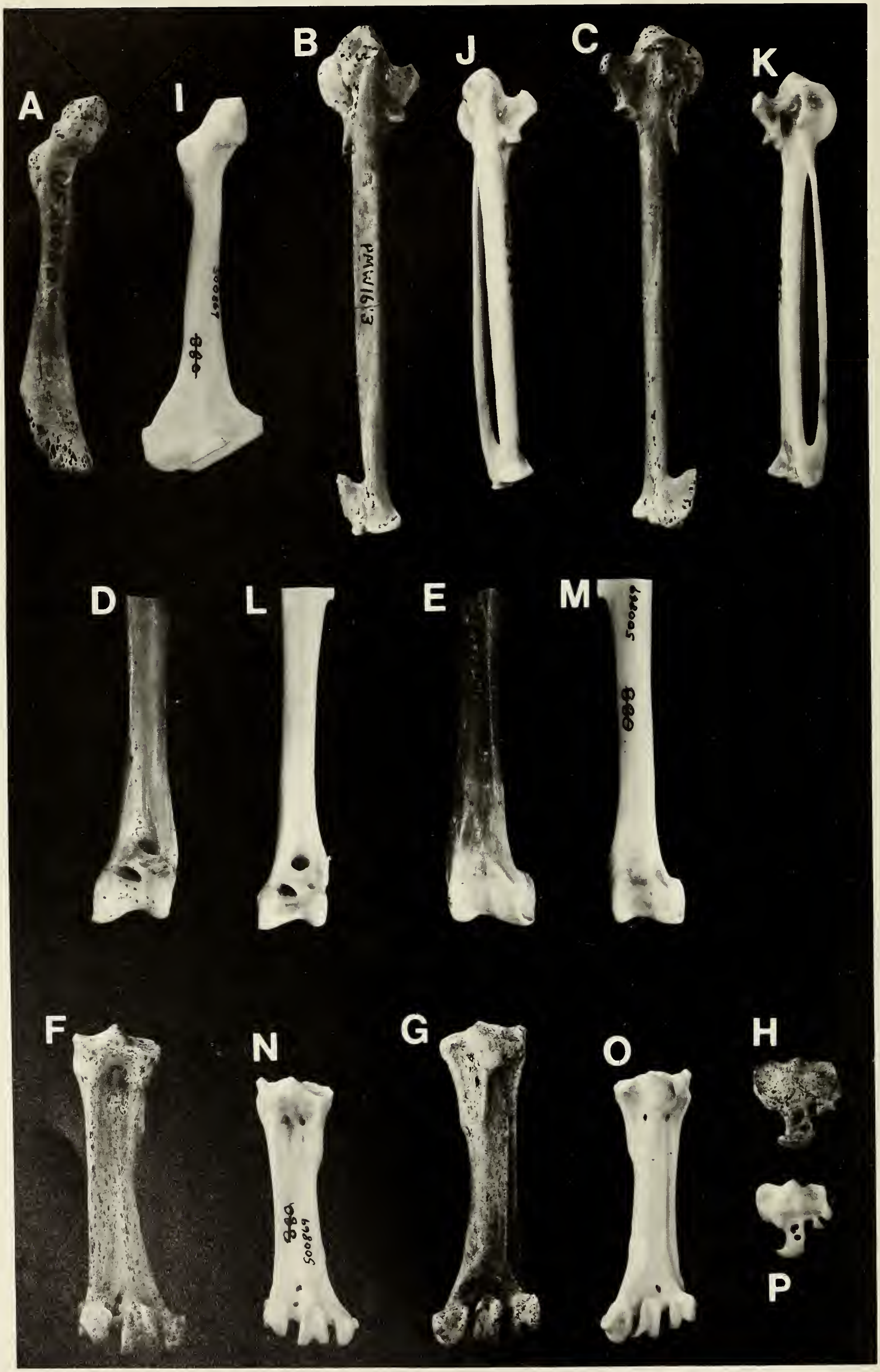
Holotype.—UNSM 20070, distal end of left humerus, from the early Hemphillian Cambridge local fauna, Frontier County, Nebraska.

Referred material.—From the Love Bone Bed local fauna, Alachua County, Florida: UF 25739, proximal end of right humerus; UF 25723, UF 25725, distal ends of right humeri; UF 26000, nearly complete right coracoid. Collected between 1974 and 1981 by personnel from the Florida State Museum.

From the McGehee Farm local fauna, Alachua County, Florida: UF 11107, distal end of right humerus. Collected June 1964 by R. Allen.

From the Haile XIXA local fauna, Alachua County, Florida: UF 61396, associated partial skeleton including the distal end of left humerus, right humerus missing proximal end, right ulna missing distal end, proximal end of right radius, right radial carpal, right carpometacarpus missing minor metacarpal, distal half of right tibiotarsus, distal half of left tibiotarsus (originally numbered PMW 1609–PMW 1616); UF 61399, complete right tarsometatarsus (PMW 1722). The associated partial skeleton was collected by Mr. George Heslop; other skeletal elements were collected by Mr. Phil M. Whisler (=PMW). All specimens of anhingas from Haile XIXA were generously donated to the Florida State Museum by Mr. Phil M. Whisler of Venice, Florida.

Age and horizon of referred material.—Late Miocene of Florida. The Love Bone Bed local fauna is latest Clarendonian in age, approximately 9 MYBP (Webb et al. 1981). Both the McGehee Farm local fauna and the Haile XIXA local fauna are early Hemphillian in age, approximately 8.5 MYBP (Hirschfeld and Webb 1968, Becker 1985). The Love Bone Bed and McGehee Farm local faunas originate in the Alachua Formation (Williams et al. 1977), the Haile XIXA local fauna is from unnamed sediments filling a solution cavity, now exposed in a limestone quarry. The determination of the relative ages of these local faunas are based on the biochronology of the included land mammals.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Description.—The referred coracoid (UF 26000) of *A. grandis* is abraded and little detail can be seen of either extremity. It appears to be comparable in size to that of *Anhinga novaehollandiae.*

In caudal view, the referred proximal end of the humerus of *A. grandis* (UF 25739) has a sharper caudo marginalis than in any living species and an inflated humeral head that blends smoothly with the shaft. The fossa pneumatotricipitalis has a heavy crus ventrale and the attachment for the posterior head of the latissimus dorsi is prominent. In cranial view, the angle between the sulcus ligamentosus transversus and the impressio m. coracobrachialis cranialis has a more rounded, less acute shape than that of the comparable structures in any living species of anhinga.

The distal end of the humerus of *A. grandis* agrees well with the holotype (USNM 20070) described by Martin and Mengel (1975), except that the holotype has a more robust shaft than in any of the specimens from Florida. One specimen (UF 61396, right humerus lacking proximal end) is sufficiently complete to estimate the total length of the humerus in *Anhinga grandis.* The length from the proximal extension of the tuberculum for the attachment of the posterior division of the latisimus dorsi through the distal end of the lateral condyle is approximately 85% of the total length of the element (Table 1). If a comparable ratio is assumed in *A. grandis,* then its humerus would have had an estimated length of 150 mm.

The referred partial ulna, proximal end of the radius, and radial carpal of *A. grandis* are much the same as in the living North American species of *anhinga,* only larger. The referred carpometacarpus of *A. grandis* is comparable in length to that of *A. novaehollandiae* or *A. melanogaster,* but is slightly more robust. The fovea carpalis caudalis is deeper than in *A. anhinga,* but is comparable to that of *A. novaehollandiae* or *A. melanogaster.* Other qualitative features are within the range of variation seen in living species.

The distal end of the tibiotarsus of *A. grandis* is slightly larger than that of *Anhinga novaehollandiae* but differs from any living species by having the posterior rim of the medial condyle more medially flared.

The referred tarsometatarsus of *A. grandis* is slightly smaller than that of *A. novaehollandiae* and is generally less sculptured than that of the living species. The hypotarsus encloses two canals (as in *A. anhinga*) and agrees with *A. anhinga* in the relative position of a shallow groove on the medial border of the shaft. The intercondylar eminence is more prominent but the medial and lateral parahypotarsal fossae are less excavated, as in *A. anhinga.* The position of the distal vascular foramen is intermediate between the Old and New World Anhingas (placed higher on the shaft in *A. anhinga*; lower in *A. melanogaster* and *A. rufa*; absent in the single available specimen of *A. novaehollandiae*).

Discussion.—The fossil record and the systematic relationships of anhingas have been recently reviewed (Olson 1985, Becker 1986). Of the two species groups of living anhingas, *Anhinga grandis* can be shown to be a member of the group that includes the living North American *A. anhinga* by the possession of the (presumably) derived condition whereby two canals are enclosed within the hypotarsus and by the relative

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Fig. 1. Skeletal elements of *Anhinga grandis* (A–H) and *Anhinga anhinga* (I–P; USNM 500869). A, UF 26000, right coracoid; B–E, UF 61396, right carpometacarpus, distal end of left tibiotarsus; F–H, UF 61399, right tarsometatarsus; A, I, Ventral view; B, J, Dorsal (external) view; C, K, Ventral (internal) view; D, L, Cranial (anterior) view; E, M, Caudal (posterior) view; F, N, Dorsal (anterior) view; G, O, Plantar (posterior) view; H, P, Proximal end view. All photographs natural size.

Table 1.—Measurements of pectoral limb elements of *Anhinga anhinga* (N = 17, 5 males, 11 females, 1 unknown sex) and *Anhinga grandis*. Data are mean ± standard deviation, and observed range. (*) = holotype. See Materials and Methods section for definition of measurements.

	Anhinga anhinga	*Anhinga grandis*
Humerus		
LENGTH	125.09 ± 5.75 113.2–137.6	—
LATIS	105.14 ± 4.41 98.6–112.5	126.2
W-SHAFT	6.59 ± 0.35 5.9–7.3	9.6* 8.3; 7.8; 8.0
D-SHAFT	5.84 ± 0.28 5.4–6.7	7.9* 6.8; 7.0; 6.7
W-DIST	13.12 ± 0.98 12.0–14.9	15.9* 15.0; 17.2; 16.0; 15.8
D-DIST	8.72 ± 0.35 7.9–9.3	11.4* 10.5; 10.0; 10.2; 10.2
D-ENTEP	7.64 ± 0.52 6.5–8.7	[10.2*] 9.4; 9.5; 9.0; 8.8
Carpometacarpus		
LENGTH	63.91 ± 2.45 59.8–68.4	74.8
W-CARPAL	6.15 ± 0.31 5.7–6.9	7.5
L-MCI	8.72 ± 0.51 7.8–9.5	9.6
D-SHAFT	3.71 ± 0.32 3.1–4.4	4.1
W-SHAFT	4.66 ± 0.43 4.1–5.8	5.0
D-DIST	5.02 ± 0.35 4.3–5.7	5.5
W-DIST	7.08 ± 0.34 6.3–7.6	7.9

Table 2.—Measurements of pelvic limb elements of *Anhinga anhinga* (N = 17, 5 males, 11 females, 1 unknown sex) and *Anhinga grandis*. Data are mean ± standard deviation, and observed range. See Materials and Methods section for definition of measurements.

	Anhinga anhinga	*Anhinga grandis*
Tibiotarsus		
W-SHAFT	5.16 ± 0.32 4.6–5.8	5.9; 6.5
D-SHAFT	4.15 ± 0.18 3.9–4.5	4.8; 5.4
W-DIST-CR	10.23 ± 0.37 9.6–10.9	11.4; 11.4
D-MCON	9.26 ± 0.35 8.8–10.0	11.1; 11.1
D-LCON	8.25 ± 0.33 7.8–8.9	9.4; 9.5
Tarsometatarsus		
LENGTH	40.68 ± 1.75 37.8–44.9	47.8
W-SHAFT	6.48 ± 0.35 6.0–7.4	7.8
D-SHAFT	3.91 ± 0.29 3.5–4.5	4.9
W-PROX	11.03 ± 0.53 10.1–12.0	12.8
D-PROX-M	11.91 ± 0.65 10.7–12.8	13.8
W-DIST	14.40 ± 0.57 13.7–15.6	16.5

position of a shallow groove on the medial border of the shaft (Harrison 1978).

The body size of fossil species can be estimated by a number of methods. Martin and Mengel (1975) estimated the mass of *Anhinga grandis* at 2.5 kg by comparison with the living North American anhinga, assuming that the width of the distal end of the humerus is isometrically proportional to body mass raised to the ⅓ power. However, the condition of isometric scaling of limb element width to body mass rarely occurs in birds (Prange et al. 1979), and probably the body mass of *A. grandis* is overestimated by this method. Prange et al. (1979) note that the length (in mm) of the humerus squared is nearly directly proportional to body mass (in grams) in flying birds. If the length of the humerus of *Anhinga grandis* is assumed to be 150 mm, then this method would estimate the body mass of this species at 2.2 kg.

Another approach is to estimate the mass of *A. grandis* by direct comparison with a living species of anhinga of comparable size. The associated skeleton (UF 61396) has the carpometacarpus, distal end of the tibiotarsus, and the referred tarsometatarsus (UF 61399) all equal to that of *A. novaehollandiae* (AMNH 11479), suggesting that the size of *A. grandis* was approximately equal to that of *A. novaehollandiae.* Serventy and Whittell (1976) report the weight of females of *A. novaehollandiae* as ranging from 1.67 kg to 2.04 kg ($\bar{x}$ = 1.84 kg); 1.47 kg for one male. By this method, the weight of *A. grandis* would be estimated as 1.8 kg, or about 1.5 times the size of the living North American anhinga.

The humerus from the associated skeleton is relatively larger than that of *A. novaehollandiae,* although the other skeletal elements are comparable. This may suggest that the wing of *A. grandis* was proportionately larger than that of *A. anhinga,* or that it had a slightly larger body size. The tarsometatarsus of *Anhinga grandis* is less sculptured by muscle attachments than that of *A. anhinga.* In comparison with *A. anhinga, Anhinga grandis* was perhaps less adapted for perching and climbing about in vegetation and more adapted for soaring.

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THE INDO-PACIFIC *AUDULLA CHELIFERA* REPORTED FROM THE CARIBBEAN SEA (CRUSTACEA: AMPHIPODA)

J. D. Thomas and J. L. Barnard

Abstract.—*Audulla chelifera* Chevreux is reported for the first time outside of the Indian Ocean and Red Sea. It has now been found in the western Caribbean inhabiting the alga *Turbinaria turbinata* (Linneaus) Kuntze in back-reef regions of the Belize barrier reef.

Audulla Chevreux (1901) was merged with *Gammaropsis* Liljeborg by J. L. Barnard (1973), who treated *Audulla* and several other genera as subgenera of *Gammaropsis*. *Audulla chelifera* was described from La Digue, Seychelles Islands (Indian Ocean) from marine algae but has never been reported since. A similar morph has now been found in great abundance from the alga *Turbinaria turbinata* L. at Curlew Cay, Belize, in the Caribbean Sea. Any distinctions between Belize specimens and the fine description of Chevreux (1901) are so miniscule that Caribbean specimens are identifiable as *A. chelifera*.

Legends

Capital letters denote main parts in the following list; lower case letters to right of capital letters or in body of figure indicate modifications as follows; lower case letters to left of capital letters indicate specimens described in captions: A, antenna; B, body; D, dactyl; G, gnathopod; I, inner plate or ramus; L, labium; M, mandible; P, pereopod; R, uropod; S, maxilliped; T, telson; V, palp; W, pleon; X, maxilla.

Family Isaeidae
Audulla Chevreux

Audulla Chevreux, 1901:431 (*Audulla chelifera* Chevreux, 1901, type species by monotypy).

Diagnosis.—Article 3 of antenna 1 as long as article 1; accessory flagellum multiarticulate; flagellum of male antenna 2 flattened, expanded, almost paddle-shaped; head deeply recessed behind eye for reception of antenna 2; mandibular palp stout, article 3 clavate; inner plate of maxilla 1 setose medially; inner plate of maxilla 2 with oblique mediofacial row of setae; dactyl of maxilliped stubby, multispino-setose; coxae ordinary to short, contiguous, coxa 2 largest, followed in order by coxae 3, 4, 5, 1, 6, 7; gnathopod 1 small in both sexes, ordinary; gnathopod 2 of both sexes slightly (female) to greatly (male) enlarged, in male carpus short and lobate, propodus immense, rectangular, chelate, thumb short and blunt, dactyl overlapping palm, with inner hump fitting slight palmer excavation; uropod 3 small but relative to its size peduncle weakly elongate, rami subequal, scarcely longer than peduncle, multispino-setose apically; telson fleshy, entire.

Relationship.—*Audulla* differs from the various genera placed in the supergenus *Gammaropsis* by J. L. Barnard (1973) in the expanded flagellum of male antenna 2, and the chelate male gnathopod 2. The diversity in size of anterior coxae is found in many other taxa of the *Gammaropsis* group and therefore has little taxonomic value.

Audulla chelifera Chevreux
Figs. 1–4

Audulla chelifera Chevreux, 1901:432–436, figs. 56–65.—Ledoyer, 1982:222, fig. 80.
Eurystheus lina Kunkel, 1910:81, fig. 31.
Eurystheus semichelatus K. H. Barnard, 1957:809, fig. 5.

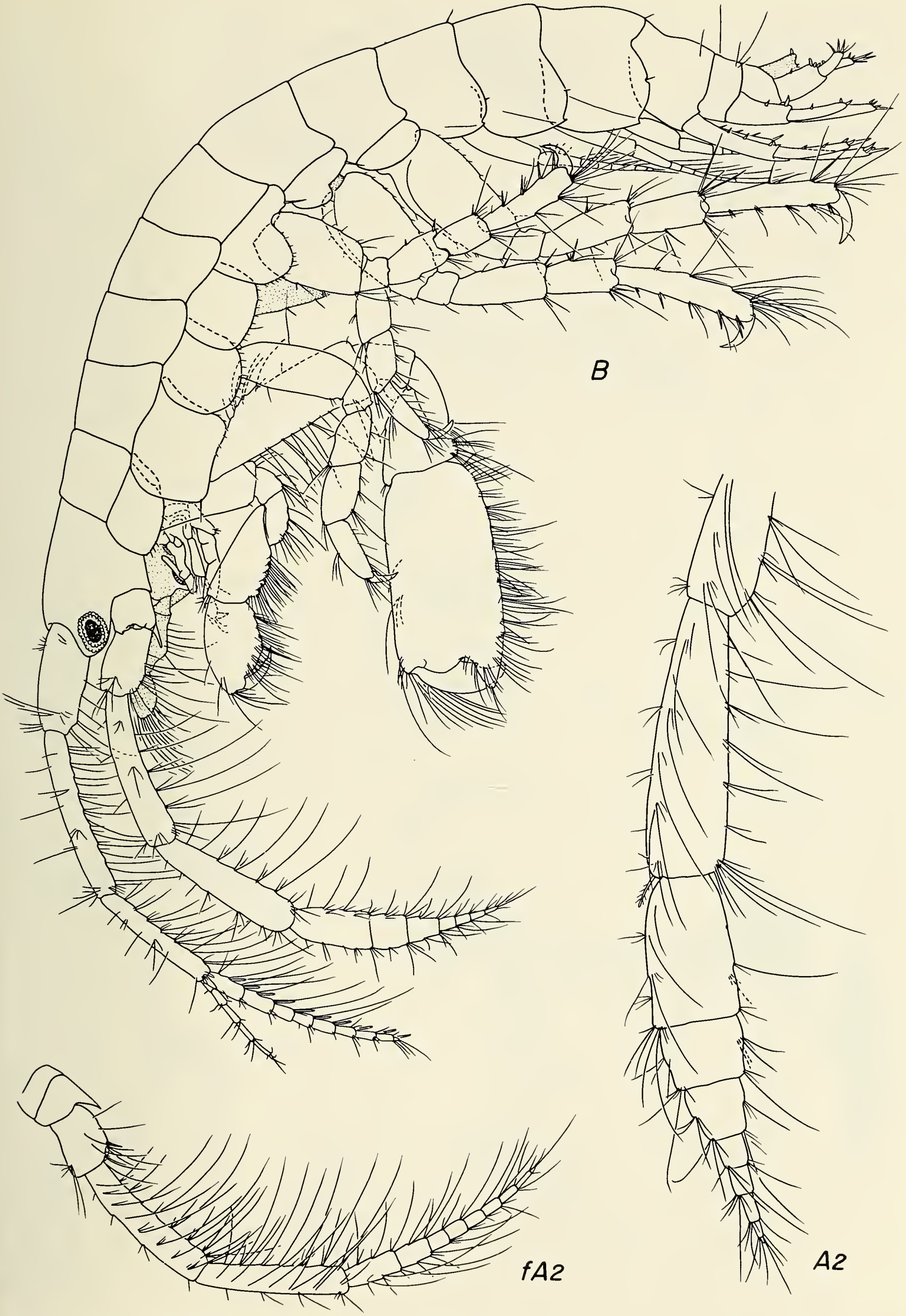

Fig. 1. *Audulla chelifera* male "e," 4.65 mm; f = female "f," 4.03 mm.

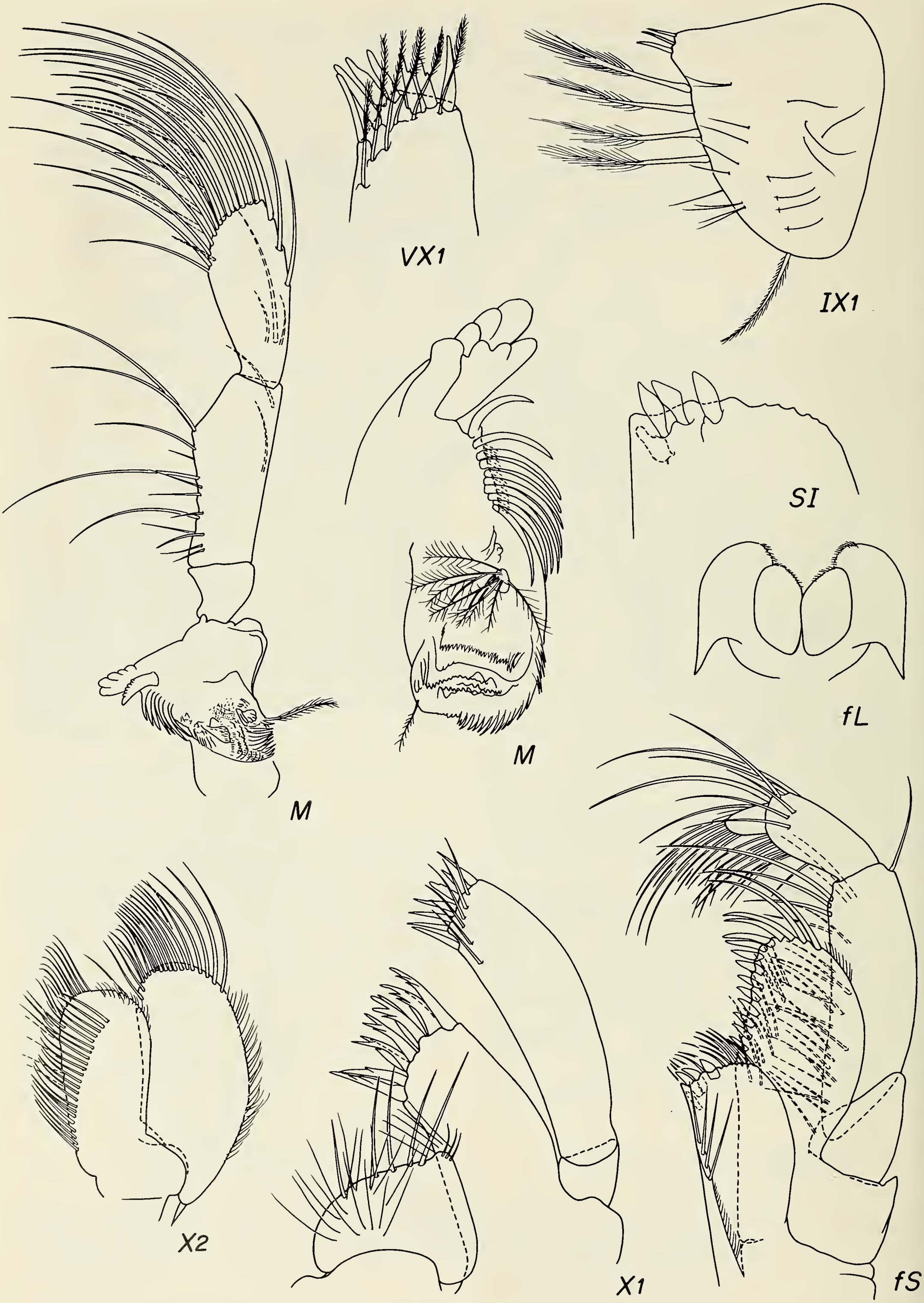

Fig. 2. *Audulla chelifera* male "e," 4.65 mm; f = female "f," 4.03 mm.

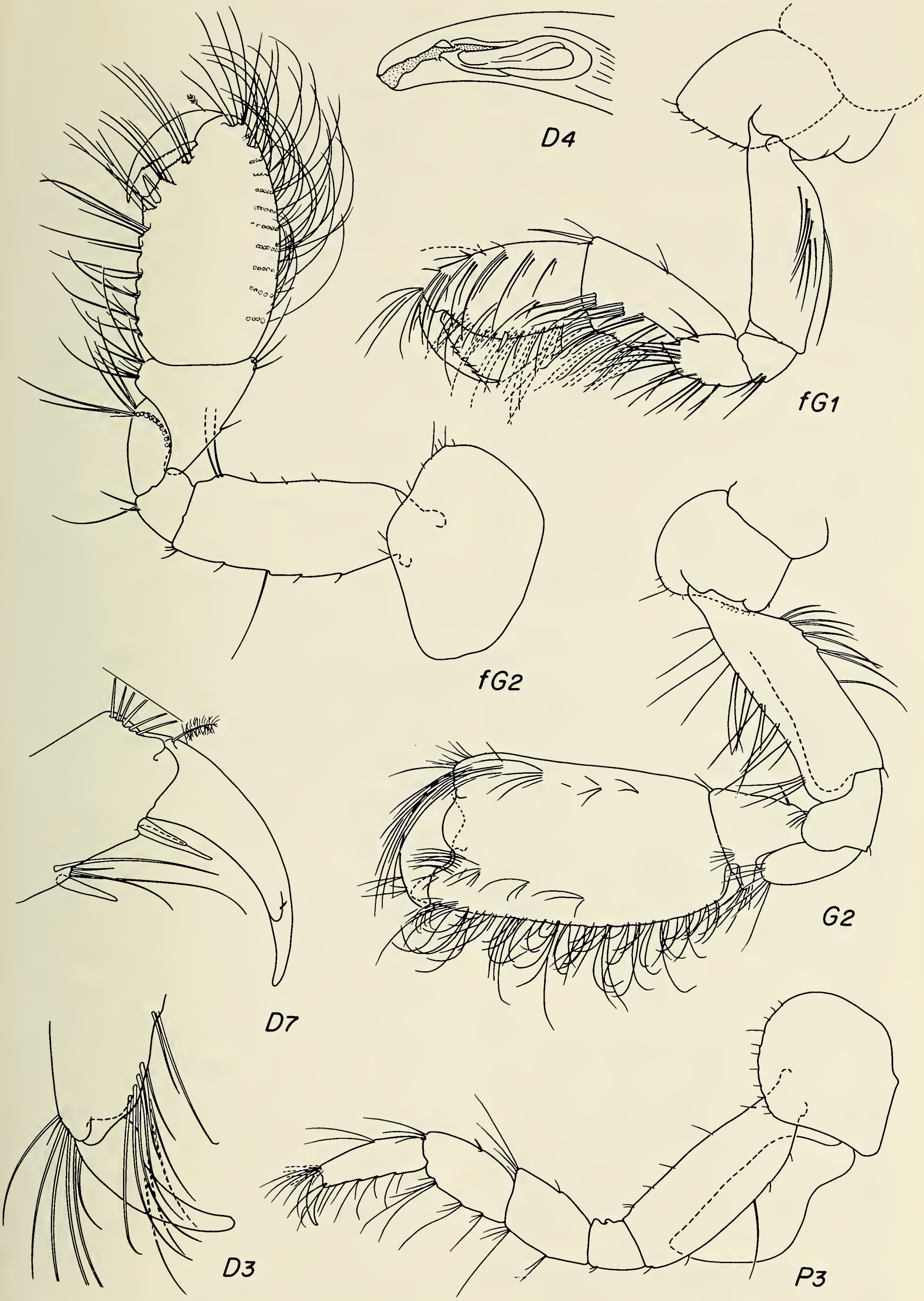

Fig. 3. *Audulla chelifera* male "e," 4.65 mm; f = female "f," 4.03 mm.

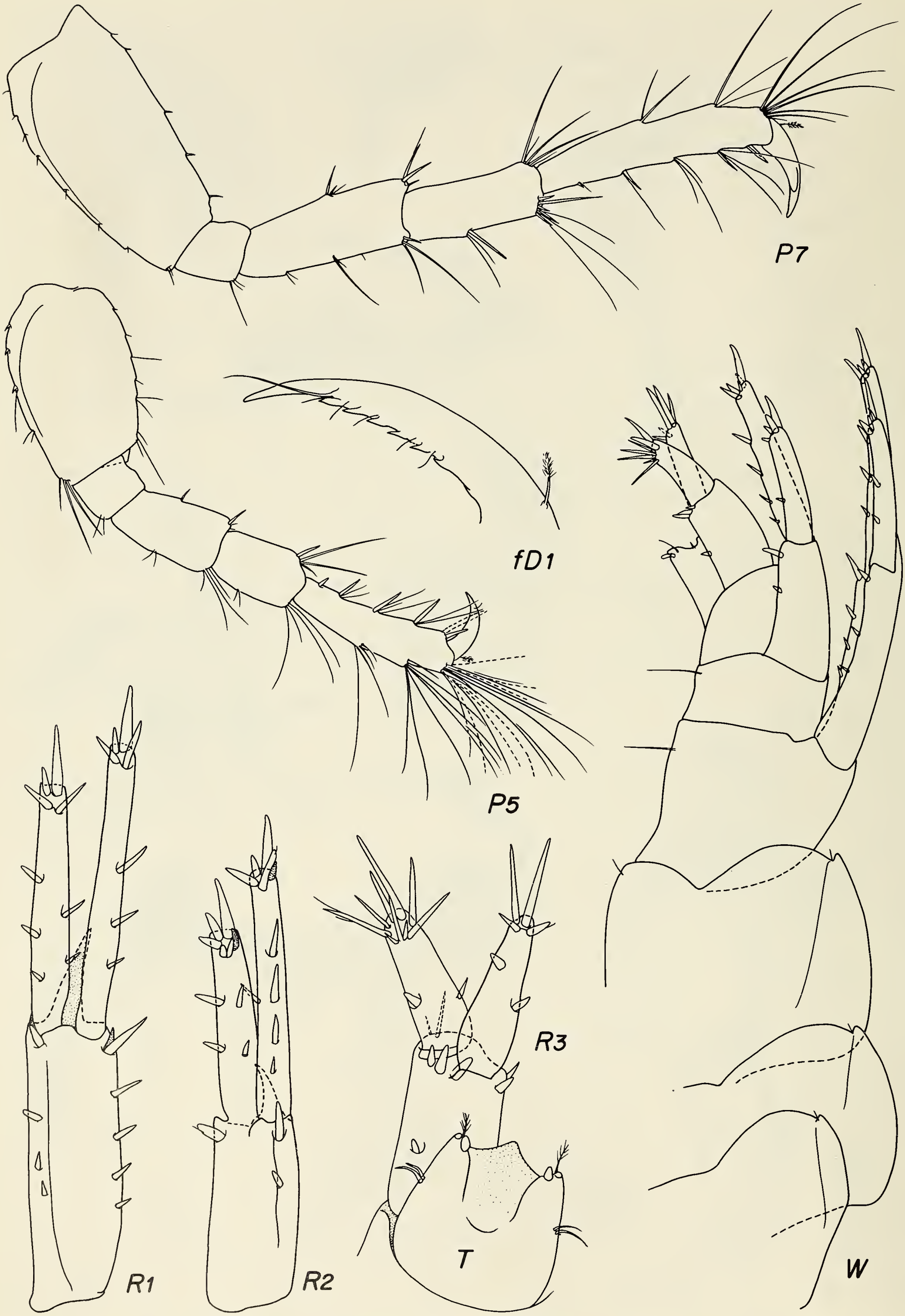

Fig. 4. *Audulla chelifera* male "e," 4.65 mm; f = female "f," 4.03 mm.

Description of male.—As in illustrations; upper lip rounded below; inner plate of maxilla 1 with 3 small apical setae besides large medial setae (not shown by Chevreux), outer plate with 10 spines on one side, 11 on other side; article 2 of gnathopod 2 with anterior longitudinal sinus to fit flexed appendage, each apex with lobe, article 3 with large locking lobe only medially; pereopod 4 smaller than pereopod 3, apices of dactyls with meatus for emission of amphipod silk; locking spines of pereopods 5–7 stout, unequal, pereopods 3–4 only with numerous setae at locking position; gills simple, broad, on coxae 2–6; ratio of peduncle to outer ramus to inner ramus on pleopods 1–3 = 78:84:105, 87:82:95, and 80:75:85, outer rami with 9 articles, inner with 8 (therefore articles on inner ramus more elongate); peduncles of uropods 1–2 with interramal ventral tooth.

Female.—Antenna 2 slender but densely setose, two basal articles of flagellum elongate as in male; gnathopod 2 slightly enlarged, carpus short, lobate, propodus rectangular, palm oblique, slightly protuberant, defined by weak cusp and strong spine, dactyl overlapping palm. Oostegites 3 and 4 well expanded, oostegites 2 and 5 weakly expanded, 2 weakly pyriform and tapering, 5 sausage-shaped, pyriform, weakly tapering, strongly setose.

Illustrations and anomalies.—Maxilla 2 drawn much reduced over maxilla 1, thus outer plate of maxilla 2 in life as long as palp of maxilla 1; left gnathopod 2 on main illustration slightly stunted, on most individuals right and left similar; uropod 2 also slightly stunted, thus uropod 2 right drawn dorsally and magnified.

Material.—JDT Belize, 94a, Curlew Cay, formalin wash of *Turbinaria turbinata* in lagoon, 0.5 m, 13 Jul 1984, coll. J. D. Thomas, male "e" 4.65 mm (illustrated), female "f" 4.03 mm (illustrated), male "c" 4.32 mm, male "d" 4.46 mm, male "g" 3.77 mm.

Color notes.—In live and freshly preserved material: body generally translucent white; antenna 1 brownish yellow, peduncular joints with white bands; accessory flagellum white with brown banding at joints; antenna 2, tip of peduncular articles banded in white, first two articles of flattened flagellum white. Body and pereopods variously mottled with brown and white blotches.

Discussion.—The paddle-shaped flagellum of male antenna 2 is similar in form to that of *Spathiopus looensis* Thomas and Barnard, 1985, from similar habitats in the Florida Keys. The function of this appendage is unknown in both species. Recent sampling trips to Curlew Cay in July 1985 failed to turn up significant numbers of *A. chelifera*. It is postulated that *A. chelifera* rafts in and "seeds" the dense *Turbinaria* beds found in the back-reef habitats of the Belize barrier reef. Studies of live *A. chelifera* are planned to determine its ecology and distribution.

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TYPE SPECIMENS OF FRESHWATER OSTRACODA DESCRIBED BY NORMA C. FURTOS IN THE COLLECTIONS OF THE NATIONAL MUSEUM OF NATURAL HISTORY, SMITHSONIAN INSTITUTION

Elizabeth Harrison

Abstract.—Type specimens of freshwater podocopid Ostracoda described by Norma C. Furtos in the collections of the National Museum of Natural History, Smithsonian Institution, are listed; these include 17 genera, 60 species, and 4 varieties. One species was collected in the Marquesas Islands, 14 in Mexico (cenotes of Yucatan and vicinity), and 45 in the United States (Florida, Massachusetts, North Carolina, and Ohio). USNM catalog number, type status, method of preservation, and locality data are given, together with references containing the original descriptions.

Norma C. Furtos described many new species and several new varieties of ostracods in six publications (Furtos 1933–1938). Much of the type material mentioned in her publications is deposited in the Division of Crustacea, National Museum of Natural History, Smithsonian Institution, U.S.A. The following is a listing of these type specimens with catalog number, type status, locality data, and method of preservation. Although the group has undergone some revisions (see Tressler 1959), the original names are used. All references containing the original descriptions are given. A survey of the literature has not been made to determine whether later workers designated lectotypes for any of Furtos (1933) syntypes. The writer was unable to locate specimens of *Candona ulignosa* Furtos, 1933 and *C. stagnalis* Sars, 1890 var. *longisetosa* n. var. Furtos, 1933 in the collections of the National Museum of Natural History. (A+S = alcohol + slide, ALC = alcohol only, and SLI = slide only.)

Candocypria osburni Furtos, 1933. USNM 67866, 17 Syntypes, A+S, United States: Ohio, Newark, Cold Spring Run.

Candona annae Mehes, 1913 var. *septentrionalis* Furtos, 1935. USNM 71421, Holotype, SLI, United States: Massachusetts, Woods Hole, in field drainage ditch.

Candona caudata Kaufman var. *ciliata* Furtos, 1935. USNM 71420, Holotype, A+S, United States: Massachusetts, in marsh between Barnstable and East Sandwich.

Candona decora Furtos, 1933. USNM 67867, 10 Syntypes, A+S, United States: Ohio, Marengo, temporary pond.

Candona distincta Furtos, 1933. USNM 67868, 7 Syntypes, A+S, United States: Ohio, canal south of Columbus.

Candona elliptica Furtos, 1933. USNM 67869, 2 Syntypes, SLI, United States: Ohio, Lake Erie, Lakeside, East Harbor. USNM 67938, 4 Syntypes, ALC, United States: Ohio, Lake Erie, between South Bass and Rattlesnake Island.

Candona eriensis Furtos, 1933. USNM 67870, 5 Syntypes, A+S, United States: Ohio, Lake Erie, between South Bass and Rattlesnake Island.

Candona exilis Furtos, 1933. USNM 67871, 1 Syntype, SLI, United States: Ohio, Columbus, temporary pond.

Candona inopinata Furtos, 1933, USNM

67872, 1 Syntype, SLI, United States: Ohio, Mount Vernon.

Candona intermedia Furtos, 1933. USNM 67873, 6 Syntypes, A+S, United States: Ohio, Newark.

Candona ohioensis Furtos, 1933. USNM 67874, 5 Syntypes, A+S, United States: Ohio, Bass Lake.

Candona punctata Furtos, 1933. USNM 67875, 4 Syntypes, A+S, United States: Ohio, Bass Lake.

Candona scopulosa Furtos, 1933. USNM 67876, 5 Syntypes, A+S, United States: Ohio, Lake Erie, Starve Island.

Candona truncata Furtos, 1933. USNM 67877, 7 Syntypes, A+S, United States: Ohio, Medina, south of temporary pond.

Candonocypris pugionis Furtos, 1936b. USNM 71382, Holotype, A+S, United States: Florida, near Fruitville.

Cyclocypris ampla Furtos, 1933. USNM 67878, 6 Syntypes, A+S, United States: Ohio, Castlia, Blue Hole Stream.

Cyclocypris cruciata Furtos, 1935. USNM 71416, Holotype, A+S. USNM 71417, 3 Paratypes, A+S, United States: Massachusetts, Marston's Mill Pond, near Hyannis.

Cyclocypris sharpei Furtos, 1933. USNM 67879, 2 Syntypes, SLI, United States: Ohio, Bass Lake.

Cypretta bilicis Furtos, 1936b. USNM 71377, Holotype, ALC, USNM 71378. Paratype, SLI, United States: Florida, 4 miles from Miakka on road to Fruitville.

Cypretta brevisaepta Furtos, 1934. USNM 68157, TYPE (Holotype), A+S. USNM 139290, Paratype, ALC. USNM 68158, Paratype, A+S. USNM 68159, 13 Paratypes, ALC, United States: Florida, Buckingham, ½ mile north of railroad station.

Cypretta brevisaepta brevisaepta Furtos, 1936b. The material listed above was referred to this variety when Furtos established the variety given below.

Cypretta brevisaepta var. *sarta* Furtos, 1936b. USNM 71395, Holotype, ALC, United States: Florida, Fort Myers, 3 miles north of railroad station.

Cypretta intonsa Furtos, 1936b. USNM 71380, Holotype, A+S, United States: Florida, 2 miles west of Kissimmee River. USNM 71381, 40 Paratypes, ALC, United States: Florida, 4 miles north of Kissimmee River.

Cypretta nigra Furtos, 1936b. USNM 71379, Holotype, A+S, United States: Florida, 9 miles from Miakka, on road to Fruitville.

Cypretta nukuhivana Furtos, 1934. USNM 68067, 50 Paratypes, A+S, Marquesas Islands: Loovii Pond, Nukuhiva, Vaehakameaua.

Cypria (*Cypria*) *palustera* Furtos, 1935. USNM 71409, Holotype, A+S. USNM 71410, 17 Paratypes, A+S, United States: Massachusetts, in marsh between Barnstable and East Sandwich.

Cypria (*Cypria*) *pseudocrenulata* Furtos, 1936b. USNM 71386, Holotype + Paratype, A+S. USNM 71387, Paratype, SLI. USNM 71388, 11 Paratypes, ALC, United States: Florida, 2 miles from Dunedin on road to Tarpon.

Cypria (*Physocypria*) *gibbera* Furtos, 1936b. USNM 71391, Holotype, A+S, United States: Florida, 1½ miles to the east of Elfer's Pool. USNM 71392, Paratype, A+S and USNM 71393, 6 Paratypes, ALC, United States: Florida, 1¼ miles to the east of Elfer's Pool.

Cypria (*Physocypria*) *globula* Furtos, 1933. USNM 67880, 7 Syntypes, A+S, United States: Ohio, Bass Lake.

Cypria (*Physocypria*) *inflata* Furtos, 1933. USNM 67881, 6 Syntypes, A+S, United States: Ohio, Lakeside, East Harbor.

Cypria (*Physocypria*) *posterotuberculata* Furtos, 1935. USNM 71412, Holotype A+S, USNM 71413, 5 Paratypes, ALC, United States: Massachusetts, Falmouth, Palmer's Pond.

Cypria (*Physocypria*) *xanabanica* Furtos, 1936a. USNM 67977, Holotype A+S, USNM 67978. Paratype, A+S. USNM 67979, 6 Paratypes, ALC, Mexico: Chichen-Itza, Xanaba Ii Cenote.

Cypricerus mollis Furtos, 1936b. USNM 71385, Holotype, A+S (soft parts only), United States: Florida, Miami, 40 miles W of Miami (wayside pool on Tamiami highway).

Cypridopsis mexicana Furtos, 1938. USNM 72455, Holotype + 8 Paratypes, ALC, Mexico, Libre Union, Yunchen Cave.

Cypridopsis okeechobei Furtos, 1936b. USNM 71375, Holotype, A+S. USNM 71376, 2 Paratypes, A+S. USNM 71394, 3 Paratypes, ALC, United States: Florida, Lake Okeechobee.

Cypridopsis (*Cypridopsis*) *inaudita* Furtos, 1936a. USNM 67955, Holotype, A+S. USNM 67956, Paratype, A+S, Mexico: Campeche, Champoton. USNM 67957, 7 Paratypes, ALC, Mexico: Campeche, Champoton, in cistern.

Cypridopsis (*Cypridopsis*) *niagranensis* Furtos, 1936a. USNM 67958, Holotype, A+S, Mexico: Yucatan, Merida, Niagra Cenote.

Cypridopsis (*Cypridopsis*) *pustulosa* Furtos, 1933. USNM 67886, 5 Syntypes, A+S, United States: Ohio, Springsville.

Cypridopsis (*Cypridopsis*) *rhomboidea* Furtos, 1936a. USNM 67959, Holotype, A+S, Mexico: Yucatan, Piste, in pond.

Cypridopsis (*Cypridopsis*) *yucatanensis* Furtos, 1936a. USNM 67961, Holotype, A+S. USNM 67962, 2 Paratypes, ALC, Mexico: Valladolid, Xix Cenote. USNM 67960, Paratype, SLI, Mexico: Yucatan, Chichen-Itza, Ixil Cenote.

Cypridopsis (*Potamocypris*) *comosa* Furtos, 1933. USNM 67885, 2 Syntypes, SLI. USNM 67940, 5 Syntypes, ALC, United States: Ohio, Lake Erie, Lakeside, East Harbor.

Cypridopsis (*Potamocypris*) *elegantula* Furtos, 1933. USNM 67887, 3 Syntypes, A+S, United States: Ohio, North Bass Island, Hollyhock Pond.

Cypridopsis (*Potamocypris*) *smaragdina* (Vavra, 1891) var. *compressa* Furtos, 1933. USNM 67933, 100 Syntypes, A+S, United States: Ohio, Starve Island, rock pool.

Cyprinotus inconstans Furtos, 1936a. USNM 67963, Holotype, A+S. USNM 67964, 6 Paratypes, ALC, Mexico: Piste.

Cyprinotus putei Furtos, 1936a. USNM 67965, Holotype, A+S. USNM 67966, Paratype, A+S. USNM 67967, 3 Paratypes, ALC, Mexico: Yucatan, Progreso, pool.

Cyprinotus unispinifer Furtos, 1936a. USNM 67969, Paratype, A+S. USNM 67970, Paratype, ALC, Mexico: Campeche, Champoton, Yalic Aguada.

Cypris (*Cypricerus*) *spendida* Furtos, 1933. USNM 67883, 2 Syntypes, SLI, United States: Ohio, Chardon.

Cypris (*Cypricerus*) *tincta* Furtos, 1933. USNM 67884, 8 Syntypes, A+S, United States: Ohio, North Bass Island, Fischer's Marsh.

Cypris (*Cyprinotus*) *fluviatilis* Furtos, 1933. USNM 67888, 7 Syntypes, A+S, United States: Ohio, Toledo, Tontogany Creek.

Cypris (*Cyprinotus*) *glauca* Furtos, 1933. USNM, 67889, 2 Syntypes, SLI, United States: Ohio, Put-in-Bay, Gibralter Island. USNM 67907, Syntype, SLI, United States: Ohio, Lake Erie, Middle Bass Island. USNM 67939, 20 Syntypes, ALC. USNM 112271, Syntype, SLI, United States: Ohio, Lake Erie, off Middle Bass Island.

Cypris (*Eucypris*) fuscata (Jurine, 1820) var. *gigantica* Furtos, 1933. USNM 67928, 9 Syntypes, ALC, United States: Ohio, North of Chagrin. USNM 67942, 5 Syntypes, ALC, United States: Ohio, North of Centersburg.

Cypris (*Eucypris*) *hystrix* Furtos, 1933. USNM 67890, Syntype, SLI, United States: Ohio, Columbus.

Cypris (*Eucypris*) *rava* Furtos, 1933. USNM

67891, Syntype, A+S, United States: Ohio, Newark, Cold Spring Run.

Eucypris arcadiae Furtos, 1936b. USNM 71383, Holotype, A+S. USNM 71384, 2 Paratypes, ALC, United States: Florida, 3 miles west of Arcadia.

Eucypris cisternina Furtos, 1936a. USNM 67971, Holotype, ALC, (Carapace only). USNM 67972, 6 Paratypes, ALC, Mexico: Campeche, Champoton.

Eucypris serratomarginata Furtos, 1936a. USNM 67973, Holotype, A+S, Mexico: Yucatan, Valladolid, Xix Cenote.

Herpetocypris meridana Furtos, 1936a. USNM 67974, Holotype, A+S. USNM 67975, Paratype, Mexico: Yucatan, Halal Aguada near Merida.

Limnocythere ornata Furtos, 1933. USNM 67892, 3 Syntypes, A+S. United States: Ohio, Chippewa Lake.

Metacypris americana Furtos, 1936a. USNM 67976, Holotype, A+S, Mexico: Yucatan, Merida, Xlaka Cenote.

Physocypria exquisita Furtos, 1936b. USNM 71389, Holotype, A+S. USNM 71390, Paratype, ALC, United States: Florida, Seminole City, 3 miles east of Indian Village.

Stenocypria longicomosa Furtos, 1933. USNM 67936, 3 Syntypes, ALC, United States, Ohio, Chippewa Lake.

Strandesia intrepida Furtos, 1936. USNM 67980, Holotype, A+S. USNM 67981, Paratype, A+S. USNM 67982, Paratype, ALC, Mexico: Yucatan, Halal Aguada near Merida.

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REDESCRIPTION OF THE GENUS *NAUPHANTA* KINBERG, 1865 (POLYCHAETA: EUNICIDAE)

Kristian Fauchald

Abstract.—The genus *Nauphanta,* described to contain the species *novaeaehollandiae* (as *novae Hollandiae*) and *corallina,* is now considered a synonym of *Marphysa.* Examination of the types has demonstrated that the two species do not belong to the same genus. *Nauphanta novaehollandiae* has simple, capillary setae and series of large, flat, thin fan-shaped setae arranged in a row on the anterior face of far posterior parapodia and lacks compound setae. *Nauphanta corallina* is a member of *Marphysa* in that it has compound falcigers in addition to simple setae and has true pectinate setae mixed with the limbate setae in the dorsal fascile. *Nauphanta* is here defined in relation to *Marphysa.* *Eunice mossambica* Peters, 1854, is newly referred to *Nauphanta.*

During a revision of species described in the genus *Eunice* (Polychaeta: Eunicidae) a review of material deposited in the Zoologisches Museum, Berlin and the British Museum (Natural History) led to the recognition that the species currently known as *Marphysa mossambica,* including the specimens originally described as *Nauphanta novae Hollandiae,* could not be comfortably contained in the genus to which it is currently referred. Furthermore, the presence of a highly characteristic fan-shaped seta in posterior setigers appears to have been overlooked by most authors (but see Crossland 1903). Both positionally and in terms of structure, these setae do not appear to be homologous with the pectinate setae usually present in eunicids and onuphids. The presence of a unique kind of seta, in addition to the total absence of any kinds of compound setae, forms the justification for recognizing *Nauphanta* as a distinct genus. The two described taxa appear to differ sufficiently, so they are here recognized as distinct species.

Nauphanta Kinberg, 1865 (emended)

Diagnosis.—Prostomium frontally bilobed with 5 occipitally placed antennae. Peristomium separated into 2 rings distinct on all sides of body; peristomial cirri absent. Maxillae with Mx III forming part of distal arc with left Mx IV and V (seen in *N. mossambica* only). Branchiae from setiger 30 or not until setiger 49. Pre- and postsetal lobes continous around the dorsal edge of the neuropodium. Ventral cirri tapering in all setigers. Notopodial cirri short and tapering, without articulations. Acicula and subacicular hooks light to dark brown. Pectinate setae and all compound setae absent. Most setae slender, narrowly limbate smooth setae present in thick fascicles. Expanded, flat fan-shaped setae present in row on anterior face of posterior parapodia. Each fan-shaped seta with or without thickened edge and numerous (up to 50) very short, trim teeth along edge.

Type species.—*Nauphanta novaehollandiae* Kinberg, 1865:564.

Discussion.—The structure and distribution of the fan-shaped setae on the anterior face of the posterior neuropodia are unique in the order Eunicida. Another characterizing feature is the total absence of compound setae of any kind; other eunicids have compound setae, either falcigers or spinigers, present prominently in their parapodia.

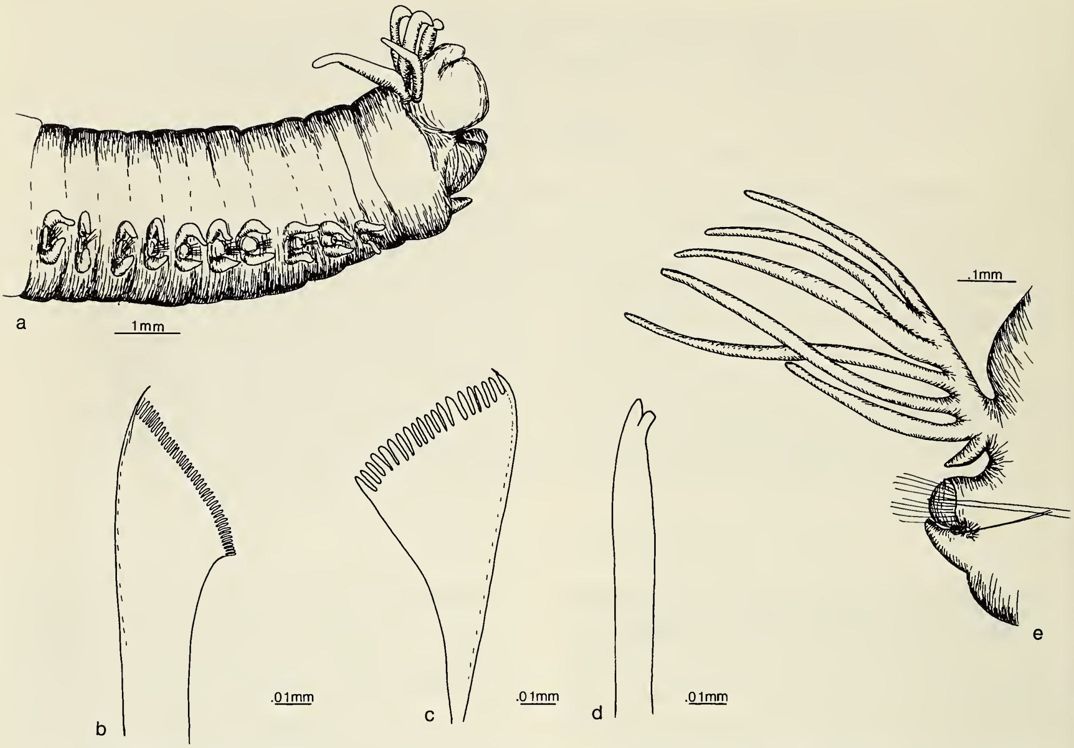

Fig. 1. *Nauphanta mossambica,* lectotype: a, Anterior end, lateral view; b, Fan-seta, setiger 186; c, Fan-seta, setiger 175; d, Subacicular hook, setiger 175; e, Parapodium 175, frontal view.

Nauphanta novaehollandiae is here considered the type species of the genus since it was listed first in Kinberg's description of the genus.

The type specimen of *Nauphanta corallina* was examined; it is a member of *Marphysa* in that it has compound, bidentate falcigers in thick fascicles in anterior setigers and has typical pectinate setae mixed in with the simple, limbate setae in the dorsal fascicles; the type will be described in a forthcoming review of the members of *Marphysa.*

Nauphanta mossambica
(Peters, 1854) (emended)
Fig. 1

Eunice mossambica Peters, 1854:612.
Marphysa mossambica.—Gravier, 1900: 267–270, pl. 14, figs. 89–90, text figs. 137–139.—Crossland, 1903:139–140, pl. 15, figs. 7–10.—Day, 1967:395, fig. 17.5.i–m.

Material examined.—Lectotype and 6 paralectotypes, ZMB 47, 4005 and F2046, Moçambique, coll. Peters. The lectotype was selected from F2046. In addition, one slide with 2 parapodia marked type, BM(NH) ZB. 1984.70.

Description.—Lectotype a complete specimen (now in 2 pieces) consisting of 420 setigers, 300 mm long, and 10 mm wide at widest. Length through setiger 10, 10 mm. Head and first 10 setigers of body basically cylindrical, but from about setiger 10, body widening rapidly and becoming dorsoventrally flattened so that parapodia carried near edges of body which becomes lens-shaped in cross-section; body retaining this shape through most of its length, but becoming increasingly flattened towards far posterior end. Width decreasing rapidly near posterior end, giving appearance of a beaver tail.

Prostomium (Fig. 1a) frontally truncate, separated into 2 diverging, but shallowly separated halves. A pair of faint eyes present between bases of outer and inner lateral antennae. Antennae tapering lacking articulations except for very short basal ceratophore; outer lateral antennae reaching second peristomial ring; inner lateral antennae reaching setiger 2, median antenna reaching setiger 3. Peristomium cylindrical divided into 2 rings of which anterior ring making up about ⅔ of total length of peristomium. Separation between 2 rings distinct on all sides of body. Peristomial cirri absent.

Maxillary formula: 1+1, 5–7+5–7, 4–7+0, 4–5+8–9 and 1+1. Mx VI absent; Mx III forming arc with distal jaw pieces on left side.

Branchiae present from setiger 41 in lectotype, from setigers 37–49 in paralectotypes. Where best developed, branchiae consisting of long, slender filaments attached to a tapering branchial stem held erect over dorsum. Maximum of 6 filaments present. Last 20–25 segments abranchiate in complete specimens.

Neuropodial acicular lobes (Fig. 1e) rounded in all setigers; pre- and postsetal lobes continuous around dorsal edge of neuropodium, forming a collar from which setae emerge. This collar lower and obliquely cut away on anterior face. Ventral cirri short, thick, tapering in all setigers; no inflated basal region present. Notopodial cirri smaller than ventral cirri, which they otherwise resemble in shape. Especially in branchiated region, notopodial cirri forming short, conical process at base of branchiae.

All parapodia having thick fascicles of slender, tapering, slightly limbate simple setae. Compound hooks or spinigers absent. Fan-shaped setae (Fig. 1b, c) present along anterior face of posterior parapodia; their exact distribution difficult to determine, but not appearing to be present before setiger 100; where best developed these setae form a series of fans in a row, covering front of exposed neuropodial acicular lobe. Each fan-seta having long thickened superior edge, ending in short spine and oblique cutting edge with numerous, up to 50, short trim teeth. Fan-setae flat, nearly translucent, apart from thickened superior edge. Up to 10 of these setae may be present in parapodium. Towards posterior end, fan-setae shifting in position to dorsal edge of parapodium and decreasing in number so that perhaps only 1 or 2 present. Acicula straight, tapering to blunt tip and light brown to dark brown in color. Slender, bidentate subacicular hooks (Fig. 1d) present from setiger 70 in lectotype; from setigers 58–73 in paralectotypes. Occurrence of these hooks very scattered; several setigers may miss them, and hooks rarely present in two consecutive setigers. Each hook very slender, less than half thickness of acicula in same setiger; tapering towards tip. Both teeth directed distally; proximal tooth blunt, or rounded distally. Distal tooth longer than proximal tooth, tapering to sharp tip. Subacicular hooks light colored, usually a very light brown or dark yellow and distinctly lighter in color than acicula of same setiger.

Two parapodia from BM(NH) both lacking branchiae. Both having abruptly tapered notopodia and thick large ventral cirri. Neuropodia distally truncate, pre- and postsetal lobes low folds continuous around dorsal edge of neuropodium. One dark acicula present in one parapodium; the other having 3 similar, tapered, distally straight-tipped aciculae. In parapodium with 3 aciculae, all setae slender, tapering capillaries in 2 fascicles, one above and one below aciculae. Superior setae in both fascicles tapering more gently than those on lower edge of each fascicle. In parapodium with single acicula, most setae similar tapering capillaries, but on dorsal side of acicula, presumably on anterior face, a series of fan-shaped setae.

Remarks.—*Nauphanta mossambica* differs from the type species, *N. novaehollandiae*, as indicated below. The fan-shaped setae were first noticed for the species by Crossland (1903), but appear to have been overlooked by observers both before and after him.

Nauphanta novaehollandiae
Kinberg, 1865 (emended)
Fig. 2

Nauphanta novae Hollandiae Kinberg, 1865:564; 1910:43, pl. 16, fig. 23, 23B, C, F, G.

Nauphanta Novae-Hollandiae.—Augener, 1922:26 (see comment below).

Eunice (*Marphysa*) *novae Hollandiae.*—Grube, 1878:165–166.

Marphysa mossambica.—Day and Hutchings, 1979:117 (not Peters, 1854; see comment below).

Material examined.—Holotype, RM Type 432, Sydney Harbor, EUGENIE-Expedition, 1858.

Description.—Holotype a fragmented specimen that has been anteriorly dissected, consisting of a total of 117 setigers at this point, 89 mm long and 4 mm wide at widest, at about setiger 20. Anterior fragment consisting of prostomium, peristomium, and 10 setigers; next section of 37 setigers and may be directly in continuation of first section. Long, completely branchiated section of 64 setigers and some short fragments of 2–6 segments completing fragmentary material.

Prostomium anteriorly truncate; two halves well separated and diverging clearly. Antennae slender, tapering and lacking articulations, apart from short, ring-shaped ceratophore. Outer lateral antennae reaching second peristomial ring, inner lateral and median antennae reaching setiger 2, with median antenna being slightly longer than other antennae. No trace of eyes visible. Peristomium a short, truncated cone, with anterior ring being about twice as long as posterior one; separation between two rings distinct on all sides, but especially clearly marked ventrally. Peristomial cirri absent.

Jaws had been dissected out and were partially present in vial. Maxillary formula appearing to be 1+1, 5+6, ?+0, ?+8, and ?+1. Distal part of left side entirely missing.

Branchiae present from setiger 30 and continuing to rest of specimen. First branchiated segment having single long filament, but other branchiae having short, sharply tapering branchial stems and up to 6 long, slender branchial filaments.

Neuropodial acicular lobes (Fig. 2c) distally rounded in all setigers examined. First few parapodia very small, but increasing rapidly in size until by setiger 5, reaching roughly full size retained in remainder of fragment. Presetal lobes are low folds in all setigers, continuous on dorsal edge with somewhat higher postsetal lobes; latter follows outline of acicular lobes closely in anterior setigers, reduced to low fold in posterior setigers. Notopodial cirri taeniform and short in all setigers, becoming increasingly tapered in posterior setigers; distinctly shorter than branchial filaments in all branchiated setigers. Ventral cirri short and tapering in all setigers; indistinct basal swelling present along ventral edge of parapodia in median and posterior setigers.

Slender limbate setae present in all setigers in large numbers; those located along dorsal edge of parapodia slimmer than those emerging from anterior or posterior setal fold. Slender, light brown, bidentate subacicular hooks (Fig. 2b) present irregularly from setiger 44 to end of fragment. Each hook distally abruptly tapering to narrow, slightly bent head; both teeth projecting distally, proximal tooth slightly larger than distal one. Thick, tapering, straight-tipped brown aciculae present in all parapodia. Most parapodia having 2 aciculae. Compound setae and pectinate setae absent. Latter replaced by translucent, thin, flattened

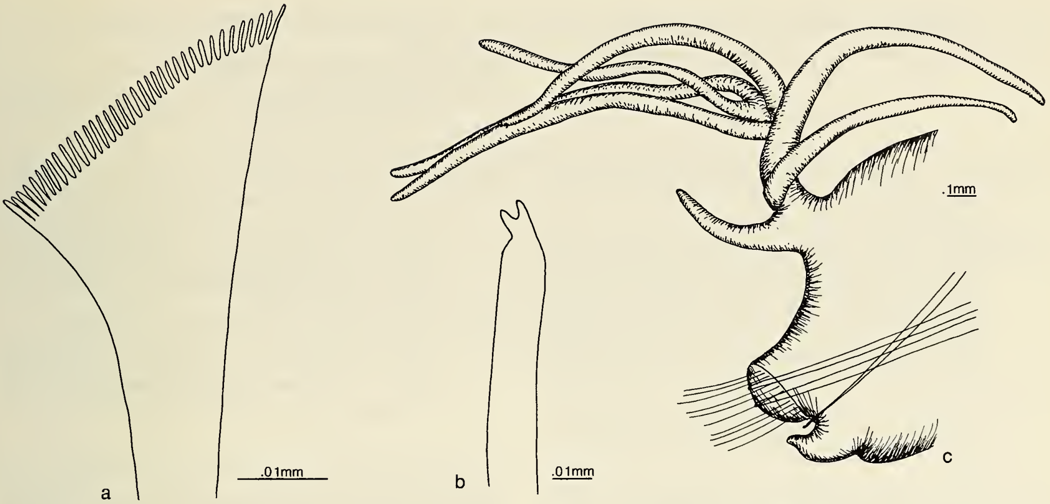

Fig. 2. *Nauphanta novaehollandiae,* holotype: a, Fan-seta, mid-posterior parapodium; b, Subacicular hook, mid-posterior parapodium; c, Mid-posterior parapodium, frontal view.

fan-setae (Fig. 2a) on anterior face of parapodia in branchial region; distribution of these setae cannot be accurately determined; but 2 or more of fan-setae present in each parapodium in largest of fragments. Each seta distally obliquely fan-shaped, having about 35 blunt-tipped teeth; marginal teeth not reinforced and no longer than other teeth in fan.

Remarks.—The history of this species has been rather complex. Described from Sydney Harbor, it was next reported from the Philippines by Grube (1878), and later synonymized with Peters' *mossambica* by Gravier (1900) and Crossland (1903) without re-examination of the type material. Augener (1922), while agreeing that the two names represented a single species, preferred to use Kinberg's name, since he preferred the more accurate description contained in Kinberg's original description over the one supplied by Peters. *Nauphanta mossambica* and *N. novaehollandiae* can be separated by the distribution of branchiae and subacicular hooks and by the shape of the latter. Branchiae are present from setiger 30 and subacicular hooks from setiger 44 in *N. novaehollandiae*; branchiae are present from setiger 37 or later and subacicular hooks not until setiger 58 in *N. mossambica.* In a study of variability of these features in members of the family, Fauchald (in prep.) has demonstrated that with similarly sized specimens, as is the case here, these differences are sufficiently large to maintain the separation between the two taxa until detailed studies have been performed.

Without examination of the material, it is difficult to tell if Grube's material from the Philippines belong to the same species, or to a similar species.

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SORSOGONA MELANOPTERA, A NEW FLATHEAD FISH FROM THE NORTHERN INDIAN OCEAN (TELEOSTEI: PLATYCEPHALIDAE)

Leslie W. Knapp and Thosaporn Wongratana

Abstract.—A new platycephalid, *Sorsogona melanoptera,* is described from the Gulf of Oman, the Arabian Sea and the Bay of Bengal. This species is distinguished from other members of *Sorsogona* Herre by its distinctive color pattern, a series of ventral projections along the lower edge of the suborbital bone, and by a substantial part of each lateral line scale being covered by adjacent scales.

More than 700 specimens of an undescribed species of Platycephalidae were taken in bottom trawl collections by the R/V *Anton Bruun* during the International Indian Ocean Expedition in 1963 and by the R/V *Meteor* Expedition to the Indian Ocean in 1965. In 1974, Wongratana discovered two specimens of the new species that had come from the Andaman Sea, in the Bangkok wholesale fish market. Since then, additional collections have been made in the Gulf of Oman and at several localities along the coast of India.

Despite its wide distribution and common occurrence, this species has frequently been confused with several other flathead species that are found in the northern Indian Ocean. It is probable that the description of *Platycephalus tuberculatus* (Cuvier, in Cuvier and Valenciennes, 1829) in Blegvad (1944) and that for *Wakiyus serratus* (Cuvier, in Cuvier and Valenciennes, 1829) by Murty (1975) refer to *Sorsogona melanoptera.* A brief description of that species as *Sorsogona* sp. was given by Knapp (1979). We hope that this study will help to clarify the species that are tentatively assigned here to *Sorsogona* Herre, 1934.

Methods

Counts and measurements follow those in Knapp (1973) except that the standard and snout lengths listed here were measured from the tip of the snout. Type material is deposited at the following institutions: Academy of Natural Sciences, Philadelphia (ANSP); Bernice P. Bishop Museum, Honolulu (BPBM); California Academy of Sciences, San Francisco (CAS); Chulalongkorn University Museum of Zoology, Bangkok (CUMZ); National Museum of Natural History, Smithsonian Institution, Washington D.C. (USNM); and Zoological Museum of Hamburg (ZMH).

Sorsogona melanoptera, new species
Figs. 1–4

Platycephalus tuberculatus (part): Day, 1876: 275–276.—Ahmed and Qureshi, 1970: 207.

Platycephalus tuberculatus: Blegvad, 1944: 196–197.

Platycephalus nigripinnis: Norman, 1939: 97.

Wakiyus serratus? Murty, 1975:685.

Sorsogona sp. Knapp, 1979:51, figs. 522, 523, 527.

Material examined.—Holotype, USNM 280331 (91 mm standard length), India, ca. 3.2 km off Cochin, trawl, 14–38 m, B. B. Collette, 2 Feb 1980.

Paratypes: Gulf of Oman: ANSP 158798, 1 (67.8), 23°46.3′N, 58°01.3′E, 15–17 m, 11 Mar 1977, sta 4, M/V *Darbat.*—USNM

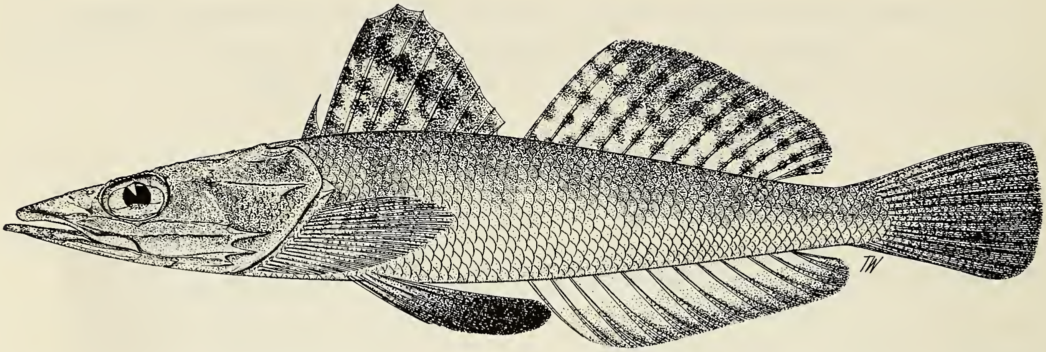

Fig. 1. *Sorsogona melanoptera,* USNM 280331, holotype, 91 mm SL, left side, lateral view, from off Cochin, India.

280332, 1 (78), 23°56′N, 57°33′E, 27–29 m, 12 Mar 1977, sta 7, M/V *Darbat.*—USNM 280333, 3 (85–101), 26°46′N, 56°47′E, 46–48 m, 1 Dec 1963, sta 257A, cruise 4B, R/V *Anton Bruun.*—USNM 280334, 1 (71), 26°10′N, 57°05′E, 55–64 m, 30 Nov 1963, sta 256A, cruise 4B, R/V *Anton Bruun.*—USNM 280335, 2 (87–104), 25°10′N, 60°27′E, 65–82 m, 29 Nov 1963, sta 248A, cruise 4B, R/V *Anton Bruun.* Arabian Sea: USNM 280336, 2 (84–85), 22°38′N, 67°11′E, 110 m, 19 Nov 1963, sta 227A, cruise 4B, R/V *Anton Bruun.*—USNM 280337, 1 (73), 22°32′N, 68°07′E, 57 m, 18 Nov 1963, sta 221A, cruise 4B, R/V *Anton Bruun.*—USNM 280338, 4 (92–119), 21°52′N, 68°06′E, 115–117 m, 18 Nov 1963, sta 219A, cruise 4B, R/V *Anton Bruun.*—USNM 280362, 31 (72–122), 17°41′N, 71°33′E, 90 m, 14 Nov 1963, sta 202B, cruise 4B R/V *Anton Bruun.*—USNM 280363, 35 (75–120), 17°25′N, 71°39′E, 96–106 m, 13 Nov 1963, sta 202A, cruise 4B, R/V *Anton Bruun.*—USNM 223751, 1 (112), 22°01′N, 68°10′E, 88–94 m, 7 Mar 1965, sta 229A, R/V *Meteor.*—ZMH 5302, 6 (86–108), same data as USNM 223751.—BPBM 27695, 3 (80–95), India, Kerala State, Vizhinjam, fishing harbor, 13 Feb 1980, purchased from fishermen, J. E. Randall. Bay of Bengal: CAS 58595, 1 (106), inshore trawling grounds off Madras, 15–22 m, Apr–Jun 1975, K. V. Rama Rao.—USNM 280339, 8 (59-104), 21°00′N, 91°59′W, 23–25 m, 5 Apr 1963, sta 46, cruise 1, R/V *Anton Bruun.*—USNM 280340, 1 (97), 15°08′N, 94°04′E, 66 m, 1 Apr 1963, sta 43, cruise 1, R/V *Anton Bruun.*—USNM 280341, 3 (82–91), 14°07′N, 97°05′E, 69–73 m, 30 Mar 1963, sta 38, R/V *Anton Bruun.*—USNM 280342, 11 (74–94), 9°54′N, 97°42′E, 70 m, 24 Mar 1963, sta 21, cruise 1, R/V *Anton Bruun.*—USNM 280343, 8 (71–94), 9°13′N, 97°51′E, 58–60 m, 23 Mar 1963, sta 120, cruise 1, R/V *Anton Bruun.*—CUMZ 2528.2.9.7, 1 (90), Andaman Sea, Bangkok wholesale fish market, 6 Nov 1974, T. Wongratana.

Material of other species examined.—*Sorsogona nigripinna* (Regan, 1905): USNM 280344, 5 (114–126), 10°03′N, 51°15′E, 31–39 m, 16 Dec 1964, sta 449, cruise 9, R/V *Anton Bruun.*—USNM 280345, 2 (90–105), 9°35′N, 50°59′E, 70–80 m, 16 Dec 1964, sta 442, cruise 9, R/V *Anton Bruun. Sorsogona tuberculata* (Cuvier, 1829): USNM 280346, 4 (64–91), Thailand, 12°32′N, 100°46′E, 19 Jan 1960, sta 60-2, M/V *Stranger.* CAS 58592, 7 (71–106), India, inshore trawling grounds off Madras, 15–22 m, Apr-Jun 1975, K. V. Rama Rao. *Sorsogona prionota* (Sauvage, 1873): ZMH 5296, 1 (130), Red Sea, 28°20′N, 33°08′E, 61 m, 19 Nov 1964, sta 22, R/V *Meteor.*—ZMH 5295, 1 (189), east coast of Somalia, 06°06′N, 49°05′E, 55–

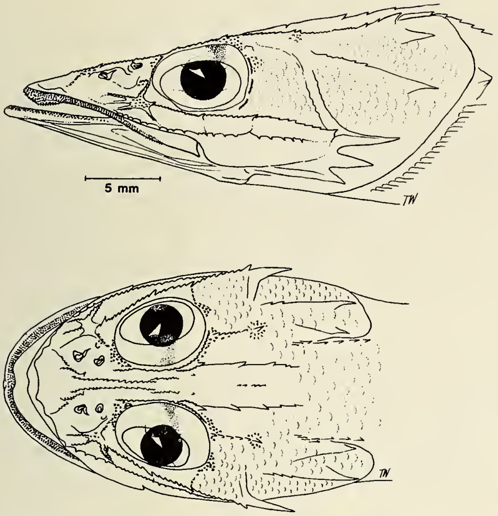

Fig. 2. Lateral and dorsal views of head of *Sorsogona melanoptera,* CUMZ 2528.2.9.7, 90 mm SL, showing cranial ridges and spines.

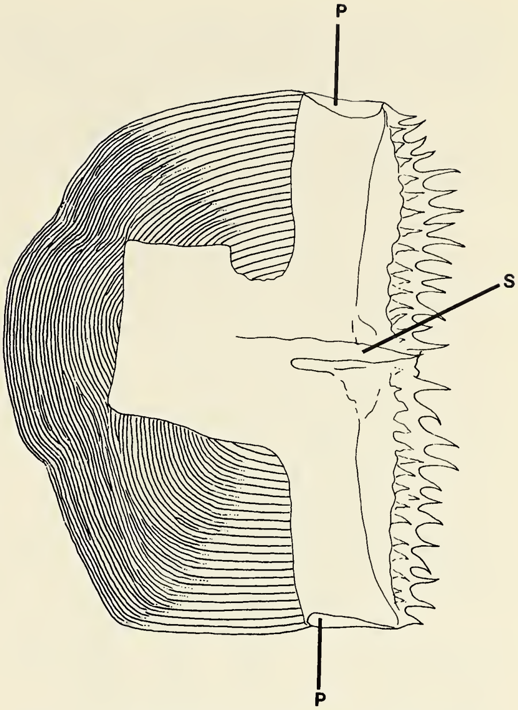

Fig. 3. Pored lateral line scale in *Sorsogona melanoptera,* CUMZ 2528.2.9.7, 90 mm SL, 15th scale behind head, right side. Abbreviations: P—pore opening to exterior; S—spine.

65 m, 28 Dec 1964, sta 123, R/V *Meteor.*—Hebrew University uncataloged, Red Sea, Eilat, sta E64/27, 11 Sept 1964, E. Lark.

Diagnosis.—A species of the genus *Sorsogona* Herre with a series of blunt projections and spines along the ventral edge of the suborbital bone, and with the anterior two-thirds of each lateral line scale covered by adjacent scales.

Description.—Values for the holotype are given in parentheses. Dorsal-fin rays I,VIII, 12–13 (12); anal-fin rays 12; pectoral-fin rays 20–22 (21), usually 2+11+8 or 2+12+7 (2+13+6); pelvic-fin rays I,4+1; pored lateral line scales 52–55 (55), usually 53, the anterior 13–34 (31) scales bearing weak spines; diagonal scales 6–8 (7); interpelvic scales 7–11 (8), usually 8–9; gill rakers 2–3+8–10 (2+8), usually 2+8–9); branched caudal-fin rays usually 11. Least interorbital width into snout length 3–4.5 (4.2) times; first dorsal-fin spine length 2.3–3.3 (2.4) times in second. Head bearing small bony tubercles; nape, cheek, and opercle with embedded scales; preocular margin with modest spine and frequently 3–6 smaller spines, usually with one or more rows of tubercles in front of marginal row; infraorbital and suborbital ridges finely serrate; lower margin of posterior suborbital bone with series of spines and blunt knobs (Fig. 2); usually three preopercular spines, uppermost longest. Lateral line pores "T"-shaped, with two openings to exterior (Fig. 3). Iris lappet bilobed. Vomer and palatines bearing small canine teeth; teeth of jaws mostly small and blunt, few small caniniform teeth near symphysis of upper jaws, inner row caniniform on mandible.

Characteristics of lateral line scales in species of *Sorsogona* as in Fig. 4A–D. In *S. prionota* (Sauvage, 1873) and in *S. tuberculata,* exposed portion of each lateral line scale relatively wide and posterior margin bearing ctenii moderately curved. Anterior

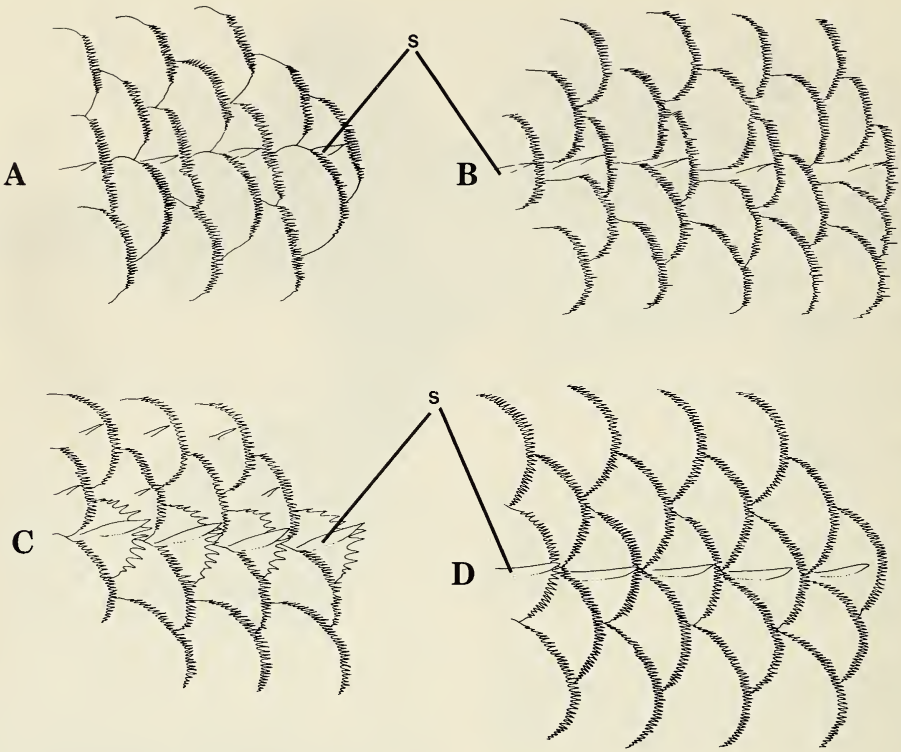

Fig. 4. Comparison of pored lateral line scales in four species of *Sorsogona* (S = spine): A, *S. melanoptera,* USNM 280331, 91 mm SL; B, *S. nigripinna,* USNM 280345, 103 mm SL; C, *S. tuberculata,* USNM 280346, 90 mm SL; D, *S. prionota,* Hebrew Univ. E64/27, 74 mm SL.

portions of lateral line scales more fully covered by adjacent scales in *S. nigripinna* (Regan, 1905) and in *S. melanoptera*; posterior margin bearing ctenii relatively straight. In *S. nigripinna,* central area of most scales exposed further anteriorly than in *S. melanoptera.* Of the four species, *S. tuberculata* has fewest and largest ctenii on posterior scale margin.

Coloration in alcohol.—Dorsum brownish, venter pale, indistinct bands crossing back in some specimens; first dorsal fin

Table 1.—Comparison of characters between *Sorsogona melanoptera, S. nigripinna, S. prionota* and *S. tuberculata.* Usual condition appears in parentheses.

Character	*S. melanoptera*	*S. nigripinna*	*S. prionota*	*S. tuberculata*
Anal rays	12	12	12	11
Branched caudal rays	10–12 (11)	12	11–12	10–11 (10)
Diagonal scales	6–8 (7)	8–9	4–6 (5)	5–6
Gill rakers	2−3+8−9	3–5+11–13	2–3+7–10	1+6–7
Approximate maximum size in mm SL	122	165	200	110
Humeral area beneath operculum	pale	pale	vermiculated pattern	dusky
Caudal fin	dusky	dusky	dark blotches	dusky
Soft dorsal fin	dark spots	dusky	dark spots	dark spots
Pelvic fin	dusky	dusky	dark spots	dark spots

dusky with dark spots along spines; pectoral and anal fins more or less clear; pelvic fins dusky; caudal fin with basal light area, posterior half dusky.

Distribution.—Gulf of Oman to the Andaman Sea off southern Thailand. Taken by trawling over sandy and muddy bottoms at depths of 15–117 m.

Etymology.—The specific name *melanoptera* refers to the dark pattern in the dorsal fins.

Remarks.—The species of *Sorsogona* are all relatively small in size, brownish in body color, and have various black patterns in the fins. Characters useful in distinguishing the four species are compared in Table 1.

Acknowledgments

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NOTES ON WESTERN ATLANTIC CALLIANASSIDAE (CRUSTACEA: DECAPODA: THALASSINIDEA)

Raymond B. Manning

Abstract.—Senior synonyms are reported for two species: *Callianassa setimanus* (DeKay, 1844), for *Callianassa atlantica* Rathbun, 1926, and *Callianassa grandimana* Gibbes, 1850, for *Glypturus branneri* Rathbun, 1900. The genus *Glypturus* Stimpson, 1866, is removed from the synonymy of *Callianassa* Leach, 1814, and *Glypturus acanthochirus* Stimpson, 1866, is shown to be a senior synonym of *Callianassa armata* A. Milne Edwards, 1870, from the Indo-West Pacific. *Corallianassa,* new genus, is recognized for *Callianassa longiventris* A. Milne Edwards, 1870, and *Callianassa borradailei* de Man, 1928. A list of the western Atlantic callianassids is presented.

Studies on eastern American callianassids, initiated in 1982 at the Smithsonian Marine Station in Fort Pierce, Florida, have revealed that several changes are needed in the nomenclature of American callianassids. Senior synonyms exist for two names now in general use, *Callianassa branneri* (Rathbun, 1900) and *C. atlantica* Rathbun, 1926. The genus *Glypturus* Stimpson, 1866, long considered to be a synonym of *Callianassa* Leach, 1814, is recognized as a distinct genus, and its type species, *Glypturus acanthochirus* Stimpson, 1866, originally described from the Florida Keys, appears to be conspecific with *Callianassa armata* A. Milne Edwards, 1870, from the Indo-West Pacific. A new genus is recognized for *Callianassa longiventris* A. Milne Edwards, 1870, from the western Atlantic and *Callianassa borradailei* de Man, 1928, from the Pacific and Indian Oceans. All of these changes, supplemented with an up-to-date list of Western Atlantic callianassids, needed because of numerous recent changes in callianassid taxonomy, are presented here. Further, the forthcoming publication of a list of scientific and common names of decapod crustaceans of the United States by the American Fisheries Society also makes these name changes timely.

This opportunity is taken to correct the name and authorship of the superfamily containing the Callianassidae erected by M. de Saint Laurent (1979:1395), who recognized the superfamily Axioidea Huxley, 1879, containing the families Callianassidae Dana, 1852, Axiidae Huxley, 1879, and Callianideidae Kossmann, 1880. According to Article 36(a) of the *International Code of Zoological Nomenclature,* third edition, 1985, a superfamily must bear the authorship and date of the oldest family name included in it. A superfamily containing the three families listed above must be known as the Callianassoidea Dana, 1852. For now I prefer to follow Bowman and Abele (1982) and include these families in the superfamily Thalassinoidea Latreille, 1831.

The Status of *Gonodactylus setimanus* DeKay, 1844

Two species of *Callianassa, C. atlantica* Rathbun, 1926, and *C. biformis* Biffar, 1971, are known to occur off the extreme northeastern coast of the United States. *Callianassa atlantica* is a sublittoral species, occurring from near shore to depths of 98–134 meters (Rabalais et al. 1981), and it has been recorded from localities between Nova Scotia and the northwestern Gulf of Mexico (Rabalais et al. 1981, Williams 1984). *Callianassa biformis* generally occurs in shallow water, in intertidal to shallow subtidal habitats, in depths to 10–15 meters. It has been recorded from localities between the Bass River, Yarmouth, Massachusetts, and the northwestern Gulf of Mexico (Biffar 1970, Rabalais et al. 1981, Williams 1984).

In 1844:34, DeKay described and figured *Gonodactylus setimanus* taken from the stomach of a cod from a market in New York. DeKay's description is rather poor, yielding little information on the identity of his species. As it may not be generally available, I quote it here:

"Shield oblong, with its side much elongated; a transverse lunate suture on its lower portion in front, with two spinous projecting teeth covering the ophthalmic ring. Internal antennae long, smooth, and furnished with plumose setae; external shorter, bifid at their extremities, which are articulated. The penultimate segment of the jaw-foot is flattened, carinate on its upper margin, dilated and furnished with long plumose setae; beyond this are three segments gradually diminishing in size to the last, which is oblong-oval, plumose on both margins. First two pair of feet didactyle; the two following with the terminal joints flat and rounded, the edges ciliated. The penultimate abdominal segment slightly arcuated, without spines, and with three rounded unarmed fins on each side, of which the inferior is largest.

"*Color,* greyish; tips of the claws of the anterior pair, ciliae on the extremities of the others, and the fins, black.

"Total length, 3.2; of the anterior pair of feet, 1.5.

"This species was obtained from the stomach of a Cod-fish in the market. I have to regret that it was too much mutilated to enable me to present its characters more in detail. It is only provisionally placed here, for in many particulars it is much more nearly allied to the family *Erichthidae.*"

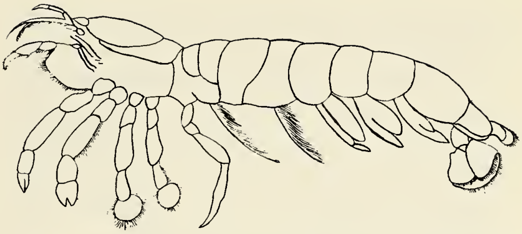

Fig. 1. *Callianassa setimanus* (DeKay, 1844) (from DeKay 1844).

DeKay's figure (pl. 8, fig. 23) clearly shows a species of *Callianassa* with: 1) a third maxilliped with a wide ischium and merus; 2) the antennular peduncle longer than the antennal peduncle (although these are reversed by DeKay in the text); 3) the minor cheliped lacking a spine on the merus and with a long carpus (longer than the chela); 4) a long sixth abdominal somite; and 5) a telson shorter than the inner uropods. DeKay's figure is reproduced here (Fig. 1).

These are among the features used by Rabalais et al. (1981:101) to distinguish *C. atlantica* from the similar *C. biformis* Biffar. These features, and the fact that DeKay's specimen was taken from the stomach of a cod, suggesting that *C. setimanus* lived offshore, support the identification of his species with *C. atlantica.*

Curiously, Gibbes (1850:194), who examined DeKay's material, remarked that it indeed was a species of *Callianassa,* and Gibbes considered *Gonodactylus setimanus* DeKay, 1844, to be a synonym of *Callianassa major* Say, 1818. Gibbes, under his account of *Callianassa major,* noted: "The crustacean described by Dr. DeKay as *Gonodactylus setimanus* . . . belongs to this genus, as can be seen from the description and figure, and I regard it as belonging to this species. Most probably the individual he obtained had lost the large anterior foot so striking in this genus, and the error was thus induced. But I have examined the specimen preserved in the New-York Cabinet with his label, and it does not belong to the *Stomapoda,* as the branchiae are in the position usual in the *Decapoda,* under the shell, and it is in fact a *Callianassa.*"

I have no hesitation in synonymizing *Callianassa atlantica* Rathbun, 1926, with *Gonodactylus setimanus* DeKay, 1844. The oldest name for this species is *Callianassa setimanus* (DeKay, 1844). Original references for this species are as follows:

Gonodactylus setimanus DeKay (1844:34, pl. 8, fig. 23). Type locality New York.

Callianassa stimpsoni Smith, in Verrill, Smith, and Harger (1873:549, pl. 2, fig. 8). Type locality Eastern United States ("Our species from the coast of the Southern States north to Long Island Sound"). [A junior homonym of *Callianassa stimpsoni* Gabb, 1864, a fossil species.]

Callianassa atlantica Rathbun (1926:107). [A replacement name for *C. stimpsoni* Smith, 1873.]

The Status of *Callianassa grandimana* Gibbes, 1850

Gibbes (1850:194) described *Callianassa grandimana,* as follows: "This species was brought *from Key West* by Dr. F. Wurdemann, and is easily distinguished from *C. major* by its large anterior claw or foot. The second segment [=ischium] is slender and narrow near its articulation with the first, and is dilated and incurved as it advances, with distant granules on its lower edge; the third segment [=merus] is broader, dilated so as to form below a sharp, serrated edge, which is truncated as it approaches the posterior articulation, inner surface of the segment is nearly plane, on the middle of the outer is a longitudinal obtuse ridge; the carpus is united with the preceding segment by a small articulating surface near its upper edge, somewhat inflated externally, the breadth, or rather the depth, nearly twice as great as the length, the posterior lower angle rounded, forming an edge without any trace of serrature; the hand broader, or rather deeper, than the carpus, and its length, exclusive of the finger, is nearly double that of the carpus, inflated on the internal surface, and more so on the external, lower edge ciliate, and with a few small distal serrations; whole surface of hand, as well as of carpus, smooth and polished." Gibbes' material has been lost and, until now, the identity of his species has been uncertain.

Balss (1924:179) identified a specimen from Jamaica with Gibbes' species, but in a poor figure showed a species with a trispinous front, a large cornea, and a cheliped with many ventral spines on the ischium and merus. The identity of *Glypturus grandimanus* sensu Balss remains uncertain, but Schmitt (1935:3, 4), recognizing that the species reported by Balss did not agree with Gibbes' account of *C. grandimana,* proposed *Callianassa hartmeyeri* as a replacement name for *Glypturus grandimanus* sensu Balss. The identity of *Callianassa hartmeyeri* Schmitt is still uncertain.

De Man (1928b:19) considered that "*Call. grandimana* is certainly a true *Callianassa,* related to *Call.* (*Callichirus*) *longiventris....*"

Schmitt (1935:2) noted that *C. grandimana* was most similar to *C. branneri* (Rathbun). Schmitt had examined material of the latter species from Dry Tortugas, some 60 miles west of the type locality, and commented "but until we know more of the Callianassas of our southern States we should refrain from making use of Gibbes' specific name."

Biffar (1971a:671–674) summarized the history of *C. grandimana* and evaluated the characters used by Gibbes. He concluded (p. 674) that "After careful comparison and evaluation, it becomes apparent that only *C. branneri* fits all the characters ascribed to *C. grandimana,*" and, "Obtaining specimens from Key West would do much to establish the position of *C. branneri* in relation to *C. grandimana,* and it is hoped that future collections will be successful in this locality."

In July 1984 I visited Key West with the aim of collecting callianassids that might

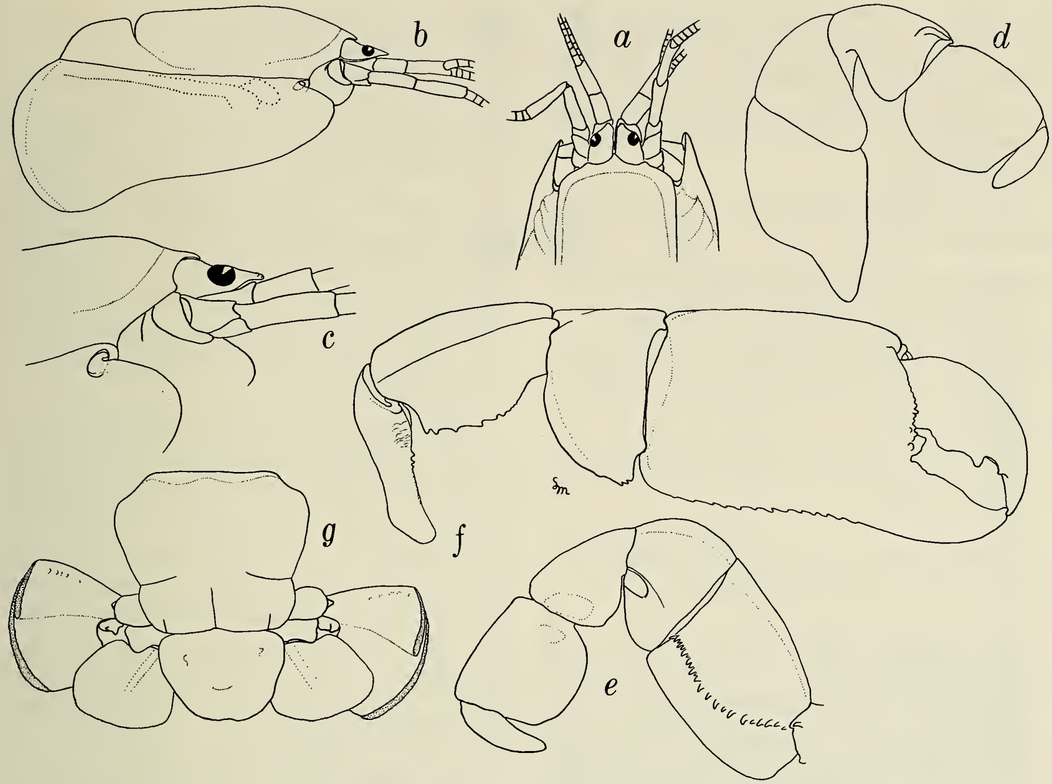

Fig. 2. *Callianassa grandimana* Gibbes, 1850. Male neotype, total length 67 mm, Key West: a, Front, dorsal view; b, Carapace, lateral view; c, Front, lateral view; d, Third Maxilliped, external surface; e, Third maxilliped, inner surface; f, Major cheliped; g, Sixth abdominal somite, telson, and uropods.

settle the identity of *C. grandimana,* and, at one site off the south coast of the island I found a colony of a *Callianassa* that until now would be referred to *C. branneri.* Gibbes description fits this material rather well; compare his account with Fig. 2f herein. On the major cheliped the ischium [second segment of Gibbes] is slender, narrow at its proximal articulation; it is more dilated distally and serrate ventrally. The merus is broader, dilated near its midlength, with a strongly serrate edge; it is distinctly truncated proximally, and there is an obtuse, longitudinal ridge on its outer surface. The carpus has a small proximal articulating surface, it is almost twice as high as long, and the lower edge generally lacks serrations. Two or three distal denticles may be present, but even when present the ventral surface proper is smooth. The palm is distinctly higher than the carpus and its length is nearly double that of the carpus. The lower edge of the palm is ciliated, and there are distinct serrations on the lower edge; these are not always visible in external view on smaller specimens.

In order to settle the identity of *Callianassa grandimana,* I select an adult male from Key West as the neotype of the species. The neotype (USNM 205630) is a male with total length of 67 mm, carapace length of 17 mm; it is shown in Fig. 2. Collection data are as follows: Atlantic Ocean, Monroe County Florida, Key West, South Roosevelt Boulevard (U.S. Highway A1A), 2.3 miles from U.S. Highway 1, clean sand flat behind sand bar about 50 meters from shore, bar separated from shore by *Thalassia* flat, depth

0.5 meter or less at low tide, taken with yabby pump by R. B. and L. K. Manning, 8 Aug 1986 (Sta RBM KW-2). The other specimens from the same collection and some collected on 7 Aug (Sta RBM KW-1) are topotypes.

The original references to *Callianassa grandimana* are:

Callianassa grandimana Gibbes (1850:194). Type locality Key West, Florida.

Glypturus branneri Rathbun (1900:150, pl. 8, figs. 5–8). Type locality Mamanguape, Brazil.

Glypturus siguanensis Boone (1927:85, fig. 17). Type locality Siguanea Bay, Isle of Pines, Cuba.

The Status of the Genus *Glypturus* Stimpson, 1866

In 1866 William Stimpson provided brief diagnoses of two new genera of callianassids, *Callichirus* and *Glypturus.* Both genera have been considered as synonyms of *Callianassa* or as subgenera of *Callianassa.* In a separate paper (Manning and Felder 1986) *Callichirus* was recognized as a genus distinct from *Callianassa.* Here it is shown that *Glypturus* also is a genus distinct from *Callianassa,* and, surprisingly, that *Callianassa armata* A. Milne Edwards, 1870, from Fiji, is a synonym of *Glypturus acanthochirus* Stimpson, 1866.

Glypturus Stimpson, 1866

Glypturus Stimpson, 1866:46. Type species *Glypturus acanthochirus* Stimpson, 1866, by monotypy.

Definition.—Rostrum triangular, with upturned, pointed apex. Carapace with lateral spinous projections anteriorly on each side above antenna, anterolateral spines distinctly separated from carapace by noncalcified membrane. Eye large, extending almost to end of first segment of antennular peduncle. Cornea small, subterminal, situated laterally. Mxp-3 pediform, ischium with row of small spines on inner surface. Both chelipeds: dorsal margin of palm cristate, armed with spines, dorsal margin ending in distal projection; ventral margin of palm cristate; dorsal and ventral margin of carpus with spines; merus spined dorsally and ventrally; ischium spined ventrally, lacking large ventral hook. Sixth abdominal somite inflated, longest of all abdominal somites, about twice as long as telson. Telson wider than long, shorter than uropods. Uropod setation all marginal. Endopod of uropods elongate oval.

Remarks.—*Glypturus,* as defined here, contains only the type species. It can be distinguished from all other callianassid genera by the following combination of characters: front trispinous, with the rostral spine upturned and the lateral spines separated from the front by a noncalcified membrane; the eyes with a small, lateral cornea; and the chelipeds in which the merus and palm of both the major and minor chelae are provided with dorsal spines.

I can find no differences between the accounts of *Glypturus acanthochirus* from the western Atlantic and those of *Callianassa armata* A. Milne Edwards (1870:90) from the Indo-West Pacific; I consider them to be conspecific. Biffar (1971a:660) noted that *G. acanthochirus* appeared to be closely related to *Callianassa armata* A. Milne Edwards. A comparison of Biffar's account and material of *G. acanthochirus* with the accounts of A. Milne Edwards (1870:90), based on material from Fiji, and Kensley's (1975: 48) description and figures of *C. armata* from Mauritius, lead me to synonymize the two species. An original figure for *G. acanthochirus* is given here (Fig. 3), and the figures in A. Milne Edwards (1870: pl. 1) and Kensley (1975: fig. 1) are reproduced as Figs. 4 and 5.

The original references for *G. acanthochirus* are as follows:

Glypturus acanthochirus Stimpson (1866: 46). Type locality Florida Keys and Tortugas.

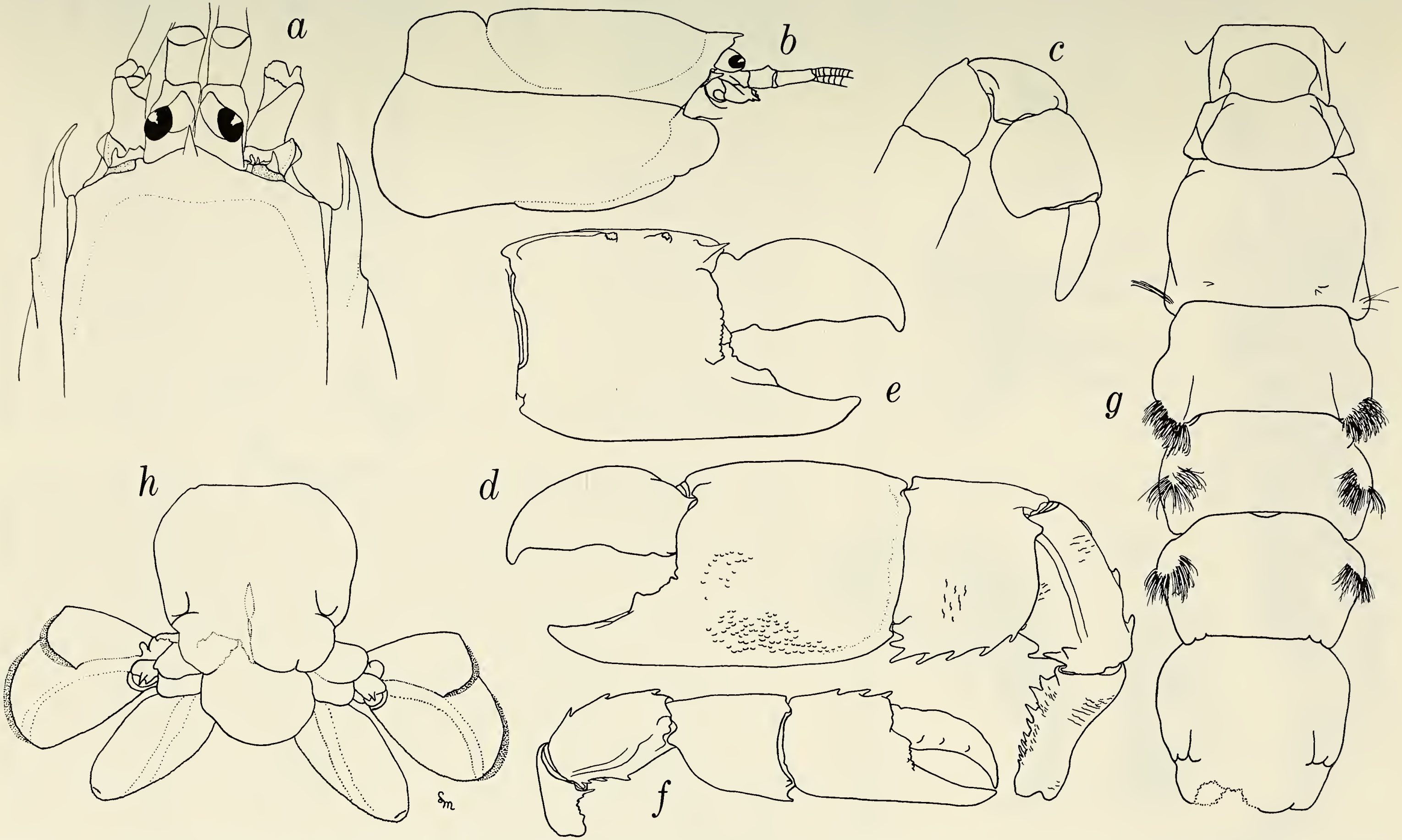

Fig. 3. *Glypturus acanthochirus* Stimpson, 1866. Male, total length 60 mm, Jamaica: a, Front, dorsal view; b, Front, lateral view; c, Third maxilliped; d, Major cheliped; e, Inner surface of major chela; f, Minor cheliped; g, Abdomen; h, Sixth abdominal somite, telson, and uropods.

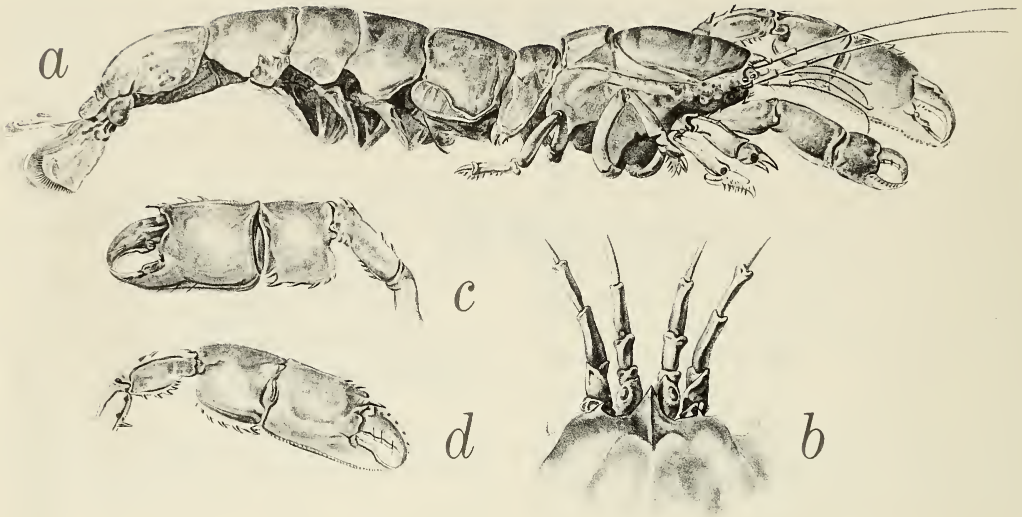

Fig. 4. *Glypturus acanthochirus* Stimpson, 1866. Fiji: a, Lateral view; b, Front; c, Major cheliped; d, Minor cheliped (from A. Milne Edwards 1870).

Callianassa armata A. Milne Edwards (1870:90, pl. 1). Type locality Fiji Islands.

If the primary features used here to distinguish *Glypturus* from other callianassid genera, the sharp, upturned rostral spine, the anterolateral spines of the carapace separated from the carapace by a noncalcified membrane, and the ornamentation of the claw, with dorsal spines on both the merus and propodus (palm) of the cheliped, prove to be variable features, several other species may have to be included in *Glypturus,* as follows: 1, *Callianassa nakasonei* Sakai (1967:46), from Okinawa; 2, *Callianassa intesi* de Saint Laurent and Le Loeuff (1979: 69), from Senegal; 3, *Callianassa haswelli* Poore and Griffin (1979:263), from Queensland, Australia [this species is very similar to *Callianassa nakasonei* and may prove to be synonymous]; and 4, *Callianassa laurae* (de Saint Laurent) (in de Vaugelas and de Saint Laurent 1984:147), from the Red Sea.

In all of these species the front of the carapace is trispinous and the rostrum is upraised, but the anterolateral spines are not separated from the carapace by a noncalcified membrane. *Callianassa laurae,* at least, has a field of granules on the palm, near the base of the fixed finger, a feature it shares with *G. acanthochirus.* All of these species appear to have similar telsons and uropods. I have seen material of none of these species and without examining material I am hesitant to include them in *Glypturus.*

A New Genus for *Callianassa longiventris* A. Milne Edwards, 1870

Corallianassa, new genus

Definition.—Rostrum large, triangular, apex sharp, overreaching base of cornea. Carapace with lateral spinous projections anteriorly on each side above antenna, projections distinctly separated from carapace by articular membrane. Eye large, with ventromesial anterior projection extending beyond cornea; eye extending to or almost to end of first segment of antennular peduncle, cornea terminal, large, occupying distal third of eye. Mxp-3 pediform, ischium with row of small spines on inner surface. Dorsal and ventral margins of both chelipeds cristate, smooth, unarmed; ischium and merus of both chelae with ventral spines, merus lack-

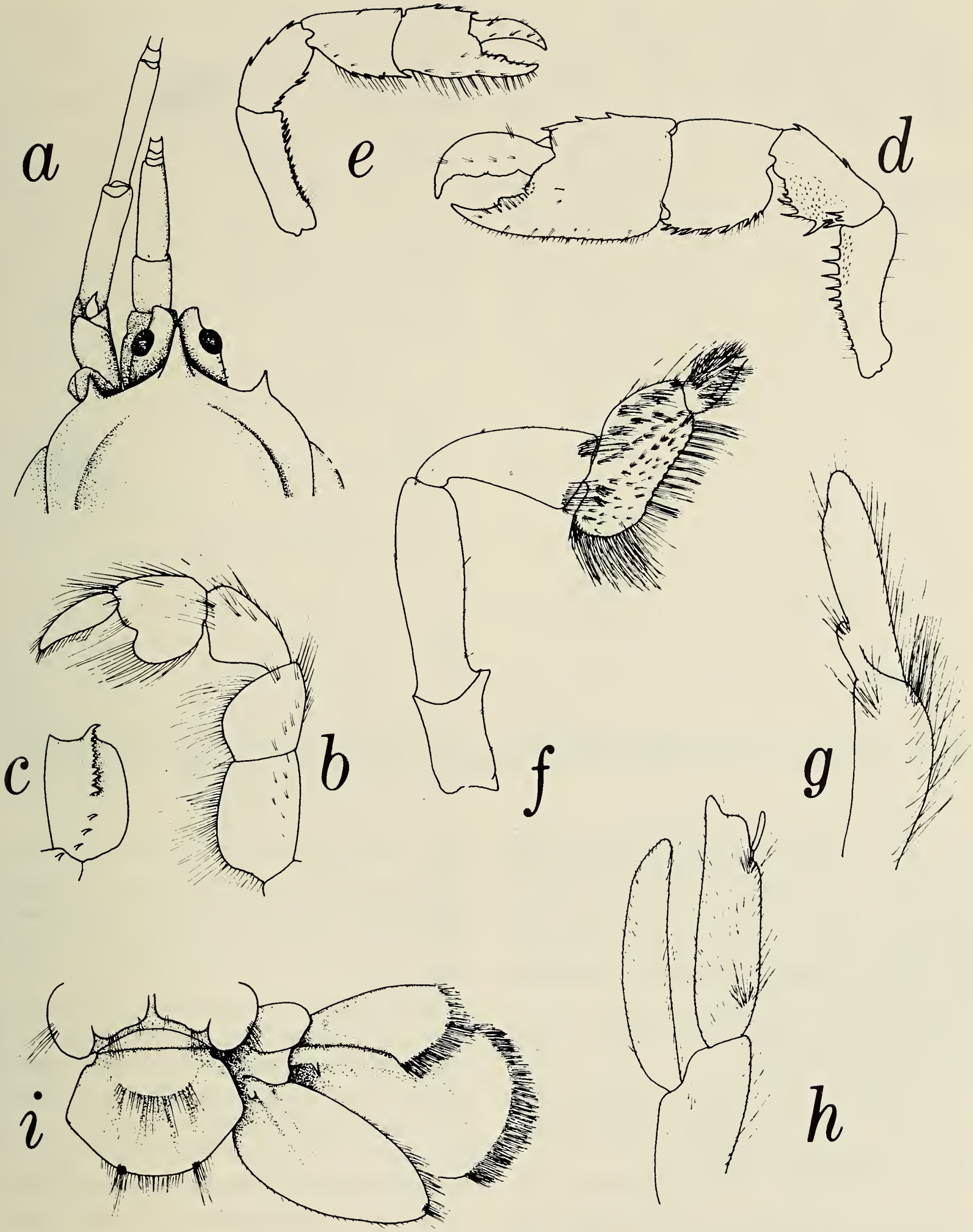

Fig. 5. *Glypturus acanthochirus* Stimpson, 1866. Male, Mauritius: a, Front; b, Third maxilliped; c, Inner face of ischium of third maxilliped; d, Major cheliped; e, Minor cheliped; f, Third pereopod; g, First pleopod; h, Second pleopod; i, Telson and uropod (from Kensley 1975).

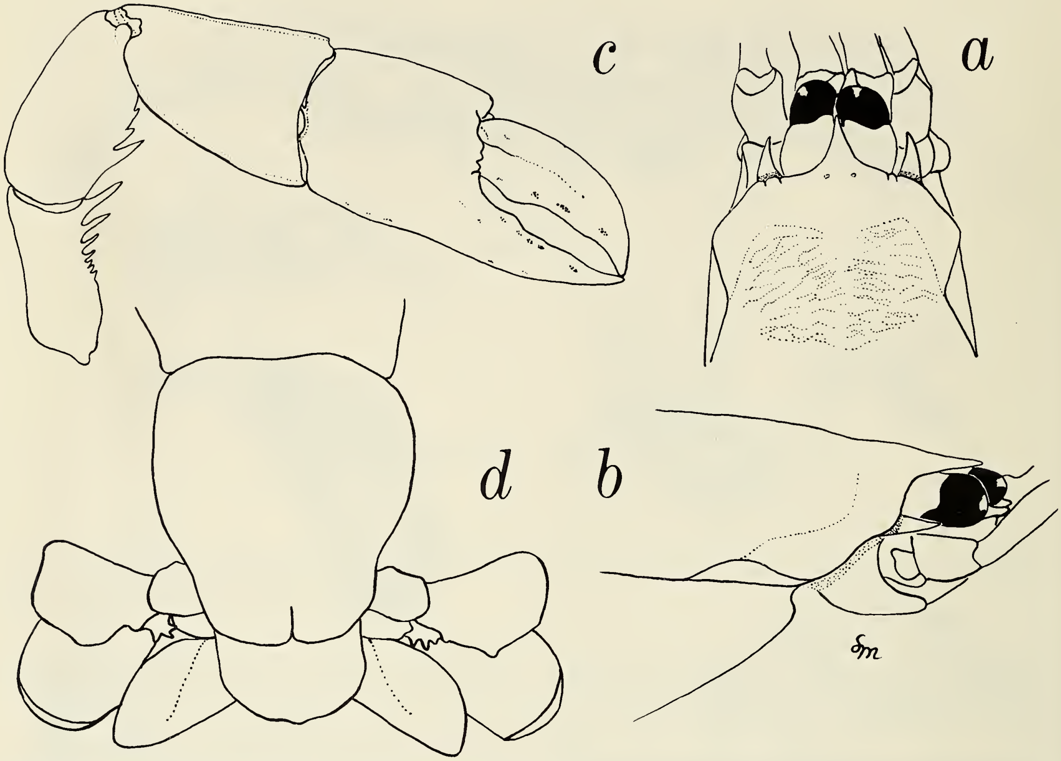

Fig. 6. *Corallianassa longiventris* (A. Milne Edwards, 1870). Male syntype, total length 46 mm, Martinique: a, Front, dorsal view; b, Front, lateral view; c, Minor cheliped; d, Sixth abdominal somite, telson, and uropods.

ing hook. Second abdominal somite long and slender, the longest abdominal somite, almost as long as sixth somite and telson combined. Sixth abdominal somite noticeably inflated. Telson shorter than uropods. Uropod setation all terminal.

Type species.—*Callianassa longiventris* A. Milne Edwards, 1870.

Etymology.—The name is derived from the Greek, korallion, coralline, and anassa, queen. The gender is feminine.

Included species.—Two, as follows:

Corallianassa longiventris (A. Milne Edwards) (1870:92).
Corallianassa borradailei (de Man) (1928a: 27), with *Callianassa oahuensis* Edmondson (1944:56), as its synonym.

Remarks.—The large eyes, with a large, well formed, distinct cornea, three-spined front, with the anteriolateral spines distinctly articulated, the chelipeds with a cristate carpus and propodus, and the long second abdominal somite, all are diagnostic for this genus.

Callianassa placida de Man (1928b:171) may belong here, but the cornea, from de Man's figure, appears to be less well developed, and, as de Man pointed out (1928b: 171), the second abdominal somite in *C. placida* is not longer than the sixth. The elongate second abdominal somite is shared by the two species here placed in *Corallianassa.*

If I had not been able to examine three specimens of *C. borradailei* from Hawaii in the collections of the British Museum (Natural History) [Registry number 1859:79], I might have synonymized both it and *C. borradailei* with *C. longiventris.* However, the chelipeds of the Indo-West Pacific species are quite different from those of *C. longiventris,* being more sharply carinate, with the dorsal carina on the palm extending distally into a distinct flange. The dorsal carina on the palm of *Corallianassa longiventris* is confined to the proximal third or so.

Figures are provided here for *Corallianassa longiventris,* based on the type (Fig. 6), and three for *Corallianassa borradailei,* one from Borradaile (1902) (Fig. 7), one from a specimen from Fiji (Fig. 8), and one based on a specimen from Hawaii (Fig. 9).

De Man (1928a:27), in his description of *Callianassa borradailei,* based on Borradaile's (1902:752, pl. 58, fig. 2) account of a specimen, now lost, from Goidu, Goifurfehendu Atoll, Maldive Archipelago, pointed out that *C. borradailei* differs from *C. longiventris* in having the carpus of the smaller cheliped as long as the palm; in the type *C. longiventris* proper, also examined by de Man (1928a:24), the palm of the smaller cheliped is shorter than the carpus. This is the condition in the type of *C. longiventris* from Martinique in the collection of the Muséum National d'Histoire Naturelle, Paris, which I examined and which is shown here in Fig. 6, as well as in the specimen illustrated by Biffar (1971a, fig. 14f). However, in other specimens from the Caribbean examined by me, the palm of the smaller cheliped may be subequal to or longer than the carpus. Apparently these proportions may vary, possibly with age. Assuming that these proportions do vary, I can find no difference between *C. borradailei* from the western Indian Ocean and *C. oahuensis* from Hawaii. In the figure of Borradaile's specimen from the western Indian Ocean (Fig. 7) the carpus of the second cheliped is equal to the palm, in the specimens examined from Fiji it is longer than the palm, and in Edmondson's account of *C. oahuensis* it is distinctly shorter than the palm.

In the collection of the Zoological Museum at Copenhagen there is a specimen of *Corallianassa borradailei* from Fiji. The specimen, obtained from the Paris Museum on exchange, was labelled "*Callianassa armata,* Insel Viti, Museum Godeffroy, Wroblewsky," and was filed in the collection as a type of *Callianassa longiventris.* It is shown here in Fig. 8.

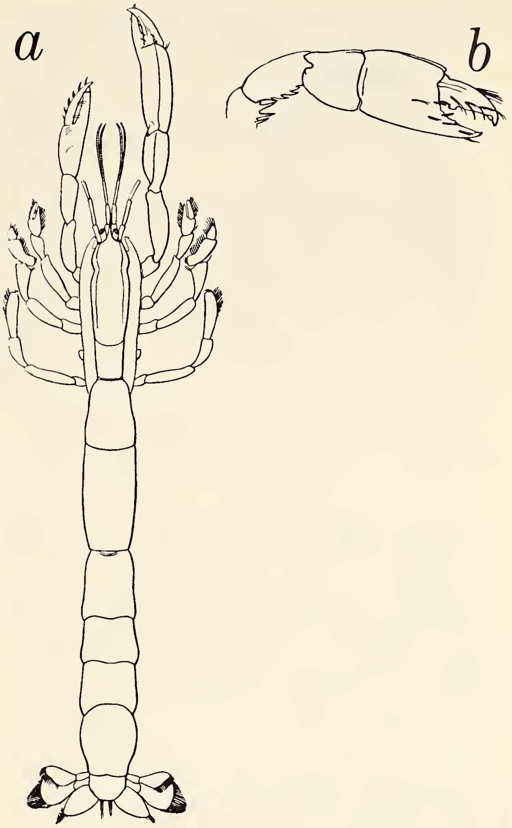

Fig. 7. *Corallianassa borradailei* (De Man, 1928). Holotype, Goifurfehendu Atoll: a, Dorsal view; b, Cheliped (from Borradaile 1902).

Hult (1938:7) and Schmitt (1939:15) identified specimens from the Galapagos Islands and Clipperton Island, respectively, with *Callianassa hartmeyeri* Schmitt, 1935, and Chace (1962:617), who also studied material from Clipperton Island, synonymized *C. hartmeyeri* Schmitt and *Callianassa oahuensis* Edmondson, 1944, as well, with *Callianassa placida* de Man, 1928. In my opinion the eastern Pacific specimens

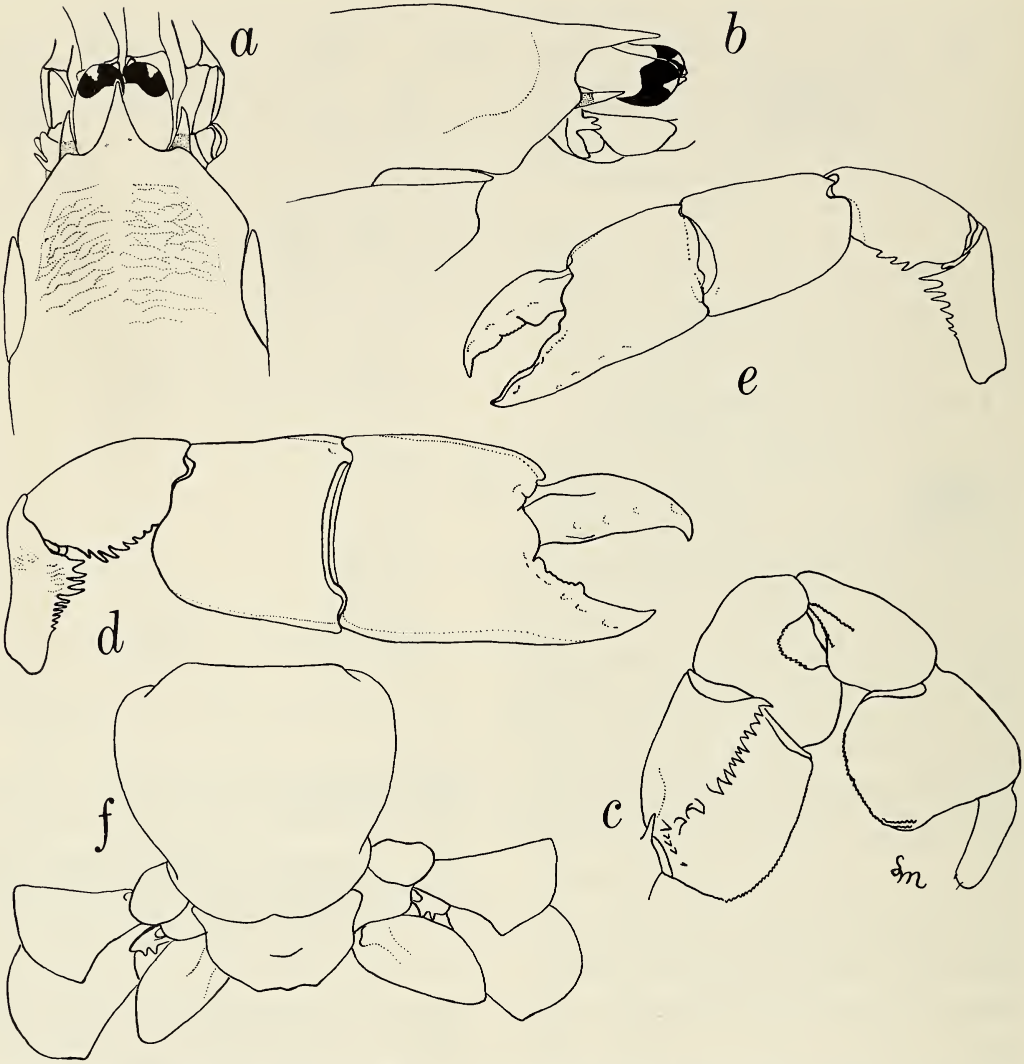

Fig. 8. *Corallianassa borradailei* (De Man, 1928). Ovigerous female, total length 62 mm, Fiji: a, Front, dorsal view; b, Front, lateral view; c, Third maxilliped; d, Major cheliped; e, Minor cheliped; f, Sixth abdominal somite, telson, and uropods.

reported by Hult, Schmitt, and Chace belong to an undescribed species of *Corallianassa.* An account of this species is in preparation.

I have seen no material of *Callianassa coutierei* Nobili (1906:110) from the Red Sea, but, judging by his account of the eyes, the three-spined front, and the relative lengths of the abdominal somites, that species could belong in *Corallianassa*; it may prove to be synonymous with *Corallianassa borradailei.*

Callianassa articulata Rathbun (1906: 892), from Hawaii, may belong in this genus, but it differs from the species placed here in the form of the telson and in the broader ischium and merus on the third maxilliped (see Edmondson's (1944:54) account).

Suchanek (1983) reported the occurrence

of *Corallianassa longiventris* in seagrass beds in shallow lagoons at St. Croix, U.S. Virgin Islands. He commented (p. 288) that rather than being deposit feeders, this species and *Glypturus acanthochirus* capture detrital seagrass and algae floating past their burrows. However, most records for members of *Corallianassa* are from reef, not lagoon, habitats. *Corallianassa longiventris* is very common on the reef flat at Carrie Bow Cay, Belize, where it forms burrows in very coarse coralline rubble. There it is easily attracted to the mouth of its burrow with pieces of conch or fish, and all of the specimens collected by D. L. Felder and myself were attracted to bait. They certainly are carnivorous, and this may be characteristic of the genus.

Members of *Corallianassa,* in contrast to members of *Callianassa,* are brightly colored, as reported by Biffar (1971a:689) for *C. longiventris,* Schmitt (1939:15, 16) for his material from Clipperton Island, and by Edmondson (1944:58) for his material from Hawaii. This, too, may be characteristic for the genus.

Checklist of Western Atlantic Callianassidae

Family Callianassidae Dana, 1852

Genus *Anacalliax* de Saint Laurent (1974: 515). Type species *Callianassa argentinensis* Biffar, 1971b, by original designation and monotypy. Western Atlantic species:

Anacalliax agassizi (Biffar) (1971b:233)

Anacalliax argentinensis (Biffar) (1971b: 229). [*Callianassa agassizi* Biffar was included in *Anacalliax* by de Saint Laurent and Le Loeuff (1979:79).]

Genus *Callianassa* Leach (1814:400). Type species *Cancer Astacus subterraneus* Montagu, 1808, by monotypy. Western Atlantic species:

Callianassa biformis Biffar (1971b:225)

Callianassa fragilis Biffar (1970:45)

Callianassa grandimana Gibbes (1850: 194)=*Glypturus branneri* Rathbun (1900: 150)=*Glypturus siguanensis* Boone (1927: 85)

Callianassa guara Rodrigues (1971:210)

Callianassa guassutinga Rodrigues (1971: 204)

Callianassa jamaicense Schmitt (1935:3, 9)

Callianassa louisianensis Schmitt (1935:12)

Callianassa marginata Rathbun (1901:92)

Callianassa minima Rathbun (1901:92)

Callianassa mirim Rodrigues (1971:214)

Callianassa rathbunae Schmitt (1935:4, 15)

Callianassa setimanus (DeKay) (1844: 34)=*Callianassa stimpsoni* Smith (1873: 549)=*Callianassa atlantica* Rathbun (1926:107)

Callianassa trilobata Biffar (1970:36)

Callianassa sp. Rabalais, Holt, and Flint (1981:106)

Genus *Calliax* de Saint Laurent (1974:514). Type species *Callianassa lobata* de Gaillande and Lagardère, 1966, by original designation and monotypy. Western Atlantic species:

Calliax quadracuta (Biffar) (1970:40). [*Callianassa quadracuta* Biffar was included in *Calliax* by de Saint Laurent and Le Loeuff (1979:95).]

Genus *Callichirus* Stimpson (1866:47). Type species *Callianassa major* Say, 1818, by original designation and monotypy. Western Atlantic species (see Manning and Felder 1986):

Callichirus major (Say) (1818:238)

Callichirus islagrande (Schmitt) (1935:3, 5)

Genus *Corallianassa,* new genus. Type species *Callianassa longiventris* A. Milne Edwards, 1870, by present designation. Included western Atlantic species:

Corallianassa longiventris (A. Milne Edwards) (1870:92)

Genus *Ctenocheles* Kishinouye (1926:63). Type species *Ctenocheles balssi* Kishinouye, 1926, by monotypy. Western Atlantic species:

Ctenocheles holthuisi Rodrigues (1978:113)

Ctenocheles leviceps Rabalais (1979:295)

Ctenocheles A Holthuis (1967:379)

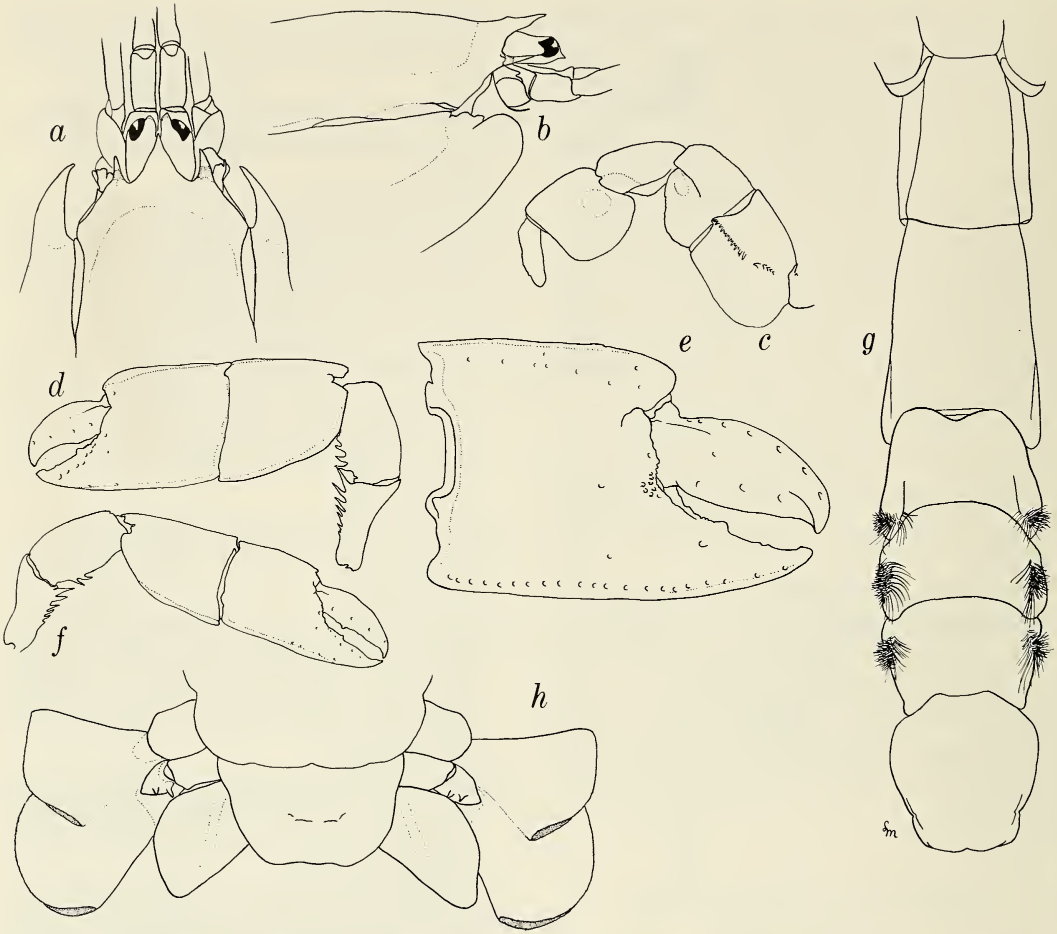

Fig. 9. *Corallianassa borradailei* (De Man, 1928). Female, total length 72 mm, Hawaii: a, Front, dorsal view; b, Front, lateral view; c, Third maxilliped; d, Major cheliped; e, Inner face of major chela; f, Minor cheliped; g, Abdomen; h, Telson and uropods.

Ctenocheles B Holthuis (1967:382)

Genus *Glypturus* Stimpson (1866:46). Type species *Glypturus acanthochirus* Stimpson, 1866, by monotypy. Western Atlantic species:

Glypturus acanthochirus Stimpson (1866: 46)=*Callianassa armata* A. Milne Edwards (1870:90)

Genus *Gourretia* de Saint Laurent (1974: 514). Type species *Callianassa subterranea* var. *minor* Gourret, 1887, by original designation and monotypy. *Callianassa minor* Gourret, 1887 is a junior homonym of *Callianassa minor* Fischer, 1886; it was renamed *Gourretia serrata* by de Saint Laurent, in de Saint Laurent and Le Loeuff (1979:79, footnote). Western Atlantic species:

Gourretia latispina (Dawson) (1967:190). [Transferred to *Gourretia* by de Saint Laurent and Le Loeuff (1979:79). Those authors note (p. 79) that there are two undescribed species of *Gourretia* in the western Atlantic.]

"Incertae Sedis":

Callianassa batei Borradaile (1903:546). [A replacement name for *Cheramus occidentalis* Bate (1888:32), which, when transferred to *Callianassa* by Borradaile (1903), became a junior homonym of *Callianassa occidentalis* Stimpson, 1856 (itself a subjective junior synonym of *Callianassa californiensis* Dana, 1852) as well as of *Callianassa occidentalis* Bate, 1888.]

Callianassa hartmeyeri Schmitt (1935:3, 4) [A replacement name for *Glypturus grandimanus* sensu Balss (1924:179). *Callianassa hartmeyeri* was synonymized with *Callianassa placida* de Man, 1928, by Chace (1962:617). Chace's material of *Callianassa placida* is, in my opinion, an undescribed species, and I can find no material or other records of *C. placida* from the western Atlantic. Until Balss' specimen can be restudied, the identity of this species remains in doubt.]

Callianassa occidentalis Bate (1888:29) [Preoccupied by *Callianassa occidentalis* Stimpson, 1856. See Schmitt (1935:3) and Biffar (1971a:649) for comments on the status of both of Bate's species.]

Acknowledgments

L. B. Holthuis reminded me of the account of *Gonodactylus setimanus* DeKay and of the probable identity of that species with *Callianassa atlantica* Rathbun. I thank R. W. Ingle, British Museum (Natural History), London, Torben Wolff, Zoological Museum, Copenhagen, and Alain Crosnier and D. Guinot, Muséum National d'Histoire Naturelle, Paris, who loaned material or provided working space during visits to their institutions. Austin B. Williams reviewed the manuscript, for which I thank him. This work was carried out at the Smithsonian Marine Station at Link Port, Florida, and is contribution number 194 from that station. The help of William D. Lee, Smithsonian Marine Station, in the field and laboratory is gratefully acknowledged. The illustrations were prepared by Lilly King Manning.

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PHREATOCERAS, A NEW NAME FOR *HADOCERAS* HERSHLER AND LONGLEY, 1986 (GASTROPODA) *NON* STRAND, 1934 (CEPHALOPODA)

Robert Hershler and Glenn Longley

Hershler and Longley (1986) erected the new genus *Hadoceras* (type species *H. taylori* Hershler and Longley, 1986) for recent phreatic Hydrobiidae from south-central Texas. Strand (1934) previously used the name *Hadoceras* for Upper Ordovician cephalopods. *Hadoceras* Hershler and Longley, 1986 is therefore a junior homonym of *Hadoceras* Strand, 1934, and requires a new name.

We propose the new name *Phreatoceras* to replace *Hadoceras* Hershler and Longley, 1986, non Strand, 1934. *Phreatoceras* is derived from the Greek words *phrear* (meaning well or reservoir) and *keras* (meaning horn), and refers to the subterranean habitat and distinctive horn-like shell of this taxon.

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A NEW, ECONOMICALLY IMPORTANT CRAYFISH (DECAPODA: CAMBARIDAE) FROM THE NECHES RIVER BASIN, TEXAS, WITH A KEY TO THE SUBGENUS *FALLICAMBARUS*

Horton H. Hobbs, Jr., and Mike Whiteman

Abstract.—*Fallicambarus* (*F.*) *devastator,* a new burrowing species, is described from Angelina County, Texas. One of only three members of the genus in which the males possess hooks on the ischia of the third and fourth pereiopods, it may be distinguished from the other two, *F.* (*F.*) *dissitus* Penn and *F.* (*F.*) *macneesei* Black, in lacking a spine on the lateral margin of the mesial ramus of the uropod.

The existence of this economically important crayfish came to the attention of the first author through an Associated Press article appearing in the *Cumberland Times/ News* (Cumberland, Maryland, on 15 May, 1986) that was sent to him by a former companion on field trips, Robert H. Gilpin. Correspondence with the second author, whose name was mentioned in the article, resulted in the subsequent arrival at the Smithsonian Institution of a series of specimens of this crayfish collected at the municipal airport at Lufkin, Texas. Much to our surprise, it belongs to a previously undescribed species. Because of its being a local seasonal nuisance and its negative impact on farming in what is believed to be a large segment of the Neches River basin, methods are being sought to control this burrowing species that in some areas is responsible for constructing over 25,000 earthen mounds per acre.

Even though there seems to be little reason to believe that other crayfishes are responsible for the devastation wrought on farm lands and lawns throughout much of the Neches Basin, the identities of populations other than that represented in the description herein must await a survey planned for the coming months. A more complete report on the geographical and ecological distribution of the species with observations on population density and habits is anticipated to result from the proposed survey.

The name proposed for this crayfish reflects the respect that it has commanded from local farmers and other residents who garden or cultivate lawns.

Fallicambarus (*Fallicambarus*) *devastator,* new species
Figs. 1, 2

Diagnosis.—Antennal scale reduced but with acute apical spine slightly overreaching basal article of antennular peduncle; ventral surface of propodus of cheliped lacking row of stiff setae along lateral margin; 2 ventral rows of tubercles on merus of cheliped clearly defined; mesial ramus of uropod lacking distomedian and distolateral spines, or, if distomedian spine present, minute and not nearly reaching apex of ramus; both rami subacute to acute distally. Telson without transverse suture but with pair of oblique incisions. Coxa of fourth pereiopods of male with very strong caudomesial boss having almost straight caudoventral margin; ischia of third and fourth pereiopods with hooks,

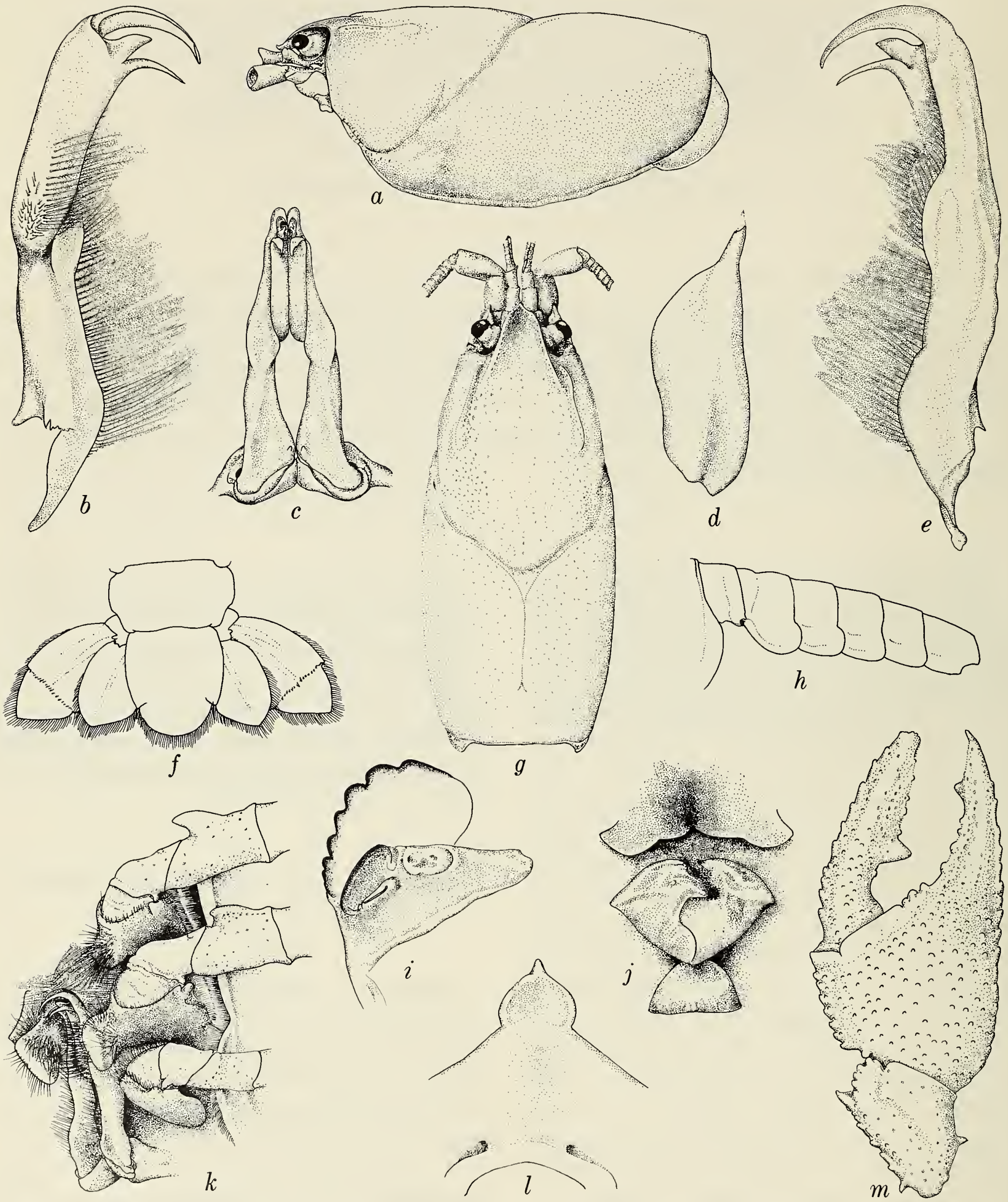

Fig. 1. *Fallicambarus* (*F.*) *devastator* (all from holotype except f and j which from allotype): a, Lateral view of cephalothorax; b, Mesial view of first pleopod; c, Caudal view of first pleopods; d, Right antennal scale; e, Lateral view of first pleopod; f, Dorsal view of caudal part of abdomen; g, Dorsal view of cephalothorax; h, Lateral view of abdominal segments; i, Cephalic view of mandible; j, Annulus ventralis and adjacent sternal features; k, Ventrolateral view of basal podomeres of third, fourth, and fifth pereiopods and first pleopods; l, Epistome; m, Dorsal view of distal podomeres of first pereiopod.

that of third opposed by very weak tubercle on basis. Chela almost twice as long as wide and palm with length of mesial margin only slightly more than half its width. First pleopod of first form male arched and bearing comparatively strongly developed, caudodistally-directed cephalic process; mesial process spiculiform, strongly curved at base with apical two-thirds almost straight and directed subcaudally; central projection strongly arched, scythelike, with apex directed proximally. Annulus ventralis broadly excavate anteriorly, not obscuring postannular sclerite in ventral aspect. Areola obliterated to linear, ranging from 37.7 to 40.5 percent of carapace length and 43.0 to 45.8 percent of postorbital carapace length.

Holotypic male, form I.—Body suboval, somewhat compressed laterally (Fig. 1a, g). Abdomen narrower than thorax (13.6 and 18.9 mm). Greatest width of carapace distinctly posterior to caudodorsal extremity of cervical groove and only slightly less than height (18.9 and 19.1 mm). Areola linear over most of its length and comprising 39.4 percent of entire length of carapace (44.4 percent of postorbital carapace length). Rostrum with convergent, only slightly thickened margins contracting anteriorly, forming short, indistinctly delimited, triangular acumen, apex of which corneous, slightly upturned, and extending just beyond proximal margin of penultimate podomere of antennular peduncle. Dorsal surface of rostrum strongly concave, particularly in anterior region, with submarginal rows of setiferous punctations and few scattered ones between. Subrostral ridges well developed and evident in dorsal aspect, but scarcely so, to base of acumen. Postorbital ridge well defined anteriorly, but sclerotized anterior crest rather short; posterior swelling clearly evident. Suborbital angle obsolete. Branchiostegal and cervical spines absent. Carapace punctate dorsally and anterolaterally, weakly granulate over ventral half of branchiostegites; extreme anteroventral branchiostegal region inflated, with distinct row of 8 or 9 closely-set tubercles on ventral flank of cervical groove, and 3 or 5 on dorsal flank.

Abdomen (Fig. 1h) shorter than carapace (36.8 and 43.1 mm); pleura very short and broadly rounded ventrally, only that of sixth segment with angular caudoventral margin; pleuron of first abdominal segment only slightly overlapped by that of second. Telson of holotype marred by injury in prior instar (see illustration of allotype in Fig. 1f); cephalic section without spines, but set off from caudal section by oblique shallow incisions and sutures; entire dorsal surface with setiferous punctations. Proximal podomere and both rami of uropod without spines except along diaresis of lateral rami, and apical part of rami strongly tapering distally, forming subacute tips; median ribs well developed but that of neither ramus reaching distal margin.

Cephalomedian lobe of epistome (Fig. 1l) submucronate and rather deeply excavate ventrally; main body long, with median area weakly depressed but lacking fovea. Ventral surface of proximal podomere of antennule with median spine slightly distal to midlength. Antennal peduncle without spines, flagellum reaching midlength of sixth abdominal segment. Antennal scale (Fig. 1d) approximately 3 times as long as broad, widest distal to midlength, and with irregular, but subparallel, mesial and lateral margins; mesiodistal margin broadly rounded. Structure of mandible depicted in Fig. 1i. Ventral surface of ischium of third maxilliped with lateral row of fine, very short setal tufts, mesial sector with 2 irregular longitudinal bands of stiff setae and few patches between bands; more lateral band made up of staggered clusters.

Right chela (Fig. 1m) approximately twice as long as broad, strongly depressed; mesial margin of palm slightly longer than half width of palm and bearing row of 7 (left with 6) tubercles subtended dorsolaterally by row of 6 smaller ones, and ventrolaterally by unevenly spaced row of 4 (evenly spaced on left); dorsal surface of palm and basal part of fingers studded with squamous tubercles; tubercles along lateral margin of chela forming subserrate row extending from near proximal extremity to base of distal fourth of fixed finger; ventral surfaces of palm, basal third of fixed finger, and basal half of dactyl mostly tuberculate, both fingers with more prominent punctations than tubercles distoventrally, there flanking, and, in part disrupting, weak median longitudinal ridges; prominent tubercle on oblique ventral ridge opposite base of dactyl. Opposable margin of fixed finger with row of 8 tubercles (10 on left); distalmost very small and situated in distal fourth of finger beyond largest tubercle, 3 subjacent tubercles forming proximal cluster opposing basal concavity on dactyl; single row of minute denticles between largest tubercle and base of corneous tip of finger. Opposable margin of dactyl with small tubercle in distal part of proximal concavity followed by very large tubercle at distal end of concavity; apical part of right cheliped broken but left with row of 8 much smaller tubercles between large tubercle and base of distal seventh of finger; single row of minute denticles (interrupted by just-mentioned tubercles) extending from major tubercle to corneous tip of finger.

Carpus of cheliped bearing poorly delimited, submedian, sinuous, longitudinal furrow dorsally, flanked mesially by punctations and tubercles and laterally by scattered punctations; mesial surface tuberculate; dorsomesial angle bearing row of 6 tubercles, distalmost of which lying at base of prominent spurlike tubercle at dorsal distomesial angle of podomere; ventral surface devoid of tubercles except for 2 prominent ones on distal margin, one mesially and other associated with distolateral articular condyle; lateral surface sparsely punctate. Merus weakly serrate dorsally, three distalmost serrations in form of spiniform tubercles; mesial and lateral surfaces punctate; ventral surface with mesial row of 17 (left with 15) tubercles and lateral one of 13; few additional small tubercles adjacent to rows. Mesioventral margin of basioischial podomere with row of 3 inconspicuous tubercles distal to fracture suture; compound podomere otherwise with scattered punctations. Chela of second pereiopod with marginal row of setae on palm, and carpus with dorsal row of long setae; mesial surface of propodus and carpus lacking tufts of plumose setae.

Ischia of third and fourth pereiopods (Fig. 1k) with simple hooks; that of third overreaching basioischial articulation and both opposed by small, inconspicuous tubercle on corresponding bases; hook on fourth pereiopod less prominently produced, not reaching basioischial articulation and not opposed by tubercle on basis. Coxa of fourth pereiopod with massive boss having almost straight, rather than arched caudoventral margin, compressed laterally, and disposed in longitudinal plane of body; mesial and lateral surfaces of boss with setiferous punctations. Coxa of fifth pereiopod lacking boss but with setiferous ventral membrane where some of setae arranged in mesially convergent rows (similar rows also present in *F.* (*F.*) *harpi* and in *F.* (*F.*) *jeanae,* but less conspicuous in former).

First pleopods (Fig. 1b, c, e) reaching coxae of third pereiopods, carried deeply in sternum, and largely concealed by setae extending from ventral margin of sternum and from coxae of third and fourth pereiopods. Proximomesial spur very weak. Shaft of appendages inclined through gentle arc; terminal elements acute to subacute; flattened, tapering, acute mesial process strongly curved near base, directed caudally; cephalic process, in form of corneous-edged, short blade, arising immediately cephalomesial to mesial process, disposed caudodistally, not reaching arched, subspiculiform, corneous central projection, which also directed caudally with apex pointing proximally toward base of appendage; tip of central projection slightly overreaching that of mesial process. Plumose setae extending caudally from more distal level than in most crayfishes: series projecting from lateral superficial fold extending almost to base of distal fifth of appendage (setae similarly, but less conspicuously, disposed in *F.* (*F.*) *harpi,* not quite so far in *F.* (*F.*) *dissitus* and *F.* (*F.*) *jeanae*).

Allotypic female.—Differing from holotype in other than secondary sexual characteristics as follows: acumen reaching midlength of penultimate article of antennular peduncle; 2 or 3 small tubercles in positions occupied by cervical spines in some species of crayfishes; left anteroventral branchiostegal region with row of only 6 tubercles; main body of epistome with fovea little larger than punctations on adjacent antennal peduncles; spine on ventral surface of proximal podomere of antennular peduncle reduced to small tubercle, that on left rudimentary; opposable margin of fixed finger of chela with row of 9 (right) and 7 (left) tubercles distal to major tubercle; dorsomesial surface of carpus with row of 6 (right) or 5 (left) tubercles; ventral surface of merus of right cheliped with mesial row of 16 (left 15) and lateral one of 11 (left 12).

Annulus ventralis (Figs. 1j, 2e) deeply imbedded in sternum, 1.5 times as broad as long and firmly fused to sternite anterior to it. Region anterior to transverse ridge with oblique, caudosinistrally directed furrow leading to fossa; sinus arising in fossa and extending dextrally across median line where almost completing hairpin turn before following gentle arc almost to apex of submedian posterior angle of annulus. Postannular sclerite in form of half oval, about 0.5 length and almost 0.6 width of annulus; rounded anterior section strongly dorsally inclined. Features of thoracic sternal elements and basal podomere/s of pereiopods depicted in Fig. 2e.

Morphotypic male, form II.—Differing from holotype in other than secondary sexual characteristics as follows: Rostrum with anterosinistral margin slightly disfigured, but margins gently converging anteriorly, not setting off acumen, apex reaching midlength of penultimate podomere of antennular peduncle; cephalic section of telson with small, movable spine at caudodextral angle and minute one at caudosinistral angle; 3 or 5 tubercles in ventrolateral row flanking mesial series on palm of chela; both dorsal and ventral longitudinal ridges on fingers prominent; opposable margin of fixed finger with row of 9 (right) and 11 (left) tubercles; proximal concavity on opposable margin of dactyl without tubercles; tubercles of dorsal row on merus very weak, numbers in ventral row within ranges occurring in holotype; basioischial podomere with 2 (left) and 4 (right) tubercles, respectively; hooks on ischia of neither third nor fourth pereiopods reaching basioischial articulation, distinctly weaker than those in holotype, and boss on coxa of fourth pereiopod less robust.

First pleopod (Fig. 2b, c) with shaft much like that of holotype, but proximomesial spur moderately well developed, and setae (not illustrated) neither so long nor so conspicuously plumose; terminal elements noncorneous; mesial process less flattened than in holotype but of similar mien and disposition; cephalic process reduced to small, subtriangular, acute prominence pressed against mesial base of central projection and not evident in lateral aspect of appendage; central projection, largest of terminal elements and much more robust than that in holotype, disposed as in latter, but shorter, much less slender, and abutting base of mesial process.

Color notes.—(Based on recently molted second form male that had been in alcohol for about 14 days.) Ground color of carapace pale pinkish lavender, fading ventrally almost to cream; rostrum with pale brownish suffusion; margins of acumen and crest of postorbital ridges burgundy. Gastric region with broad transverse burgundy band abutting cervical groove, and pair of similarly colored small spots short distance anterior to band; pair of paler, larger, but much less sharply delimited spots marking pos-

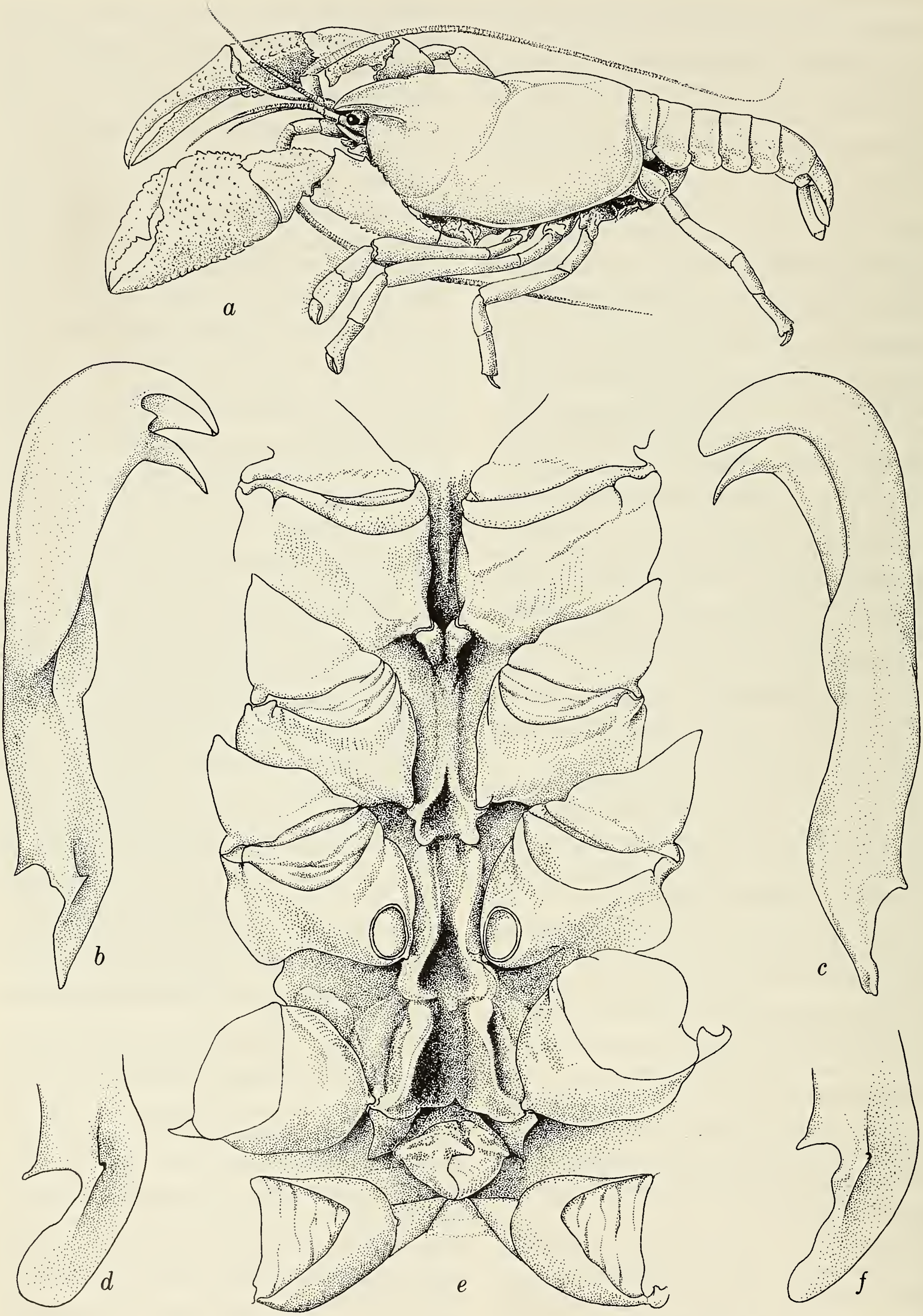

Fig. 2. *Fallicambarus* (*F.*) *devastator*: a, Dorsolateral view of paratypic male, form I; b, Mesial view of first pleopod of morphotype; c, Lateral view of first pleopod of morphotype; d, f, Mesial view of basal part of left first pleopods of paratypic first form males; e, Ventral view of sternal elements of thoracic region of allotype.

terior tumescences of postorbital ridges, and another more mesial pair between latter. Anterodorsal margin of branchiostegites with very narrow burgundy band broadening medially where spanning anterior wedge of areola; similarly colored narrow band on posterodorsal margin of carapace. Abdomen also pale pinkish lavender; caudal margins of terga with hair line of burgundy. Cheliped with merus cream basally, gradually becoming suffused with pinkish lavender distally, and with brownish blush along dorsal subserrate ridge broadening distally; carpus also basically pinkish lavender but with straw brown suffusion dorsomesially, tubercles burgundy, larger ones with pale tips; dorsomesial face of chela with palm and basal part of dactyl pinkish lavender to purplish; fingers fading to pale blue distally, and palm and lateral part of fixed finger fading to cream laterally; most dorsal tubercles situated mesiad of cream, subserrate lateral row dark purple to dark brown, some of larger ones with pale tips; ventral surface of all mentioned podomeres pinkish to cream. Remaining pereiopods with pinkish to pale blue blush dorsally, pinkish to almost cream ventrally.

Size.—The largest specimen examined is a female having a carapace length of 50.5 (postorbital carapace length 44.7) mm. The smallest first form male, the holotype, has corresponding lengths of 43.1 and 38.2 mm, respectively. Neither ovigerous females nor ones carrying young are available for determining measurements.

Type locality.—Prairie grass-land at Angelina County Airport in Burke Community, about 5 miles (8 km) south of Lufkin, Angelina County, Texas.

Disposition of types.—The holotype, allotype, and morphotype (USNM 218546, 218547, and 218548, respectively) are deposited in the National Museum of Natural History, Smithsonian Institution, as are the paratypes consisting of 2 ♂ I, 7 ♂ II, and 10 ♀.

Range and specimens examined.—All of the specimens available were collected at the type locality by the second author on 23 October, 1986 (1 ♂ I, 10 ♀), and 24 November, 1986 (2 ♂ I, 8 ♂ II, 1 ♀).

Table 1.—Measurements (mm) of *Fallicambarus* (*F.*) *devastator.*

	Holotype	Allotype	Morphotype
Carapace:			
Entire length	43.1	49.1	43.0
Postorbital length	38.2	43.0	37.7
Width	18.9	21.8	19.2
Height	19.1	21.6	19.0
Areola:			
Width	0	0	0
Length	17.0	18.5	16.7
Rostrum:			
Width	6.2	7.2	5.9
Length	6.4	7.6	6.0
Right chela:			
Length, palm mesial margin	9.1	9.7	8.0
Palm width	16.3	18.9	15.3
Length, lateral margin	32.4	36.3	32.6
Dactyl length	broken	28.5	24.6
Abdomen:			
Width	13.6	14.9	12.6
Length	36.8	43.0	36.3

Variations.—The shape of the rostrum varies considerably: the margins may converge gently from a broad base to the apex, the acumen merging imperceptibly with the basal part, or the base of the acumen may be marked by almost an angle where the degree of convergence of the margins increases rather suddenly. The uninjured apex in all recently molted individuals consists of a corneous, acute, upturned tubercle, but the tip is apparently abraded during the intermolt stages, and in some individuals there is no indication of a dorsal attitude assumed by the apex. The basal segment of the antennule may or may not bear a spine on the ventral surface. The distomesial margin of the lamelliform part of the antennal scale may be rounded or straight, extending proximomesially from the base of the distolateral spine in a straight line; the spine, itself subject to abrasion, is quite variable in size, sometimes not reaching the distal margin of the basal article of the antennular peduncle. The anterior section of the telson may or may not possess a small movable spine at the caudolateral angle; the fixed, more laterally situated spine present in most other cambarids is absent. The dorsomedian ridge of the mesial ramus of the uropod may or may not end in a weak spine; if present, it never reaches the distal margin of the ramus. A row of six or seven tubercles is characteristic of the mesial margin of the palm of the chela as is a cluster, sometimes arising from a common tumescence, of two or three tubercles near the opposable base of the fixed finger. The excavation on the basal part of the opposable margin of the dactyl may or may not bear a small tubercle that lies immediately proximal to the conspicuous tubercle marking the distal extremity of the excavation. Of the three first form males available, only in the holotype are the central projections of both first pleopods entire; in one of the specimens, the projection on the left appendage is broken near the base, that on the right is quite short and clearly pointed, but it is very dark, suggesting that an injury, and perhaps an infection, was responsible for what is believed to be an abnormality. In the other specimen, the central projection of the sinistral appendage is torn. The mesial process is also subject to variation, perhaps influenced by injury, for in one specimen instead of tapering to a single apex it ends in three short spines.

Relationships.—Of the six species recognized herein as belonging to the nominate subgenus, *Fallicambarus* (*F.*) *devastator* probably has its closest affinities with *F.* (*F.*) *strawni* (Reimer, 1966), *F.* (*F.*) *macneesei* (Black, 1967), and *F.* (*F.*) *harpi* Hobbs and Robison (1985). Among the similarities existing among them is a moderately- to well-developed cephalic process on the first pleopod of the first form male, a primitive feature shared with no other species of the genus. Only in *F.* (*F.*) *macneesei, F.* (*F.*) *dissitus* (Penn, 1955), and *F.* (*F.*) *devastator* do the males possess hooks on the ischia of the third and fourth pairs of pereiopods, and *devastator* is easily distinguished from the other two by lacking distolateral spines on the mesial ramus of the uropods. The cheliped of *F.* (*F.*) *devastator* resembles that of *F.* (*F.*) *harpi* in that the gape at the base of the dactyl is opposed by a prominent tubercular cluster on the fixed finger rather than by a single conspicuously large tubercle as is present in *F.* (*F.*) *jeanae* Hobbs (1973) and *F.* (*F.*) *spectrum* Hobbs (1973). All of the members of the subgenus *Fallicambarus* possess a proximomesial spur on the first pleopod of the first form male, but the latter, which is especially conspicuous in *dissitus,* is, by comparison, almost rudimentary in available first form males of *devastator* (Fig. 2d, f). The distally pointed mesial ramus and the distal unit of the lateral ramus of the uropod are more nearly triangular in *devastator* than in any other species of the genus and represent extreme departures from the more rounded to subtruncate generalized condition found in other congeners.

Remarks.—All of the specimens at hand were obtained on warm, rainy nights when they were either at the mouth of a burrow or wandering about the grassy area. Perhaps as many as 100 individuals, including mostly young having total lengths of approximately 25 to 40 mm, were seen in an area of about 1000 square feet (90 m^2). All eight of the second form males had clean exoskeletons, suggesting a recent molt, that contrast conspicuously with the crusty ones of the three first form males.

Key to the Crayfishes of the Subgenus *Fallicambarus*

1. Mesial ramus of uropod with distolateral spine 2
– Mesial ramus of uropod without distolateral spine 3
2. Distomedian spine on mesial ramus

of uropod not reaching distal margin of ramus .... *dissitus*
- Distomedian spine on mesial ramus of uropod extending much beyond distal margin of ramus .... *macneesei*

3. Telson lacking lateral incision, no trace of transverse suture ..... *strawni*
- Telson with shallow lateral incision and at least paired oblique lateral sutures 4

4. Hooks on ischia of third and fourth pereiopods; both rami of uropods tapering distally to subangular apex .... *devastator*
- Hooks on ischia of third pereiopods only; both rami of uropods rounded distally 5

5. First pleopod of first form male with cephalic process .... *harpi*
- First pleopod of first form male lacking cephalic process ....*jeanae*

[*Fallicambarus* (*F.*) *spectrum* Hobbs (1973) is here considered to be a color morph of *F.* (*F.*) *jeanae.*]

Acknowledgments

We extend our thanks to the personnel of the Texas Agricultural Extension Service for their cooperation and encouragement and to Robert H. Gilpin of Cumberland, Maryland, for his part in arousing the interest of the first author in the crayfish described herein. For their criticisms of the manuscript appreciation is expressed to Joseph F. Fitzpatrick, Jr., of the University of South Alabama, Raymond B. Manning of the Smithsonian Institution, and Douglas G. Smith of the University of Massachusetts.

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INTERNATIONAL COMMISSION ON ZOOLOGICAL NOMENCLATURE

% British Museum (Natural History)
Cromwell Road,
London, SW7 5BD

8 October 1986

The following applications have been received by the Commission and have been published in volume 43, part 3, of the *Bulletin of Zoological Nomenclature* (6 October, 1986). Comment or advice on them is welcomed and should be sent % The British Museum (Natural History), London, England. Comments will be published in the *Bulletin.*

Case No.
2536 *Rhabdodon* Matheron, 1869 (Reptilia, Ornithischia): proposed conservation by suppression of *Rhabdodon* Fleischmann, 1831 (Reptilia, Serpentes).
2512 *Megalonaias* Utterback, 1915 (Mollusca, Bivalvia): proposed conservation by the suppression of *Magnonaias* Utterback, 1915.
2460 *Ammonites neubergicus* Hauer, 1858 (Cephalopoda, Ammonoidea): proposed conservation by the suppression of *Ammonites chrishna* Forbes, 1846.
2520 *Corixa albifrons* Motschulsky, 1863 (Insecta, Heteroptera): proposed confirmation of neotype designation.
2252 *Dexia* Meigen, 1826 (Insecta, Diptera): proposed designation of *Musca rustica* Fabricius, 1775, as type species.
2562 *Lepralia punctata* Hassall, 1841 (Bryozoa, Cheilostomata): proposed designation of a replacement neotype.
2557 PSEUDOCALANIDAE Sars, 1901 (Crustacea, Copepoda): proposed precedence over CLAUSOCALANIDAE Giesbrecht, 1892.
2565 *Geonemus* Schoenherr, 1833 and *Brachyomus* Lacordaire, 1863 (Insecta, Coleoptera): proposal to maintain current usage by designation of a type species of *Geonemus.*
2524 *Phaulacridium vittatum* (Sjöstedt, 1920) (Insecta, Orthoptera): proposed conservation by suppression of *Acridium ambulans* Erichson, 1842, *Trigoniza manca* Bolívar, 1898 and *Trigoniza australiensis,* Bolívar, 1898.
2528 *Phisis* Stål, 1861 and *Teuthras* Stål, 1874 (Insecta, Orthoptera (Grylloptera)): confirmation of *Listroscelis pectinata* Guérin [-Méneville] 1831 as type species.
2513 Proposed amendments to the Code introducing the term ‘Nomenclaturally valid’: a useful new term in nomenclature.
2529 *Taeniolabis* Cope, 1882 (Mammalia, Multituberculata): proposed designation of *Polymastodon taoensis* Cope, 1882 as type species.

P. K. TUBBS
Executive Secretary

INTERNATIONAL COMMISSION ON ZOOLOGICAL NOMENCLATURE

% British Museum (Natural History)
Cromwell Road,
London, SW7 5BD

18 December 1986

The following applications have been received by the Commission and have been published in volume 43, part 4, of the *Bulletin of Zoological Nomenclature* (11 December, 1986). Comment or advice on them is welcomed and should be sent % The British Museum (Natural History), London, England. Comments will be published in the *Bulletin.*

Case No.
2439 *Liasis* Gray, 1842 (Reptilia, Serpentes): proposed designation of *Liasis mackloti* Duméril & Bibron, 1844 as type species.
2508 *Filellum serpens* (Hassall, 1848) (Cnidaria, Hydrozoa): proposed conservation of both generic and specific names.
2426 *Lycaena mirza* Plötz, 1880 (Insecta, Lepidoptera): proposed conservation by the suppression of *Lycaena mirza* Staudinger, 1874.
2574 *Paraphytomyza* Enderlein, 1936 (Insecta, Diptera): proposed designation of *Phytagromyza luteoscutellata* de Meijere, 1924 as type species.
2447 *Heriaeus* Simon, 1875 (Arachnida, Araneida): request for confirmation of *Thomisus hirtus* Latreille 1819 as type species.
2580 *Trypanosoma brucei* Plimmer & Bradford, 1899 (Protozoa, Mastigophora): proposed confirmation of spelling.
2560 *Simulium austeni* Edwards, 1915 (Insecta, Diptera): proposed precedence over *Simulia posticata* Meigen, 1838.
2394 *Simulia ferruginea* Wahlberg, 1844 (Insecta, Diptera): proposed precedence over *Simulia rufa* Meigen, 1838 and *Simulia borealis* Zetterstedt, 1842.
2571 *Belemnites paxillosa* Lamarck, 1801 (Mollusca, Coleoidea): proposed suppression of both generic and specific names.
2566 *Cobitis* Linnaeus, 1758 (Osteichthyes, Cypriniformes): proposed designation of *Cobitis taenia* Linnaeus, 1758 as type species and request for a ruling on the stem of the family-group name COBITIDIDAE Swainson, 1839.
2575 *Tribolium castaneum* (Herbst, 1797) (Insecta, Coleoptera): proposed conservation by the suppression of *Tribolium navale* (Fabricius, 1775).
2438 *Cornalatus* Attems, 1931 (Diplopoda, Polydesmida): proposed designation of *Cornalatus permutatus* Attems, 1938 as type species.
2561 *Opius* Wesmael 1835 (Insecta, Hymenoptera): proposed designation of *Opius pallipes* Wesmael, 1835 as type species.
2572 *Leptura marginata* Fabricius, 1781 (Insecta, Coleoptera): proposed conservation by the suppression of *Leptura marginata* O. F. Müller *in* Allioni, 1766.

P. K. TUBBS
Executive Secretary

INTERNATIONAL COMMISSION ON ZOOLOGICAL NOMENCLATURE

℅ British Museum (Natural History)
Cromwell Road,
London, SW7 5BD

8 October 1986

The following Opinions, rulings of the International Commission of Zoological Nomenclature, have been published in volume 43, part 3, of the *Bulletin of Zoological Nomenclature* (6 October, 1986).

Opinion No.
1400 (p. 229) *Simia fascicularis* Raffles, 1821 (Mammalia, Primates): conserved.
1401 (p. 231) *Leucaspis* Signoret, 1869 (Insecta, Homoptera): conserved.
1402 (p. 233) *Bagrus* Bosc, 1816 (Osteichthyes, Siluriformes): conserved.
1403 (p. 235) *Lumbricus lacteus* Örley, 1881 designated as type species of *Octolasion* Örley, 1885 (Annelida, Oligochaeta).
1404 (p. 237) *Indodorylaimus elongatus* Baqri, 1982 designated as type species of *Indodorylaimus* Ali & Prabha, 1974 (Nematoda, Dorylaimida).
1405 (p. 239) *Aphelinus mytilaspidis* Le Baron, 1870 (Insecta, Hymenoptera): conserved.
1406 (p. 241) *Phalaena stagnata* Donovan, 1806 designated as type species of *Nymphula* Schrank, 1802 (Insecta, Lepidoptera).
1407 (p. 243) *Lamia aethiops* Fabricius, 1775 designated as type species of *Ceroplesis* Serville, 1835 (Insecta, Coleoptera).
1408 (p. 245) *Hypocryphalus mangiferae* (Stebbing, 1914) given nomenclatural precedence over *Cryphalus inops* Eichhoff, 1872 and *Hypothenemus griseus* Blackburn, 1885 (Insecta, Coleoptera).
1409 (p. 247) *Adianthus bucatus* Ameghino, 1891 (Mammalia): neotype designated.
1410 (p. 249) *Williamia* Monterosato, 1884 (Mollusca, Gastropoda): conserved.
1411 (p. 251) *Drymus ryeii* Douglas & Scott, 1865 (Insecta, Hemiptera): neotype set aside.
1412 (p. 253) *Leptoclinum fulgens* Milne Edwards, 1841 designated as type species of *Leptoclinum* Milne Edwards, 1841 (Tunicata, Ascidiaea).
1413 (p. 256) *Delphinus truncatus* Montagu, 1821 (Mammalia, Cetacea): conserved.
1414 (p. 258) *Panopea* Ménard de la Groye, 1807 (Mollusca, Bivalvia): conserved.
1415 (p. 262) *Polygnathus bilineatus* Roundy, 1926 designated as type species of *Gnathodus* Pander, 1856 (Conodonta).
1416 (p. 264) *Cnetha* Enderlein, 1921 and *Pseudonevermannia* Baranov, 1926 (Insecta, Diptera): type species designated; *Atractocera latipes* Meigen, 1804: confirmation of holotype.
1417 (p. 267) *Chromis* Cuvier *in* Desmarest, 1814 (Osteichthyes, Perciformes): gender confirmed as feminine.

P. K. TUBBS
Executive Secretary

INTERNATIONAL COMMISSION ON ZOOLOGICAL NOMENCLATURE

% British Museum (Natural History)
Cromwell Road,
London, SW7 5BD

18 December 1986

The following Opinions have been published by the International Commission on Zoological Nomenclature in the *Bulletin of Zoological Nomenclature,* volume 43, part 4 on 11 December 1986:

Opinion No.
1418 (p. 325) *Glyphipterix* Hübner, [1825] (Insecta, Lepidoptera): *Tinea bergstraesserella* Fabricius, 1781 designated as type species.
1419 (p. 328) *Democricetodon* Fahlbusch, 1964 (Mammalia, Rodentia): *Democricetodon crassus* Freudenthal, 1969 designated as type species.

P. K. TUBBS
Executive Secretary

INFORMATION FOR CONTRIBUTORS

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Olson, S. L. 1973. The fossil record of birds. Pp. 79–238 *in* D. Farner, J. King, and K. Parkes, eds., Avian biology, volume 8. Academic Press, New York.

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PROCEEDINGS

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THREE NEW SPECIES OF *RENOCILA* (CRUSTACEA: ISOPODA: CYMOTHOIDAE), EXTERNAL PARASITES OF CORAL REEF FISHES FROM THE RYUKYU ISLANDS OF JAPAN

Lucy Bunkley Williams and Ernest H. Williams, Jr.

Abstract.—*Renocila yamazatoi,* n. sp., is described from *Chromis ovatiformis* collected at Iriomote Island; *R. kohnoi,* n. sp., from *Centropyge heraldi* and *C. vrolicki* collected at Iriomote and Ishigaki islands; and *R. bollandi,* n. sp., from *Scorpaenopsis cirrhosa* and *Scorpaena bynoensis* collected at Okinawa Island. *Renocila yamazatoi* is distinguished by extremely long exopods of the uropods, lengthened dactyls of pereopods 2–6, and posteroventral angles of pereonite 7 extending to or beyond pleonite 3; *R. kohnoi* by swellings on the dactyls and lobes on posterodistal corners of basis of pereopods 1–3 and also swelling on dactyls of pereopod 4, antennae 1 longer than 2, and posteroventral angles of pereonite 7 extending to pleonite 5 or further; *R. bollandi* by pereonites and pleonites with medial posterior projections, produced posteroventral angles of pereonites 4–7, and an immersed head. Darkly colored *R. kohnoi* contrasts strikingly with the yellow body of *C. heraldi* but this isopod is camouflaged on *C. vrolicki.* The juveniles of *R. kohnoi* attach to the host soon after escaping from the brood pouch of the female. The duplex female-male arrangement could be a precursor to both the double female-micromale pattern and the traditional female-male pattern of cymothoids. *Renocila yamazatoi* and *R. kohnoi* occurred in the same geographic location, only *R. bowmani* and *R. colini* have so overlapped previously. The limited geographic ranges, high levels of infection, and strong host specificity previously suggested for members of *Renocila* apply to these new species.

Five species of *Renocila* have been described from the Indo-west Pacific (Bowman and Mariscal 1968). Williams and Williams (1980) described four additional species in this genus from the Caribbean and eastern Pacific and suggested a circumtropical distribution for this genus. The present study describes three new species, the first from the subtropical western Pacific.

Materials and Methods

Fishes with isopods were collected with an elastic band speargun or quinaldine fish relaxant and nets, using scuba. Hosts were immediately sealed in individual plastic bags, and held in a mesh diving bag for no more than two hours. Hosts were measured for standard and total length to the nearest millimeter and preserved in 10% formalin. Isopods were measured for total length (from anterior margin of head to posterior extent of uropods), head to pleotelson length (anterior margin of head to posterior margin of pleotelson), and maximum width to the nearest 0.1 mm, using slight pressure on the dorsal surface to straighten any curling, and preserved in 70% ethanol. Broods were removed from preserved female isopods, counted, and a random sample of 20 measured for total length and maximum width to the nearest 0.01 mm. Mouthparts and appendages were mounted in glycerine jelly and drawn with the aid of a Nikon projection microscope. Whole specimens were drawn with a Nikon SMZ-10 stereo microscope with a built-in camera lucida. Photographs were taken with a Nikon F2 camera and 55 mm macro-lens. Pleotelsons of the illustrated specimens were drawn in a natural or slightly depressed position; therefore, the length of pleotelsons in illustrated dorsal views do not represent the actual total lengths. Measurements are given in mm, means in parentheses. Isopod specimens are deposited in the Division of Crustacea and fish hosts in the Division of Fishes of the National Museum of Natural History, Smithsonian Institution (USNM). Names of the hosts follow Masuda et al. (1984).

Renocila yamazatoi, new species
Figs. 1–31, 70–73, Table 1

Specimens examined.—14 specimens: 2 females, 3 males, 25 to 26 Nov 1985, south of Saba Saki (Point), Amitori Bay, Iriomote Island, Japan, 24°20.15′N, 123°41.80′E.—4 females, 3 males, 2 juveniles, 26 Nov 1985, off Toubari Saki (Point), Funauki Bay, Iriomote Island, Japan.

Type specimens.—Holotype (female), USNM 231049, allotype (associated male), USNM 231050; 12 paratypes, USNM 231051–231056.

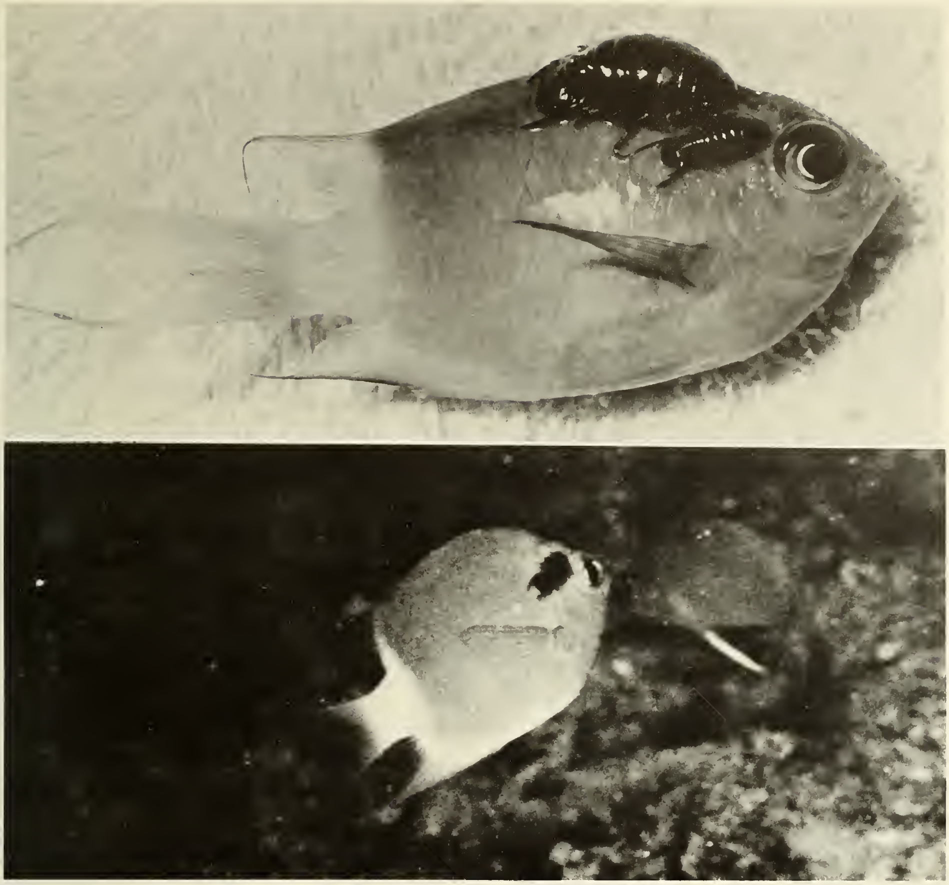
Type locality.—Reef slope off Toubari Saki, Funauki Bay, Iriomote Island, Japan, 24°20.35′N, 123°43.30′E.

Type host.—Maru-suzumedai, *Chromis ovatiformis* Fowler (Perciformes: Pomacentridae) (Fig. 1), USNM 267533–267534.

Site of infection.—Male attaches on the side of the head above the posterior portion of the eye of the host. The female attaches directly above the male (Fig. 1).

Description.—Body elongate oval. Antennae 1 7–8-merous. Antennae 2 6-merous. Antennae 1 with setae present on distal ventral corners of distal 5 articles, broader and longer than antennae 2. Anterior margin of head broadly rounded, ventrally flexed, produced into lobe between bases of antennae 1. First segment of mandibular palp not expanded, 4 simple setae on inner margin of distal segment. Incisor process of mandible with pointed tip and expanded proximal portion. Maxilla 1 with 1 large and 3 smaller recurved apical spines. Distal lobes of maxilla 2 each with 2 short blunt spines; distal portion of semilunar pectinate scales longer than those on other mouthparts. Distal segment of maxillipedal palp with 3 stout recurved spines. Posteroventral angles of pereonite 4 moderately produced, 5–7 produced, that of pereonite 7 extending posteriorly to level of pleonite 3 to pleotelson. Median ridge on pleon, low anteriorly, becoming more raised posteriorly. Pleonite 5 with medial posterior projection. Pleotelson heart-shaped, 1.36–1.76 times wider than long. Uropod extending far beyond posterior margin of pleotelson, exopod twice or more than twice as long as endopod. Pereopods 1–3 without swelling in dactyl and without lobe at posterodistal corner of basis. Dactyls of pereopods increasing in length from 1 to 4 and decreasing in length from 4 to 7. Dactyls of pereopods 2–6 very long and slender, those of pereopods 1 and 7 abruptly shorter than other dactyls. Pereopods all subequal in length. Color of body and appendages uniformly slate gray.

Juvenile (attached to host) (n = 2): Total length 3.0 and 3.7, head to pleotelson length 2.6 and 3.1, maximum width 1.1 and 1.3. Appendix masculina of pleopod 2 as long as endopod. Penes lobes absent. No comb-like teeth on inner margin of dactyls or hooks on inner margin of propodus of pereopods 1–3. Body uniformly slate gray except lateral margins of pereon and pleon and exopod of uropods which slightly darker. This coloration differs from juvenile or manca larvae of brood pouch, which have lateral row of dark pigment spots in band along outer margins of pereon, pleon, and exopod of uropod; pigment spots on posterior margins of pereonites, pleonites, and anterior



Figs. 1, 2. 1, (top): Female (19.1 mm) and male (11.5 mm) *Renocila yamazatoi* on 51 mm SL maru-suzumedai, *Chromis ovatiformis* Fowler, laboratory photograph at Amitori; 2, (bottom): Male *Renocila yamazatoi* on the maru-suzumedai, *Chromis ovatiformis* Fowler, underwater photograph by senior author, 15 m depth, south of Saba Saki, 25 Nov 1985, first specimen observed, not collected.

margin of head; diffuse small pigment spots over dorsal surface of body; some pigment spots outlining parts of pereopods, pleopods and labrum.

Male (n = 6): Total length 5.7–11.6 (8.0), head to pleotelson length 5.0–9.5 (6.8), maximum width 2.1–5.0 (3.4). Penes lobes of male separate. Appendix masculina of pleopod 2 linear with unmodified apex. Color uniformly slate gray.

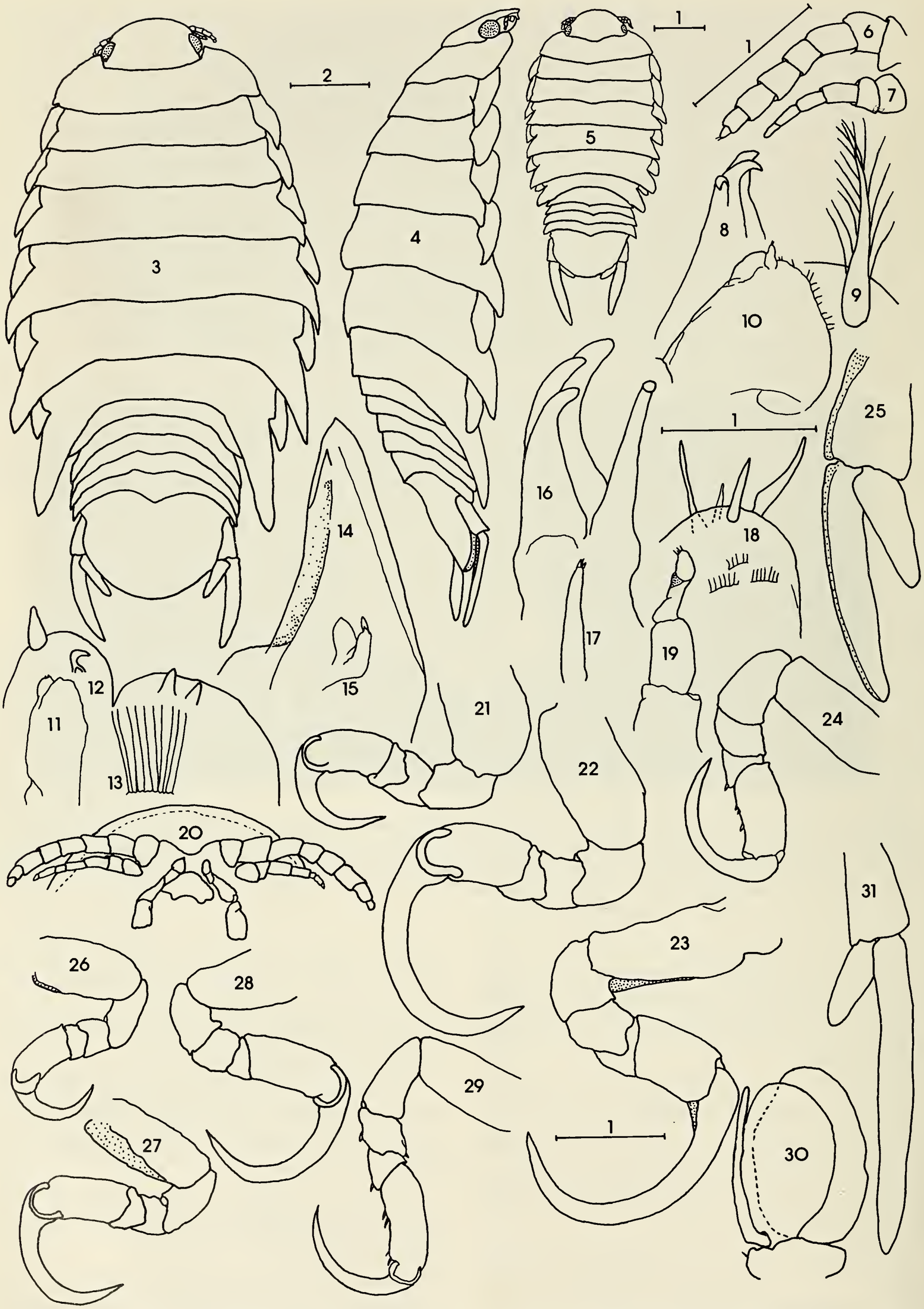
Female (n = 6): Total length 11.9–19.1 (14.6), head to pleotelson length 11.3–17.8 (13.7), maximum width 6.0–9.5 (7.7). No remnants of appendix masculina or penes lobes present. All but one female (13.2 × 7.7) possess oostegites.

Brood pouch reproduction (n = 20 of each brood). (See Table 1.)

Etymology.—The specific name is in honor of Dr. Kiyoshi Yamazato, who made our visit to, and research throughout Japan possible.

Japanese standard common name: Yamazato-yadori-mushi (shin-shô) = Yamazato's isopod.

Remarks.—*Renocila yamazatoi* most closely resembles *R. heterozota* Bowman and Mariscal by having an exopod of the uropod



Figs. 3–31. *Renocila yamazatoi,* new species (3, 4, 20 = 15.4 mm female holotype with oostegites; 5 = 7.0 mm male allotype; 6–19, 21–25 = 15.3 mm female paratype with oostegites; 26–31 = 11.6 mm male paratype)

Table 1.—Description of development in the brood pouch of 4 females of *Renocila yamazatoi* (measurements in mm).

Number	Description	Length (mean)	Width (mean)
229	Subspherical embryos	0.75–0.86 (0.79)	0.65–0.75 (0.70)
16[1]	Hunched embryos with internal segmentation, broad cephalic end and darkly pigmented eyes	1.25–1.41 (1.31)	0.62–0.76 (0.67)
348[1], 1[2]	Manca larvae with eyes, antennae and 6 pereopods, no pigment spots, body compressed	2.15–2.45 (2.26)	0.65–0.75 (0.70)
148[2], 121	Juveniles with flattened pigmented body (as described in text)	2.16–2.36 (2.28)	0.66–0.75 (0.72)

[1] Mixed brood, 16 and 348 in same female.

[2] Mixed brood, 1 and 148 in same female.

twice as long as the endopod, anterior margin of head inflexed and produced into rounded lobe between bases of antennae 1, pereopods 1–3 without swelling of the dactyls and without lobate posterodistal corners of the basis. It differs from *R. heterozota* and all other known *Renocila* species by the lengthened dactyls of pereopods 2–6. It also differs from *R. heterozota* by having the posteroventral angles of pereonite 5 produced and those of pereonite 7 extending laterally to or beyond pleonite 3.

The 14 *R. yamazatoi* were attached to seven *Chromis ovatiformis* 35–52 (46.6) in standard length. Masuda et al. (1984) noted that few reports of *Chromis ovatiformis* had been published since its description in 1946 because of its deep habitat, between 20 and 40 m, seldom swimming shallower. In the present study, *C. ovatiformis* with *R. yamazatoi* were observed as shallow as 6.1 m and isopods were collected on fish at 7.6 m to 18 m depth. Those observed at 6.1 m were associated with vertical rock faces. Unparasitized fish were abundant as shallow as 9 m in dead, intact, branched *Acropora* sp. (Scleractinia: Acroporidae) on reef slopes that reached into deep water (80 m). This fish was abundant in similar depths off Ishigaki, Kuro, and Okinawa islands, but was not observed parasitized by *R. yamazatoi. Chromis ovatiformis* were infected with one or more *R. yamatazoi* in 8.3–15.0% (12.3%) of those observed (three observation periods for a total of 130 fish).

Five *C. ovatiformis* were collected with isopods in male-female pairs (Fig. 1); 1 with a female-juvenile pair; and 1 was host to a single large male. One juvenile was associated with a male-female pair.

Two lengths are given for *R. yamazatoi* because the uropods reach far beyond the posterior border of the pleotelson. Total length is not representative of the body length of this isopod.

Renocila kohnoi, new species

Figs. 32–59, 74–77, Tables 2–3

Specimens examined.—Thirty specimens: 5 females, 3 male-female transitionals, 3 males, 1 juvenile-male transitional, 2

⟵

(Scale bars in mm; scale of 3 and 4 equal; scale of 6, 7, 10, 11, 15, 17, 19 equal; scale of 20–31 equal; 8, 9, 12–14, 16, 18 enlargements from associated mouthpart figures). 3, Dorsal view; 4, Lateral view; 5, Dorsal view; 6, Antennae 1; 7, Antennae 2; 8, Apex of maxillipedal palp; 9, Seta of maxilliped; 10, Maxilliped; 11, Maxilla 2; 12, Distal lobes of maxilla 2; 13, Semilunar pectinate scale on maxilla 2; 14, Incisor process of mandible; 15, Mandible; 16; Apex of maxilla 1; 17, Maxilla 1; 18, Apex of distal segment of mandibular palp, with scales; 19, Mandibular palp; 20, Head, ventral view; 21, Pereopod 1; 22, Pereopod 2; 23, Pereopod 4; 24, Pereopod 7; 25, Uropod; 26, Pereopod 1; 27, Pereopod 2; 28, Pereopod 4; 29, Pereopod 7; 30, Pleopod 2; 31, Uropod.

Figs. 32, 33. 32, (top): Female (21.2 mm) *Renocila kohnoi* on 78 mm SL herarudo-koganeyakko, *Centropyge heraldi* Woods and Schultz, laboratory photograph at Amitori; 33, (bottom): Male (11.3 mm) on side opposite female in Fig. 32 (note old wound of a female isopod anterior and overlapping position of "new" male).

juveniles, 27 Nov 1985, reef front in mouth of Sakiyama Bay, Iriomote Island, Japan, 24°18.97′N, 123°40.35′E; 4 females, 8 males, 1 juvenile-male transitional, 3 juveniles, 4 Dec 1985, Fukapi "Atoll" (local name), Yonehara Reef, NE of Tomino, Ishigaki Island, Japan.

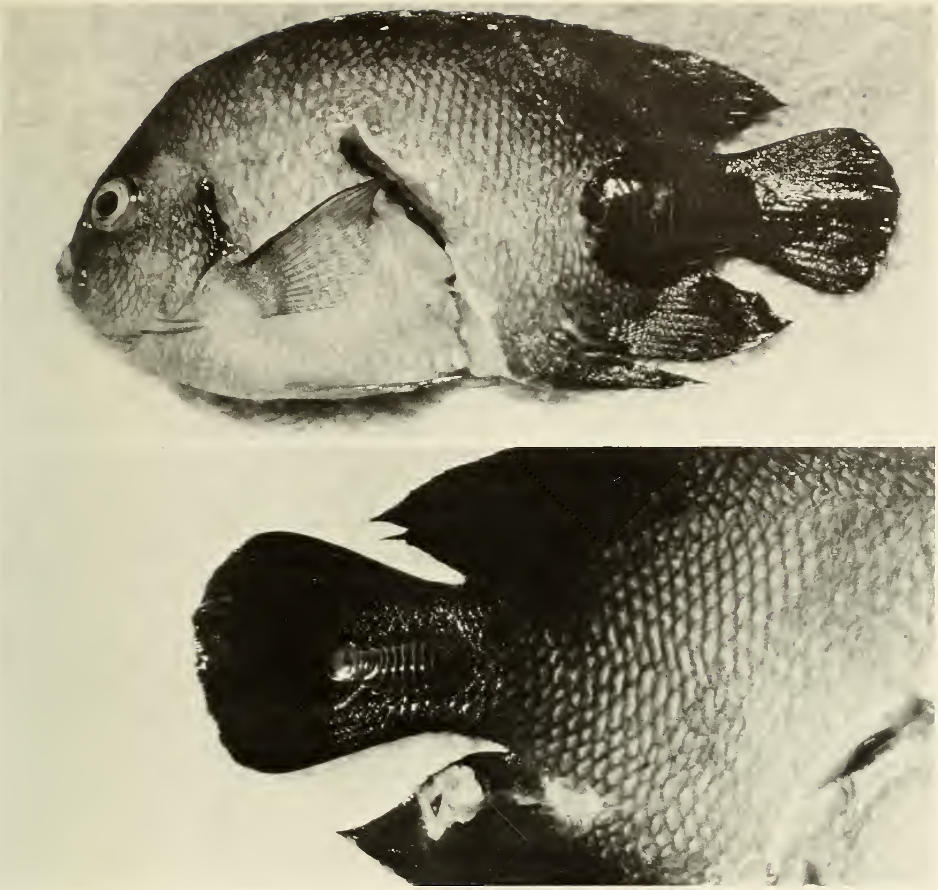
Type specimens.—Holotype (female), USNM 231057, allotype (associated male), USNM 231058, 28 paratypes, USNM 231059–231068.

Type locality.—South side, Fukapi "Atoll" (local name), Yonehara Reef, NE of Tomino, Ishigaki Island, Japan, 24°27.7′N, 124°10.61′E.

Type host.—Herarudo-koganeyakko, *Centropyge heraldi* Woods and Schultz (Perciformes: Pomacentridae) (Figs. 32–33), USNM 276531.

Additional host.—Namerayakko, *Centropyge vrolicki* (Bleeker) (Figs. 34–35), USNM 276532.

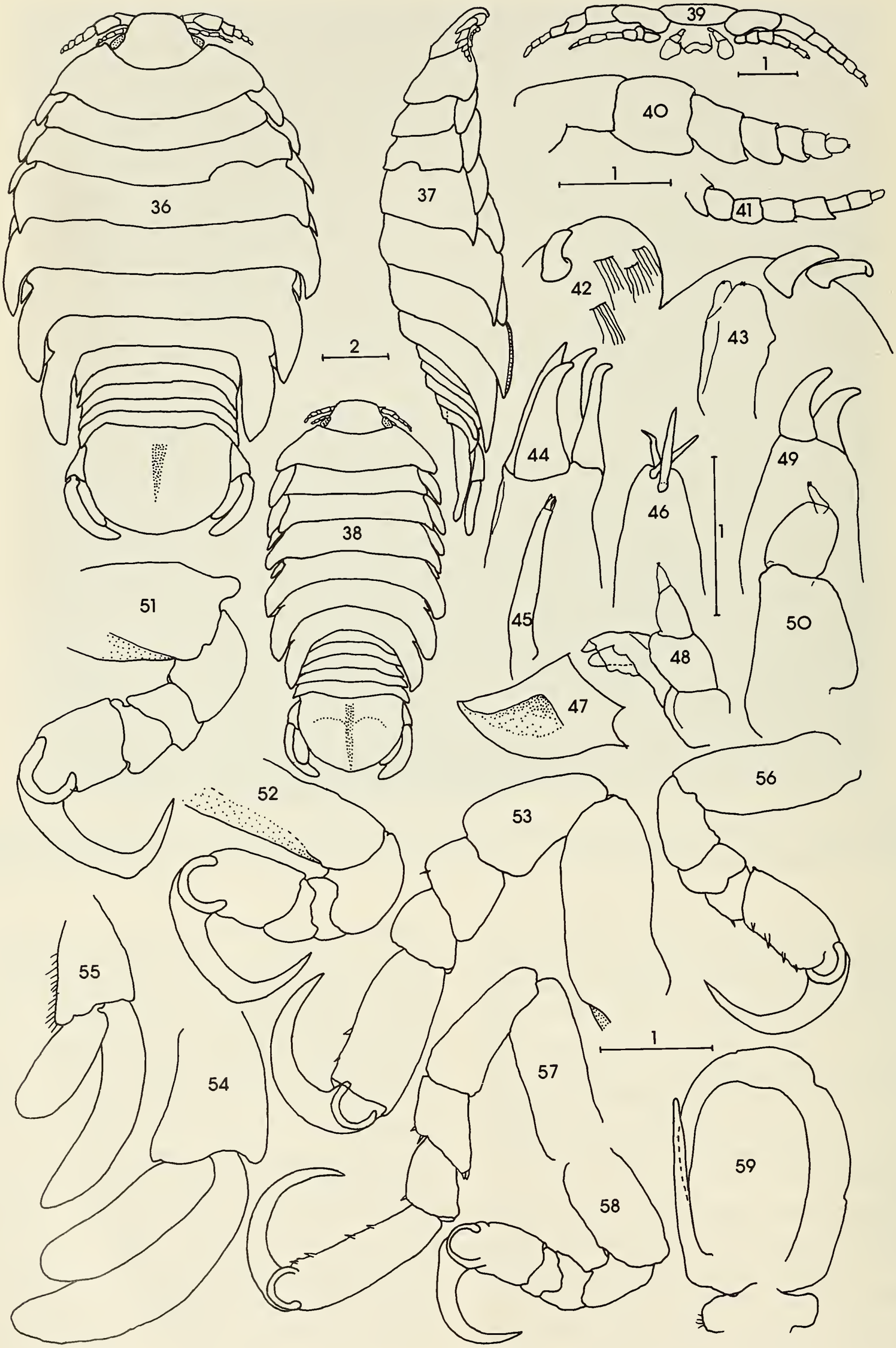
Site of infection.—Female attaches along center of the lateral side of the host just anterior of the caudal peduncle. The male attaches on the opposite side of the fish on the caudal peduncle (Figs. 32–35). Additional males attached anterior of the female or on the posterior tips of the dorsal and anal fins in some hosts. Juveniles attached



Figs. 34, 35. 34, (top): Female (20.7 mm) *Renocila kohnoi* on 73 mm SL namerayakko, *Centropyge vrolicki* (Bleeker), laboratory photograph an Amitori; 35, (bottom): Male (9.6 mm) on side opposite female in Fig. 34.

on the posterior tips of the dorsal and anal fins in some hosts. On one host, three males were arranged in a tight triangle about midbody along the center of the lateral side, anterior of the female. Two females were attached slightly posterior to the body midline, and one male was attached posterior of the caudal peduncle. Number of isopods per host varied from two to seven and averaged 2.9.

Description.—Body ovate. Antennae 1 7-merous, antennae 2 7–8-merous. Antennae 1 distinctly longer and wider than antennae 2, distal 5 articles with tufts of setae on distal ventral corners. Anterior margin of head ventrally flexed, produced into broadened lobe between bases of antennae 1. First segment of mandibular palp slightly expanded, 3 simple setae on tip of distal article. Incisor process of mandible with pointed tip. Maxilla 1 with 1 slender and 3 more robust, recurved spines. Distal lobes of maxilla 2 with 1 spine on inner lobe and 2 spines on outer lobe, spines short and almost obscured by long distal portions of semilunar pectinate scales which are longer on this appendage than on others. Distal segment of maxillipedal palp with 2 recurved spines. Posteroventral angles of pereonite 1 moderately produced, those of 4–7 produced, and that of 7 extending to lateral portion of pleonite 5 or to posterior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extent of basis of uropods. Pleotelson semicircular, 1.43–1.75 (1.56) times wider than long with median ridge rising from posterior to anterior. Exopod of uropods only ¼ to ⅓ longer than endopod. Exopod and not endopod reaching beyond posterior border of pleotelson but in 2 cases neither ramus attaining posterior border of pleotelson. Pereopods 1–4 with swelling of dactyls. Pereopods 1–3 with lobe at posterodistal corner of basis. Dactyls subequal in length, none lengthened. Pereopods 1–6 subequal in length or increasing in length slightly from 1–6. Pereopod 7 abruptly longer than pereopod 6. Color uniform slate gray.

Juvenile (attached to host) (n = 5): Total length 3.7–4.0 (3.9), maximum width 1.0–1.2 (1.1). Possessing 6 pairs of pereopods, no appendix masculina and no penes lobes. Three juveniles possessing setae on pleotelson and terminal portions of uropods; pereopods 1–3 with comb-like teeth on inner margin of dactyls and row of large hooks on inner margin of propodus; large chromatophores on snout along line between anterior extreme of eyes; large darkly pigmented lateral stripe from eyes along pereon, becoming more diffuse on sides of pleon, reappearing as dark stripe on outer edge of exopod of uropods; pigment spots outlining edges of pleopods 1 and 2, spots on distal outer margins of pleopod 3 and sometimes 4; pigment spots on midventral surface of pereopods; pigment spots dispersed along posterior borders and middle of pereonites and pleonites, forming elongated oval of pigment spots along mid-line of isopod. These 3 juveniles similar in size and morphology to juveniles found in brood pouches of 2 female *R. kohnoi.* Remaining 2 attached juveniles (3.7 and 4.0 long, 1.1 and 1.2 wide) resembling first 3 except for pigment spots uniformly dispersed over dorsal surface; comb-like teeth on inner margins of dactyls and hooks present on inner margin of propodus of pleopods 1–3 reduced in length. This second morphological type may represent first molt after settling on host. These 5 juveniles all attached to fishes also parasitized by female *R. kohnoi* with reproductive products other than juveniles.

Juvenile-male transitional (n = 2): Total length 5.6 and 7.8, width 2.2 and 2.0. Both isopods possessing 7 pairs of pereopods, appendix masculina as long as or longer than endopod or pleopod 2, and no penes lobes apparent. Shorter (and wider) isopod colored uniformly slate gray (male coloration) and possessing no comb-like teeth on inner margins of dactyls or hooks on inner margins of propodus of any pereopods. Longer isopod similar in color and pereopod morphology to group of 2 attached juveniles described above.

Male (n = 11): Total length 5.6–11.3 (8.6), width 2.0–6.0 (4.1), appendix masculina linear with unmodified tip, slightly shorter to slightly longer than endopod of pleopod 2. Penes lobes small, bilobed, conical process. Possessing no remnants of comb-like teeth on inner margins of dactyls or hooks on inner margins of propodus. Color uniformly slate gray.

Male-female transitionals (n = 3): Total length 9.2–13.0 (10.5), width 4.4–7.0 (5.4) with appendix masculina shorter than inner

←

Figs. 36–59. *Renocila kohnoi,* new species (36, 37, 39 = 15 mm female holotype with oostegites; 38 = 11.1 mm male allotype; 40–54 = 18.6 mm female paratype lacking oostegites; 55–59 = 11.3 mm male paratype; all from *Centropyge heraldi*) scale bars in mm; scale of 36–38 equal; 40–41, and 51–59 equal; 43, 45, 48, and 50 equal; 42, 44, 46, 47, 49 enlargements from associated mouthpart figures). 36, Dorsal view; 37, Lateral view; 38, Dorsal view; 39, Head, ventral view; 40, Antennae 1; 41, Antennae 2; 42, Distal lobes of maxilla 2 with semilunar pectinate scales; 43, Maxilla 2; 44, Apex of maxilla 1; 45, Maxilla 1; 46, Apex of distal segment of mandibular palp; 47, Incisor process of mandible; 48, Mandible and palp; 49, Apex of maxillipedal palp; 50, Maxilliped; 51, Pereopod 1; 52, Pereopod 4; 53, Pereopod 7; 54, Uropod; 55, Uropod; 56, Pereopod 6; 57, Pereopod 7; 58, Pereopod 1; 59, Pleopod 2.

Table 2.—Description of development in the brood pouch of 4 females of *Renocila kohnoi* (measurements in mm).

Number	Description	Length (mean)	Width (mean)
111	Subspherical embryos	1.32–1.56 (1.44)	1.20–1.26 (1.22)
219	Hunched embryos with internal segmentation, broad cephalic end and darkly pigmented eyes	1.80–1.98 (1.86)	0.95–1.10 (1.04)
109, 109	Juveniles with racing stripes (as described in text)	3.95–4.11 (4.03)	1.09–1.15 (1.12)

blade of pleopod 2 and penes lobes not apparent. Color uniformly slate gray.

Female (n = 9): Total length 15.6–21.2 (18.8), width 9.7–13.2 (11.6), no remnants of appendix masculina or penes lobes present. All but 2 females (17.1 and 18.6 long and 11.2 and 11.3 wide), possessing oostegites.

Brood pouch reproduction (n = 20 of each): See Table 2.

Etymology.—The specific name is in honor of Mr. Hiroyoshi Kohno, who told us about this isopod, and helped us to collect specimens.

Japanese standard common name.—Kohno-yadori-mushi (shin-shô) = Kohno's isopod.

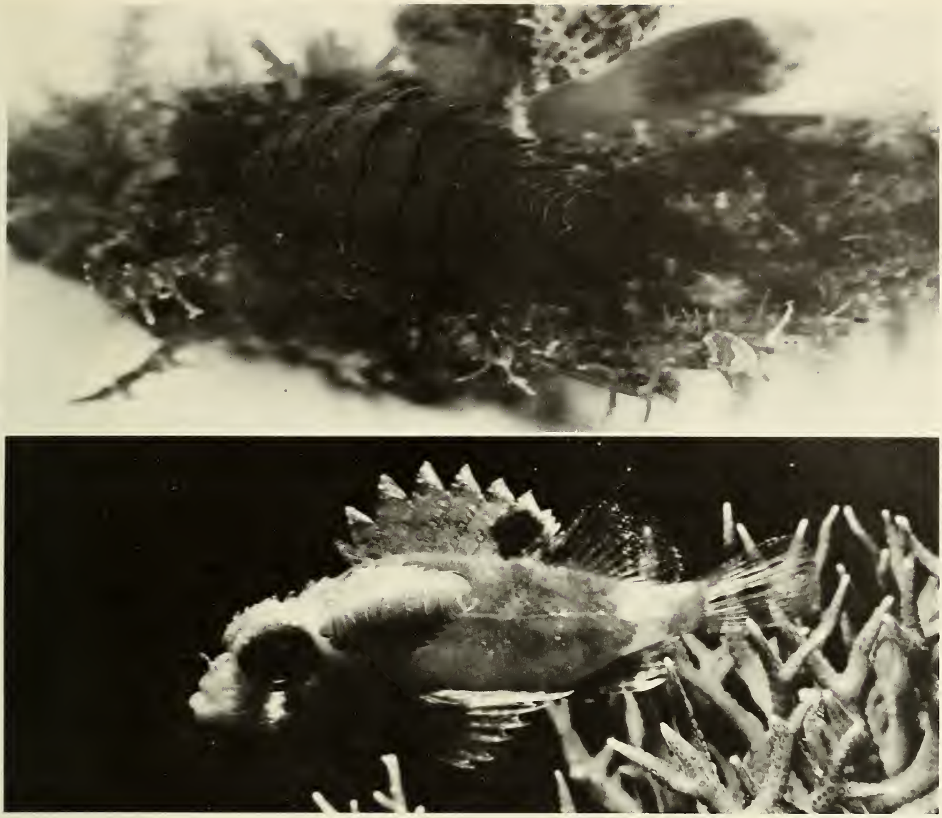
Remarks.—*Renocila kohnoi* resembles *R. periophthalmi* in general body shape. It differs from all known species of the genus by having swelling of the dactyl of pereopod 4 in addition to those on pereopods 1–3.

The 30 *Renocila kohnoi* were collected from eight *Centropyge heraldi,* 55–80 (68.1) in standard length, and two *C. vrolicki,* 69 and 73 in standard length. Parasitized *C. heraldi* were observed as deep as 27.4 m (collected at 24.3 m at Iriomote Island) and collected as shallow as 9.1 m at Ishigaki Island. Parasitized *C. vrolicki* were collected at 7.6 m at Iriomote Island and 6.1 m at Ishigaki Island and observed as shallow as 4.6 m at Ishigaki Island. Of the nine species of *Centropyge* reported from the Yaeyama Islands (Masuda et al. 1984), we observed seven. *Centropyge bispinosus* (Gunther), *C. tibicen* (Cuvier), *C. bicolor* (Bloch), *C. nox* (Bleeker), and *C. ferrugatus* Randall and Burgess were not observed to be parasitized by external isopods. Twenty–thirty-three percent (22%) (five observations for a total of 98 fish) of *C. heraldi* and 20–40% (33.3%) (two observations for a total of 15 fish) of *C. vrolicki* were observed parasitized by *R. kohnoi.* Only one *C. heraldi* was observed with a single (male?) isopod (not collected); all other infections observed were by more than one isopod.

Renocila kohnoi, a dark-colored isopod, was very visible in the water attached to the yellow *C. heraldi* (Figs. 32–33). A similar situation exists with *Anilocra holacanthi* Williams and Williams, where the dark-colored isopod attaches under the eye of *Holacanthus tricolor* (Bloch) whose face is yellow (Williams and Williams 1981). *Renocila kohnoi* is almost invisible on *C. vrolicki* which is light brown on the anterior body and dark brown on the posterior one-third of the body and caudal peduncle where the isopod attaches (Figs. 34–35). The correspondence of the dark isopod to the limited dark areas of this host may be more than coincidence. Possibly *R. kohnoi* was first a parasite of *C. vrolicki* and later parasitized both hosts.

Four *R. kohnoi* were partially molted with the posterior three pereonites and the pleon in a softened condition, the head and pereonites 1–4 not molted.

Three of the five juveniles of *R. kohnoi* attached to the hosts were identical in size, shape, and coloration to the juveniles of the brood pouch (Table 2). These juveniles apparently attached to the host soon after leaving the brood pouch, and, therefore, may not have any intermediate planktonic period or intermediate host.



Figs. 60, 61. 60, (top): Female 13.9 mm holotype (USNM 228659) of *Renocila bollandi* on the 44 mm type-host specimen of onikasago, *Scorpaenopsis cirrhosa* (Thunberg), aquarium photograph by Dr. Robert F. Bolland; 61, (bottom): Female (uncollected) of *Renocila bollandi* on madara-fusakasago, *Scorpaena bynoensis* Richardson, from Onna Point, Okinawa, underwater photograph by Mr. Gary Hagland.

Renocila bollandi, new species
Figs. 60–69

Type specimen.—Holotype (female), USNM 228659.

Type locality.—"Horseshoe Cliffs," 1 km WNW Onna Village, Okinawa, Japan, 26°30.0′N, 127°50.9′E (2 Jan 1985, 38.1 m, 0800 hrs, temperature at depth 24.8°C).

Type host.—Onikasago, *Scorpaenopsis cirrhosa* (Thunberg), Scorpaeniformes: Scorpaenidae) (Fig. 60).

Additional host and locality.—Madara-fusakasago, *Scorpaena bynoensis* Richardson (Fig. 61), Onna Point, Okinawa, Japan (20 Sep 1985, 12.2 m, 2200 hrs) (2 underwater photographs).

Site of infection.—Female attaches on the anterior, lateral portion of the host, posterior of and dorsal of the eye (Figs. 60–61).

Description.—Body oval. Head immersed in pereonite 1. Eyes small. Antennae 1 6-merous, not reaching posterior border of head; antennae 2 3-merous, very short, reaching to third or fourth article of antennae 1. Anterior margin of head rounded, not ventrally flexed. Coxae of pereonites produced laterally, those of pereonites 2–3 reaching posterior extent of segments. Posterolateral angles of pereonite 3 moderately produced, those of pereonites 4–7 produced posteriorly and laterally, that of pereonite 7 extending posteriorly to level of lateral portion of pleonite 4–5. Pereonites and pleonites with projection at middle of posterior border of segment, that of pleonite 5 larger than others, raised dorsally and extending over pleotelson. Medial ridge rises from anterior pereon to posterior pleon. In dorsal view, pleotelson deeply incised anteriorly by medial posterior projection of pleonite 5. Pleotelson 1.36 times wider than long, rounded posteriorly, slightly pointed at medial posterior border. Uropods extending to posterior border of pleotelson, exopod longer than endopod. Pereopods 1–3 without swelling of dactyls or lobate posterodistal corners of propodus. Dactyls and pereopods increasing in length from 1 to 3 or 4 (which are sub-equal) then decreasing gradually in length to pereopod 7. Pereopod 1 abruptly shorter than pereopod 2. Color, yellowish-brown with posterior borders of all segments and anterior border of head and pereonite 1 outlined by darkly pigmented line.

Female (n = 1): Total length 13.9, maximum width 8.8. No remnants of appendix masculina or penes lobes, with oostegites.

Etymology.—The specific name is in honor of Dr. Robert F. Bolland who collected, photographed, and provided additional information about this isopod.

Japanese standard common name.—Zebra-yadori-mushi (shin-shô) = zebra isopod.

Remarks.—Antennae, mouthparts, and uropods were not detached from the holotype to avoid damaging the single specimen.

Renocila bollandi differs from the diagnosis of the genus (Bowman and Mariscal 1968) by having an immersed head, produced posteroventral angle of pereonite 4, medial posterior projections of pereonites and pleonites, and reduced antennae 2.

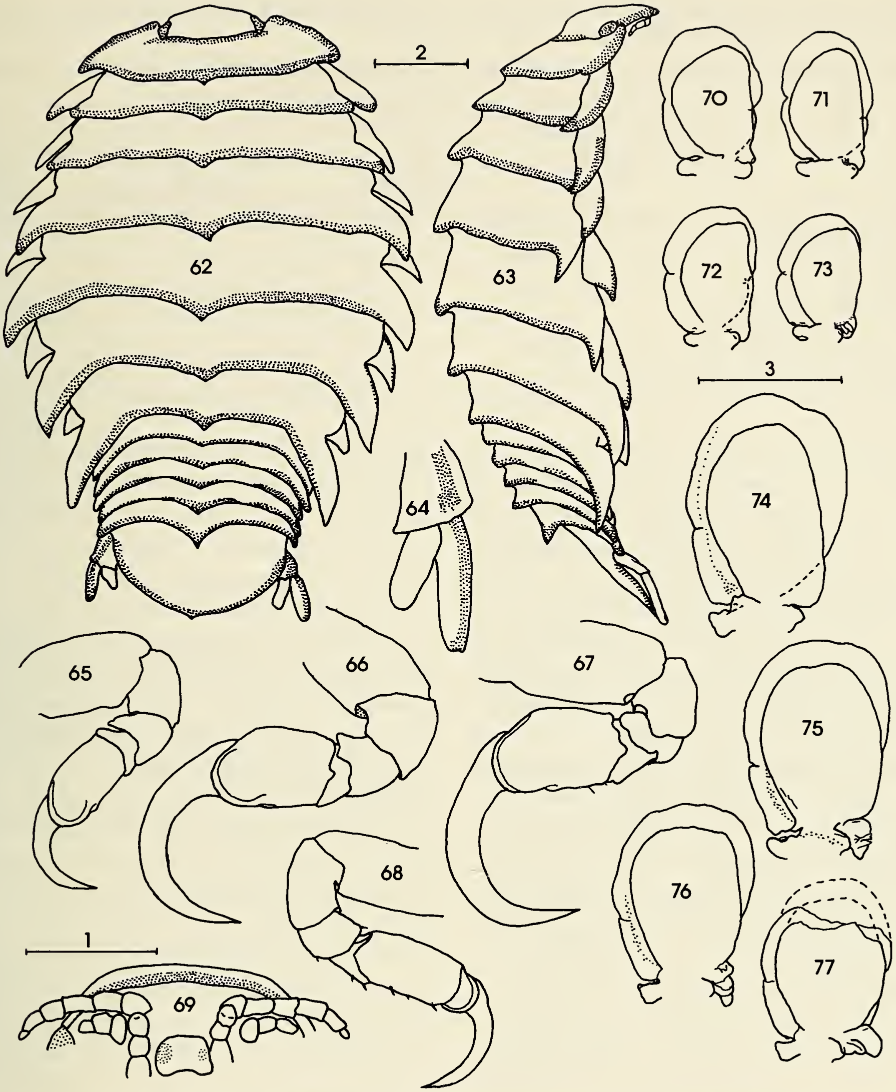
The specimen of *Scorpaenopsis cirrhosa* was 44 in standard length and the observed and photographed *Scorpaena bynoensis* approximately 49 in standard length. Both hosts are young specimens. This isopod has been observed in depths from 12.2 to 38.1 m.

This isopod is known from a 500 m section of the west coast of central Okinawa. We did not see this isopod during approximately 80 hrs of day and night scuba observations around Sesoko Island, 14–20 km north of Onna Point (May 1985–Mar 1986). We only observed one other common species of scorpaenid, satsumakasago, *Scorpaenopsis diabolus* (Cuvier), in the Ryukyu Islands, but it was never observed parsitized by this isopod.

Discussion

Cymothoids are traditionally associated in intimate, stable, long-term, female-male pairs. This process seems to be stabilized by neuro–endocrine control of the male by the female (as summarized by Brusca 1981). The female (or male) somehow excludes the attachment and growth of additional conspecific isopods. The constancy of this traditional pattern among almost all of the cymothoid isopods is probably based on the parasite-carrying capacity of hosts. No more than one female isopod and one male can be accommodated without threatening the survival of the host. The female isopod, through a series of non-growth reproductive cycles interspersed with vegetative growth periods (Williams and Williams 1982), probably grows to an optimum size for the size of the host. This is supported by the direct relationship between host length and female isopod length found in many cymothoids (Trilles 1964; Williams and Williams 1982). The obvious advantage of maximum female isopod size (as large as can be supported by the host) is that larger isopods (of the same species) produce more individual offspring. The number of eggs varies directly with body length within a species (Brusca 1981).

We have observed two major modifications of this traditional pattern. The first occurs in Carribean *Anilocra.* The juvenile serves as a mobile male (micromale) and the host-carrying capacity, normally occupied by the male, can be taken by a second female. Thus the reproductive potential is



Figs. 62–69. *Renocila bollandi,* new species, 13.9 mm female holotype. (Scale bars in mm; scale of 62–63 equal, scale of 64–69 equal.) 62, Dorsal view; 63, Lateral view; 64, Uropods; 65, Pereopod 1; 66, Pereopod 2; 67, Pereopod 4; 68, Pereopod 7; 69, Head, ventral view.

Figs. 70–73. *Renocila yamazatoi,* new species, 15.3 mm female paratype. (Scale bars in mm; scale of 70–77 equal.) 70, Pleopod 2; 71, Pleopod 3; 72, Pleopod 4; 73, Pleopod 5.

Figs. 74–77. *Renocila kohnoi,* new species, 18.6 mm female paratype. 74, Pleopod 2; 75, Pleopod 3; 76, Pleopod 4; 77, Pleopod 5.

essentially doubled (Williams 1984). The second modification involves a physical separation of the female-male pair on the host. This duplex arrangement was described for *Mothocya bohlkeorum,* where a single male and female occupy different gill chambers on a single host (Williams and Williams 1982). *Lironeca circularis* Pillai and *Lironeca* sp. also follow this pattern in 33 hosts (*Amblygaster sirm* (Walbaum)) we examined from Thailand and the Ryukyu Islands.

Table 3.—A developmental listing of 31 *Renocila kohnoi* arranged by hosts, and ranked in female-male pattern categories.

Status	Host number									
	1	2	3	4	5	6	7	8	9	10
	Developing toward duplex female-male		Stable duplex female-male			Developing toward traditional female-male			Developing toward female pair	
Development stage										
Female		1	1	1	1	1	1	1	1	1
Male-female transitional	1								1	1
Male			1	1	1	2	3	4		
Juvenile-male transitional	1	1								
Juvenile		1			2			2		

All species of the genus *Renocila* for which the attachment positions are known, except *R. kohnoi,* display the traditional female-male arrangement on the host. In contrast, *R. kohnoi* is strongly duplex in its female-male pattern by having the largest two isopods in the same position on opposite sides of the host. In addition, a number of smaller isopods also attach to the host and complicate this duplex pattern in five of the ten hosts examined. This combination of duplex arrangement and additional small isopods may indicate that this isopod-host relationship is a fairly recent phenomenon. By examining the specific relationships of these isopods on each host, we may gain some understanding of how the three basic arrangements came about.

Table 3 ranks the isopods occurring on each host by development stage, and also divides the assortment found on each host in terms of the three female-male patterns (Traditional female-male, Duplex female-male, and Double female-micromale). Our interpretation is that isopods on hosts 1 and 2 (Table 3) are developing toward a stable duplex female-male arrangement. The male-female transitional in host 1 will become a female and the juvenile-male transitionals in hosts 1 and 2 will become males. The isopods on hosts 3–5 are stable duplex female-male pairs. The attachment of the juveniles in host 5 is interesting because they could develop into males as in hosts 6–8, but our field and aquarium experiments (Williams 1984) have demonstrated that mere attachment of juveniles does not necessarily guarantee survival and growth. Hosts 6–8 have additional males. Two of these are attached in front of the female, very similar to some traditional female-male pairings (*Renocila colini* Williams and Williams, for example). This suggests a method by which a traditional female-male arrangement could be developed from a duplex arrangement, but, in the case of *R. kohnoi,* some mechanism (for example: limited space available for attachment of adult isopods to the caudal peduncle, or more swimming stability of hosts with large isopods on both sides) seems to be maintaining the duplex arrangement. Hosts 9–10 (Table 3) have the unusual relationship of female and male-female transitional. This suggests lack of female control of the male over the distance of opposite sides of the host. If the male-female transitional also became a female on this host and if a functional male was small and mobile (as in Caribbean *Anilocra*), then a double female-micromale arrangement could develop.

Thus, the arrangement of individuals of *R. kohnoi* on a host displays the duplex arrangement as well as possible methods of changing to either a traditional or a double female arrangement. It is possible that the duplex arrangement is a precursor to the more frequently observed female-male relationships, particularly when an isopod is parasitizing a new host.

Williams et al. (1983) reported the only known case of more than one species of *Renocila* (*R. bowmani* Williams and Williams and *R. colini*) occurring at the same geographic location (Isla Saona, Dominican Republic). We observed a specimen of *R. kohnoi* on a *Centropyge heraldi* among *Chromis ovatiformis* parasitized by *R. yamazatoi* south of Saba Saki in Amitori Bay.

The extremely limited geographic ranges, high levels of infection and strong host specificity suggested for the species of *Renocila* by Williams and Williams (1980) are not contradicted by these three new species from the Ryukyu Islands.

Key to *Renocila* Species

1\. Dactyls of pereopods 1–3 with swelling on outer margin 2

– Dactyls of pereopods 1–3 without swelling 5

2\. Antennae 1 shorter than antennae 2 .... *R. dubia* (Nierstrasz)

– Antennae 1 longer than antennae 2 3

3\. Pleotelson longer than wide .... *R. periophthalma* Stebbing

– Pleotelson wider than long 4

4\. Dactyl of pereopod 4 with swelling on outer margin .... *R. kohnoi*, n. sp.

– Dactyl of pereopod 4 without swelling .... *R. indica* Schioedte and Meinert

5\. Antennae 1 and 2 subequal 6

– Antennae 1 longer than 2 9

6\. Posteroventral angle of pereonite 7 produced laterally, not covering lateral margins of anterior pleonites in dorsal view 7

– Posteroventral angle of pereonite 7 not produced laterally, covering lateral margins of anterior pleonites in dorsal view 8

7\. Posteroventral angle of pereonite 5 produced, antennae 2 extending beyond posterior border of head .... *R. colini* Williams and Williams

– Posteroventral angle of pereonite 5 not produced, antennae 2 not extending to posterior border of head .... *R. thresherorum* Williams and Williams

8\. Brown in color, antennae 2 8-merous, antennae 1 slightly shorter than 2 .... *R. waldneri* Williams and Williams

– Black in color, antennae 2 7-merous, antennae 1 slightly longer than 2 .... *R. bowmani* Williams and Williams

9\. Lobe of head between bases of antennae 1, exopod of uropod more than twice as long as endopod ... 10

– No lobe between bases of antennae 1, exopod of uropod only slightly longer than endopod 11

10\. Posteroventral angle of pereonite 5 produced, dactyls of pereopods 2–6 lengthened . *R. yamazatoi*, n. sp.

– Posteroventral angle of pereonite 5 not produced, dactyls of pereopods subequal .... *R. heterozota* Bowman and Mariscal

11\. Pereonites and pleonites with medial posterior projections, head immersed .... *R. bollandi*, n. sp.

– Pereonites and pleonites lack medial posterior projections, head not immersed .... *R. ovata* Miers

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FALLICAMBARUS (*CREASERINUS*) *BURRISI* AND *F.* (*C.*) *GORDONI,* TWO NEW BURROWING CRAWFISHES ASSOCIATED WITH PITCHER PLANT BOGS IN MISSISSIPPI AND ALABAMA (DECAPODA: CAMBARIDAE)

J. P. Fitzpatrick, Jr.

Abstract.—Two new burrowing crawfishes, closely related to *Fallicambarus* (*Creaserinus*) *byersi* (Hobbs) are described from southern Mississippi and Alabama. They share with *F. byersi* and *F. caesius* Hobbs the characteristic, not otherwise known in the genus, of having a row of long stiff setae along the ventrolateral margin of the chela. They differ from them in having a more slender central projection on the gonopod of the first form male and from each other by the degree to which the apex of the mesial process of that member is curved caudoproximally. Each species has a unique annulus ventralis, and other morphological features serve to indicate the several species.

Several years ago, when the Mississippi Academy of Science was initiating studies to identify the state's Rare and Endangered species, I called attention to the unique relationship between *Fallicambarus* (*Creaserinus*) *byersi* (Hobbs 1941) and pitcher plant (*Sarracenia* spp.) bogs. My discovery of a second, closely related, similarly environmentally restricted species elicited the interest of the Mississippi Natural Heritage Program. As a result, they have paid special attention to the collection of burrowers, and the results of some of their labors are reported here.

Fallicambarus (*Creaserinus*) *burrisi,* new species

Figs. 1, 2a–d

Diagnosis.—Antennal scale much reduced, lacking usual spiniform distal terminus of lateral thickened part (Fig. 1e); coxa of fourth pereiopod with large, caudomesially directed boss; telson undivided, entire. Ventrolateral surface of propodus of chela with row of long stiff setae near lateral margin. First pleopod of first form male inclined caudally in distal third, apices of terminal elements inclined at about 130° to main axis of pleopod shaft. Annulus ventralis of female large, about 1.3 times longer than wide; with lateral and caudal margins conspicuously raised; prominent inverted U-shaped sinus arising on caudal margin, well lateral to midline, passing cephalically 20% of length of annulus, and recurving and disappearing beneath cephalic overhang of caudal elevation on same side of midline as origin; overhang of caudal part of annulus completely obscuring postannular sclerite.

Holotype male, Form I.—Cephalothorax subovate, compressed (Fig. 1b, h); eyes reduced. Abdomen much narrower than thorax (6.2 and 9.6 mm); greatest width of carapace less than depth at caudodorsal margin of cervical groove (9.6 and 10.8 mm). Areola obliterated along most of length; length 39.6% of entire length of carapace (42.8% of postorbital carapace length). Rostrum depressed, with mildly convergent, slightly thickened margins constricting near midlength to tip of indistinctly delimited acumen, tip slightly upturned, reaching base of ultimate podomere of antennular peduncle;

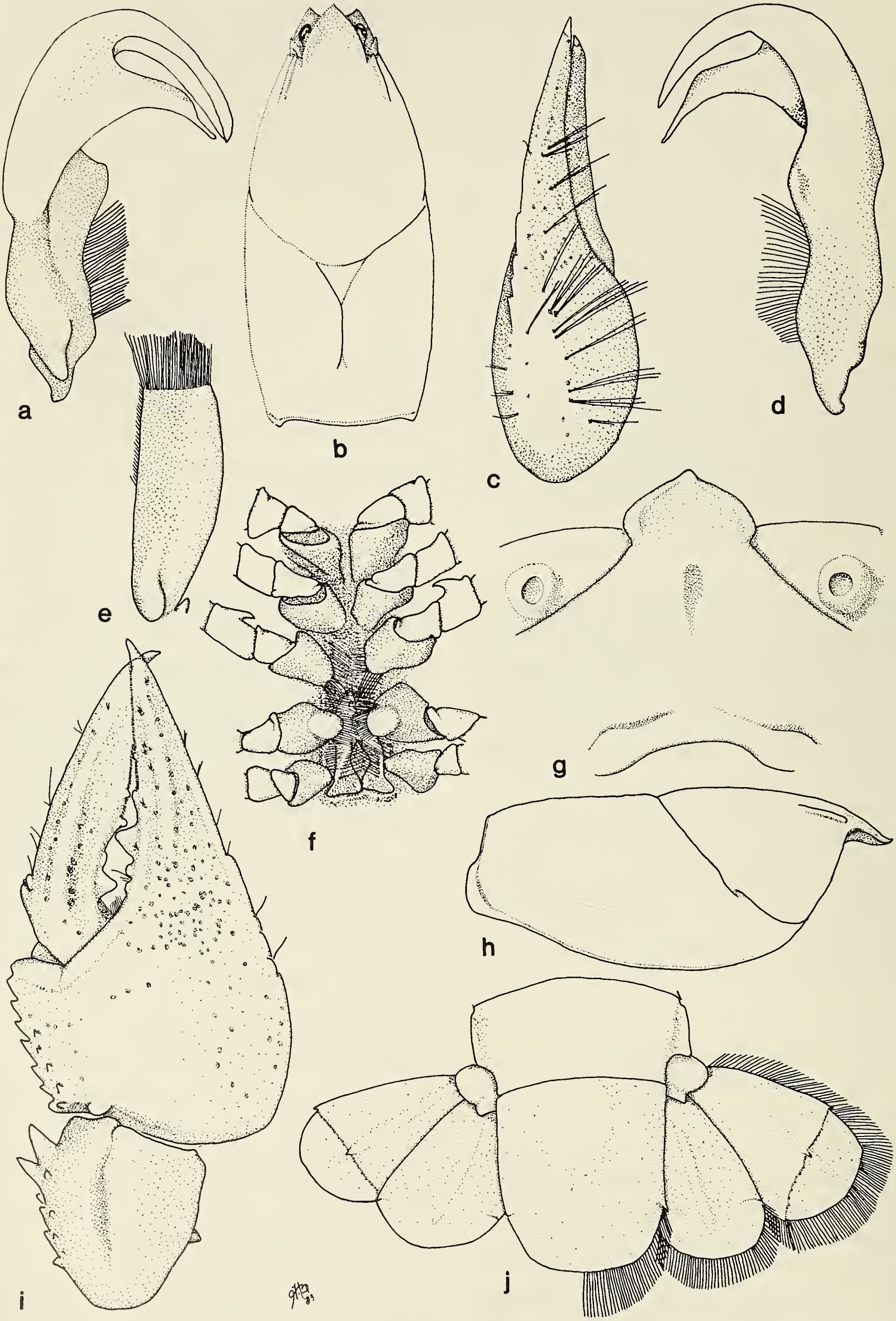

Fig. 1. *Fallicambarus* (*Creaserinus*) *burrisi,* holotype: a, Mesial view of first pleopod; b, Dorsal view of carapace; c, Lateral view of chela; d, Lateral view of first pleopod; e, Antennal scale; f, Ventral view of thoracic

dorsal surface deeply concave cephalically and subplanar caudally. Subrostral ridges poorly evident in dorsal aspect. Postorbital ridges prominent, grooved laterally, and terminating cephalically in weak tubercles. Suborbital angle and branchiostegal spine absent. Carapace sparsely punctate dorsally with slightly granulate branchiostegites.

Abdomen shorter than carapace (17.3 and 21.7 mm); pleura quite short and broadly rounded; cephalic lobe of pleuron of second segment overlapping reduced pleuron of first (Fig. 2e). Telson not clearly divided into cephalic and caudal portions (Fig. 1j); dextral margin provided with short, acute, fixed spine posterior to midlength, spine absent from corresponding position on sinistral margin. Proximal podomere of uropod with broadly rounded tubercle on medial lobe; both rami rounded distally; lateral ramus with very tiny fixed lateral spine and small, acute, premarginal medial spine at end of weak median ridge; mesial ramus with small, fixed lateral spine and median ridge.

Cephalomedian lobe of epistome (Fig. 1g) subovoid with slightly raised margins and prominent cephalomedian tubercle; main body with longitudinal median fovea and transverse grooves along cephalolateral margins of arched epistomal zygoma. Ventral surface of proximal podomere of antennule with obtuse tubercle near midlength. Antennal peduncle lacking spines; flagellum reaching not quite to caudal margin of carapace. Antennal scale (Fig. 1e) short, stout, lacking usual broad lamellar part mesially and terminal distolateral spine scarcely developed and obscured by dense setal row; about 2.5 times longer than wide; distal margin provided with dense row of long, stiff setae; scale reaching about midlength of penultimate podomere of antennular peduncle. Ventral surface of ischium of third maxilliped (Fig. 2b) with sparse band of long, stiff setae just mesial to midline and irregular submedian row of much shorter stiff setae, often clustered.

Chela (Fig. 1i) about 1.7 times longer than broad, strongly depressed; mesial margin of palm with row of 7 tubercles, second row of 5 just medial to it; dorsal surface with scattered, sometimes setiferous punctations, but numerous only on fingers; ventral surface with arched sublateral row of punctations bearing tufts of long setae (Fig. 1c); distal ridge, opposite base of dactyl, with subacute tubercle and low rounded one medial to it; middle third of lateral (outer) margin of chela with row of 4 low tubercles. Opposable margin of fixed finger with row of 5 tubercles in proximal two-thirds, middle one markedly largest; single row of minute denticles in distal half; small tuft of setae obscuring margin in most proximal part; dorsal and ventral surfaces with prominent submedian longitudinal ridge flanked by punctations; lateral margin strongly costate. Opposable margin of dactyl with row of 4 tubercles in proximal half, proximalmost largest; conspicuous excision in margin delimited distally by penultimate, next largest, tubercle; single row of crowded minute denticles beginning at penultimate tubercle and extending distally to horny tip. Mesial margin with cluster of 3 tubercles, one set ventrally to others, in proximal fourth and row of punctations with long stiff setae extending distally; dorsal and ventral surfaces with prominent submedian longitudinal ridge flanked by punctations.

Carpus (rotated about 20° counterclockwise in Fig. 1i) with prominent longitudinal furrow dorsally, flanked mesially by irregular row of 4 tubercles; mesial surface with twin spikelike spines in distal fourth and 3 much smaller spines proximal to them; ventral surface smooth with 2 small subacute tubercles in mesio- and laterodistal corners;

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region; g, Epistome; h, Lateral view of carapace; i, Dorsal view of distal podomeres of cheliped; j, Dorsal view of telson and uropods.

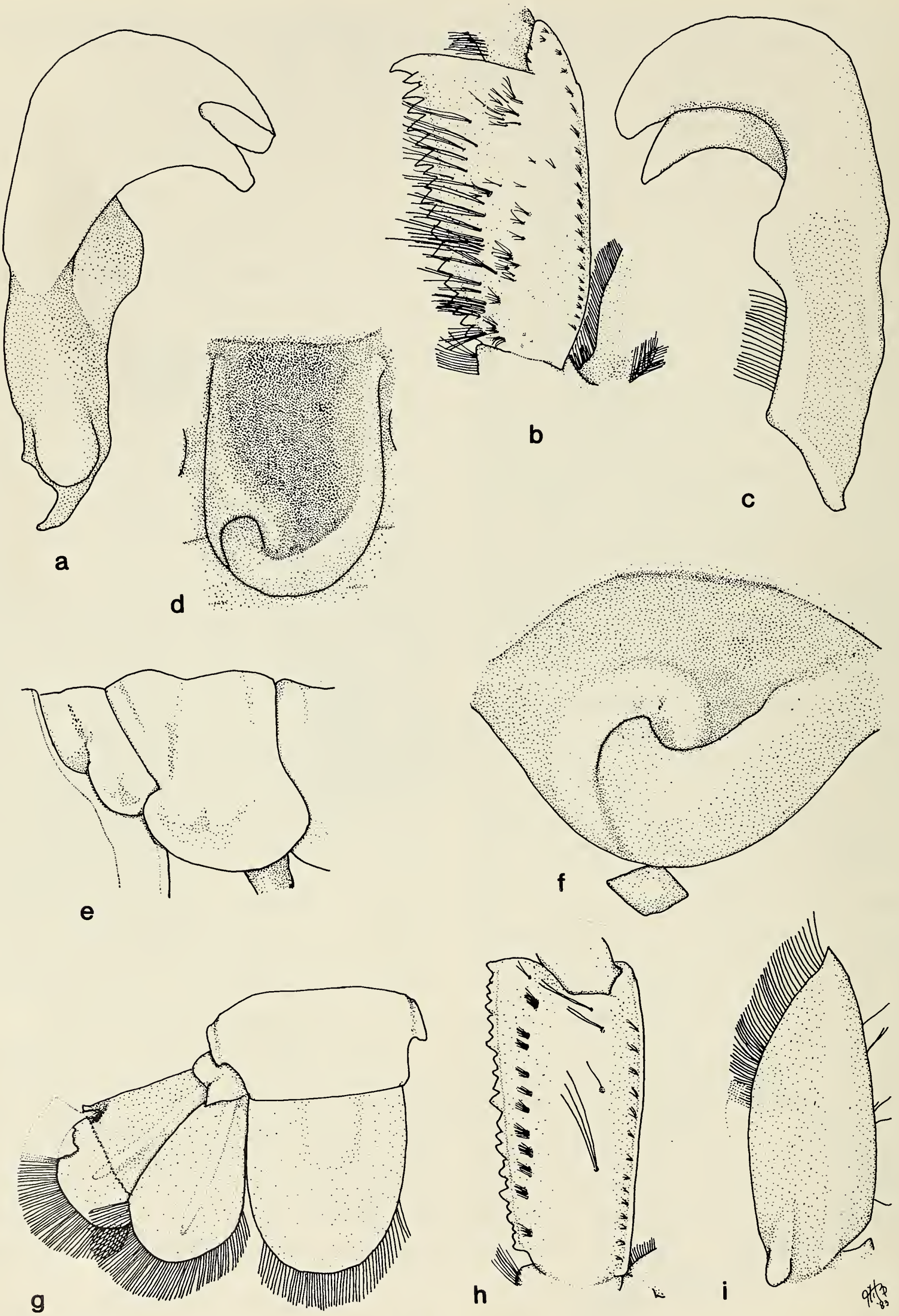

Fig. 2. Types of new species of *Fallicambarus* (a–d, *F. burrisi*; e–i, *F. gordoni*): a, Mesial view of first pleopod of morphotype; b, Ventral view of ischium of third maxilliped of holotype; c, Lateral view of first pleopod of

lateral surface punctate with prominent ventrolateral articulate knob. Dorsodistal surface of merus entire with small punctations; ventromesial margin with row of 7 small tubercles, distalmost and antepenultimate ones subacute; ventrolateral margin with row of 6 subacute tubercles intermixed with row of long stiff setae. Sufflamen well developed.

Chela of second pereiopod with row of long setae on both margins of palm and on dorsal and ventral margins of carpus; distal half of ventral margin of merus with similar row of setae.

Ischium of third pereiopod with simple curved hook not reaching basioischial articulation (Fig. 1f) and not opposed by tubercle on basis. Coxa of fourth pereiopod with large, caudomesially directed boss. Coxa of fifth pereiopod lacking caudomesial boss but with setiferous ventral membrane.

First pleopod (Fig. 1a, d, f) not quite reaching coxa of third pereiopod, situated deep within sternum and obscured, particularly distally, by setae extending caudally and mesially from ventral margins of sternum and proximal margins of coxae of third and fourth pereiopods; proximomesial spur lacking; distal half of shaft inclined caudally; terminal elements consisting of broad, corneous central projection, scarcely notched subterminally; and mesial process attenuate distally but apical third somewhat flattened in cephalocaudal aspect, entire process deflected sharply laterad, and tip not extending beyond tip of central projection; cephalic process absent.

Allotypic female.—Excluding secondary sexual characters, differing from holotype in following respects: small spine on sinistral margin of telson and none on dextral; mesial margin of palm with only one tubercle dorsomedial to mesialmost row; mesial margin of dactyl with row of 3 tubercles in proximal third; distal ridges of ventral surface of palm with only one tubercle opposite base of dactyl. Carpus of cheliped with single spikelike tubercle on distomesial surface; tubercles associated with ventrodistal margin more acute. Tubercles associated with ventromesial margin of merus of cheliped all acute.

Annulus ventralis (Fig. 2d) deeply excavate except for lateral and caudal elevated ridges; as described in Diagnosis. Caudal overhang of annulus completely obscuring first abdominal sclerite. First pleopods much reduced and biramous.

Morphotypic male, Form II.—Differing from holotype in following respects: mesial margin of palm with row of 8 tubercles, second more medial row of 3 near midlength, and single tubercle just medial to central tubercle of latter row; dactyl with row of 5 tubercles on mesial margin and with tubercle just dorsal to second from base; distal ridge of ventral surface of palm with 2 acute tubercles opposite base of dactyl. Carpus with single spikelike tubercle on mesial margin. Ventromesial margin of merus of cheliped with row of 9 subacute tubercles, ventrolateral margin with row of 8. Hook on ischium of third pereiopod as well developed as in holotype, but caudomesial boss of coxa of fourth pereiopod less well developed. First pleopod (Fig. 2a, c) with distal half not so clearly inclined caudally; both terminal elements non-corneous, blunter; central projection lacking subapical notch; mesial process contiguous to central projection along basal half, tip extending no further caudad than central projection.

Type locality.—Burrows in saturated sandy soil of hillside *Sarracenia* bog; T4N, R5W, E/2 Sec. 21, Greene County, Mississippi.

Disposition of types.—The holotypic male,

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morphotype; d, Annulus ventralis of allotype; e, Lateral view of cephalic segments of abdomen of holotype; f, Annulus ventralis of allotype; g, Dorsal view of telson and left uropod of holotype; h, Ventral view of ischium of third maxilliped of holotype; i, Antennal scale of holotype.

Form I, the allotypic female, and the morphotypic male, Form II (USNM 206881, 206883, and 206882, respectively), are located in the National Museum of Natural History, Smithsonian Institution, as well as a small paratypic series (3 ♂I, 1 ♂II, 4 ♀, 2 ♂ imm., 1 ♀ imm.). Another series of paratypes (2 ♂I, 9 ♀, 2 ♂ imm., 3 ♀ imm.) is at the Mississippi Museum of Natural Science, plus one dubiously identified collection, probably assignable to this species and not designated paratypic (1 ♂II, 1 ♂ imm.).

Variations and color.—Most of the variations encountered are represented among the primary types, but some points need to be noted. In a male, Form II, from Washington County, Alabama, the setae are absent from the ventrolateral margin of the palm, and in the same specimen, the ischium of the third maxilliped is not as hirsute as usual. Strikingly, in second form males, the caudomesial boss of the coxa of the fourth pereiopod is nearly as well developed as in the first form male. Equally striking is the remarkable congruence of tubercular ornamentation of the opposable margins of the fingers; not only are the numbers constant, but the relative sizes seem to be independent of sex and are the same. I have no specific color notes on this species, but my field notes in one instance (Washington Co., Alabama) indicate that the colors do not differ significantly from those of *Fallicambarus* (*Creaserinus*) *byersi.*

Size.—The largest specimen collected is the morphotype; the smallest first form male is the holotype, and the largest has a 26.4 mm carapace length; the largest female, 27.4 mm. For measurements see Table 1.

Range and specimens examined.—All specimens were collected from pitcher plant bogs in the Chickasawhay and Escatawpa drainages of Alabama and Mississippi.

ALABAMA. Washington County (all Escatawpa drainage): (1) bog, 1.5 mi (2.4 km) SE of County Road 18 (Vinegar Bend Rd.) on U.S. Hwy. 45, T3N, R3W, 1 ♂I, 3 ♀, 2 ♂ imm., 1 ♀ imm., 6 Apr 1974, J. F. Fitzpatrick, Jr., and B. A. Laning, colls.; (2) bog, 2.1 mi (3.4 km) NW of Mobile County line on U.S. Hwy. 45, T2N, R3W, 1 ♂II, 25 May 1974, J.F.F., Jr., and B.A.L., colls.; (3) small swamp stream 9.4 mi (15.1 km) N of Mobile County line on St. Rte. 17, T3N, R3W, 1 ♀, 3 ♀ imm., 22 Apr 1970, E. Black and H. H. Hobbs, Jr., colls.; (4) 6.2 mi (10.0 km) W of McIntosh on St. Rte. 35, hillside seepage, T4N, R2W, 1 ♂I, I ♀, 21 Apr 1970, E. B. and H.H.H., colls.; (5) roadside ditch, 5 mi (8.0 km) N of Citronelle on U.S. Hwy. 45, T2N, R3W, 1 ♂II, 1 ♀, 2 ♂ imm., 2 ♀ imm., 21 Apr 1970, E. B. and H.H.H., colls.

MISSISSIPPI. Greene County (all Chickasawhay drainage): (6) about 9.5 mi (15.3 km) S of town of State Line, 1 ♂I, 1 ♂II (morphotype), 1 ♀, 10 May 1979, John W. Burris, coll.; (7) about 1 mi W of Yellow Pine, Alabama, T5N, R5W, NE/4 Sec. 14, 1 ♂I, 2 Aug 1979, J.W.B., coll; (8) type locality, 1 ♂I, 1 ♀ (holo- and allotype), 25 Jun 1981, J.W.B., coll.; (9) Kurtz State Forest, seepage area in headwaters of Brannon Creek, T4N, R5W, SE/4 Sec. 21, 3 ♀, 1 ♀ imm., 29 Mar 1983, S. E. Mott and M. Stegall, colls.; Jackson County (all Escatawpa drainage): (10) 0.75 roadmi (1.2 km) W of Escatawpa River on St. Rte. 614, T5S, R5W, SE/4 SW/4 SE/4 Sec. 2, 2 ♀, 2 ♂ imm., 2 ♀ imm., 1 unsexed carapace fragment, 19 Apr 1983, R. L. Jones and S.E.M., colls.; (11) 4.8 airmi (7.7 km) SW of George County line at Alabama state line, T4S, R5W, NE/4 NE/4 SE/4 Sec. 16, 3 ♀, 15 Aug 1984, R.L.J., coll.; (12) (probably assignable to this species) T4S, R5W, SE/4 SW/4 NW/4 Sec. 16, 1 ♂II, 1 ♂ imm., 12 Dec 1984, R.L.J., J. Wiseman, and R. Lohoefnar, colls.

Environmental notes.—The species seems always to be associated with pitcher plant bogs, always burrowing, and usually into a sandy clay substrate, exhibiting complex branching patterns in the burrow design; often a trickle of water runs through the habitat—except perhaps in midsummer. My best notes are from locality no. 2, above. There *Sarracenia leucophylla* was the dominant plant, by far, but *S. alata, S. psittacina, Dichomena latifolia, Drosera rotundiflora* and *Stockesia laevis* were also conspicuous. At that time, *Cambarus* (*Lacunicambarus*) *diogenes ludovicianus* Faxon, 1884, was also dug from burrows in the area. The site had been visited earlier (on 6 Apr) when the dominant identifiable plants were *S. alata* and *D. rotundiflora,* the former in bloom. Also identifiable were *S. psittacina* and *S. leucophylla.* In flower were *D. latifolia, S. laevis, Drosera filiformes* and *Lachnocaulon anseps. Fallicambarus* burrows were provided with freshly worked and thoroughly plugged chimneys 6–8 in (15.2–20.3 cm) tall. A solid plug filled the burrow to a depth of 8–10 in (20.3–25.4 cm), and beneath this, the burrow was filled with a slurry of about 50% water and 50% sand and clay. Only rarely was a clear chamber encountered, and no crawfishes were collected although several burrows were excavated as far as could be detected. About 12 in (30.5 cm) below the surface, burrow temperature fell sharply to about 65°F from about 85°F air temperature.

Relationships.—*Fallicambarus* (*Creaserinus*) *burrisi* has its closest affinities with *F.* (*C.*) *byersi, F.* (*C.*) *gordoni,* n. sp., below, and *F.* (*C.*) *caesius* Hobbs, 1975, and more remotely to *F.* (*C.*) *danielae* Hobbs, 1975, and *F.* (*C.*) *oryktes* (Penn and Marlow 1959). Among the common features shared by the first four species are a caudally inclined gonopod of the first form male, a conspicuous row of long setae on the ventrolateral surface of the palm of the chela, and the abdomen of the male being markedly narrower than the carapace. The annulus of the *F.* (*C.*) *burrisi* female, however, is unique; in no other species of the genus is it so scooplike and does it project so far caudad. The conspicuous boss on the coxa of the male fourth pereiopod is not matched by any close relative. The attenuate tip of the mesial process of the first form male extends no further than the apex of the central projection, a characteristic shared with *F.* (*C.*) *byersi* and *F.* (*C.*) *oryktes.* It can be separated from *F.* (*C.*) *oryktes* by the row of setae on the ventrolateral margin of the palm and from *F.* (*C.*) *byersi* by the lack of an inflated part of the mesial process which overlaps the caudal margin of the central projection. The relatively slender terminal elements of the first pleopod and overall configuration of the palm of the cheliped are more like *F.* (*C.*) *oryktes* than the other mentioned species, but *burrisi* shares more features with *F.* (*C.*) *byersi, F.* (*C.*) *caesius,* and *F.* (*C.*) *danielae* than with *oryktes.*

Fallicambarus (*Creaserinus*) *gordoni,*
new species
Figs. 2e–i, 3

Diagnosis.—Antennal scale reduced, usual lamellar development of mesial part reduced. Ventrolateral surface of propodus of chela with row of long stiff setae near lateral margin; coxa of fourth pereiopod of first form male with small, but conspicuous, transversely-oriented caudomesial boss. First pleopods of first form male inclined caudally in distal one-fourth; apex of central projection directed at angle of about 120° to main axis of pleopod, but mesial process at nearly right angle. Annulus ventralis of female about as long as wide, deeply excavate cephalically and sigmoid sinus so developed that opposing halves of raised caudal part resembling interlocking fingers; annulus projected caudad only slightly, overhang scarcely, if at all, obscuring postannular sclerite.

Holotypic male, Form I.—Cephalothorax subovate, compressed (Fig. 3b, f); eyes reduced. Abdomen much narrower than thorax (6.0 and 9.1 mm); greatest width of carapace less than depth at caudodorsal margin of cervical groove (9.1 and 10.5). Areola obliterated along middle half of length; length 37.9% of entire length of carapace (43.0% of postorbital carapace length). Rostrum only slightly depressed, with moderately converging, slightly thickened mar-

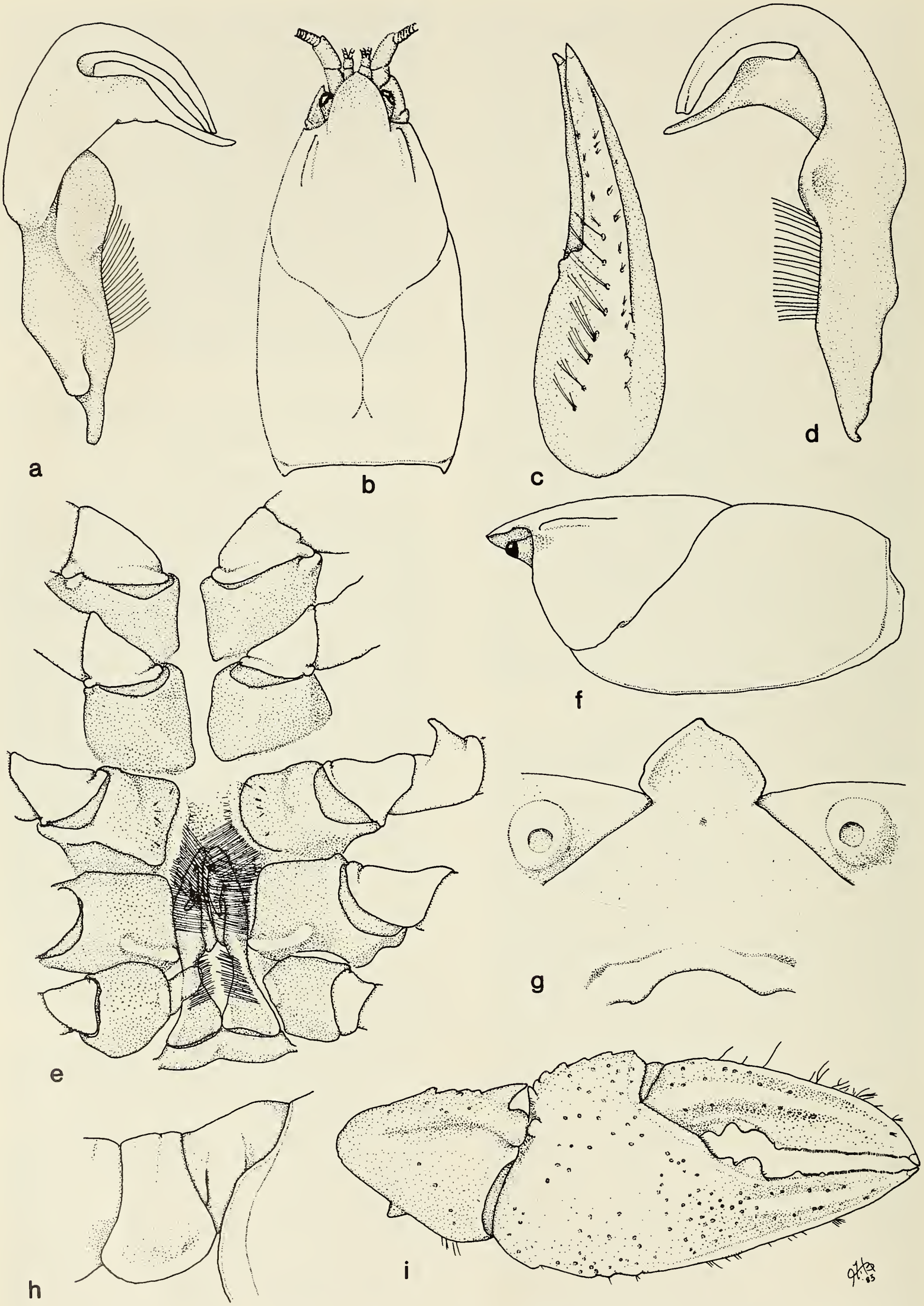

Fig. 3. *Fallicambarus* (*Creaserinus*) *gordoni,* holotype: a, Mesial view of first pleopod; b, Dorsal view of carapace; c, Lateral view of chela; d, Lateral view of first pleopod; e, Ventral view of thoracic region; f, Lateral

gins, latter constricting from near midlength to obtuse acumen; tip not upturned and reaching not quite to base of ultimate podomere of antennular peduncle; dorsal surface concave cephalically becoming subplanar caudally. Subrostral ridges poorly evident in dorsal aspect. Postorbital ridges prominent, grooved laterally and terminating cephalically in weak tubercles. Suborbital angle virtually obsolete; branchiostegal spine absent. Carapace sparsely punctate dorsally with slightly granulate branchiostegites.

Abdomen shorter than carapace (16.5 and 21.1 mm); pleura quite short and very broadly rounded; cephalic lobe of pleuron of second segment not prominent but overlapping reduced pleuron of first (Fig. 3h). Telson undivided (Fig. 2g), lacking lateral spines. Proximal podomere of uropod with subacute tubercle on mesial lobe; both rami rounded distally; cephalic portion of lateral ramus with small fixed spine in distolateral corner and row of small acute spines along entire distal margin, median one only very slightly larger than rest; mesial ramus with weakly developed median ridge, but lacking spines.

Cephalomedian lobe of epistome (Fig. 3g) broadly subtriangular with slightly raised margins and weak cephalomedian tubercle; main body with small median fovea near cephalic end and transverse grooves along cephalolateral margins of arched epistomal zygoma. Ventral surface of proximal podomere of antennule with small tubercle near midlength. Antennal peduncle lacking spines; flagellum reaching about midlength of areola. Antennal scale (Fig. 2i) short, stout, usual broad lamellar mesial part much reduced; terminal distal spine of expanded lateral portion small but stout and subacute; about 2.1 times longer than wide; mesial and mesiodistal margins with dense row of long, stiff setae, such setae sparse on lateral margin; scale reaching about midlength of penultimate podomere of antennal peduncle. Ventral surface of ischium of third maxilliped (Fig. 2h) with row of long, stiff setae just mesial to midline and widely scattered, sometimes clustered submedian row.

Chela (Fig. 3i) about 1.8 times longer than broad; strongly depressed; mesial margin of palm with single row of 6 tubercles; dorsal surface with scattered setiferous punctations, most numerous near base of immovable finger; ventrolateral surface with arched row of punctations, each with one or more long, stiff setae (Fig. 3c); distal ridge, opposite base of dactyl, with low tubercle; proximal third of lateral (outer) margin of palm with row of 4 low tubercles. Opposable margin of fixed finger with row of 4 tubercles in proximal half, second from base markedly largest, distal subequal in size and smaller; single row of minute denticles on distal half, beginning just distal to penultimate tubercle; tuft of setae in most proximal part almost negligible; dorsal and ventral surfaces with prominent longitudinal ridges flanked by punctations; lateral margin strongly costate. Opposable margin of dactyl with 4 tubercles in proximal half, 2 in conspicuous excision largest, and penultimate one delimiting distal extent of excision; single row of minute denticles beginning just distal to ultimate tubercle and extending nearly to corneous tip; mesial margin with complex ridge pattern in basal third but lacking tubercles; long setae prominent only in distal half; dorsal and ventral surfaces with prominent longitudinal ridge flanked by punctations.

Carpus with prominent longitudinal furrow dorsally, flanked mesially by few punctations; mesial surface with spikelike tubercle in distal fourth and irregular row of 4 subacute tubercles proximal to it; ventral surface smooth with low subacute tubercle in each distal corner; lateral surfaces sparse-

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view of carapace; g, Epistome; h, Lateral view of cephalic segments of abdomen; i, Dorsal view of distal podomeres of cheliped.

ly punctate with few long setae and prominent ventrolateral articular knob. Dorsodistal surface of merus entire with few small punctations; ventromesial margins with row of 10 rounded to slightly subacute tubercles; ventrolateral margin with row of 7, antepenultimate and penultimate bifid, low tubercles flanked medially by row of long stiff setae. Sufflamen well developed.

Chela of second pereiopod with row of long setae on both margins of palm, and on dorsal and ventral margins of carpus; distal half of ventral surface of merus with similar row.

Ischium of third pereiopod with simple, slightly curved hook not overreaching basioischial margin (Fig. 3e) and not opposed by tubercle on basis. Coxa of fourth pereiopod with small but prominent, transversely oriented caudomesial boss. Coxa of fifth pereiopod lacking boss but with setiferous ventral membrane.

First pelopod reaching just beyond caudal margin of coxa of third pereiopod, situated deeply within sternum, and somewhat obscured, particularly distally, by setae extending caudally and mesially mostly from ventrolateral margins of sternum; proximomesial spur lacking; distal fourth of shaft inclined caudally (Fig. 3a, d, e); terminal elements consisting of moderately broad, corneous central projection, obtusely notched subapically; mesial process subspatulate in distal half, expanded and somewhat compressed laterally just proximal to midlength but not contiguous with adjacent central projection; cephalic process absent.

Allotypic female.—Excluding secondary sexual characters differing from holotype in following respects: merus of cheliped with 8 (none bifid) spinose tubercles on ventrolateral margin; ventromesial row of 9; inner margin of palm with small squamous tubercle just dorsolateral to third from proximal end of row.

Annulus ventralis (Fig. 2f) about as broad as long, deeply excavate cephalically; caudal margin elevated, sinistral half tilted cephalically overhanging more cephalic part of caudal half of annulus; sinus originating beneath overhang near midline and extending cephalically short distance before recurving caudally, forming inverted-U, and disappearing before reaching caudal margin; dextral elevated portion flanking cephalic and lateral sides of sinus disappearing beneath sinistral overhang, sculpture providing overall appearance of interlocking fingers when viewed ventrally. Postanular sclerite reduced and subconical; provided with setae. First pleopod reduced and biramous.

Male, Form II.—No morphotype is designated because in all of the second form males I have seen there is so much variability, especially in the first pleopod, that I cannot select one as "typical" of the species. There is no consistency in the relative lengths of the terminal elements; they are subequal in 26.7%, the mesial process longer in 60.0%, and the central projection longer in 13.3%. The elements are bent (in relation to the principal axis of the basal part of the pleopod) about 90° in 33.3%, about 135° in 20.0%, between 90 and 135° in 33.3%, and up to 180° in 13.4%. The two elements are contiguous through at least 90% of their lengths in 37.5%, but are not so in 62.5%. The central projection is always blunt or bluntly rounded apically, but the mesial process, although always tapering from base to tip, can be described as apically constricted only in 20% of the specimens. None of these characteristics seems to be correlated with each other; neither does size seem to be a factor in the nature of their expression. Two other characters seem to be more developed as the animal gets larger: the hook on the ischium of the third pereiopod and the caudomesial boss of the coxa of the fourth. Nevertheless, even this relationship is not absolute. In five specimens the hook was as prominent as in the holotype (and other first form males). Their carapace lengths ranged from 24.1 to 30.4 mm, but the hook was much less developed in three other animals of the same size range (24.8, 24.8 and 25.3). Generally, the boss size was correlated with hook size; in one second form male, however (carapace length 28.0), it was scarcely identifiable. In one animal, the boss was rounded, although not as much so as in *F.* (*C.*) *burrisi,* and the associated females were clearly assignable to *F.* (*C.*) *gordoni.* Other types of variation are discussed below.

Type locality.—DeSoto National Forest, Camp Shelby Military Reservation, T2N, R10W, SE/4 NE/4 SE/4 Sec. 5, Perry County, Mississippi. Here the animals were dug from multiple-branched burrows in saturated sandy soil at the edge of a pitcher plant savannah. Nearby (within 1 km) burrows yielded specimens of *Cambarus* (*Lacunicambarus*) *diogenes ludovicianus* and *Procambarus* (*Ortmannicus*) *planirostris* Penn, 1953.

Disposition of types.—The holotype and allotype (USNM 206877 and 206878, respectively) are deposited in the National Museum of Natural History, Smithsonian Institution, together with a paratypic series (1 ♂II, 2 ♀, 1 ♀ imm., 1 ♀ ov.); The Mississippi Museum of Natural Science has a larger paratypic series (4 ♂I, 19 ♂II, 19 ♀, 3 ♂ imm., 4 ♀ imm.).

Variations.—Some of the variability encountered is encompassed within the descriptions of the types and discussion of the second form male, above, but other differences which were encountered merit discussion here. In all but two of the females (1 adult, 1 juvenile) the annulus was a mirror image of the allotype. In two mature females the sinus is more broad than that of the allotype, and, independent of maturity, in three the cephalic overhang of the caudal elevation is more pronounced. In about half the specimens, the tip of the rostrum is slightly upturned, but in a nearly equal number, the apical development is so unpronounced that one could not term the slight compression there an acumen. In nearly two-thirds of the specimens the cephalic extremity of the postorbital ridge merges imperceptibly into the cephalothorax, a situation somewhat more prevalent in larger than smaller specimens. The cephalolateral margins of the epistomal zygoma in many specimens have deeper pits associated with their cephalolateral bases than do the type specimens.

A remarkably early establishment of the pattern of tubercles associated with the opposable margins of the fingers of the chela apparently occurs. The smallest animals I have seen (15.4–19.0 mm cephalothorax length) all have a hand which in size and ornamentation allows them to be unquestionably assigned to this species. In some adults, however, there are differences in the arrangement and number of tubercles that are not clearly associated with regeneration of the member. Two females and a second form male from locality (8) below have the more basal tubercle in the excision of the movable finger larger than the next most distal, and the tubercle which marks the distalmost limit of the excision is, by far, the largest of the three; just distal to this last-mentioned tubercle are two small rounded ones. The proximolateral margin of the dactyl has a subtriangular cluster of three low tubercles. On the opposable margin of the immovable finger opposite the dactyl excision is a small, but still prominent, tubercle proximal to the usual two. Several animals from several localities also have some kind of tubercular development in the proximomesial region of the dactyl.

Setal development is likewise variable. In about half the specimens, the ischium of the third maxilliped has more than one, often arranged in a row, medial punctation in its basal half from which a tuft of long stiff setae emerges; in two animals from different localities, their maxillipeds were asymmetrical with respect to this character. Although always present, the row of setiferous punctations along the ventrolateral surface bears setae of different lengths and number; in only one specimen were the setae as long as

Table 1.—Measurements (in mm) of types of *Fallicambarus* (*Creaserinus*) *burrisi* n. sp. and *F.* (*C.*) *gordoni* n. sp.

	Holotype	Allotype	Morphotype
F. (*C.*) *burrisi*			
Carapace			
Total length	21.7	23.0	29.6
Postorbital length	20.1	21.2	26.5
Width	9.6	10.6	13.7
Height	10.8	10.9	14.5
Areola			
Length	8.6	9.0	12.0
Rostrum			
Length	3.5	3.7	5.0
Width	4.0	3.8	5.0
Chela			
Length, mesial margin palm	4.1	3.7	5.2
Width, palm	6.9	6.1	9.5
Length, lateral margin propodus	11.9	11.8	16.9
Length, dactyl	7.0	7.4	10.5
Abdomen			
Length	17.3	17.7	23.3
Width	6.2	6.6	9.0
F. (*C.*) *gordoni*			
Carapace			
Total length	21.1	21.0	—
Postorbital length	18.6	18.6	—
Width	9.1	8.5	—
Height	10.5	9.4	—
Areola			
Length	8.0	8.1	—
Rostrum			
Length	3.6	4.3	—
Width	4.0	4.4	—
Chela			
Length, mesial margin palm	3.7	3.0	—
Width, palm	6.1	5.5	—
Length, lateral margin propodus	11.2	11.0	—
Length, dactyl	7.0	7.3	—
Abdomen			
Length	16.5	10.2	—
Width	6.0	5.6	—

found in *F.* (*C.*) *byersi* and *F.* (*C.*) *burrisi.* The setae along the lateral margin of the dactyl also vary in number and length, but in only one specimen was there no trace of such.

The apex of the central projection of the first form male is blunt, but only in the holotype and one other is there any suggestion of a notch, and such indication is most pronounced in the holotype. In the first form male from locality (4) below the hook on the ischium of the third pereiopod is so acutely arched that the tip clearly overreaches the basioischial margin.

Size.—The smallest first form male is 21.0 mm in cephalothorax length, and the largest, 25.5. The largest second form male is 30.4 mm. The largest female is 32.5 mm and is the largest animal collected; the ovigerous female is 28.1 mm in cephalothorax length. For measurements see Table 1.

Range and specimens examined.—This crawfish is known from eight locations, all in the DeSoto National Forest (Pascagoula River drainage) in Perry County, MISSISSIPPI: (1) type locality, 1 ♂I, 1 ♀ (holo- and allotype, respectively), 25 Oct 1982, Robert L. Jones, coll.; (2) Camp Shelby Military Reservation, T2N, R10W, NW/4 SW/4 SW/4 Sec. 4, 1 ♂II, 1 ♀, 1 ♀ imm., 5 Nov 1982, R.L.J., K. L. Gordon, S. Mott, colls.; (3) Camp Shelby Military Reservation, T2N, R10W, SE/4 SW/4 NW/4 Sec. 15, 1 ♀, 1 ♀ ov., 9 Nov 1982, R.L.J., S.M., and K.L.G., colls.; (4) T2N, R10W, NE/4 NW/4 NE/4 Sec. 8, 3.3 airmi (5.3 km) SSE of New Augusta, 1 ♂I, 3 ♀, 29 Mar 1985, R.L.J., coll.; (5) compartment 71, T2N, R10W, NW/4 NE/4 SW/4 Sec. 20, bog on S side of Forest Service Rd. 304, about 0.45 airmi (0.7 km) SSW of jct. F. S. Rd. 304 and St. Rte. 29, 3 ♂I, 7 ♂II, 3 ♀, 18 Mar 1986, R.L.J. and K.L.G., colls.; (6) compartment 62, T2N, R10W, SE/4 NE/4 NW/4 Sec. 21, about 0.7 airmi (1.1 km) NE of crossing of St. Rte. 29 over Cypress Creek, 4 ♂II, 5 ♀, 18 Mar 1986, R.L.J. and K.L.G., colls.; (7) T2N, R10W, NW/4 SW/4 SW/4 Sec. 4, 1 ♂II, 1 ♀, 1 ♂

imm., 1 ♀ imm., 29 Mar 1985, R.L.J., coll.; (8) compartment 61, T2N, R10W, SE/4 SE/4 SW/4 Sec. 8, small bog area just S of active oil well, about 4.1 airmi (6.6 km) SSE of jct. U.S. Hwy. 98 and St. Rte. 29 in New Augusta, 6 ♂II, 6 ♀, 1 ♂ imm., 2 ♀ imm., 18 Mar 1986, R.L.J. and K.L.G., colls.

Life history and environmental notes.—First form males were taken on 18 and 29 March and 29 October; the ovigerous female was captured on 9 November, at which time she was carrying about 36 fertile eggs and was discovered within the chimney, above the water table. All were taken from saturated sandy soil associated with pitcher plant savannahs. Collections 1–3, above, were dug from the complex burrows, but the subsequent ones were collected using a modification of a trap designed by Norrocky (1984) for use in Ohio. These traps have yielded remarkable results for the Mississippi Museum personnel in their studies of south Mississippi habitats. The greatly increased number of specimens per unit effort afforded by this technique has permitted them to accumulate an excellent collection of burrowing crawfishes from the Jackson Prairie, which is, except for Hobbs' efforts in Georgia and South Carolina, spread over many more years, possibly the most thorough representation of such animals from a particular region available anywhere.

I have not collected the animals myself, so I have no details of associated plants or color notes. In one formalin-preserved specimen, however, a lavender ground color, not unlike *F.* (*C.*) *byersi,* was evident when I first examined the specimen. I also was able to examine methanol-preserved specimens from localities 5, 6, and 8, above, within one month of their collection. In all a distinct lavender color, similar to that seen in *byersi,* was evident on the hand or dactyl or both. In two of the first form males, the rostral margins and postorbital ridges were deep purple.

Relationships.—*Fallicambarus* (*Creaserinus*) *gordoni* is most closely related to *F.* (*C.*) *danielae* but it is easily distinguished by a broader rostrum and the presence of two, rather than one, prominent tubercles in the excision on the opposable margin of the dactyl. In first form males the mesial process extends scarcely beyond the tip of the central projection, and the notch at the apex of the latter, if present, is never so obvious as in *danielae.* In females, the sinus begins in the far caudal half of the annulus, beneath an overhanging elevation of the caudal margin. In *F.* (*C.*) *danielae* the tip of the mesial process extends well beyond the apex of the central projection, which projection is also clearly notched subapically; the annulus of the female has no overhanging, conspicuously elevated caudal margin, and the sinus originates near the middle of the annulus. The central projection and mesial process of *F.* (*C.*) *danielae* are directed so that their apices are more or less 90° to the principal axis of the basal part of the pleopod; in *F.* (*C.*) *gordoni* the central projection apex is directed at least 150° and the mesial process as much as 145°. See also the comments under the "Relationships" section for *F.* (*C.*) *burrisi,* above.

Acknowledgments

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TWO NEW OPERCULATE LAND SNAILS FROM THE PALAU ARCHIPELAGO

Fred G. Thompson and Thomas M. Iliffe

Abstract.—*Georissa zea* Thompson, n. sp. (Gastropoda, Prosobranchia, Hydrocenidae) is described from Machachar Island. It differs from other species by its large size and regularly-spaced granular sculpture. It is the first hydrocenid recorded from the Palau Archipelago. A second species, *G. rufula,* also occurs there. *Pupina nitidula* Thompson, n. sp. (Gastropoda, Prosobranchia, Pupinidae) is described from Ngeruktabel Island. It is differentiated by its small size and slender form.

The land snail fauna of the Palau Islands is better known than that of most other western Pacific archipelagos. Four of the six numerically dominant groups of snails inhabiting the islands have been monographed in recent years, based primarily upon collections made by the Bernice P. Bishop Museum Micronesian Expedition in 1936 (Baker 1938–1941; Clench 1949; Cooke and Kondo 1960; Solem 1976, 1983). Notwithstanding these revisionary studies, the fauna remains only partially known, even among those families that are monographed. Species have been reported from only six of the nearly 200 islands that comprise the archipelago, and only two (Koror and Peleliu) have been sampled at more than a few stations.

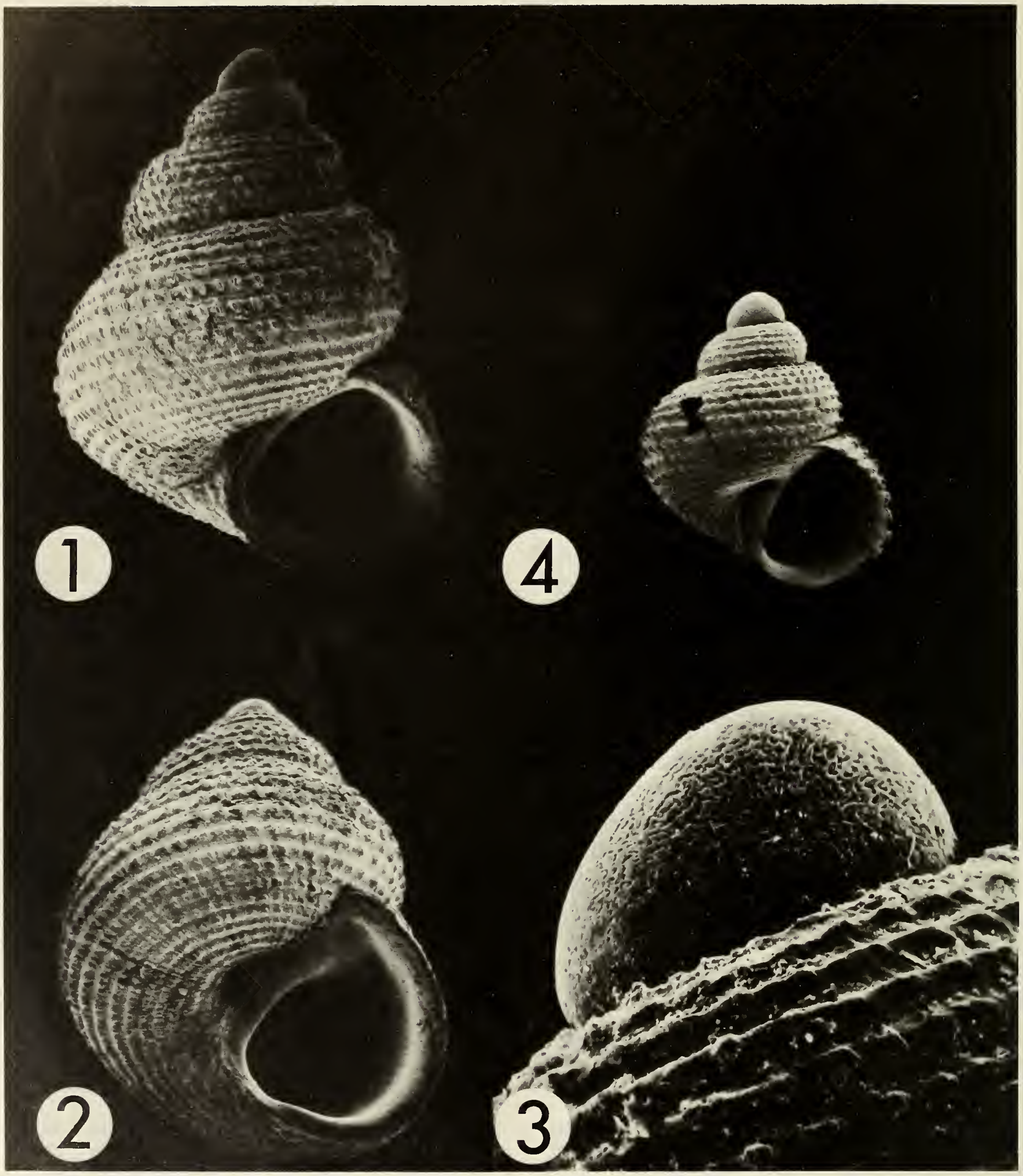
Recent field work in Palau by the authors has added important collections from seventeen other islands and islets not reported upon in earlier studies. The new snails described below are from two of these islands.

Georissa zea Thompson, new species
Figs. 1–4

Diagnosis.—A moderately large species characterized by its light yellow color, its ovate-turbinate shape, and teleoconch sculpture consisting of strong spiral cords bearing nodes that are synchronized along growth lines.

Description.—Shell light yellow in color. Moderately thick, opaque. About 6.5 mm long at maturity. Ovate-turbinate in shape (Fig. 1); about 1.4 times as wide as high in adult shells. Spire moderately high, about 1.4 times height of aperture. Whorls 4.2. Protoconch strongly protruding; sculptured with dense mesh of minute longitudinal granules (Fig. 3); initial half whorl horizontal, 0.30 mm wide by 0.40 mm long. Whorls of teleoconch uniformly rounded with deeply impressed suture; sculptured with strong spiral cords adorned with regularly-spaced rounded nodes synchronized along growth lines; cords and nodes nearly uniform in size over surface of shell; 19 cords on body whorl, 10 on penultimate whorl and 8 on antipenultimate whorl. Umbilicus closed but deeply indented with narrow rimate impression at maturity (Fig. 2). Columellar lip rounded, not forming broad, flattened plate. Immature shells imperforate; with broad plate-like expansion of columella, typical of *Georissa* (Fig. 4). Aperture broadly ovate-triangular in shape; 0.9 times as high as wide. Peristome continuous across parietal wall; thickened along posterior corner; basal lip and columellar lip nearly straight and forming pronounced angle; baso-columellar corner sharp and weakly projecting forward.

Inner surface of holotype operculum with thick calcereous peg projecting to right and attached to plate to margin. (The peg was



Figs. 1–4. *Georissa zea* Thompson, new species: 1–3, Holotype (UF 90523); 4, Paratype (UF 90524). Enlargements: 1, 2, 4 × 26; 3 × 175.

broken at this point in the only specimen available.) Outer face paucispiral; nucleus located at left-basal margin. Outer surface covered with thin calcareous layer. Basal plate surrounded by a chitinous fringe. Basal plate 0.86 mm wide and 1.15 mm high.

Measurements in mm of two specimens follow.

Specimen	length	width	aper. h.	aper. w.	whorls
Holotype	6.45	4.71	2.73	2.54	4.2
Paratype	3.41	2.73	1.67	1.80	3.3

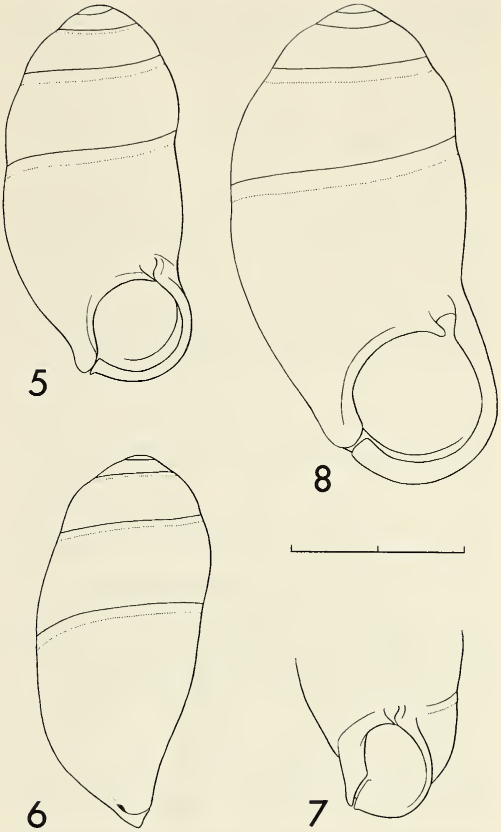
Type locality.—Republic of Belau (Palau Islands), northwest point of Machachar Island, 134°22′20″E, 07°08′45″N. HOLOTYPE: UF 90523; collected 22 Oct 1985 by Fred G. Thompson. PARATYPE: UF

90524; same data as holotype. The holotype and paratype were gold-plated for SEM study.

The area at the type locality consists of a strongly karsted limestone terrain in a primary rainforest with a sparse understory of woody shrubs and vines. The ground was covered with a thin layer of dead leaves. The holotype, the only live specimen found, was on the underside of a rotting piece of wood. The single paratype was found in leaf litter.

Remarks.—This species is unique among *Georissa* because of its sculpture. The umbilical indentation of the holotype is also unique. All other *Georissa* are imperforate and have a broad plate-like columellar lip as is depicted in Fig. 4. The umbilical pit of the holotype may be a gerontic teratology. It appears to be caused by rolling of the columella. Not withstanding the structure of the umbilical area this species is readily identified by its sculpture and its size. It is the largest *Georissa* known from the Pacific or the Philippine Islands.

This is the first species of Hydrocenidae recorded from the Palau Islands. A second species that was originally described from Panope, *Georissa rufula* Moellendorff, 1900, is widely distributed in the Palau Archipelago. It is distinguished from *G. zea* by its minute size, being about 2.5 mm long, and its smooth reddish shell that is sculptured with very fine spiral striations. Usually, the striations are apparent only on fresh shells. Zilch (1973, pl. 13, fig. 22) illustrates the lectotype of *G. rufula.* Both species were found together on Manchachar Island. *Georissa rufula* also inhabits leaf-litter. Three other species, *G. elegans* Quadras and Moellendorff, 1894, *G. biangulata* Quadras and Moellendorff, 1894, and *G. laevigata* Quadras and Moellendorff, 1894, are described from Guam. Numerous other species are known from the Philippine Islands, southeast Asia, Indonesia, Australia and various south Pacific islands. None of these has sculpture that is similar to that of *G. zea.*



Figs. 5–8. 5–7, *Pupina nitidula* Thompson, new species, holotype (UF 79186). 8, *Pupina difficilis* Semper (UF 84348), Peleliu Island, Kloulklubed. Scale equals 2 mm.

Etymology.—The species name *zea* is taken from the generic name for maize, *zea,* and alludes to the noded sculpture arranged in rows much like kernels on a corncob.

Pupina nitidula Thompson, new species
Figs. 5–7

Diagnosis.—A species of *Pupina* s.s. that is not closely related to other known species of the genus. It is characterized by its small size, slender shape, and notches in the peristome. The small, slender, transparent shell is flexed weakly to the left at the third whorl. The palatal lip inserts on the front of the shell (Fig. 5), not on the side as in other members of *Pupina* s.s. such as *P. difficilis* Semper. The posterior corner of the aperture has a nearly tubular channel formed by the parietal tooth and a tubercular projection on the palatal lip. The columellar pore lies deep behind the columella and is connected to the peristome by a narrow oblique slit.

Description.—Shell small, about 4.5 mm long; ovate-cylindrical in shape with rounded apex. Shell weakly flexed to left at third whorl (Fig. 5). Slender, 0.46–0.51 times as wide as high. Surface smooth and glossy; transparent; grayish white. Whorls 4.8–4.9; weakly arched between sutures. Penultimate whorl flattened above front of aperture. Suture weakly impressed with distinct hyaline subsutural zone. Aperture circular, 0.49–0.51 times width of shell. Peristome nearly continuous across parietal wall as low rounded callus merging into parietal lamella at base. Peristome lying in plane with anterior slope of penultimate whorl (Fig. 6). Peristome incised by parietal sinus and columellar pore (Fig. 7). Parietal sinus formed by oblique parietal lamella extending into aperture for about ⅛ whorl forming narrow channel along posterior corner of aperture; upper end of palatal lip with tubercular projection partially overlapping outer edge of parietal lamella. Parietal lamella not extending beyond edge of aperture. Columellar pore located at base of columella, consisting of small elliptical pore connected to margin of peristome by deep, narrow, oblique slit (Fig. 6). Pore nearly vertical and opening internally behind flattened columellar wall.

Measurements in mm of three specimens are as follows. The aperture is measured internally.

	length	width	aper. h.	aper. w.	whorls
Holotype[1]	4.46	2.29	1.05	1.12	4.9
Paratype[2]	4.40	2.11	0.99	1.05	4.9
Paratype[3]	4.46	2.05	1.05	1.05	4.8

[1] UF 79186; [2] UF 79187; [3] UF 79188.

Type locality.—Republic of Belau (Palau Islands), southeast end of Ngeruktabel Island, 134°26′50″E, 07°15′30″N; 150 m altitude. The type locality is 1 km north of the ruins of a World War II Japanese artillery installation, and is just a few meters below the crest of the island on the east slope. The area is on limestone substrate covered by rain forest with very little understory or ground vegetation. Specimens were found deep in leaf-litter in association with *Pupina difficilis* Semper. HOLOTYPE: UF 79186; collected 23 Oct 1985 by Fred G. Thompson. PARATYPES: UF 79187, UF 79188; same data as holotype.

Pupina nitidula is known only from the type locality. Ngeruktabel is a long narrow crescent-shaped island about 30 km long and 1–2 km wide. The island is uninhabited. It is accessible only at a few points along the shore, because it is surrounded by nearly continuous vertical cliffs. Six field collections were made by the authors and Jeffry Bozanic from the east end of Ngeruktabel over a linear distance of less than five km. The central region is higher and broader. It has not yet been explored for land snails.

Remarks.—*Pupina nitidula* is readily identified by its small size, its slender shape with a rounded apex, and its aperture notches. It is the smallest known *Pupina* s.s. It is not closely related to other known species because of the structure of the aperture. In other species the embayment between the parietal lamella and the palatal lip is broader, the palatal lip inserts in a more lateral position, and the columellar pore is broader with a more rounded perforation connected to the edge of the peristome by a horizontal transverse slit. These characters ae typically depicted in *Pupina difficilis* Semper. Clench (1949) illustrates all of the known Pacific *Pupina,* including the type species, *Pupina keradreni* Vignard. None approaches *Pupina nitidula* in the characters of the aperture.

Pupina nitidula is most similar to *Pupina difficilis* because of its bluntly rounded apex. *Pupina difficilis* is widely distributed throughout the Palau Islands, and is the only other *Pupina* from there. It was found with *Pupina nitidula* at the type locality.

Etymology.—The species name *nitidula* is from the Latin *nitidus,* diminutive, and refers to the elegant, shiny aspect of this small snail.

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(FGT) Florida State Museum, University of Florida, Gainesville, Florida 32611; (TMI) Bermuda Biological Station for Research, Inc., Ferry Reach 1–15, Bermuda.

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CLASSIFICATION OF THE ASCOTHORACIDA (CRUSTACEA)

Mark J. Grygier

Abstract.—The order- and family-level classification of the maxillopodan crustacean superorder Ascothoracida is revised in light of recent advances in taxonomical and morphological knowledge of this group. It is divided into two orders and six families, two of which have two subfamilies. New taxa proposed are the orders Laurida and Dendrogastrida (which supersede the suborders Lauroidida Wagin and Synagogoidida Wagin), the family Ascothoracidae, and the subfamilies Introcorniinae and Ulophysematinae.

The Ascothoracida consist of about 70 described species of parasites of echinoderms and anthozoans. Their taxonomic rank and relationship to other maxillopodan crustaceans, especially to the Cirripedia, have been interpreted differently (e.g. Grygier 1983b, Boxshall 1983, Boxshall and Lincoln 1983). Here they are considered a superorder coordinate with the Cirripedia and the Facetotecta ("Hansen's y-larvae") within the maxillopodan subclass Thecostraca (classification of Grygier 1985a).

Wagin (1976) divided the Ascothoracida, considered by him an order of the Entomostraca, into two suborders: Lauroidida for most of the anthozoan parasites; and Synagogoidida primarily for the echinoderm parasites, but *Synagoga mira* Norman, the type of its genus, infests an antipatharian coral. Wagin's arrangement of Gruvel's (1905) four families and their contained genera follows:

Lauroidida—Lauridae: *Laura, Baccalaureus, Gorgonolaureus*
—Petrarcidae: *Petrarca*
Synagogoidida—Synagogidae: *Synagoga, Ascothorax, Parascothorax*
—Dendrogasteridae (sic): *Ulophysema, Dendrogaster*

Numerous new species and genera have been described since 1980, mostly by the present author, and the family Ctenosculidae, previously thought to be molluscan, has been transferred to the Ascothoracida (Warén 1981, Grygier 1983d). After the separation of the crinoid-infesting *Waginella* from *Synagoga* (Grygier 1983a), Wagin's suborders could no longer logically be used if the basic, apparently sound division by host phylum were to be preserved. *Synagoga,* now limited to anthozoan parasites, may reasonably be transferred to the other suborder, but both subordinal names would then come to apply to the old Lauroidida, and the remaining portion of the former Synagogoidida would be left nameless. The recent addition of several genera of gorgonian parasites to the Synagogidae (Grygier 1981, 1984a; Moyse 1983; Lowry 1985) makes the need for an ordinal revision more pressing, and it has also exacerbated the paraphyletic nature of the Synagogidae, which was already evident in Wagin (1976) (defined by possession of a generalized body plan).

The present paper revises the ordinal and familial classification of the Ascothoracida in a manner consistent with current morphological knowledge of the animals (Grygier 1984b) and seeks, as far as possible, to employ monophyletic taxa.

Table 1 is a character state matrix for the genera of Ascothoracida described through early 1986. A very high level of convergence is evident, probably because most of the apomorphic states are easily duplicated reductions associated with parasitism. Therefore, one of the preconditions for a meaningful cladistic treatment, the assumption of relatively rare convergence, is not met. Despite this limitation, several apparently monophyletic taxa have been identified. However, the family Synagogidae, as defined below, and thus also the order Laurida, may still be paraphyletic due to: 1) the near absence of synapomorphies between *Waginella* and other genera, and 2) the possibility that one or more of the advanced synagogid genera, such as *Thalassomembracis,* form the sister group of the Lauridae. Despite these faults, which may eventually be correctable, I believe the following classification of the Ascothoracida to be an improvement over its predecessor, and, aside from possible further subdivision of the Synagogidae, it will serve to place numerous undescribed species and genera now in preparation.

Class Maxillopoda Dahl, 1956
Subclass Thecostraca Gruvel, 1905, sensu Grygier (1985a)
Superorder Ascothoracida Lacaze-Duthiers, 1880

Diagnosis.—Bivalved crustaceans (valves often fused in females), diverticula of midgut and gonads in carapace. Primitively with 11 free trunk segments, first 6 with biramous thoracopods, seventh with biramous or uniramous penis in both sexes, last with movable furcal rami. Eyes usually absent. Frontal filaments often present, sometimes combined with uniramous antennae(?) into sensory organs, better developed and plumose in males. Antennules primitively 6-segmented, prehensile, with claw guard and movable claw on sixth segment, setae on fourth, fifth, and sixth. Antennae usually absent. Labrum conical or pear-shaped, sheathing other mouthparts to form oral cone; maxillae usually with movable subterminal hooks. Female gonopores and often filamentary appendages at base of first legs. Thoracopods primitively paddle-like and setose, usually abutting medially, with 2-segmented exopods, 3-segmented endopods (2-segmented in legs 1 and 6). Seminal receptacles usually in coxae of legs 2–4 or 2–5. Furcal rami blade-like, unsegmented, with various arrangements of terminal and medial setae, primitively a setal fan. Commonly a pair of posteroventral telsonic spines. Apparently gonochorists (Grygier 1987) or (Petrarcidae) simultaneous hermaphrodites. Eggs and larvae usually brooded under carapace; larvae include nauplii and bivalved, "ascothoracid larvae." Parasites of echinoderms and anthozoans.

Remarks.—Features, especially of the appendages, are modified or reduced in various ways in different ascothoracidans as indicated in the following diagnoses.

Order Laurida, new order

Diagnosis.—Parasites of Anthozoa (except *Waginella,* ectoparasitic on crinoids). Adult morphology highly variable.

Family Synagogidae Gruvel, 1905

Diagnosis.—Parasites of antipatharians, octocorals, and stalked crinoids. Main body and appendages in general plesiomorphic (see above). Carapace bivalved or dorsally fused and expanded into stiff-walled brood chamber (latter correlated with vertical cephalic attachment zone and unpaired dorsal humps or horns on thorax). Fifth antennular segment with several to many setae (but 0–2 in *Thalassomembracis*); sixth with proximal sensory process, usually with aesthetasc and 3 setae (less well developed in *Thalassomembracis* and *Waginella*). Antenna(?)-frontal filament complexes present, best developed in males. Mandibles

Table 1.—Character state matrix for the genera of Ascothoracida (adult females unless otherwise noted). List of symbols: 0, plesiomorphy; 1–3, apomorphies; +, present, −, absent; /, variable within genus; ?, uncertain.

Character states / Genera[1]:	W	S	G	Is	Ca	T	L	Ba	Zo	Po	In	Pe	Zi	Pa	A	Ct	E	U	Bi	D
Carapace bivalved (0) or univalved with restricted aperture (1)	0	0	1	1	1^2	1	1	1	1	1	0	0	0	1^2	1^2	1	1	1	1	1
Cephalic attachment zone to carapace dorsal or anterodorsal (0), anterior and vertical (1), or anterior and inverted (2)	0	0	1	1	1	1	2	2	2	2	1	0	0	1	1	2	2	2	0	0
Antennules 6-segmented (0), 5-segmented (1), 4-segmented (2), or reduced or vestigial (3)	0	0	0	0	0	0	3	3	3	3	1	1	1	1	1	3	3	3♀ 2 larva	2	2
Plumose appendage (antenna?) associated with frontal filament (♂ and/or ♀)	+	+	+	+	+	+	−	−	−	−	−	−	−	−	−	−	−	−	−	−
Oral cone "normal" (0), with long languette (+), or with reduced or missing mouthparts (1)	0	+	+	+	+	+	0	1?	0	0	0	1	1	0	0	0	1	1	1	1
Maxillae bifid (+) or not (−)	−	+	+	?	$+^3$	+	+	+	+	+	$+^3$	−	−	+	+	$+^3$	$+^3$	−	+	+
Thorax "normal" (0), greatly enlarged and/or with processes (1), or with reduced segmentation (2)	0	0	1	1	1	1	1	1	1	1	0	2	2	1	1	1	1	1	2	2
Filamentary appendages	$+^4$	−	−	+	+	−	−	+	+	+	−	−	−	+	±	$+^4$	+	−	−	−
Thoracopods biramous and paddle-like (0), leaf-like with reduced rami (1), or uniramous (2)	0	0	0	0	0	0	2	2	2	2	2	2	2	1	1	1	1	2	−	$-^5$
Six pairs of thoracopods (0), some absent (1), or all absent (2)	0	0	0	0	0	0	0	0/1	1	1	1	0/1	1	0	0	0	0	1	2♀ 1♂	2♀[5] 1♂
Seminal receptacles	+	+	+	+	+	$+^6$	+	+	$+^6$	+	+	$+^6$	$+^6$	+	+	+	+	−	−?	−
Abdomen 5-segmented (0), clearly 4-segmented (1), or further reduced (2)	0	0	0	0	0	0	1	1	1	1	0	2	2	0	0	1	1	2	2	2
Penis biramous (0) or uniramous (1) (esp. ♂♂)	0	0	0	1	0	1	1♀	1	1	1♀	0	0	1	1	1	?	1	1	1	1
Telsonic spines large (0) or minute or absent (1)	0	0	1	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Furca forming a tail fan (0), with setose rami but no fan (1), or reduced or absent (2)	0	0	0/1	0	0	1	1	1	1	1	1	2	2	1	1	1	1	2	2	2
Simultaneous hermaphrodites	−	−	−	−	−	−	−	−	−	−	+	+	+	−	−	?	−	−	−	−
Nauplii with strong endites (0) or not (1)	?	0	1	?	1	1	0	0	0	0	?	0	0	1	1	?	1	1	1	1
Nauplii with biramous antennae and mandibles (0) or not (1)	?	0	0	?	0	0	0	0	0	0	?	0	0	0	0/1	?	1	0/1	0	0/1

[1] Generic abbreviations: W, *Waginella*; S, *Synagoga*; G, *Gorgonolaureus*; Is, *Isidascus*; Ca, *Cardomanica*; T, *Thalassomembracis*; L, *Laura*; Ba, *Baccalaureus*; Zo, *Zoanthoecus*; Po, *Polymarsypus*; In, *Introcornia*; Pe, *Petrarca*; Zi, *Zibrowia*; Pa, *Parascothorax*; A, *Ascothorax*; Ct, *Ctenosculum*; E, *Endaster*; U, *Ulophysema*; Bi, *Bifurgaster*; D, *Dendrogaster*.

[2] Large aperture present, but no hinge.

[3] Posterior process probably not movable.

[4] Missed by Grygier (1983a, 1983c).

[5] While most females of *Dendrogaster* are limbless, a few specimens with uniramous legs have been observed (Grygier, unpubl.).

[6] Some (Zo) or all (Pe, Zi, 1 species of T) seminal receptacles found in thorax instead of legs.

lanceolate or broad-based but attenuate, with complex but variable medial armament (little armament in *Waginella*). Maxillules blunt with one or more longitudinal comb-rows of setae (styliform and unarmed in *Waginella*). Maxillar tips variable. Hypopharynx produced into long languette (not in *Waginella*). Filamentary appendages present or not. Large epaulets on thoracomere 6 (not in *Synagoga*). Details of penis, telsonic spines, and furca variable.

List of genera.—*Synagoga* Norman, 1888; *Waginella* Grygier, 1983a; *Gorgonolaureus* Utinomi, 1962; *Isidascus* Moyse, 1983; *Thalassomembracis* Grygier, 1984a; *Cardomanica* Lowry, 1985.

Remarks.—*Waginella* is included in this family despite its echinoderm hosts (when known) and its somewhat exceptional mouthparts because it and *Synagoga,* the two most generalized ascothoracidan genera, are in most respects extremely similar and until recently were classified in the same genus (Grygier 1983a).

Family Lauridae Gruvel, 1905

Diagnosis.—Endoparasites or mesoparasites of zoanthids. Female carapace univalved, greatly enlarged relative to body, often with lateral pouches or coils, cephalic attachment zone inverted; males bivalved, much smaller than females. Antennules reduced in females, claw vestigial or absent; male antennules generalized. Oral cone normal. Mandibles usually with medial hairs, maxillules blunt, unarmed, maxillae generalized. Four to 6 pairs of uniramous, segmented legs with short, spine-like setae in females; 6 pairs in males, some biramous. Female filamentary appendages oval, platelike (absent in *Laura*). Abdomen 4-segmented, last segment sometimes showing partial division. Penis uniramous (often very long in males). Telsonic spines small or absent. Furcal rami with up to 4 terminal setae, usually no medial setae.

List of genera.—*Laura* Lacaze-Duthiers, 1865; *Baccalaureus* Broch, 1929; *Zoanthoecus* Grygier, 1985b; *Polymarsypus* Grygier, 1985b.

Family Petrarcidae Gruvel, 1905

Diagnosis.—Endoparasites of scleractinian corals. Carapace of two thick valves armed with spines and/or papillae, lacking brood chamber. Antennules 5-segmented, not subchelate, only distal segment well armed. Antennae absent. Oral cone variable; mandibles and maxillules with short, medial cutting edge, rarely unarmed; distal parts of maxillae reduced. Thoracopods uniramous, with few or no setae, first pair reduced or absent, no filamentary appendages. First abdominal segment much larger than others. Penis and terminal abdominal segment variable. Simultaneous hermaphrodites.

List of subfamilies.—Introcorniinae, new subfamily; Petrarcinae Gruvel, 1905.

Subfamily Introcorniinae, new subfamily

Diagnosis.—Carapace spherical with papillae; cephalic attachment zone vertical. Antennular cuticle of even thickness, distal segment generalized. Labrum normal; maxillae with hairy, vestigially bifid tips. Thorax clearly segmented. Thoracopod 1 absent; other 5 pairs segmented, weakly setose, some with seminal receptacles. Abdomen 5-segmented, penis in form of 2 blunt lobes. Furcal rami well developed.

List of genera.—*Introcornia* Grygier, 1983d (type genus).

Subfamily Petrarcinae Gruvel, 1905

Diagnosis.—Carapace ovoid or dome-shaped, with spines and/or papillae; cephalic attachment zone dorsal, horizontal. Basal antennular segments with distinct sclerites; conspicuous armament of fifth segment reduced to claw and claw guard bearing a large seta. Labrum blunt, rear edges widely separated; maxillae forming a short, massive labium. Thoracic segmentation obscure. Five or 6 pairs of unsegmented, unarmed, usually lobular thoracopods, first pair narrow or setiform when present. Seminal receptacles in thorax. Extremely long and robust penis with short rami or none. No more than 4 abdominal segments, all but first very reduced. Furcal rami vestigial or absent.

List of genera.—*Petrarca* Fowler, 1889; *Zibrowia* Grygier, 1985c.

Order Dendrogastrida, new order

Diagnosis.—Parasites of echinoderms. Carapace valves in females at least partly fused, soft-walled with delicate cuticle, often greatly enlarged. Trunk variable, generalized to extremely reduced. Antennules 4- or 5-segmented and subchelate at some stage of development, or vestigial; proximal sensory process of terminal segment reduced to isolated aesthetasc and seta, aesthetasc ribbon-like in larvae (antennular details to be confirmed in larval Ctenosculidae). Antennae absent. Mandibles and maxillules unarmed, at least medially, when present. Thoracopods leaf-like, uniramous, or absent.

Family Ascothoracidae, new family

Diagnosis.—Bursal parasites of ophiuroids. Carapace in females roughly spherical or ovoid, valves partly fused with pair of thin-walled, dorsal brood chambers; cephalic attachment zone vertical; males bivalved, much smaller than females. Antennules 5-segmented, subchelate, fourth segment usually with toothed process. Labrum normal. Mandibles setiform with distal hairs. Anterior thoracomeres usually greatly swollen with bilateral protrusions. First thoracopods short, uniramous; filamentary appendages often present. Next 4 pairs of legs leaf-like, with short, rounded rami (legs narrow in males, endopod reduced or absent); sixth legs short. Seminal receptacles small, tubular, often only in legs 2–4. Abdomen 5-segmented, sharply bent at segment 4; penis a short lobe, even in males. Furcal rami elongate, usually with short ventral setae in females, a few distal setae in males.

List of genera.—*Ascothorax* Djakonov, 1914 (type genus); *Parascothorax* Wagin, 1964.

Family Ctenosculidae Thiele, 1925

Diagnosis.—Mesoparasites of starfish. Ovoid carapace with short, posteroventral or ventral aperture. Cephalic attachment zone inverted. Antennules minute or absent. Front side of labrum short. Mandibles apparently absent; maxillae bifid, but not hooked. Thorax enlarged, with humps or long dorsal horns. Thoracopods typically leaf-like, sometimes uniramous; filamentary appendages sometimes present. Abdomen 4-segmented, penis vestigial or absent. Furcal rami large, variable. Adult males unknown.

List of genera.—*Ctenosculum* Heath, 1910; *Endaster* Grygier, 1985d.

Family Dendrogastridae Gruvel, 1905
(name corrected)

Diagnosis.—Female carapace (mantle) produced into large, soft-walled lobes or branches. Antennules 4-segmented, subchelate at some stage of development. Mandibles and maxillules vestigial or absent. Thoracopods short and uniramous, or absent; first pair always absent. No filamentary appendages or seminal receptacles. Abdomen at most 3-segmented, often absent, furcal rami present as unarmed lobes or absent.

List of subfamilies.—Ulophysematinae, new subfamily; Dendrogastrinae Gruvel, 1905.

Subfamily Ulophysematinae,
new subfamily

Diagnosis.—Endoparasites of irregular echinoids. Mantle with anterior and posterior lobe and ventral aperture, cephalic attachment zone inverted. Antennules in adult poorly segmented, with small distal segment and claw. Mouthparts absent except for small labrum. Dorsal horns on first 4 thoracomeres. Four or 5 pairs of short, uniramous limbs with short setae. Abdomen 2- to 3-segmented, with or without fixed furcal lobes. Adult males unknown.

List of genera. — *Ulophysema* Brattström, 1936 (type genus).

Subfamily Dendrogastrinae Gruvel, 1905

Diagnosis. —Endoparasites of starfish. Female mantle developed into pair of posterior lobes or bilateral system of branches with very small aperture. Cephalic attachment zone anterodorsal. Males bivalved, each valve with posterior protrusion; living in female brood chamber. Antennules and maxillae well developed in adults; third antennular segment lacking process, but usually with 1 or 2 spine-like setae opposing claw. Thorax and abdomen obsolete, saclike, limbs generally absent, no furca.

List of genera.—*Dendrogaster* Knipovich, 1890 (subjective synonyms: *Myriocladus* Okada, 1925 and probably *Laocoon* Nierstrasz and Entz, 1922); *Bifurgaster* Stone and Moyse, 1985.

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Note added in proof

The new genus *Paremedius* Stone, 1987 (Journal of Natural History 21:219–224) belongs to the Dendrogastrinae. I regard it as a synonym of *Bifurgaster,* and in all described features it agrees with that genus in Table 1.

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A NEW SUBSPECIES OF *RALLINA EURIZONOIDES* (AVES: RALLIDAE) FROM THE BATAN ISLANDS, PHILIPPINES

Robert S. Kennedy and Charles A. Ross

Abstract.—Specimens of the Slaty-legged Crake (*Rallina eurizonoides*) collected on Batan Island, Philippines, in 1981 and 1985 are the first records of the species for the Batan Islands and are here recognized as *R. e. alvarezi,* new subspecies. The first three records of *R. e. eurizonoides* for Fuga Island in the Babuyan Islands are also reported.

The Slaty-legged Crake (*Rallina eurizonoides*) ranges from India through Southeast Asia to the Greater Sundas, and from the Ryukyu Islands of Japan south through the Philippines to Celebes. Ripley (1977) recognized six subspecies with nominate *R. e. eurizonoides* restricted to the Philippines, where duPont (1971) listed it from the islands of Basilan, Bohol, Cagayan, Cebu, Leyte, Luzon, Mindanao, Mindoro, Negros, Panay, and Jolo. Recently, duPont and Rabor (1973) have reported it from Sanga Sanga in the Tawitawi Group, and Dickinson, Kennedy, and Rozendaal (in prep.) have located specimens from Guimaras, Marinduque, Samar, and Siquijor taken by the 1887–1888 Steere Expedition to the Philippines. It is also known from three previously unpublished specimen records from Fuga Island in the Babuyan Group collected for the Delaware Museum of Natural History on 16 Mar 1980 (DMNH 70273, 70275) and 17 Mar 1980 (DMNH 70274).

During a visit to Batan Island in the Batan Islands north of Luzon in the Philippines on 31 Oct 1981, Kennedy collected a specimen of *R. eurizonoides* (LSUMZ 105082, female) that is the first record for the island. Recent collections we made in the Batan Islands in collaboration with the Philippine National Museum and Silliman University from 28 May to 11 Jun 1985 yielded additional specimens of *R. eurizonoides* (4 skins: 2 adult males, 1 half-grown male and 1 adult female; and 1 complete and 1 partial skeleton).

After comparing the Batan birds with specimens of *R. e. eurizonoides* from other islands in the Philippines and samples of the other subspecies, particularly *R. e. formosana* from Taiwan and *R. e. minahasa* from Celebes, we have concluded that the specimens from Batan represent a new subspecies, to be known as:

Rallina eurizonoides alvarezi,
new subspecies

Holotype.—PNM 16301, adult male in breeding condition (largest testis—7 × 14 mm), 31 May 1985, western slope of Mt. Iraya, 180 m elevation, Sitio Nacamaya, 3 km NE of Basco, Batan Island, Batanes Province, Philippines, R. S. Kennedy and party (collector's no. 1048).

Paratypes.—LSUMZ 105082 and USNM 582810–582812, Batan Island, 1.5 to 4 km N or NE of Basco, R. S. Kennedy and party, 31 Oct 1981 (LSUMZ 105082) and 31 May to 8 Jun 1985 (USNM 582810–582812).

Subspecies characters.—Differs from *R. e. eurizonoides* and *R. e. formosana* by having: the upperparts, and outer edges of wing and tail feathers darker olive brown; the top and sides of head, hind neck, lower throat and breast darker chestnut; the white barring of underparts narrower and less pronounced; the throat, in males, chestnut, not pale rufous as in *R. e. eurizonoides* or white as in *R. e. formosana*; and the inner webs of wing and tail feathers dusky brown almost black. Differs further from *R. e. formosana* in having a longer tail (*R. e. alvarezi* (4) 66.9 ± 1.31, range 65.5–68.0; *R. e. formosana* (2) 60.5 ± 4.95, range 57.0–64.0), shorter culmen (from feathers on side of culmen: *R. e. alvarezi* (4) 20.6 ± 0.46, range 20.4–21.2; *R. e. formosana* (2) 24.4 ± 1.13, range 23.6–25.2), and a shorter tarsus (*R. e. alvarezi* (5) 43.3 ± 0.85, range 42.2–44.0; *R. e. formosana* (2) 44.5 ± 0.85, range 43.9–45.1).

Like *R. e. minahasa* in being of similar size, in having dark olive brown upperparts and in having narrow and less pronounced white barring on the underparts. Differs from *R. e. minahasa* in having the top and sides of head, hind neck, lower throat and breast darker chestnut and the throat, in males, chestnut, not pale rufous.

Rallina e. alvarezi differs from the other subspecies by size and color of the head and neck (*R. e. sepiaria* from the Ryukyu Islands), and by the narrow white barring of the underparts and throat color of the male (*R. e. amauroptera* from India; and *R. e. telmatophila* from mainland South-east Asia). Females are like males except that they have pale rufous throats like *R. e. eurizonoides* and *R. e. minahasa*.

Soft parts.—Iris dark orange in males and bright red with a faint inner ring of orange in females; eye ring orange; upper mandible dark gray, almost black, with blue-green to green base; lower mandible with blue-green to green proximally turning to gray distally; legs and feet gray.

Description of juvenile.—USNM 582812, about 3–4 weeks old; forehead, superciliary line and malar region with black down feathers; crown, neck, upper back and wings blackish gray with a dark olive brown wash; lower back and rump blackish neutral gray; throat dark neutral gray; underparts sooty gray with a faint olive brown wash and with some white flecks on the breast and belly. Iris dark olive brown; bill and legs black.

Measurements.—Wing chord (4) 131.4 ± 6.61, range 123.2–137.7; see above for other measurements. Weight (1 ♂) 128 g, (1 ♀ with fully developed shelled egg in the oviduct) 180 g.

Range.—Batan Island. Kennedy and A. Fidel heard this species calling on Sabtang Island in the Batan Islands. The species was not encountered on nearby Ivojos Island and is unknown to the inhabitants.

Status.—Fairly common but extremely secretive in forest and second growth. All specimens were located and flushed from the forest floor by a dog. Known in the Ivatan dialect as *Adongong.*

Etymology.—Named in honor of Jesus B. Alvarez, Jr., for his untiring efforts to conserve Philippine fauna and flora.

Remarks.—Of the three known specimens from Fuga, two clearly resemble *R. e. eurizonoides.* The third (DMNH 70274) has the white barring on the belly as in *R. e. eurizonoides* but the olive brown of the upperparts is nearly as dark as in *R. e. alvarezi* and darker than in any of the specimens of *R. e. eurizonoides* we examined. Nevertheless, the Fuga birds, although tending toward *R. e. alvarezi,* appear to be closer to *R. e. eurizonoides.*

The relationships of *R. e. alvarezi* are not clear. It is most similar to *R. e. minahasa* of Celebes and least similar to *R. e. formosana* and the other races of *R. eurizonoides* owing to its more richly colored upperparts and narrower abdominal barring.

Specimens examined.—*R. e. alvarezi*: 1 (LSUMZ), 1 (PNM), 3 (USNM). *R. e. amauroptera*: 4 (USNM). *R. e. eurizonoides*: Bohol, 1 (FMNH); Cebu, 3 (DMNH); Fuga, 3 (DMNH); Leyte, 2 (USNM); Luzon, 57 (DMNH), 3 (FMNH); Mindanao, 2 (USNM); Mindoro, 1 (FMNH); Negros, 1 (FMNH); Panay, 1 (USNM); Sanga Sanga, Tawitawi, 3 (DMNH); Siquijor, 2 (USNM). *R. e. formosana*: 3 (USNM). *R. e. minahasa*: 3 (AMNH), 1 (USNM). *R. e. sepiaria*:

2 (AMNH), 1 (type) (USNM). *R. e. telmatophila*: 2 (USNM).

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TWO WOODPECKERS FROM THE LATE PLIOCENE OF NORTH AMERICA

Alan Feduccia

Abstract.—Three bones from the late Pliocene Rexroad Formation, Meade County, Kansas, represent two species of woodpeckers, a large species comparable in size to the species of the ivory-billed group (genus *Campephilus*), but not of that genus, and a flicker, similar in size to modern *Colaptes auratus.* Because of the extreme homogeneity in the postcranial bones of the Picidae these bones are not assigned to a new species.

Although woodpecker fossils are known during the Pleistocene, especially in North America (Brodkorb 1971a), the pre-Quaternary fossil record of the Picidae is extremely sparse, and is currently represented by only three valid species. *Pliopicus brodkorbi* (Feduccia and Wilson 1967) and *Palaeonerpes shorti* (Cracraft and Morony 1969), both known from the Ogallala Group in Kansas and Nebraska, respectively, are moderate-sized woodpeckers, possibly related to the melanerpine assemblage. *Campephilus dalquesti* (Brodkorb 1971b) is from the late Pliocene (Blancan) of Texas, and represents a large woodpecker, comparable in size to modern species of the ivory-billed group, genus *Campephilus.* Because of the extreme morphological homogeneity of the postcranial skeletons of the Picidae these generic allocations may be questioned; however, there seems at least little doubt that the abovementioned forms represent three species of Pliocene woodpeckers, one of large size. In addition to the abovementioned forms, Wetmore (1931) reported a fossil woodpecker, represented by a nearly complete right ulna, of flicker-like affinities in the Lower Pliocene Devil's Gulch Beds (Blancan), near Ainsworth, Nebraska. Becker (1986), likewise, reported a species of flicker (*Colaptes*), larger than modern *C. auratus* from the Oreana local fauna (Blancan), of Owyhee County, Idaho, which correlates in age with the well-known Hagerman local fauna, thought to be slightly younger than the fossils reported herein from Rexroad Formation (see Feduccia 1975).

In their 1969 paper describing *Palaeonerpes shorti,* Cracraft and Morony discuss its relationships through a laborious four page section (pp. 4–7), giving detailed generic analyses as well as comparisons with fossils that were not actually examined, but seen only in published figures. I can now confirm few, if any, of their assertions concerning the generic distinctiveness of *Palaeonerpes,* and it seems possible that *P. shorti* belongs in the genus *Melanerpes.* Likewise, the generic distinctiveness of *Pliopicus brodkorbi* could also be questioned. Feduccia and Wilson (1967:4) stated that "*Pliopicus* seems to be most closely allied to the genus *Melanerpes, . . .*" However, I recommend leaving the above genera until a complete revision of the family is undertaken.

In addition to *Palaeonerpes shorti* and *Pliopicus brodkorbi,* Olson (1985) reported having examined fossils of a medium-sized woodpecker from the middle Miocene (late Barstovian) of New Mexico, which would represent the earliest known occurrence of the family, and Ballmann (1976) assigned the proximal end of an ulna from the late Miocene of Italy to the Picidae.

Two of the fossils reported here (Fig. 1) are a left ulna (University of Michigan Museum of Paleontology no. 31711), and a left carpometacarpus (UMMP 24754), both from the Wendell Fox Pasture locality (UM-K3-53) (see Feduccia 1975), and represent a large woodpecker similar in size to species of the genus *Campephilus.* Although the ulna has no distinctive characters to ally it with any specific genus of large woodpecker, it is nevertheless not assignable to *Campephilus,* as it lacks the strong inward curve of the proximal end of the ulna found in the genus. In size the fossil most closely approximates *Campephilus melanoleucus* of all the forms examined. The fossil ulna measures 52.8 mm in total length; *C. melanoleucus,* n = 6, was 49.8–54.2 (mean = 52.1). The carpometacarpus measures 25.0 in total length; *C. melanoleucus,* n = 6, is 24.0–27.2 (mean = 25.4).

A third fossil element is the distal end of a right tarsometatarsus (UMMP 31881, from the Fox Canyon locality, UM-K1-47), that agrees very closely with the genus *Colaptes.* The tarsometatarsus of *Colaptes* is distinguished by lacking any substantial excavation of the trochlea for digit III when compared with that of other woodpeckers having a robust trochlea metatarsi tertii. This character presumably reflects the terrestrial habits of the genus. The greatest width at the level of the distal foramen is 2.9, for *Colaptes auratus,* n = 6, the same measurement is 2.5–3.2 (mean = 2.8). The specimen of *Colaptes* described by Becker (1986) is slightly younger than this fossil and slightly larger than living *C. auratus.* However, there is little to preclude the possibility that the two represent the same species or that both represent a Blancan form of modern *C. auratus.*

Two woodpeckers, one certainly different from those currently known in the fossil record, are represented by the fossils described herein. These fossils, together with those previously described, may possibly indicate a greater diversity of woodpeckers during the Pliocene of North America. Pending a complete review of the osteology of the Picidae, it seems most prudent not to assign new names to these fossils at present. They point, however, to the need for a thorough study of the postcranial osteology of the woodpeckers, and suggest the possibility that the living genera are oversplit.

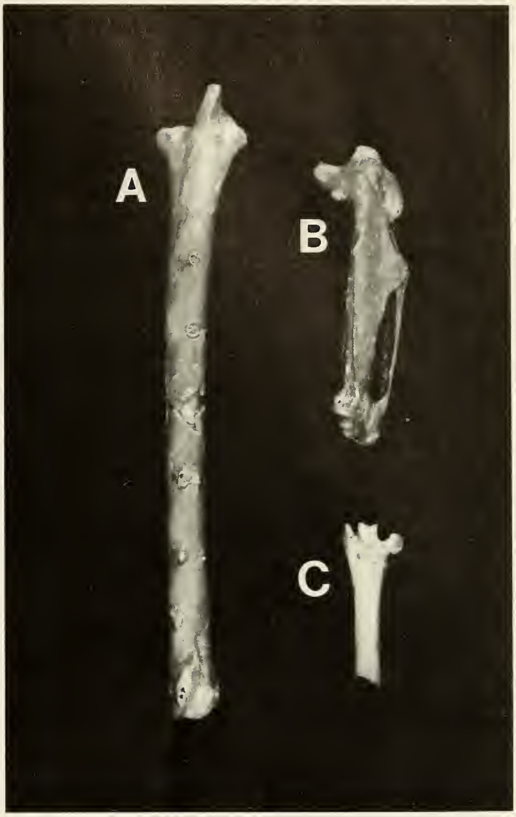

Fig. 1. A, Left ulna, 52.8 mm, anconal view, B, Left carpometacarpus, 25.0 mm, external view, of a large Pliocene woodpecker. C, Distal end of right tarsometatarsus, 13.6 mm, anterior view, of Pliocene *Colaptes* sp. Photo by Susan Whitfield.

Acknowledgments

I am grateful to Storrs L. Olson, Department of Vertebrate Zoology, National Museum of Natural History, for advice and for providing working facilities in the Division of Birds. The late Claude W. Hibbard of the Museum of Paleontology, University of

Michigan, placed these fossils at my disposal.

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GUITARRA ABBOTTI AND *G. ISABELLAE*, NEW SPONGES FROM THE EASTERN PACIFIC

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Abstract.—Two new species of the genus *Guitarra* are reported from the eastern Pacific. One of these, *G. abbotti,* was collected from a submerged seamount, the Cordell Bank, off the central California coast at 35–46 m. The second, *G. isabellae,* was collected off Albemarle Island in the Galapagos Islands at 82.3 m. A new spicule type, the biplacochela, is described from both species and the nature of the microscleres has been shown to differ significantly from those described from other *Guitarra* species.

Recent collections obtained through the auspices of the Cordell Bank Expeditions and deposited at the California Academy of Sciences have brought to light several new and unusual sponge species as well as range extensions. Among those sponges new to science is the first *Guitarra* species to be reported from the eastern Pacific Ocean. In the process of looking for comparative material a second new species of this genus was uncovered in the collections of the Allan Hancock Foundation, University of Southern California. Dr. G. J. Bakus kindly provided for description the single specimen that was found in collections made in the Galapagos Islands by the Foundation in 1934. These two new species are described below.

Guitarra Carter, 1874
Guitarra abbotti, new species
Figs. 1–13

Holotype and type locality.—CASIZ 060483 (Lee No. 34), Cordell Bank (Sta No. 821009), Marin County, California.

Paratypes.—BMNH 1986:5:7:2, BMNH 1986:5:7:2a (Lee No. 64), BMNH 1965:5:7:3 (Lee No. 0–2), USNM 34058 (Lee No. 66), USNM 34059 (Lee No. 69), CASIZ 057844 (Lee No. 20), CASIZ 057843 (Lee No. 0–1), CASIZ 057841 (Lee No. 2), and CASIZ 057852 (Lee No. 29).

Distribution.—Pacific Coast of North America, Cordell Bank, Marin County, California. Depth 35–46 m.

Local occurrence. No. 34, No. 20-Cordell Bank, Marin County, 38°01.8′N, 123°25.1′W), 9 Oct 1982, 34.7–42.0 m; No. 2-Cordell Bank, Marin County, 37°59.1′N, 123°25.5′W), 14 Sep 1980, 42–45.7 m; No. 0–1, No. 0–2-Cordell Bank, Marin County, 38°01.8′N, 123°25.1′W, 10 Oct 1981, 34.7–40.2 m; No. 69-Cordell Bank, Marin County, 38°01.8′N, 123°25.7′W, 15 Dec 1981, 40.2–43.9 m; No. 29-Cordell Bank, Marin County, 38°01.8′N, 123°25.1′W, 10 Oct 1982, 34.7–42.1 m; No. 64, No. 66-Cordell Bank, Marin County, 38°01.8′N, 123°25.1′W, 23 Oct 1982, 34.7–42.1 m.

Description.—*Guitarra abbotti* is an encrusting to massive, subtidal species. Form ovoid or pulvinate when small to massive, digitate and irregular in larger specimens (Fig. 1). Larger specimens frequently lumpy in appearance due to infolding of the surface to form deep furrows which delineate relatively smooth and gently rounded lobes, the latter often broadly flattened as a result of the invasion of the grooves beneath. These lobes are closely appressed to the colony so as not to disrupt its overall shape. The smallest specimen (CASIZ 057854) measures 2.8 × 3.8 × 4.7 cm and the largest (CASIZ 057843) 8.0 × 3.5 × 6.5 cm.

Color in life dark chocolate to reddish

Fig. 1. *Guitarra abbotti,* specimen No. WL-34 (holotype). Scale: life-size.

brown. Specimens in alcohol beige, often mottled with light to dark gray. In a few specimens the gray may dominate, especially on the extremities of the lobes.

Body surface superficially smooth with the exception of deep grooves which isolate the round or oblong lobes described above. These lobes are found more frequently on the larger specimens. Surface may vary greatly (Fig. 2a, b). It can be smooth to minutely granular, the granular appearance due to closely spaced and slightly raised spicule brushes. Commonly smooth, minutely raised ridges may be seen here as well. Elsewhere the spicule brushes may be distinctly elevated and more hispid with very shallow and somewhat wide grooves isolating narrow plateaus or ridges containing rows of these raised spicule brushes. Finally the spicule brushes may form distinct opaque conules, often coalescing to form ridges divided by shallow to deep furrows. While all conditions may be found in a single specimen, the smooth, granular appearance is more frequently seen on smaller specimens, whereas conules and deep grooves are more characteristic of larger specimens. The smoother surface areas possibly represent portions of the sponge where the thin surface membrane is still intact. However, the surface is always minutely hispid, this showing best when the specimen has been dried. The spicules seen are almost always derived from the spicule brushes on the conules or ridges. The surface feels smooth to the touch and the consistency is firm and somewhat elastic.

Oscula (Fig. 3) often difficult to locate, tending to be found in clusters, never evenly spaced. Oval to oblong or diamond-shaped with their opening commonly measuring from 1.0–3.5 mm. Larger oscula may reach 6.0 mm. The openings frequently surrounded by a collar 0.25–1.0 mm wide, with a noticeably smoother surface than the rest of the body, lighter in color and often very slightly raised to 1.0 mm. Collar sometimes flared. Ostia not seen.

Dermal membrane 4.0–6.0 μm thick and difficult if not impossible to see in all but a few areas. It is most readily seen on the smooth rim of the oscula where it is somewhat protected and not penetrated by spicules. In most other areas it is either obscured by dense spicules or eroded away.

Dermal membrane penetrated by styles in the form of spicule brushes made up of columns of 20–30 spicules (Fig. 4). Usually 7–20 spicules actually penetrate the surface, these extending 120–200 μm above the surface. Surface showing a more or less regular pattern of these columns, spaced 180–242 μm apart. Penetrating spicules erect in the center of the bundle and splayed to as much as 45° at the edge. The result is to form a spicule network at the surface that traps considerable debris and foreign spicules.

The columns act as structural support for the surface ridges and from above can be seen to be connected by more or less loose spicule bundles of megascleres, 3–6 per bun-

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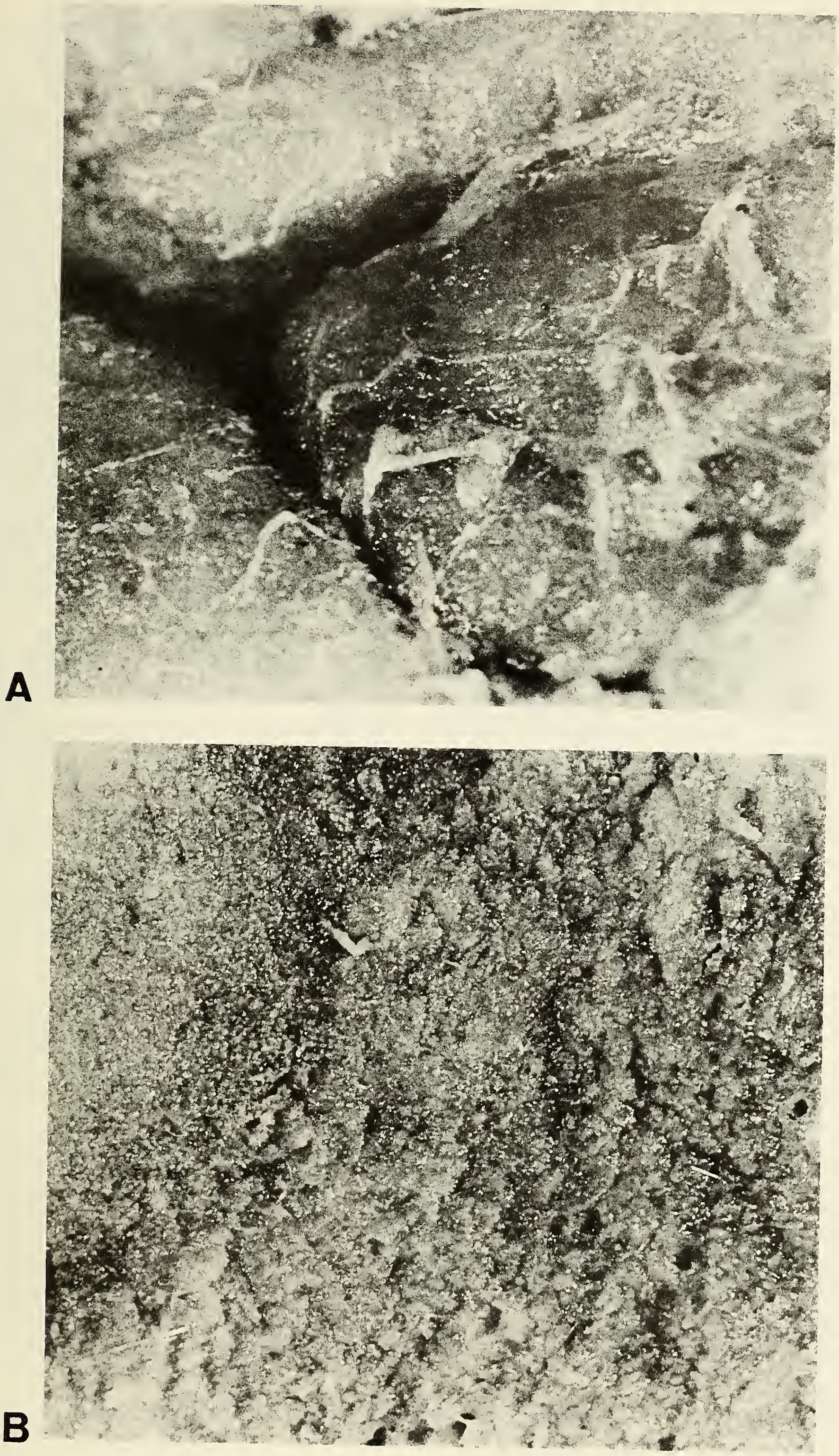
Fig. 2. Surface features of *Guitarra abbotti,* specimen No. WL-34 (holotype): A, Smooth surface area at edge of surface furrow; B, Rough surface area. Scale: 10×.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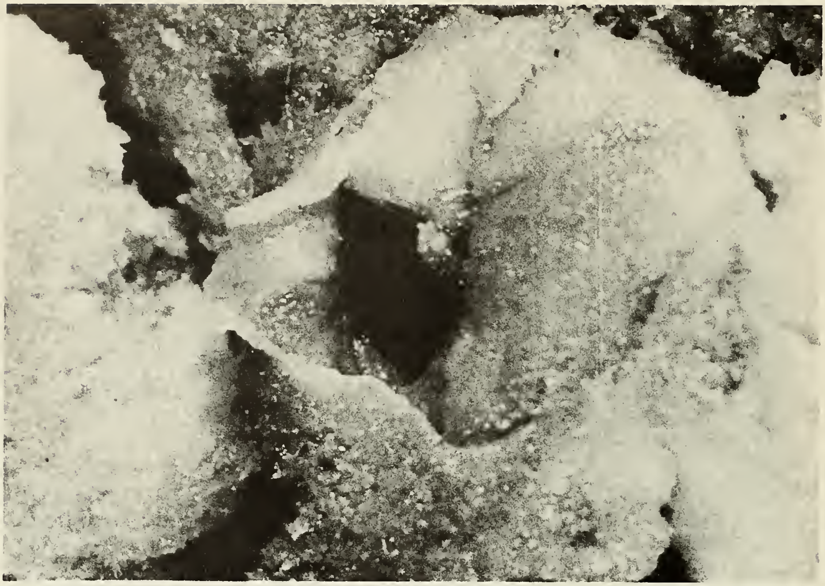

Fig. 3. Osculum of *Guitarra abbotti*, specimen No. WL-34 (holotype). Scale: 5 ×.

dle. These bundles as well as individual scattered megascleres form a loose surface network which is best seen in tangential section (Fig. 5). Cross sections usually do not show this network well because spicules close to the surface other than those in the columns tend to be disrupted by sectioning.

As noted above, each column is formed by 20–30 or more spicules, these being difficult to count because they are so closely packed. These spicules are derived in part from 2 or more secondary bundles of 8–14 or more spicules which intersect from below at about a 45° angle, these deriving from the choanosome. The distance from the surface to the point at which these bundles interdigitate to form the ectosomal columns is 400–600 μm. Biplacochelae, placochelae and "bipocillae" are abundant in the interstices.

Choanosome (Fig. 4) consisting of a fairly regular isotropic reticulation of bundles of

Table 1.—Spicule measurements (μ).

Species (type)	WL No.	Megasclera			Placochela	
		Length	Range	Width	Large	Range
G. abbotti						
Holotype	WL-34	341.05 ± 38.51	259–379	7.50 ± 1.80	86.65 ± 7.15	74.1–97.6
Paratype	WL-01	330.12 ± 38.19	279–382	7.55 ± 1.95	85.79 ± 3.57	78.2–91.5
Paratype	WL-02	338.88 ± 36.54	278–396	7.58 ± 1.73	81.61 ± 7.76	64.2–97.2
Paratype	WL-69	317.37 ± 31.80	268–349	7.35 ± 1.57	82.25 ± 5.85	69.1–96.2
Paratype	WL-64	324.75 ± 19.49	250–365	7.90 ± 1.46	82.35 ± 4.66	75.9–91.4
Paratype	WL-66	338.48 ± 20.13	254–374	7.21 ± 2.11	83.36 ± 5.92	70.7–91.6
Paratype	WL-20	323.96 ± 21.65	249–362	7.20 ± 1.82	83.18 ± 2.43	80.4–88.1
Paratype	WL- 2	321.44 ± 16.06	272–374	7.48 ± 1.65	80.55 ± 9.39	65.7–93.3
Paratype	WL-29	339.07 ± 19.48	277–377	7.62 ± 1.80	84.09 ± 6.63	74.6–100.1
G. isabella						
Holotype	WL-AHF	354.45 ± 46.58	224–406	7.62 ± 1.73	106 ± 10.66	72.3–122.9

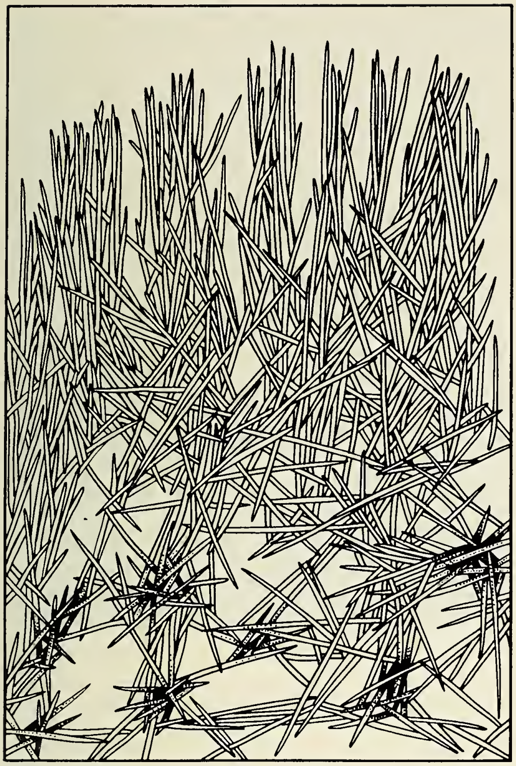

Fig. 4. Skeletal architecture of *Guitarra abbotti* as seen in cross-section.

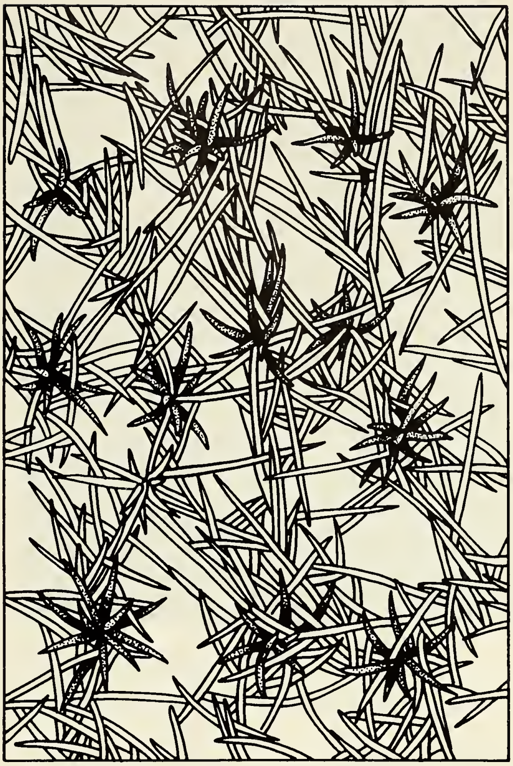

Fig. 5. Dermal skeletal architecture of *Guitarra abbotti* as seen from above.

megascleres, 2–10 spicules thick, which intersect at intervals of 200–300 μm. In cross-section these areas appear as distinct nodes. Added to this reticulate network are numerous individual megascleres scattered at random. Biplacochelae and "bipocillae" abundant. As the choanosome approaches the ectosome the regular nature of the net-

Table 1.—Continued.

Placochela		Biplacochela		Microsclera		
Small	Range	Size	Range	Sigma	"Bipocilla"	Range
36.70 ± 7.35	26.7–49.7	37.75 ± 3.25	28.5–45.2		7.62 ± 1.72	3.3–11.6
36.42 ± 3.27	28.7–43.4	35.79 ± 2.46	31.4–40.3		7.15 ± 2.04	4.1–11.8
38.37 ± 7.55	30.2–53.1	32.00 ± 4.25	23.2–40.7		6.68 ± 1.52	2.8–9.9
38.11 ± 5.63	31.1–45.1	37.16 ± 3.27	30.1–44.3		8.80 ± 1.60	4.6–13.2
38.60 ± 3.29	32.9–45.5	36.94 ± 3.31	23.1–43.7		8.71 ± 1.60	4.8–14.0
37.32 ± 3.13	28.5–48.4	35.33 ± 4.21	22.8–42.3		7.43 ± 1.92	3.6–12.3
36.89 ± 3.38	30.1–47.3	37.32 ± 3.42	30.4–42.7		7.29 ± 1.67	3.6–11.4
37.92 ± 4.11	26.7–45.7	35.76 ± 3.29	29.9–42.8		6.57 ± 1.65	3.6–11.1
37.42 ± 3.40	30.4–45.4	38.50 ± 3.38	27.9–45.7		6.59 ± 1.63	3.6–11.5
45.49 ± 6.53	26.5–62.7	27.33 ± 2.59	22.2–33.3	28.47 ± 7.12		14.4–36.2

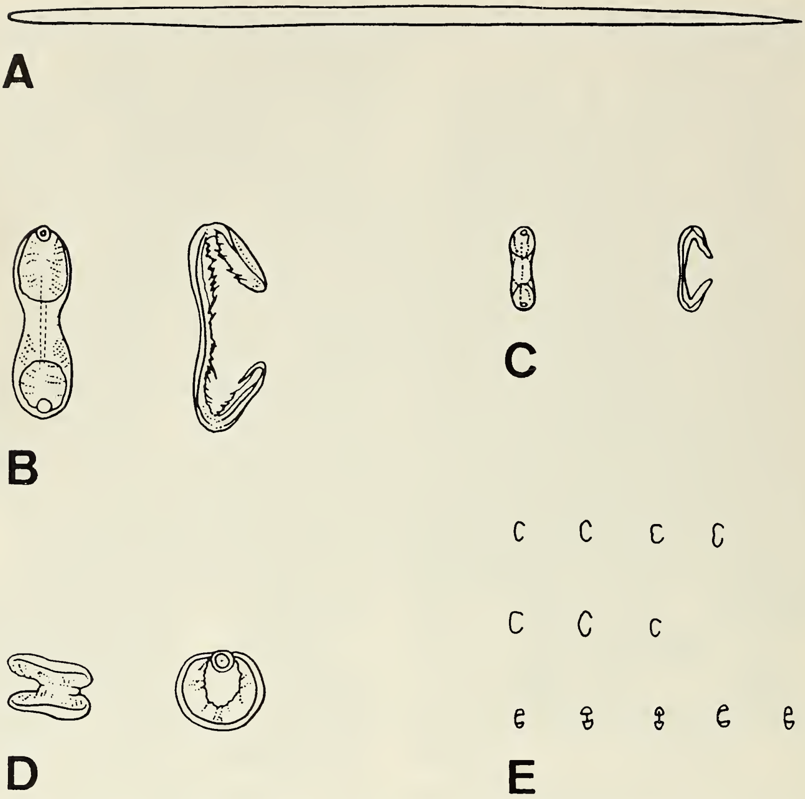

Fig. 6. *Guitarra abbotti*: A, Style, ×250; B, Large placochela, ×250; C, Small placochela, ×250; D, Biplacochela, ×250; E, "Bipocillae," ×250.

work begins to take on a more confused configuration and about 400–600 μm below the surface the distinctive structures of these 2 regions overlap to form a narrow band where no clear pattern can be discerned.

Canals 121 μm × 60 μm–360 μm × 182 μm are abundant in the choanosome. Frequently one sees canals approximately 60 μm wide leading to subectosomal canals of the larger sizes reported.

Spicules and their dimensions are listed in Table 1. Mean dimensions of each spicule category and size ranges for each specimen are based on 100 measurements. Megascleres of a single type, styles (Fig. 6a), which have their widest dimension in the center and taper to both ends. The middle third of the spicule is barely tapered while the width decreases rapidly at the last quarter of each end. One end sharply pointed, the other minutely rounded. Spicules may be straight or very slightly sinuous.

Microscleres of 2 basic types: "bipocillae" and placochelae. Placochelae (Figs. 6b, c, 7a, b) typical for the genus, closely matching the description given by Carter (1874) for those found in *Guitarra fimbriata*. However, differences do exist. To facilitate a description of these differences, terminology pertinent to the placochelae is given in Fig. 8.

The placochelae of *G. abbotti* occur in 2 distinct size classes. In the larger size class, accounting for 3.5–10.1% of this spicule type, the shafts are relatively wide, their centers measuring approximately 50–59% of the distance of their greatest width. End plates equal or subequal to the width of the shaft at each end. The ratio of end-plate length to total length is 30–36% and the end-plate falx is prominent as is the axial rib.

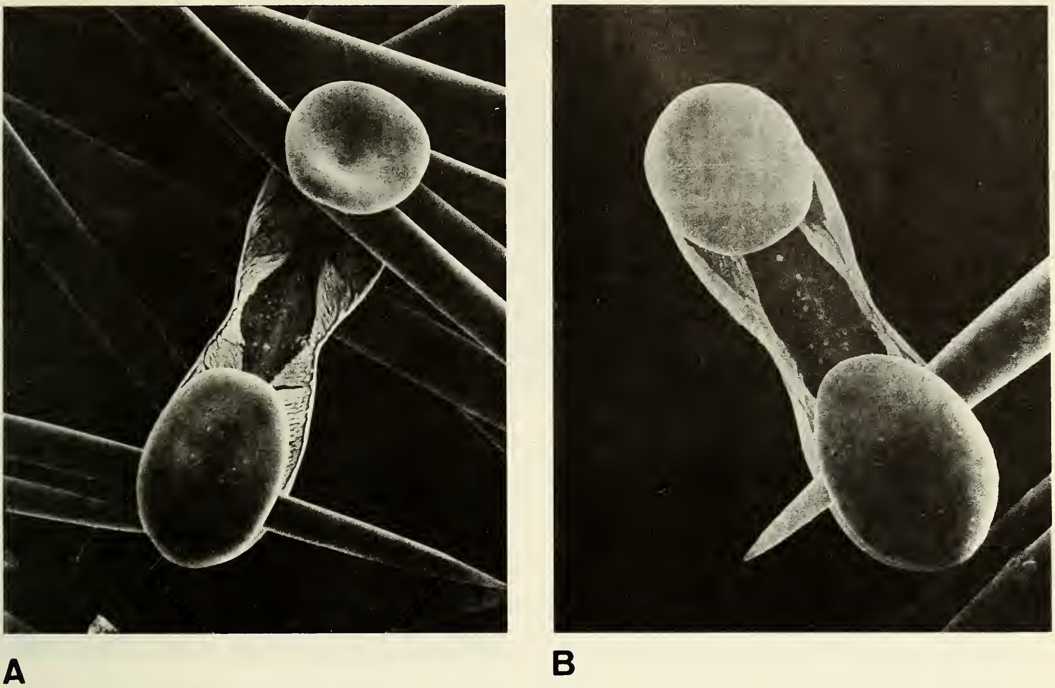

Fig. 7. *Guitarra abbotti*: A, Large placochela, ×1200; B, Small placochela, × 2500.

The central pellucid area is a broad diamond shape which may have slightly rounded edges. It almost always occupies all of the inter-plate area, sometimes extending just beyond the edge of the end-plates when these are folded back to the shaft. The terminal pellucid area is narrowly expanded from its point of origin at or near the inner edge of the end-plate to the outer edge. While the interior of the placochela is characterized by a bordering fringe directed inwards towards the shaft, leaving the somewhat diamond-shaped clearing opposite the constriction in the center as described above, the exterior is smooth. SEM photographs (Fig. 9) show the fringe to be made up of numerous closely spaced papillae with pointed ends.

The smaller size class differs from the larger in several ways. The overall shape is much wider with the center width 80–89% of the greatest width. The axial rib is very prominent and the border fringe restricted to the inner edges of the spicule, leaving a very large pellucid area which has its widest point at the mid-point of the spicule and tapers broadly and gradually to each end.

Related to the placochelae but definitely a new spicule type is the biplacochela (Figs. 6d, 10). This spicule characterized by a very much shortened shaft which connects 2 highly expanded, round end plates. Under the light microscope these are most frequently seen end-on and appear somewhat transparent. The shaft can be seen through the end plate as 2 concentric circles. The edge of the end plate seems to be denser than the center giving the appearance of a circle with a clear center and a thickened rim. The entire effect makes the spicule look like an eyeball. SEM photographs (Fig. 11a, b) show the exterior to be smooth and the interior to be made up of the same kind of papillae as seen in the placochelae. Furthermore, under the light microscope this spicule looks very much like the end plates of an intact placochela. However, the biplacochelae are almost round, length and

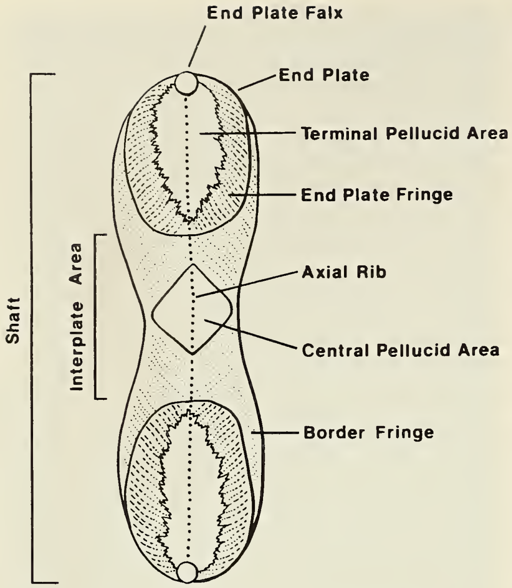

Fig. 8. Placochela structure—terminology.

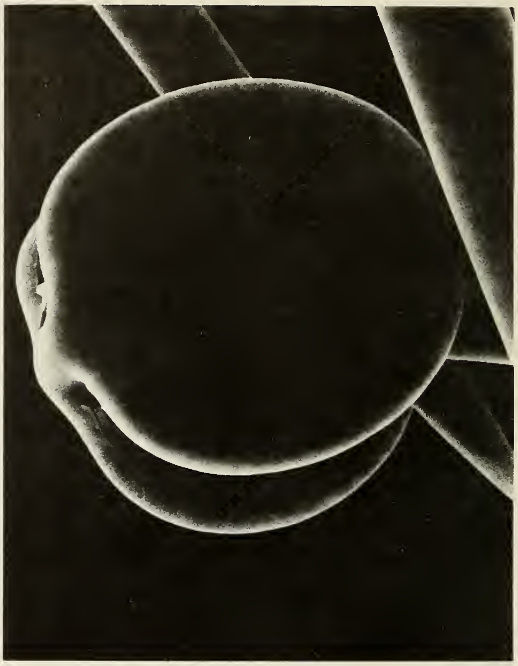

Fig. 10. *Guitarra abbotti*: Biplacochela, ×2500.

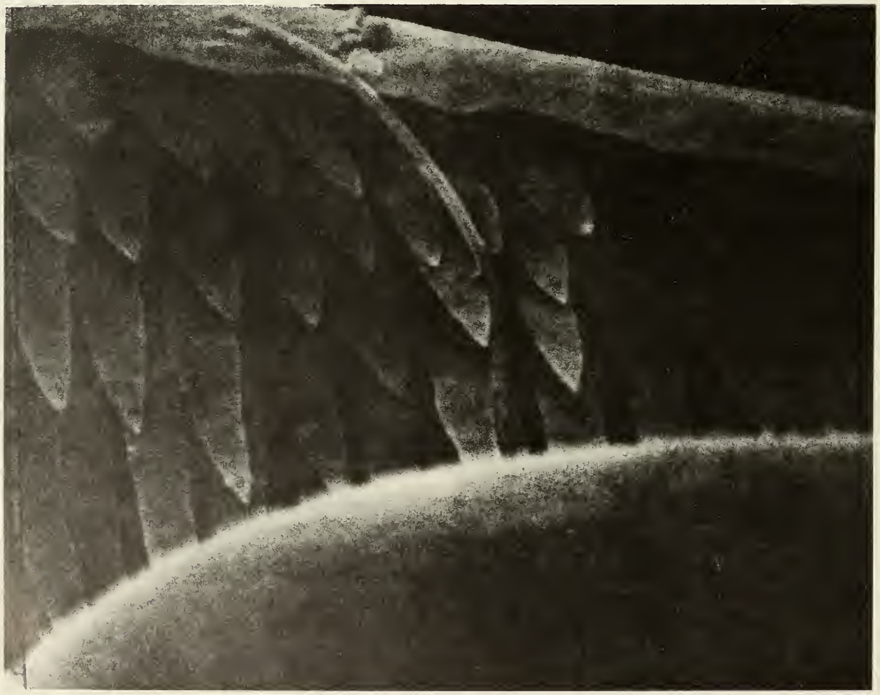

Fig. 9. *Guitarra abbotti*: Border fringe of large placochela, ×15,000.

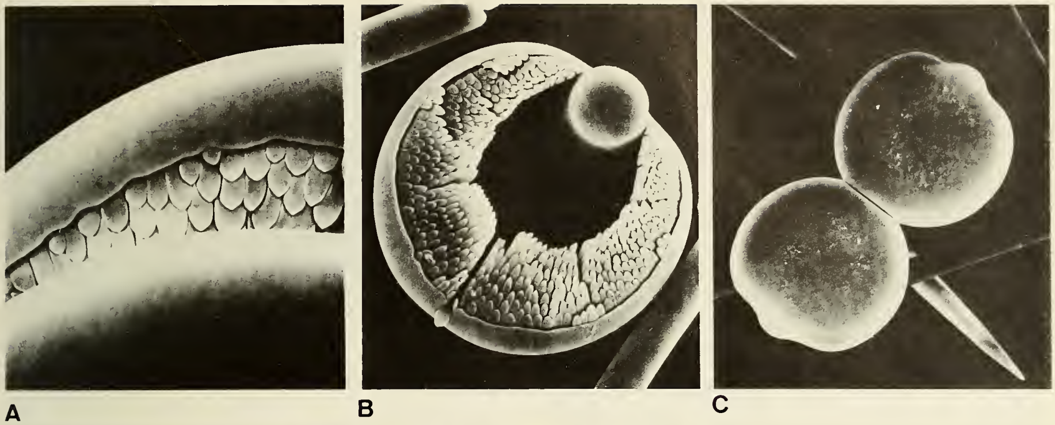

Fig. 11. *Guitarra abbotti,* Biplacochela: A, Interior fringe, ×8000; B, Interior half of one side, ×2500, note rounded falx, border fringe; C, Formation of biplacochelae from placochela with greatly expanded terminal plates, ×1100.

width being identical, and their dimensions significantly larger than the end plates of the larger placochelae.

Considerable investigation showed no torn or broken edges as might be expected if these had been broken from a typical placochela. Furthermore, no intact placochela was initially found with end plates of similar dimensions. However, one interesting specimen (WL-29) showed many more biplacochelae than seen in other specimens. Frequently two of these would be found facing one another closely as if they had been attached, but no connection could be seen. In one case, however, connecting biplacochelae were observed (Fig. 11c). In every way they matched the typical large placochelae with the exception that the end plates were much larger and round. Interestingly, the distribution of large and small placochelae in this specimen was significantly different from that in all other specimens, the large placochelae making up some 28.7% of all placochelae as opposed to the usual 3.5–10.1% seen in all other specimens. While it is too early to say with certainty, it appears that biplacochelae are derived from large placochelae whose end plates grow to a larger size. Whether or not these are derived from the typical large placochela or from a special type of placochela is unknown at this time.

"Bipocillae" (Figs. 6e, 12) under light microscopy appear to resemble distorted sigmas. In some cases the true nature of these microscleres may be discerned. However,

Fig. 12. *Guitarra abbotti*: "Bipocilla," ×8000.

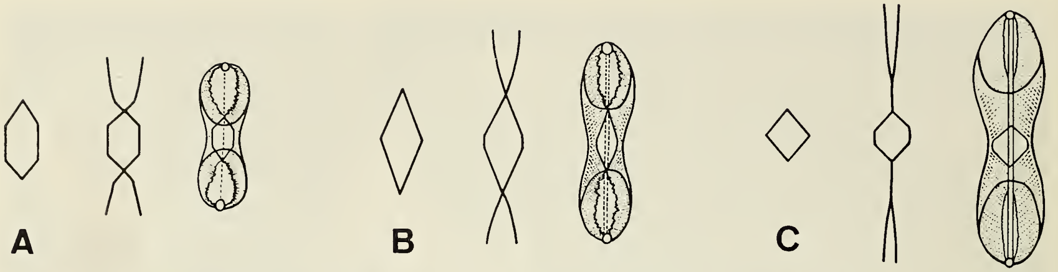

Fig. 13. Comparison of large placochelae from: A, *Guitarra fimbriata* Carter, 1874; B, *G. abbotti*; C, *G. isabellae.* Note shape and extent of central pellucid area and terminal pellucid areas (outlined to left of each diagram) and axial rib.

details can only be seen under SEM (Fig. 12). Here one can see that the shaft is shortened and widened and the 2 ends expanded somewhat to give a hooded appearance and bent together to leave an angular opening. The interior is smooth while the exterior is remarkably ornate with usually 5 rows of papillae tipped with numerous small, slender spines. The general appearance is that of a slipper bent upon itself. These spicules differ significantly from the "bipocillae" of *G. fimbriata,* neither of the 2 actually being a true bipocilla. For reasons discussed later in this paper, I have maintained the terminology used by Carter (1874) and others (Topsent 1904, Hentschel 1914, Dendy 1916, 1924, Bronsted 1924) to avoid confusion, but have used the term bipocilla with quotation marks to denote that the terminology will be changed as a result of an ongoing revision of the group. This revision will offer a full explanation of the origin and nature of these spicules.

Habitat and natural history.—The holotype and paratypes for this species were chosen from a collection of 37 specimens all collected by divers at depths of 31.1–60.4 m on the Cordell Bank, a submerged seamount 32.2 km due west of Point Reyes, California. The base depth of this seamount is 54.9 to 64 m and it is characterized by numerous steep, jagged ridges and pinnacles rising to 36.6–42.1 m. The sponge fauna is mainly restricted to the tops of these pinnacles and ridges and is rich and abundant in species. *Guitarra abbotti* is one of the dominant species found and is frequently associated with *Mycale* spp. which likewise occur abundantly. As a result, it is not unusual to find numerous spicules from *Mycale* spp. on the surface of *G. abbotti* and incorporated in its tissues.

Taxonomic discussion of Guitarra abbotti.—*Guitarra abbotti* is distinguished from all other *Guitarra* species by having biplacochelae and unique "bipocillae." Its closest relative seems to be *Guitarra fimbriata* Carter, 1874. The original description of the bipocillae by Carter as well as recent SEM photographs of the spicules of *G. fimbriata* and the details of the structure of the placochelae clearly show these two species to be quite distinct from one another. Figure 13 compares the features of the placochelae of the two species.

Etymology.—*Guitarra abbotti* is respectfully named for the late Dr. Donald P. Abbott, Professor Emeritus of the Hopkins Marine Station of Stanford University. Don was my teacher, my colleague and a very dear friend. In an age where pride, ego, and competition so prevail, he stood out as a shining example of the real meaning of a learned man. He was a great teacher, loved knowledge for the sake of knowledge alone, delighted in the process of sharing what he knew, fought vigorously for what he believed right and just, and above all, he cared deeply for his fellow man. He will be missed by all who knew him.

Fig. 14. *Guitarra isabellae* (holotype). Scale: 2 ×.

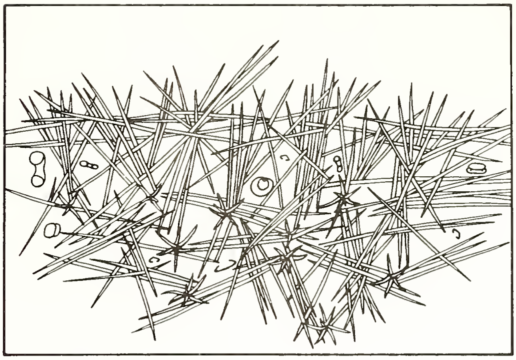

Fig. 15. Skeletal architecture of *Guitarra isabellae* as seen in cross-section.

Guitarra isabellae, new species
Figs. 13c, 14–18

Holotype and type locality. —BMNH 1986:5:7:1, 1986:5:7:1a (AHF no. D-20/L 35576). Tagus Cove, Albemarle Is. Galapagos Is. *Velero* sta 324-35, 82.3 m, 10 Dec 1934.

Paratypes. —USNM 34060, CASIZ 061407, CASIZ 061408, CASIZ 061409.

Distribution. —Tagus Cove, Albemarle Is., Galapagos Is. 0.5°S, 91′W.

Description. —The following is based on 3 moderately-sized fragments and approximately 7 smaller pieces. *Guitarra isabellae* is a deep-water sponge. Form (as represented by the few specimens seen) ovoid to irregular and flattened (Fig. 14). Holotype measures 25 × 21 × 5 mm and the paratypes 20 × 9 × 6 mm–20 × 16 × 4 mm. There is evidence to suggest that each of the lobe-like pieces was attached at the base of the lobe on the side with the narrowest dimensions. Given the almost universal ovoid to massive shape of other *Guitarra* species and their organization into thin, ovoid and flattened lobes, it is possible that the form reported here merely represents the outer lobes of a much larger specimen torn off in the process of dredging.

Color in life not recorded. Specimens all uniformly beige to light orange-beige in alcohol. A few areas with slightly gray tones but these not extensive or localized as in *G. abbotti.*

Body surface smooth. Narrow grooves (0.15–0.25 mm) occasionally cut the surface. These extend at most to 0.75 cm in length. It is difficult to discern whether these grooves are actually part of the surface structure or artifacts of surface damage.

Surface remarkably constant in appearance, superficially smooth, granular and hispid when dry. Granular appearance deriving from barely protruding, closely spaced, spicule brushes which penetrate the surface from very slightly raised conules. This condition is the one most often seen. However, on the edges and interior of oscula and, rarely, on the general surface, larger conules and a more hispid appearance may be found. Rarely, one finds what look like developing lobes and these tend to have larger and more hispid conules on their edges. Oscula rare, tending to be irregular in shape and from 1.5–3.0 mm maximum width. No collars as seen in *G. abbotti* present but the edges of the oscula have more hispid and larger conules and the spicules penetrate further than on the surface. Ostia not seen.

No dermal membrane seen. Surface penetrated by megascleres in the form of spicule brushes of 8–10 or more spicules. Usually most of these penetrate the surface, extending 30–50 μm above the surface, rarely to 121 μm. Surface showing a very irregular pattern of these columns, spaced 151–212 μm apart (Fig. 15). Penetrating spicules al-

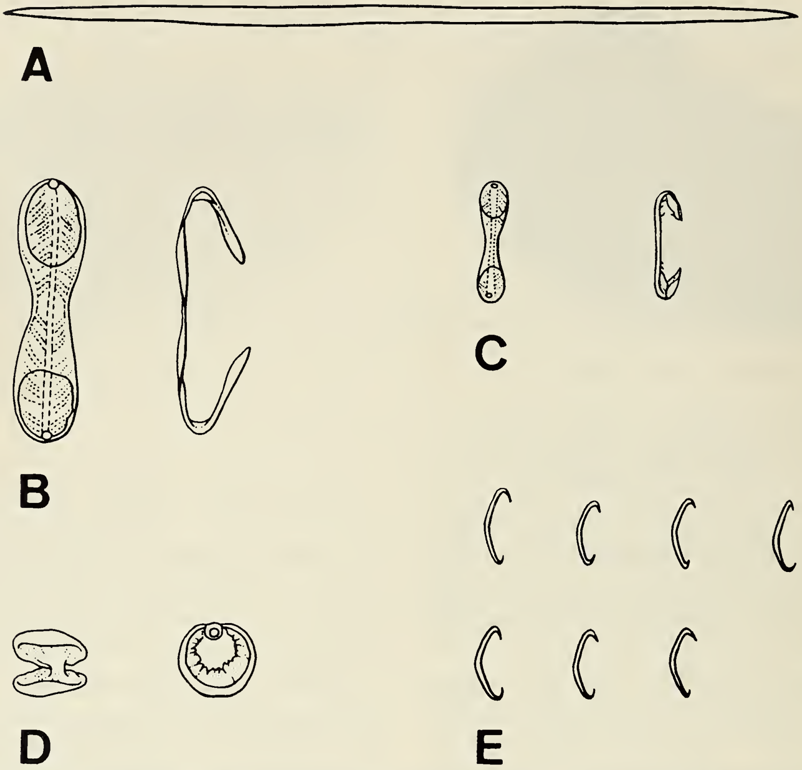

Fig. 16. *Guitarra isabellae*: A, Oxea, ×250; B, Large placochela, ×250; C, Small placochela, ×250; D, Biplacochela, ×250; E, Sigmas, ×250.

most always widely splayed and frequently penetrating the surface at an angle of up to 85°. Surface unevenly strewn with loose megascleres radiating in all directions. These forming an ill-defined layer, 2–3 spicules thick, strewn over the surface. Columns merge almost immediately into a vast choanosomal isotropic network of bundles of megascleres 3–5 or more spicules thick. The network highly irregular and made more confused by the presence of large numbers of loose megascleres as well as microscleres strewn at random. In cross-section *G. isabellae* resembles *G. abbotti* in its major features (spicule brushes, isotropic reticulation, etc.) but the architecture is less obvious due to an abundance of scattered loose spicules, large numbers of microscleres, the unclear division of ectosome and choanosome, and the more irregular nature of the spicule brushes and reticulate pattern.

Typically, one edge of the specimen has distinct spicule brushes and a predominance of spicules penetrating the surface whereas the other has less obvious brushes, few penetrating spicules and a strong element of horizontal megascleres at the surface, suggesting again that the "specimens" may only represent lobes torn from a larger colony.

Canals 242 × 61 μm–600 × 150 μm infrequently seen. These may represent cuts along the edges of canals rather than cross-sections.

Spicules and their dimensions are listed in Table 1. Megascleres of a single type, oxeas (Fig. 16a). These either straight or slightly bent. The bend may be at almost any point along the shaft. Both ends tapered to a sharp point. The taper frequently uneven, one end tapering rapidly to a very sharp and even point, the other tapering

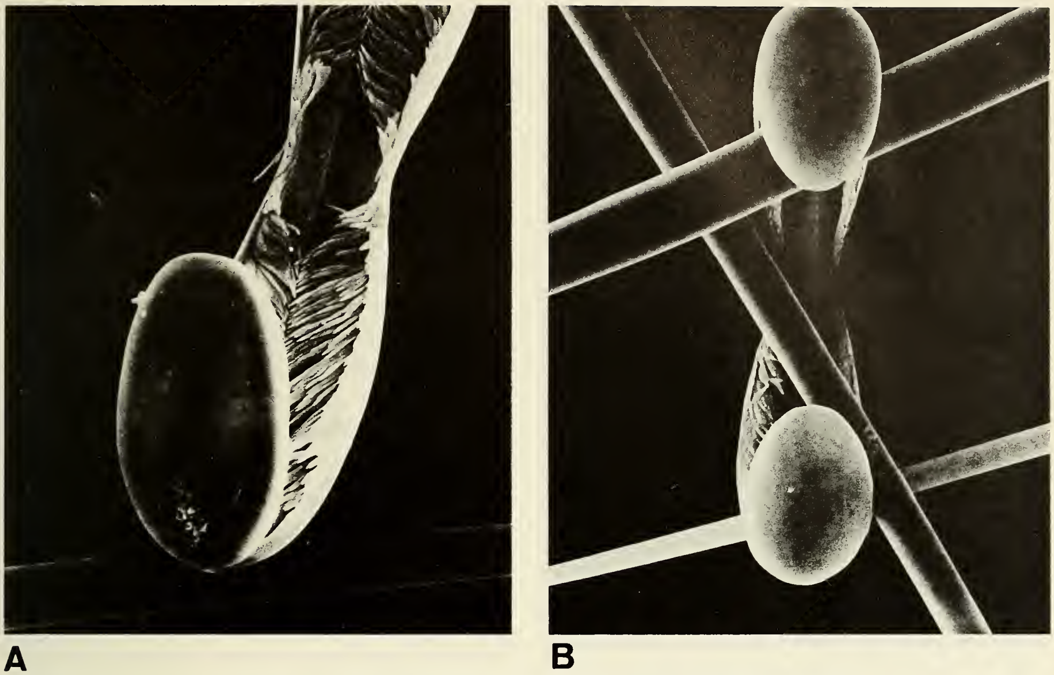

Fig. 17. *Guitarra isabellae*: A, Large placochela, ×1300; B, Small placochela, ×2200.

more gradually to a hastate or somewhat rounded, point. The nature of the tapering in this spicule and its slightly narrower width make it look much more slender than the megascleres of *G. abbotti.*

Microscleres of 3 basic types; placochelae, biplacochelae, and sigmas. Placochelae (Figs. 16b, c, 17a, b) occurring in two size classes, the larger of these accounting for 10.6% of all placochelae. This microsclere is similar in many respects to that described from *G. abbotti* but differs in the following ways: Central constriction 48–58% of the widest point; the central pellucid area a distinct diamond shape (closer to a square on end) and almost never reaching the edges of the end plates; the central pellucid area usually takes up only 51–71% of the area between the end plates and the terminal pellucid areas are almost non-existent and difficult if not impossible to see in most cases since the axial rib is so prominent.

The smaller size class placochelae significantly narrower than those of *G. abbotti,* the central constriction reaching to 44–50% of the widest point. End plate length to overall length ratio likewise different ranging from 27–37%. As with the smaller size class placochelae of *G. abbotti* and *G. fimbriata* the border fringe is restricted to the edge of the shaft. Here, however, the central and terminal pellucid areas are merged into a large pellucid area with its narrowest dimensions at the midpoint of the spicule. This then expands slightly to a pellucid area that has sub-parallel sides to the end of the spicule.

Biplacochelae (Fig. 16d) as described for *G. abbotti.* These have a short shaft connecting 2 equal, highly expanded rounded end plates with smooth surfaces on the exterior and numerous pointed papillae internally, and differ from those found in *G. abbotti* only in their smaller size.

G. isabellae has numerous, large sigmas (Figs. 16e, 18). These not gently curved but distinctly bent in the center. One end curved inward in a distinct C-shape with a taper to

Fig. 18. *Guitarra isabellae*: Sigma, ×3000.

a point. The other end sharply and abruptly bent inward and tapering abruptly to a very sharp point.

Habitat and natural history.—Little is known of the habitat or natural history of this species other than its depth of collection and that it was taken on a rock bottom. It is impossible at this time to comment on associations, etc.

Taxonomic discussion of G. isabellae.—The closest relatives to *G. isabellae* are *G. sigmatifera* Topsent, 1916, and *G. antarctica* Hentschel, 1914. *Guitarra isabellae* differs from *G. sigmatifera* by virtue of its biplacochelae, the shape and size of its sigmas which are two and one-half times as large as those in *G. sigmatifera* and its oxeas which are half the size of those in *G. sigmatifera*. Comparison with the type of *G. sigmatifera* shows the sigmas of the two species to be quite different from one another. *Guitarra isabellae* differs from *G. antarctica* by possessing biplacochelae, having distinctly smaller megascleres and by the structure of its large placochelae. Figure 13 shows a comparison of the placochelae of this species with those of *G. fimbriata* and *G. abbotti.*

Etymology.—It is a pleasure to name this new species for Dr. Isabella Abbott, Department of Botany, University of Hawaii. Dr. Abbott is a well known phycologist who has done significant taxonomic work on Eastern Pacific algae, and a long time friend and colleague. Interestingly, it came to the author's attention after the name had been chosen that Albemarle Is. was formerly known as Isla Isabella.

Taxonomic discussion of the genus Guitarra.—Burton (1929) synonymized all extant species of *Guitarra.* Burton's synonymy was based on the fact that two specimens described by Topsent (1904) from the same locality (*G. voluta*) showed as much variability as was seen in all extant species of *Guitarra.* Furthermore, he proposed that former investigators were confused over the nature of the microscleres. Burton proposed that bipocillae were found in all species of *Guitarra* and that the presence of sigmas noted by former investigators was in error. Noting variability in megasclere and microsclere dimensions that were no greater than the differences seen in a single species, *G. voluta,* and what appeared as confusion over the nature of the microscleres, Burton suggested that all of the described species, some eight of them, were nothing more that variants of a single species, *Guitarra fimbriata.*

In preparing the descriptions of these two new species of *Guitarra* it was imperative to examine the holotype of *Guitarra fimbriata* Carter, 1874. Ms. Shirley Stone, of the British Museum, kindly provided the Carter type material as well as three additional specimens. Two of these were identified by M. Burton and one by V. Koltun as *G. fimbriata.* SEM analysis of the spicules of all of these specimens showed them to be distinctly and uniquely different from the two species described herein as well as from each other. Furthermore, the nature of the "'bipocillae" in these specimens showed that they were indeed not bipocillae at all as commonly described for the genus *Iophon*, and that they all shared a common origin. This information further suggested that neither Burton nor any of his colleagues were in a position accurately to identify *Guitarra* species since many of the species' specific characters are only readily discernable through SEM.

Analysis of numerous specimens of *G. abbotti* from Cordell Bank showed that intraspecific variability is low, at least within this species. I suggest that the "variability" which led Burton to synonymize all known species of *Guitarra* was not variability at all but merely the differences between species which could not be separated on the basis of light microscopy alone.

Analysis of the type specimens of *G. fimbriata, G. sigmatifera* and *G. antarctica* as well as the additional three specimens mentioned above suggests that there are many species of *Guitarra* and that they differ significantly in respect to several characters. These characters include: the nature of the "bipocillae" which are not true bipocillae; the details of structure of the placochela; presence or absence of biplacochelae; the size, shape and nature of the megascleres; and the details of the skeletal architecture. Accordingly, a complete revision of the genus *Guitarra* is now underway.

Acknowledgments

The author would like to give special thanks to Mary Ann Tenorio who spent many long and productive hours at the SEM and to Lynette Cooke who produced the excellent artwork. My gratitude also goes to Dr. G. J. Bakus who kindly provided specimens and long hours of meaningful discussion on this project. My thanks also to Dr. M. Ghiselin, Dr. T. Gosliner, Dr. G. J. Bakus, and Dr. V. Zullo for reading and commenting on the manuscript. Ms. Shirley Stone, British Museum, was extraordinarily helpful in obtaining specimens and information pertaining to the location of important material and data, as were Dr. C. Levi and Dr. D. Kuhlmann who provided the types of *G. sigmatifera* and *G. antarctica*, respectively. Mr. Robert Van Syoc, Mrs. Sarah Klontz and Dr. Peter Rodda all share in providing valuable comments and information.

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MARINE TUBIFICIDAE (OLIGOCHAETA) FROM PUERTO RICO WITH DESCRIPTIONS OF TWO NEW SPECIES, *TUBIFICOIDES AGUADILLENSIS* AND *HETERODRILUS PAUCIFASCIS*

Michael R. Milligan

Abstract.—Five species of Tubificidae were collected during a study of benthic infauna off the west coast of Puerto Rico. Two species are new to science and described as *Tubificoides aguadillensis* and *Heterodrilus paucifascis.* One partially mature specimen of *Heterodrilus* sp. A is described and is the first record of a member of this genus outside the South Pacific possessing setae with subdental ligaments. Two marine species, *Duridrilus tardus* Erséus, 1983b, and *Tubificoides wasselli* Brinkhurst and Baker, 1979, are newly reported from Puerto Rico, and compared with the original descriptions.

Little information is available concerning marine Tubificidae from the Caribbean. Brinkhurst (1965, 1966), Righi and Kanner (1979), Erséus (1981a, b, 1983a, b), and Erséus and Baker (1982), are the only authors who have reported on tubificid specimens collected from this region. From these studies, only four species have been identified from Puerto Rico.

Brinkhurst (1965) described two specimens from Puerto Rico that he designated as "?*Spiridion insigne* Knöllner, 1935." Erséus (1979) concluded from Brinkhurst's descripton that this form actually may be more closely related to *Bathydrilus adriaticus* (Hrabe 1971a). Further examination of Brinkhurst's specimens is necessary before a final determination can be made.

Righi and Kanner (1979) described a new species, *Marcusaedrilus hummelincki,* from a sandflat with *Thalassia* and *Halimeda* in southwest Puerto Rico. This species has subsequently been reported from Bermuda, southeast Florida, and throughout the Caribbean in intertidal and subtidal muds and sands to a depth of 21 m (Erséus 1983a).

Two species of *Thalassodrilides* were reported from Puerto Rico by Erséus (1981a). *Thalassodrilides gurwischi* (Hrabe 1971b) and *T. belli* (Cook 1974) were collected in mud samples from an enclosed brackish-water lagoon (salinities 8–44‰) in western Puerto Rico. The former species was also collected from an estuary in northeast Puerto Rico and is common throughout the Caribbean and Europe. *Thalassodridides belli* has been reported from both coasts of North America and the Gulf of Mexico.

Additional species of Tubificidae were collected during a recent study of invertebrate fauna off the west coast of Puerto Rico. Two species, one *Tubificoides* and one *Heterodrilus,* are new to science and are described here. Because of the unique setae, the description of one partially mature specimen within the genus *Heterodrilus* is included as *Heterodrilus* sp. A. Taxonomic notes are provided for two other species for geographic comparison. Species in the subfamily Limnodriloidinae will be described by Erséus and Milligan (in preparation).

Material and Methods

Samples were collected by Dr. Allan Stoner for the Center for Energy and Environmental Research at the University of

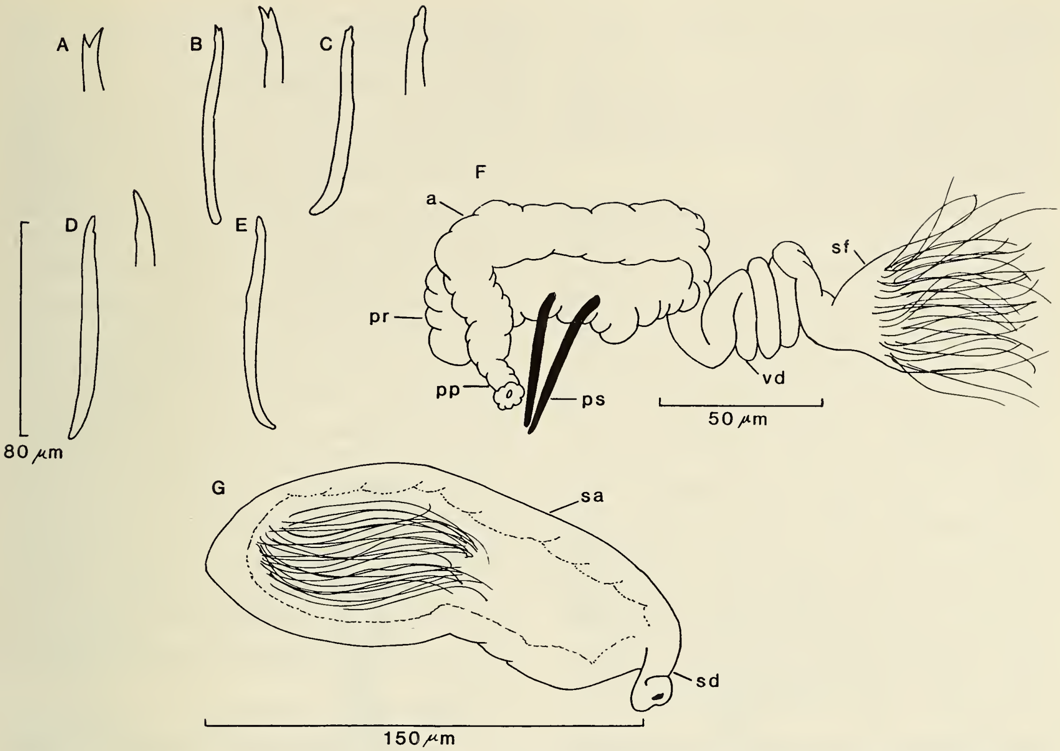

Fig. 1. *Heterodrilus paucifascis*: A, Seta from VII; B, Seta from VIII; C, Seta from IX; D, Seta from X; E, Posterior seta; F, Male genitalia; G, Spermatheca.

Puerto Rico from Aguadilla and Mayaguez Bays off the west coast of Puerto Rico using a Van Veen grab. The samples were fixed in formalin and subsequently sieved through a 0.5 mm screen. The worms were removed from the residue and preserved in 70% isopropyl alcohol. Mature oligochaetes were temporarily mounted in glycerin, then stained in Grenacher's alcohol borax carmine, dehydrated, cleared in terpineol, and permanently mounted in Canada balsam. Representative specimens of all species have been deposited at the National Museum of Natural History (USNM), Washington, D.C. Length and width measurements in the descriptions refer to fixed, whole-mounted specimens. Segment number is referred to by Roman numeral.

Abbreviations used in figures are as follows: a, atrium; apr, anterior prostate; cps, cuticular penis sheath; pp, pseudopenis; ppr posterior prostate; pr, prostate; ps, penial setae; sa, spermathecal ampulla; sd, spermathecal duct; sf, sperm funnel; st, sperm trap; vd, vas deferens.

Subfamily Rhyacodrilinae

Heterodrilus Pierantoni, 1902

Heterodrilus paucifascis, new species

Fig. 1

Holotype.—Whole-mounted specimen, west coast of Puerto Rico. Aguadilla Bay, 2 km from shore, 39 m depth; coarse sand and shell, coll. Allan Stoner; 18 Apr 1985, USNM 101443.

Paratype.—Two whole-mounted specimens, type locality, USNM 101444–101445.

Other material examined.—One whole-mounted specimen, type locality, author's collection.

Etymology.—*Pauci,* Latin, few; *fascis,* Latin bundle, referring to the fewer number of anterior bisetal bundles than in most other species in this genus.

Description.—Three specimens complete with up to 56 segments. Length 3.3–6.3 mm, width at clitellum 0.15–0.20 mm. Clitellum extending over ½X–XII. Setae 2 per bundle in II–VIII, bifid with short divergent teeth, upper tooth shorter and thinner than lower, to 82 μm long and 4 μm wide (Fig. 1A). Thereafter "bundles" unisetal. In VIII, upper tooth becoming more reduced, and indistinct third tooth or swelling, developing subdistally (Fig. 1B). Swelling more prominent on the setae of IX and upper tooth rudimentary (Fig. 1C). All setae from X similar, bluntly pointed with small subdistal swelling (Fig. 1D–E), to 80 μm long, 4 μm wide. Penial setae simple pointed, 2 per bundle, 43–52 μm long, 4 μm wide. Spermathecal pores located anteriorly in X and slightly ventral to the lines of ventral setae. Male genitalia paired. Sperm funnel large, entering into tightly coiled vas deferens of indeterminate length,10 μm wide. Atrium "c-shaped," 135 μm long and 20 μm wide, lobed prostate attached ventrally along entire length, termininating in small pseudopenis (Fig. 1F). Spermathecae paired. Spermathecal duct short 25 μm long, 22 μm wide leading into large thick-walled sacciform ampulla (Fig. 1G), 150 μm long, 60 μm wide. Sperm arranged in random masses.

Remarks.—*Heterodrilus paucifascis* is the only species within this genus possesing bisetal bundles with only bifid setae in II–VIII, and unisetal "bundles" beginning in IX. The unisetal "bundles" of *Heterodrilus maccaini,* recently described by Erséus (1985), may begin in either VIII or IX, and those of *Heterodrilus pentcheffi* Erséus, 1981 may begin in IX–XIII, but both species possess trifid setae anteriorly. The unisetal bundles of all other species of *Heterodrilus* begin in X or XI. *Heterodrilus subtilus* (Pierantoni 1917), *H. hispidus* Erséus, 1986 and *H. jamiesoni* Erséus, 1981b are the only other species within this genus with bifid setae anteriorly and a tightly coiled vas deferens. However, *H. subtilus* and *H. hispidus* differ from *H. paucifascis* in totally lacking trifid setae. The present material is very similar to *H. jamiesoni* described from the Great Barrier Reef in the South Pacific. The form of the male genitalia is virtually identical, but *H. paucifascis* possesses a distinct spermathecal duct which is inconspicuous in *H. jamiesoni.* Both species possess similar setal morphology; however, the subdistal swelling on the setae of *H. jamiesoni* begins in V (not until VIII in *H. paucifascis*), and is much more pronounced on the setae of the post-clitellar segments. The new material also has a similar general setal morphology to *Heterodrilus occidentalis* Erséus, 1981b, but lacks the "m-shaped" atrium, trifid anterior setae, and posterior simple setae of the latter.

Habitat and distribution.—Coarse sand, 39 m depth, known only from Aguadilla Bay, Puerto Rico.

Heterodrilus sp. A
Fig. 2

Material examined.—One whole-mounted specimen, west coast of Puerto Rico. Aguadilla Bay, 1.5 km from shore, 17 m; coarse sand, coll. Allan Stoner, 18 Apr 1985, USNM 101446.

Description.—Specimen complete with 72 segments. Length 7.5 mm, width at XI 0.19 mm. Setae 2 per bundle in II–IX, 62–91 μm long and 3 μm wide, trifid with teeth nearly equal in length, upper tooth thinnest, middle tooth slightly thicker and lower tooth thickest with thin ligament connecting it to shaft (Fig. 2A). Posterior from IX somatic setae bifid (Fig. 2B), and only one representing each bundle, to 82 μm long and 5 μm wide, ligament absent, lower tooth gradually reduced (Fig. 2C). Penial setae unidentate, 2 per bundle, 90 μm long and 5 μm wide at base (Fig. 2D).

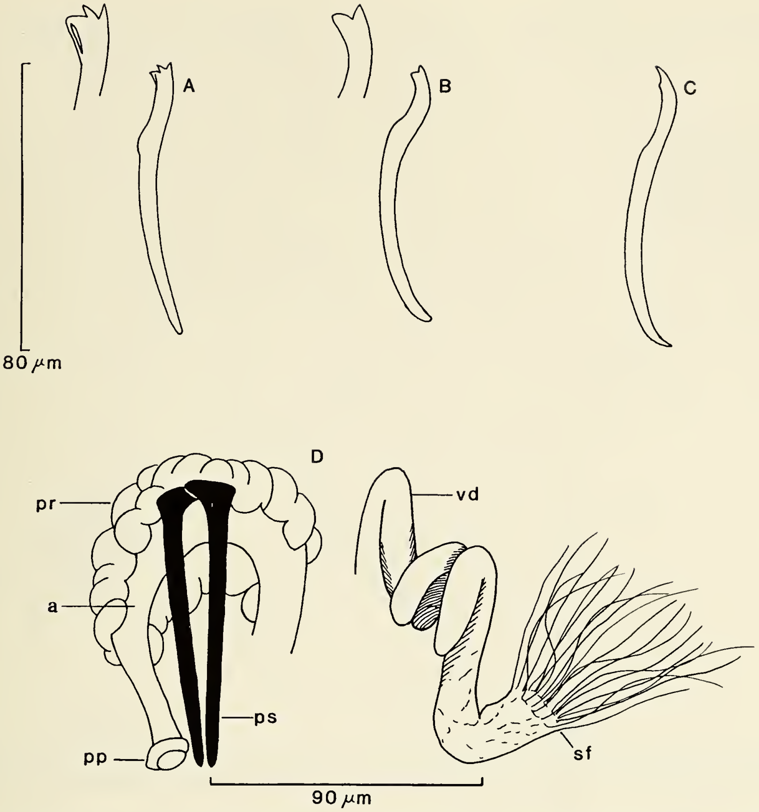

Fig. 2. *Heterodrilus* sp. A: A, Seta from VIII; B, Seta from IX; C, Posterior seta; D, Male genitalia.

Coelomocytes abundant, large and granulated. Male genitalia paired (Fig. 2D). Sperm funnel large, vas deferens tightly coiled, 10 µm wide. Atrium convoluted, 20 µm wide, globular prostate attached ventrally along entire length, narrowing ectally and terminating in pseudopenis. Spermathecae not observed.

Remarks.—This specimen from Puerto Rico is most similar to the original description of *H. pentcheffi* Erséus with respect to the tighty coiled vas deferens, narrow ectal region of the atrium, and morphology of the posterior setae. The exact configuration of the atrium was difficult to determine in the single specimen examined; however, Erséus (1981b) described the atrium of *H. pentcheffi* as "m-shaped." The major difference between the present form and *H. pentcheffi* is the presence of a thin ligament connecting the lower tooth to the shaft of the anterior trifid setae in the material from Puerto Rico. Although five species of *Heterodrilus* possess this characteristic type of aberrant setae, they also have this subdental ligament present in the posterior bifid setae as well, and possess an uncoiled vas deferens. The presence of the ligament, to date, has only been described in species collected from the South Pacific. Although the present specimen cannot be fully described, it is important to note this setal form in a species of *Heterodrilus* from the Atlantic. Until additional specimens can be examined and the exact morphology of the atrium and spermathecae can be determined, the specific designation is best left questionable.

Habitat and distribution.—Coarse sand, 17 m depth, known only from Aguadilla Bay, Puerto Rico.

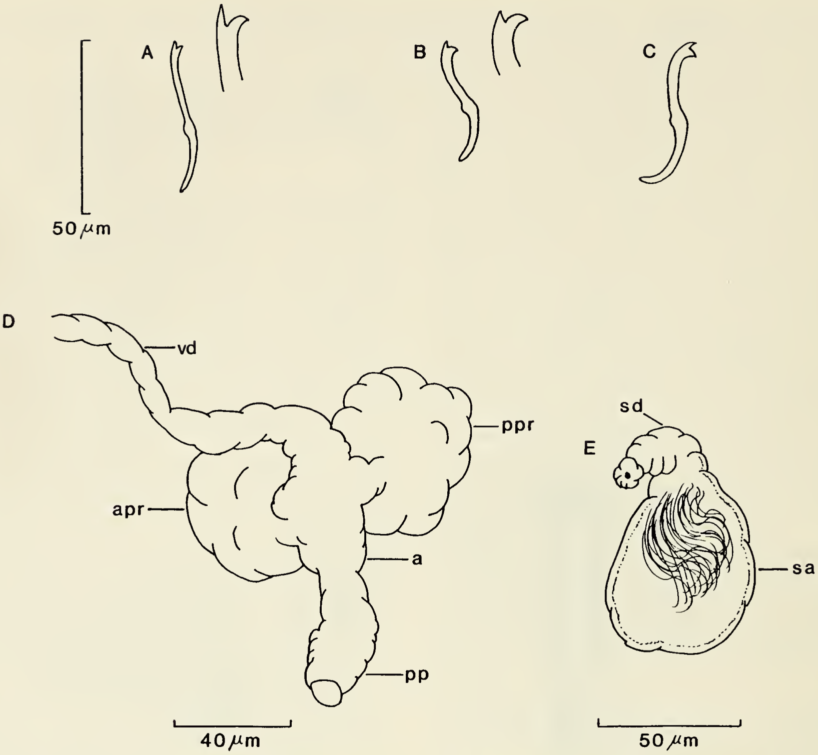

Fig. 3. *Duridrilus tardus*: A, Seta from V; B, Seta from X; C, Posterior seta; D, Male genitalia; E, Spermatheca.

Subfamily Phallodrilinae
Duridrilus Erséus, 1983
Duridrilus tardus Erséus, 1983
Fig. 3

Duridrilus tardus Erséus, 1983b:29–32, figs. 1–2.

Material examined.—Three whole-mounted specimens, west coast of Puerto Rico. Aguadilla Bay, 2 km from shore, 38.8 m depth, coarse sand and shell, coll. Allan Stoner, 18 Apr 1985, USNM 101447.

Description of new material.—Specimens incomplete; largest specimen with 72 segments, and 11.5 mm long, width at clitellum 0.20 mm. Prostomium partially retractable into II. Cuticle thick "dusted" with small adherent particles, segments of post-clitellar region with up to 35 fine annulations producing a "wavy" appearance. Clitellum not well developed. All setae bifid, 40–48 μm long, two per bundle in II–VIII with upper tooth slightly thinner and subequal to lower, nodulus proximal (Fig. 3A). One seta per bundle posterior to VIII, upper tooth very reduced and lower tooth much thicker, nodulus median (Fig. 3B–C). Setae absent from XI. Male and spermathecal pores paired, in line with ventral setae. Spermathecal pores located far anteriorly in X.

Male genitalia paired. Vas deferens 160 μm long and thin walled, 7 μm wide, entering atrium apically. Atrium thin walled, more or less erect or obliquely directed posteriorly (Fig. 3D). Ampulla of atrium 65 μm long and 30–40 μm wide, thin walled, granulated. Two prostrates attached opposite each other on posterior and anterior face of atrial ampulla (Fig. 3D). Ectal duct of atrium 40 μm long and 10 μm wide, terminiating in pseudopenis. Spermathecae composed of ectal duct 30 μm long, 10 μm wide, and oval ampulla 63 μm long, 43 μm wide (Fig. 3E). Sperm in random masses.

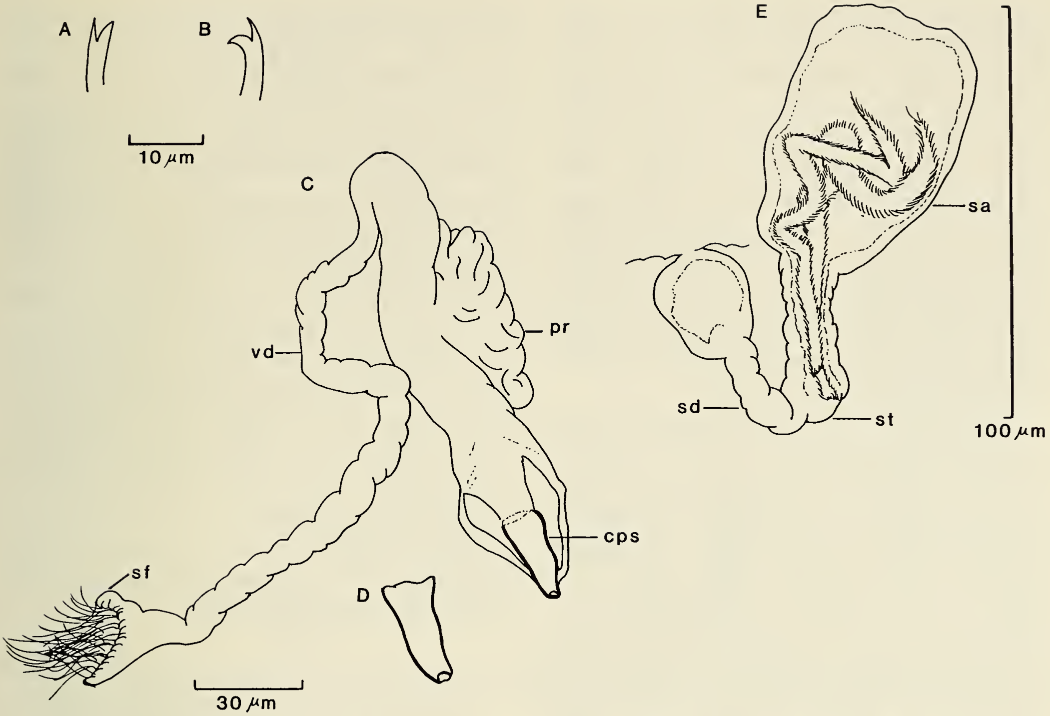

Fig. 4. *Tubificoides aguadillensis*: A, Seta from IV; B, Posterior seta; C, Male genitalia; D, Penis sheath; E, Spermatheca.

Remarks.—The new material conforms closely in all respects to the original description. Two other species of *Duridrilus* have been described by Erséus (1984, 1985). *Duridrilus tardus* differs from *D. piger* Erséus, 1984, described from Hong Kong, by possessing a thicker cuticle with fine secondary annulations, unisetal bundles posteriorly (bisetal in *D. piger*), and sperm not forming spermatozeugmata as in *D. piger. Duridulus tectus* Erséus, 1985, from Saudi Arabia has dorsally located spermathecal pores (ventral in *D. tardus*), no secondary cuticular annulations, and an extremely reduced upper tooth in posterior setae.

The presence of *D. tardus* in Puerto Rico was not unexpected. Erséus (1983b) predicted its occurrence throughout the Caribbean and more specimens are likely to be encountered as new areas in this region are explored.

Habitat and distribution.—Coarse sand, 8–39 m, known from Bermuda, Barbados, and Puerto Rico.

Subfamily Tubificinae
Tubificoides Lastochkin, 1937
Tubificoides aguadillensis, new species
Fig. 4

Holotype.—Whole-mounted specimen, west coast of Puerto Rico, Aguadilla Bay, 2 km from shore, 17 m depth; mud with shell fragments, coll. Allan Stoner, 18 Apr 1985, USNM 101448.

Paratype.—One whole-mounted specimen, type locality, USNM 101449.

Etymology.—Named for the type locality.

Description.—Length 4.2 mm, 35 segments, width at XI 0.2 mm. Body wall naked. Bifid setae absent dorsally. Dorsal setae all smooth, straight hairs, 5–7 per bundle anteriorly, 50–109 μm long generally alternating from long to short within each bundle, posteriorly 3–5 hair setae per bundle, 50–70 μm long. Ventral setae all bifid, 3 per bundle to VIII, 50–60 μm long, thereafter 2 per bundle in all segments. Teeth of anterior ventral setae equal in length, upper tooth thinner than lower (Fig. 4A), posteriorly lower tooth slightly longer and much thicker than upper tooth (Fig. 4B). Unmodified ventral setae present in X. Male and spermathecal pores paired and in line with ventral setae. Spermathecal pores slightly anterior to ventralsetae in X.

Male genitalia paired. Sperm funnel small leading into vas deferens, 210 μm long, 10 μm wide, ciliated throughout and entering atrium subapically. Compact prostate attached medially on atrium (Fig. 4C). Atrium tripartite, 98 μm long, 23 μm wide, composed of 1) an ental "cap" above the attachment of the vas deferens, 2) a central cylindical ampulla, and 3) an enlarged ectal "penial bulb." Penis with somewhat conical cuticular penis sheath 30 μm long and 19 μm wide at base, tapering to blunt distal end with small terminal opening (Fig. 4D). Spermathecae with long duct, 30 μm long, 14 μm wide, terminating ectally in bulbous projection. Spermathecal ampulla ovoid, 100 μm long, 50 μm wide, joining ectally with spermathecal duct via "sperm trap" (Fig. 4E). Spermatozeugmata vermiform.

Remarks.—The species of *Tubificoides* are exclusively estuarine or marine. This is one of the largest genera of marine Oligochaeta and is now composed of 38 species. This genus was recently reviewed by Brinkhurst (1985, 1986). Twenty-seven species possess hair setae in at least some bundles. Although only two mature specimens were collected from Puerto Rico, they were significantly different enough from all congeners to warrant establishing them as a new species. *Tubificoides aguadillensis* is immediately distinguished from all congeners by the total lack of bifid setae in all dorsal bundles, the distinctive shape of the cuticular penis sheath and the short vas deferens. The only other species of *Tubificoides* lacking bifid setae dorsally is one currently being described by Helgason and Erséus. However, the penis sheaths of their species differ from *T. aguadillensis* by having a conspicuous subapical spur, and the vas deferens of the former is much longer. Dr. M. Loden has reported a new species of *Tubificoides* which lacks dorsal bifid setae from the Gulf of Mexico (pers. comm.). The penis sheaths of his species and *T. aguadillensis* appear to be identical. The former species, however, differs from the latter in the following ways: 1) the prostate is attached entally on the atrium, 2) the body wall is papillated, 3) the upper tooth of the ventral crotchets is equal to or longer than the lower, and 4) the hair setae are bent.

Habitat and distribution.—Mud with shell fragments, 17 m depth, known only from Aguadilla Bay, Puerto Rico.

Tubificoides wasselli Brinkhurst and Baker, 1979
Fig. 5

Peloscolex gabriellae Marcus, 1950, sensu Brinkhurst, 1965:133, figs. 5L–5N.—Brinkhurst and Simmons, 1968:187 (in partim).

Peloscolex gabriellae typica Brinkhurst and Cook, 1966:17 (in partim).

Tubificoides gabriellae (Marcus), sensu Brinkhurst and Baker, 1979:1556 (in partim).

Tubificoides gabriellae (Marcus), Brinkhurst, 1979:7.

Tubificoides wasselli Brinkhurst and Baker, 1979:1556, fig. 1.—Brinkhurst, 1986: 1276–1278, fig. 5.

Tubificoides foliatus Baker, 1983:1274–1276, fig. 5.

not *Tectidrilus gabriellae* (Marcus), Erséus, 1982:25–258.

Material examined.—Two whole-mounted specimens, west coast of Puerto Rico, Aguadilla Bay, 2 km from shore, 39 m depth, silt-clay, with pockets of detritus, coll. Allan Stoner, 14 May 1985, USNM 101450.

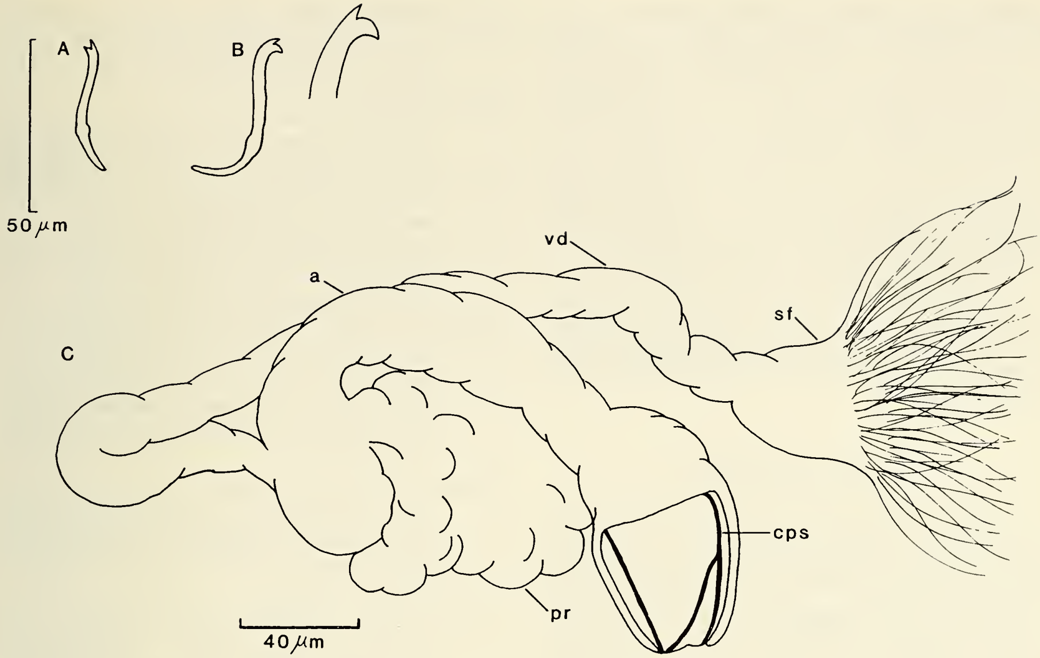

Fig. 5. *Tubificoides wasselli*: A, Seta from VII; B, Seta from VIII; C, Male genitalia.

Description of new material.—Specimens incomplete. Largest specimen with 20 segments, length 3.3 mm, width at XI 0.26 mm. Prostomium and II retractile. Body wall densely covered with large papillae from IV. All setae bifid, 2 per bundle to VII, about 45 μm long, upper tooth shorter and thinner than lower (Fig. 5A). From VIII one seta per bundle, about 52 μm long, upper tooth very reduced, lower tooth thick and recurved (Fig. 5B). Setae absent from XI. Modified genital setae absent. Spermathecal and male pores paired, in line with ventral setae. Clitellum not observed.

Male genitalia paired. Vas deferens of uniform width, 15 μm, and 370 μm long, ciliated internally with thin walls, entering atrium subapically. Prostate large, compact, entering atrium opposite vas deferens. Atrium tripartite, 170 μm long, maximally 29 μm wide, composed of 1) ental cap-like region, 2) muscular tubular middle portion, and 3) ectally a bulbous penial apparatus with cuticular penis sheath (Fig. 5C). Penis sheath conical with shovel-shaped opening, 40 μm long and 40 μm wide at base. Spermathecae paired, duct elongate 170 μm, 20 μm wide, ampullae sacciform, 70 μm long, 55 μm wide. Spermatozeugmata not observed.

Remarks.—*Tubificoides wasselli* has been the subject of much confusion. Erséus (1982) found that the type specimens of *Peloscolex gabriellae* (sensu Marcus) should actually be in the genus *Tectidrilus* Erséus, 1982, because of the presence of gut diverticula and absence of a cuticular penis sheath. Therefore, specimens attributed to *Tubificoides gabriellae* without the above criteria needed to be reexamined. Baker (1983) described a new species, *Tubificoides foliatus,* and presented an extensive discussion concerning the synonymy of it and specimens originally attributed to *Tubificoides gabriellae.* Apparently, many previous studies on the northwest coast of North America combined *T. foliatus* with *T. gabriellae. Tubificoides foliatus* was originally separated from *T. wasselli* solely by the relative size of the genitalia. New material from Florida, examined by Brinkhurst, was found to be intermediate between the two species. Based on this, Brinkhurst (1986) has now synonymized *T. foliatus* with *T. wasselli.* The material from Puerto Rico more closely approximates the diminutive size of the genitalia of the "*foliatus*" form. This new record from Puerto Rico increases the known range into the Caribbean.

Habitat and distribution.—Sand and mud, intertidal to 60 m depth, Delaware to Florida, British Columbia to California, and Puerto Rico.

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AMMOANITA ROSEA, NEW GENUS AND NEW SPECIES OF DEEP WATER TROCHAMMINIDAE, FORAMINIFERIDA

George A. Seiglie and Mary B. Baker

Abstract.—Ammoanita Seiglie and Baker, new genus is described and distinguished by its lens-shaped test, acute periphery, and umbilical-extraumbilical aperture. *Ammoanita rosea* Seiglie and Baker, new species is also described; its distinguishing characteristics are: an acute but rarely keeled periphery, a thick test, and seven to eight chambers in the last whorl. An emended description of *Ammoanita trinitatensis* (Cushman and Jarvis) is included.

Most of the species of agglutinated foraminifers having a low trochospire, with an aperture on the umbilical side with no other *en évidence* morphological characteristics, have been included in the genus *Trochammina* Parker and Jones, 1859. Brönnimann, Zaninetti, and Whittaker (1983) indicate the necessity for a redefinition of this genus in the future. This has been done in part (e.g. Brönnimann and Whittaker 1983a, b). A group of Cretaceous and Jurassic species included in the genus *Trochammina* have common morphological characteristics, such as a relatively large number of chambers in the last whorl arranged in a low trochospire, which distinguish them from the Tertiary species of *Trochammina*. Among the Cretaceous species are *T. eilete* Tappan, 1957, *T. stefanssoni* Tappan, 1957, and *T. parallela* Cushman and Applin, 1947. Dain (1972) illustrated *T. kondaensis* Levina, 1972, a Jurassic species of this group from Siberia. *Trochammina gyroidiniformis* Krasheninnikov (1974) and *T. gyroides* Cushman and Waters (1927) are planoconvex Cretaceous species with a semicircular aperture, that probably should be included in a new and different genus.

We describe herein a new genus morphologically and probably phylogenetically close to *Trochammina*, Parker and Jones (1859), *Ammoanita*, and two species: *A. rosea*, n. sp. and *A. trinitatensis* (Cushman and Jarvis, 1928) emended. The Cretaceous species *A. rosea* is the ancestor of the Paleocene *A. trinitatensis.*

Trochamminidae Schwager, 1877
Ammoanita, new genus

Type species.—Ammoanita rosea, n. sp.

Etymology.—From the Greek *ammos,* sand, and Anita, a feminine proper noun.

Description.—Test biconvex and trochospiral, with 7–10 chambers in last whorl; periphery acute, and may be keeled; surface finely agglutinated; aperture interiomarginal, umbilical-extraumbilical.

Age.—Santonian?, Campanian to Paleocene.

Differences from other genera.—The closest genus to *Ammoanita* is *Trochammina,* mainly the Jurassic and Cretaceous stock of *Trochammina. Ammoanita* has a more restricted umbilical area, is larger and more convex on both sides, has a higher trochospire, and a more acute periphery than the Cretaceous species of the genus *Trochammina.* It is distinguished from the Cenozoic species of *Trochammina* by the greater number of chambers in the last whorl and a more acute periphery.

Ammoanita includes two species with relatively short stratigraphic ranges, and separated morphologically from the species of the genus *Trochammina.*

Geographic distribution.—The species of this genus have been found in Late Cretaceous deep-waters of the Middle East, and the Paleocene deep-waters of West Africa, and Trinidad Antilles.

Ammoanita rosea, new species
Fig. 1a–c, 2a–c

Description.—Test biconvex, umbilicate and slightly more convex on umbilical side; last whorl composed of 7–8 chambers arranged in a trochospire; chambers semilunar on dorsal side, subtriangular on ventral side; sutures arched on dorsal side, sigmoidal on umbilical side; periphery acute, rarely weakly keeled; wall agglutinated with a finely grained surface; aperture an interiomarginal, umbilical-extraumbilical slit. Size 0.50–0.79 mm in diameter.

Age.—Santonian?, Campanian to Early Maestrichtian.

Type specimens.—The holotype is illustrated in Fig. 1a–c. The holotype and paratype are deposited in the National Museum of Natural History, Washington, D.C. (USNM 00005003 and USNM 00005004), respectively.

Type locality.—The holotype and paratype were found between 7540 to 7580 feet in the Wadi Rafash-lx well in Oman, at approximately 23°32′N, 56°07′E.

Differences from other species.—*Ammoanita rosea* is distinguished from the closest related species, *A. trinitatensis*, by the lower number of chambers in the last whorl, the thicker test and a periphery which is rarely keeled.

Paleoenvironment.—This species has been found, to date, in the Middle East. It is associated with a lower bathyal to abyssal, dominantly agglutinated foraminiferal assemblage, which includes: *Allomorphina trigona* Reuss, *Dorothia bulleta* (Carsey), *Clavulina gaultina* Morozova, *C. californica* (Mallory), *Plectina conversa* Jedlitschka, *Gaudryina pyramidata* Cushman, *G. aissana* ten Dam and Sigal, *Gyroidina globulosa* (Hagenow), *Glomospira charoides* (Jones and Parker), *Rzehakina epigona* (Rzehak), *Melonis pompilioides* (Fichtell and Moll), *Marssonella oxycona* (Reuss), *Quadrimorphina trochoides* (Reuss), *Hormosina globulifera* Brady, *Trochammina gyroidiniformis* Krasheninnikov, *Schizammina* sp., *Ammobaculites* sp., *Haplophragmoides* sp., *Bathysiphon* sp. and *Psammosphaera* sp.

Ammoanita trinitatensis
(Cushman and Jarvis, 1928),
new combination
Fig. 3a–c

Trochammina trinitatensis Cushman and Jarvis 1928:96.

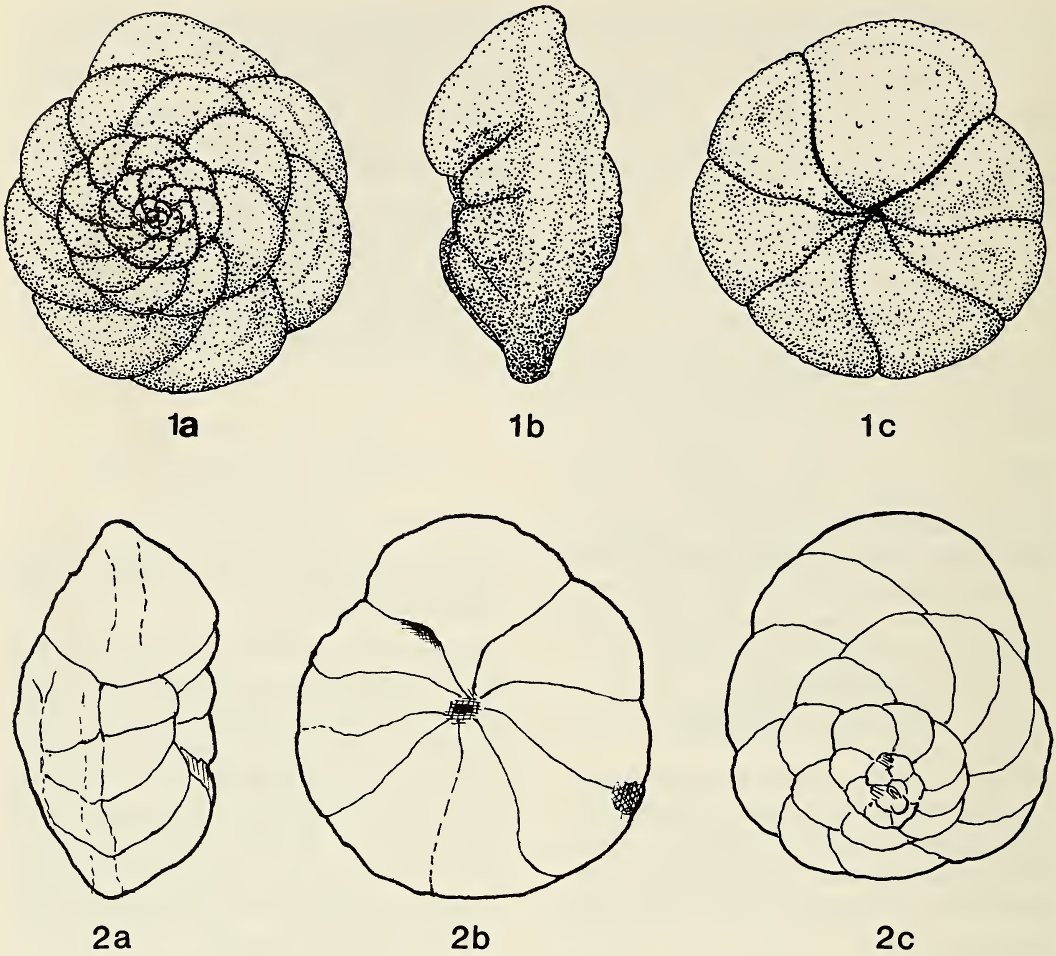
Description.—Test equally biconvex and umbilicate; chambers arranged in a trochospire with 9 to 13 chambers in last whorl; chambers semilunar on dorsal side, subtriangular on ventral side; sutures arched on dorsal side, radial to sigmoidal on ventral side; periphery keeled; wall agglutinated, surface fine-grained; aperture an interiomarginal, umbilical-extraumbilical slit. Size 0.40–0.73 mm in diameter.

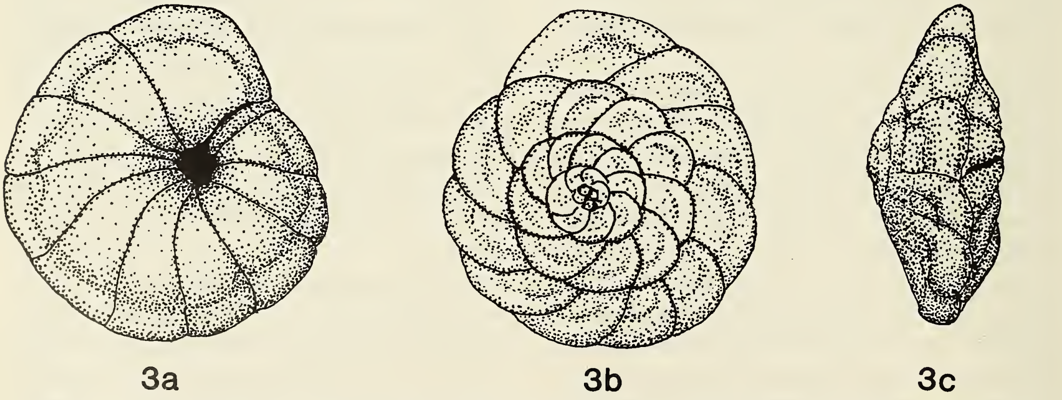
Age.—Paleocene.

Locality.—The specimens used for this study were found in the Bekuma-lx well offshore Cameroon, between 6610 and 6640 feet. The specimen illustrated is deposited in the National Museum of Natural History, Washington, D.C. (USNM 00005005).

Geographic distribution.—This species occurs in Trinidad (Antilles) and off West Africa.

Paleoenvironment.—*Ammoanita trinitatensis* is associated with a lower bathyal-abyssal foraminiferal assemblage including: *Clavulina californica* (Mallory) *Rzehakina epigona* (Rzehak), *Trochammina globigeriniformis* Parker and Jones, *Hormosina globulifera* Brady, *Haplophragmoides* sp., *H. walteri* (Grzybowsky), *Psammosphaera*





Figs. 1–2. *Ammoanita rosea*: 1a–c, Wadi Rafash-lx well, Oman, 7540–7580 feet, maximum diameter 0.60 mm, holotype, USNM 00005003; 2a–c, Wadi Rafash-lx well, Oman, 7840–7870 feet, maximum diameter 0.47 mm, paratype, USNM 00005004; Early Campanian.

Fig. 3a–c. *Ammoanita trinitatensis* (Cushman and Jarvis) Bekuma-lx well, Cameroon, 6610–6640 feet, maximum diameter 0.54 mm, USNM 00005005; Paleocene.

sp., *Spiroplectammina spectabilis* (Grzybowsky), and *Bathysiphon* sp.

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INGOLFIELLA FUSCINA, NEW SPECIES (CRUSTACEA: AMPHIPODA) FROM THE GULF OF MEXICO AND THE ATLANTIC COAST OF NORTH AMERICA, AND PARTIAL REDESCRIPTION OF *I. ATLANTISI* MILLS, 1967

Masahiro Dojiri and Jürgen Sieg

Abstract.—A new species of ingolfiellid amphipod, *Ingolfiella fuscina*, is described from relatively shallow waters (17–151 m) off the Atlantic coast and in the Gulf of Mexico, United States. The species differs from its congeners by having the following combination of characters: pereonites and pleonites higher than long, trifid tip of the ungulus of pereopods 3 and 4, stout ungulus with accessory process on pereopods 5–7, 4 rows of spinules on uropod 2, acuminate pleopods 1–3, and a sexually dimorphic element (simple seta in female; pectinate spine in male) on the peduncle of uropod 1.

Ingolfiella atlantisi Mills, 1967, is partly redescribed from the holotype. It differs from the new species in the shape and armament of gnathopods 1 and 2, and in the shape of the ungulus of pereopods 3–7.

Sexual dimorphism in the Ingolfiellidea and the classification of *Ingolfiella* at the subgeneric level are discussed.

Zusammenfassung.—Eine neue Art aus der Amphipoden Unterordnung Ingolfiellidea, *Ingolfiella fuscina*, wird aus verhältnismässig geringer Tiefe (17–151 m) von den Vereinigten Staaten von der Atlantikküste und dem Golf von Mexiko beschrieben. Die Art unterscheidet sich von allen anderen Vertretern der Gattung in der Kombination der Merkmale Pereonite and Pleonite höher als lang, dreizackiger Spitze des Ungulus in den Pereopoden 3 und 4, hakenförmigem Ungulus mit zusätzlichem Vorsprung in den Pereopoden 5–7, 4 Borstenreihen auf dem Uropoden 2, zugespitzten Pleopoden 1–3 und weist am Pedunkel des Uropoden 1 ein Merkmal auf, das Sexualdimorphismus zeigt (1 einfache Borste beim Weibchen; beidseitig gefiedert beim Männchen).

Ingolfiella atlantisi Mills, 1967, wird unter Verwendung des Holotypus teilweise nachbeschrieben. Sie unterscheidet sich von der neuen Art in der Form und Bewehrung der Gnathopoden 1 und 2 sowie in der Form des Ungulus der Pereopoden 3–7.

Der Sexualdimorphismus innerhalb der Ingolfiellidea und bei *Ingolfiella* die Klassifikation auf dem Niveau der Untergattungen werden diskutiert.

The Outer Continental Shelf Environmental Studies Program under the Department of the Interior's Minerals Management Service (MMS) (formerly part of the Bureau of Land Management) conducts extensive collections of the fauna of the continental shelf and slope from Alaska and California, the Gulf of Mexico and along the east coast of the United States from George's Bank, off Massachusetts, to southern Florida, in order to provide baseline data of the organisms occurring in these

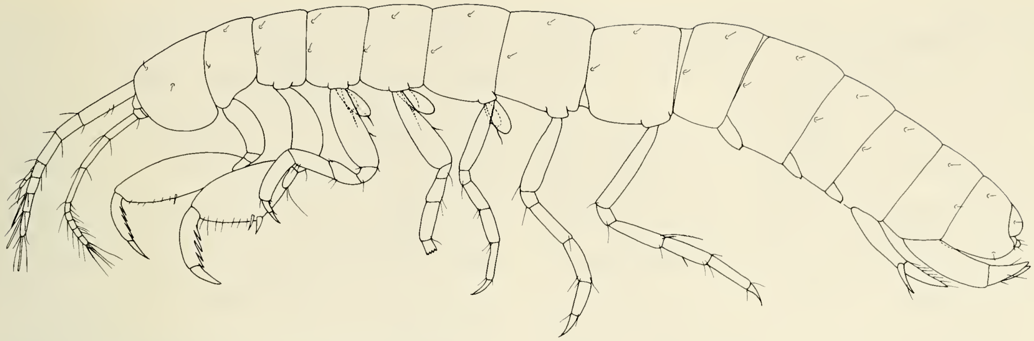


Fig. 1. *Ingolfiella fuscina,* female: body, lateral.

waters. The collected specimens, mostly identified, are maintained in the National Museum of Natural History, Smithsonian Institution, and are available for study. During a routine examination of the unidentified Crustacea from the MMS South Atlantic Benchmark Program (SABP) collection, we found specimens of a new species of *Ingolfiella* collected off the coast of South Carolina in 17 m of water. Additional material was obtained from the South Atlantic Area Living Marine Resources Study (LMRS); Mississippi, Alabama, Florida Survey (MAFLA), and from SABP samples collected off South Carolina and Florida at various depths.

The Ingolfiellidea is a suborder of the Amphipoda. According to Stock (1976) the group contains two families, the monotypic Metaingolfiellidae and the Ingolfiellidae. The latter family has three genera, *Trogloleleupia* Ruffo, 1974a, with three species, *Ingolfiella* Hansen, 1903, with 23 species, and *Stygobarnardia* Ruffo, 1985, containing only *S. caprellinoides* Ruffo, 1985, which was formerly identified as the male of *Ingolfiella opisthodorus* (now considered a species of *Trogloleleupia* Ruffo, 1974a) by K. H. Barnard (1966).

The members of this suborder have been reported from very diverse habitats and a wide range of depths (Spooner 1960, Stock 1976). The present discovery, however, is the first record of an ingolfiellid in relatively shallow water off the eastern coast of the United States. Although Mills (1967) described *Ingolfiella atlantisi* from the western North Atlantic, it was reported from the deep sea (4743–4892 m). *Ingolfiella atlantisi* is partly redescribed from the holotype and compared to the new species described below. A discussion of Ingolfiellidea is also presented.

Ingolfiella fuscina, new species
Figs. 1–5

Type specimens.—Holotype ♀ (USNM 224991), allotype ♂ (USNM 224992), paratypes (10 ♀♀, 1 ♂; USNM 224993) collected off South Carolina, sta 2B (32°54′06″N, 079°11′58″W) with box core at 17 m depth for Minerals Management Service (MMS), Department of Interior, 17 Nov 1977.

Additional specimens.—1 ♀ (USNM 224994) collected off Crystal River, Florida, sta III-2316 (28°42′00″N, 084°20′01″W) at 25 m depth for MMS in 1975; 1 ♀ (USNM 224995) with same collection data as preceding specimens, but collected in 1976; 1 ♀ (USNM 224996) collected off Panama City, Florida, sta V-2529 (29°55′59″N, 086°06′29″W) at 38 m depth for MMS, 7 Feb 1976; 1 ♀, 1 ♂ (USNM 224997) collected off Florida, sta 7E (29°36′00″N, 080°10′59″W) with box core at 151 m depth for MMS, 2 Sep 1977; 7 ♀♀ (2 dissected on slides) (USNM 221271) collected off South Carolina, sta 0S06 (32°29′06″N, 078°49′18″W) with Smith-MacIntyre grab at 48 m depth for MMS, 4 May 1981; 8 ♀♀, 3 ♂♂ (USNM 228520) collected off Tampa Bay, Florida, sta 066 (29°40′00″N, 83°15′28″W) at 30 m depth, Oct 1983 for MMS.

Location of material.—All specimens are deposited in the Division of Crustacea, National Museum of Natural History, Smithsonian Institution, Washington, D.C., except dissected specimens in collections of the authors.

Type locality.—Western North Atlantic, off South Carolina, 32°54′06″N, 79°11′58″W, 17 m.

Etymology.—The specific name *fuscina,* a feminine noun (Latin for three-pronged fork or trident), alludes to the trifid tip of the ungulus of pereopods 3 and 4.

Description of female (other than holotype).—Body: Total body length (frontal margin of head to tip of telson) 1.43–1.80 mm, based on 6 specimens. Body (Fig. 1) elongate, laterally compressed; each body somite shorter than high, and bearing a few setules. Small subtriangular process, "ocular lobe," present between bases of first and second antennae; this process rounded at apex and hyaline, not extending beyond distal margin of basal segment of second antenna.

First antenna (Fig. 2A) with 3-segmented peduncle and 4-segmented flagellum; first segment of peduncle longer than segments 2 and 3 combined; armament formula for peduncle and flagellum: 16, 12, 7, 2, 4 + 1 esthete, and 7 + 2 esthetes. Accessory flagellum (Fig. 2A) 3-segmented, first segment naked; second segment with 3 setae; terminal segment with 2 setae and 1 esthete.

Second antenna (Fig. 2B) with 5-segmented peduncle and 5-segmented flagellum; "gland cone" (see Stock 1976) on second segment of peduncle digitiform; armament formula for peduncle and flagellum: 0, 1, 5, 8 (3 additional setae, indicated by arrows, present in 1 specimen), 11, 2, 5, 4, 5, 6 (1 of these somewhat esthete-like: broad with rounded tip).

Labrum (Fig. 2C) with rounded posterior margin.

Right mandible (Fig. 2D) with 3 or 4 teeth on masticatory area (pars incisiva); lacinia mobilis with several small teeth flanked by 2 large teeth; 2 spinulate setae at base of lacinia mobilis; pars molaris an elongate, sharply pointed process with 2 needlelike processes at tip and 1 row of spinules along margin. Left mandible (Fig. 2E) from same individual differing conspicuously from that just described; masticatory area with more clearly defined teeth; teeth on lacinia mobilis all similar in size; 3 spinulate setae at base of lacinia mobilis.

First maxilla (Fig. 2F) with rounded proximal endite bearing 3 setae; distal endite with 3 spinulate spines (1 spinulate only along inner margin), 1 pectinate spine, and 2 bifid spines; 2-segmented palp tipped with 3 apical setae.

Second maxilla (Fig. 2G) with 2 lobes each with 5 naked apical setae.

Maxilliped (Fig. 2H) with digitiform endite bearing 2 setae; palp 5-segmented with armament: 2, 1, 1, 1, 2 + 1 (clawlike spine).

Coxal gills present on pereopods 3 to 5 (Fig. 1).

Gnathopod 1 (Fig. 3A) with basis longer than ischium and merus combined; basis and ischium each with 1 seta; merus with 2 setae near junction with carpus; carpus relatively slender, with 1 seta on anterodistal corner; palm bearing 4 spines, 7 simple setae, and 4 Y-shaped setae (see detailed Fig. 3A); claw formed from propodus and dactylus; propodus with 2 anterior and 2 posterior setae; dactylus with 1 anterior seta and 4 elongate teeth (fourth tooth closely appressed to or fused with dactylus and bearing 1 seta at base).

Gnathopod 2 (Fig. 3B) with basis, ischium, and merus similar to those of gnathopod 1; carpus somewhat triangular, anterodistal corner bearing 1 seta, and conspicuously stouter than that of gnathopod 1; palm carrying 3 spines (1 of which large), 8 simple setae, 3 Y-shaped setae, and 2 small teeth (1 located between second and third Y-shaped setae; another immediately distal to third) (Fig. 3B); propodus and dactylus

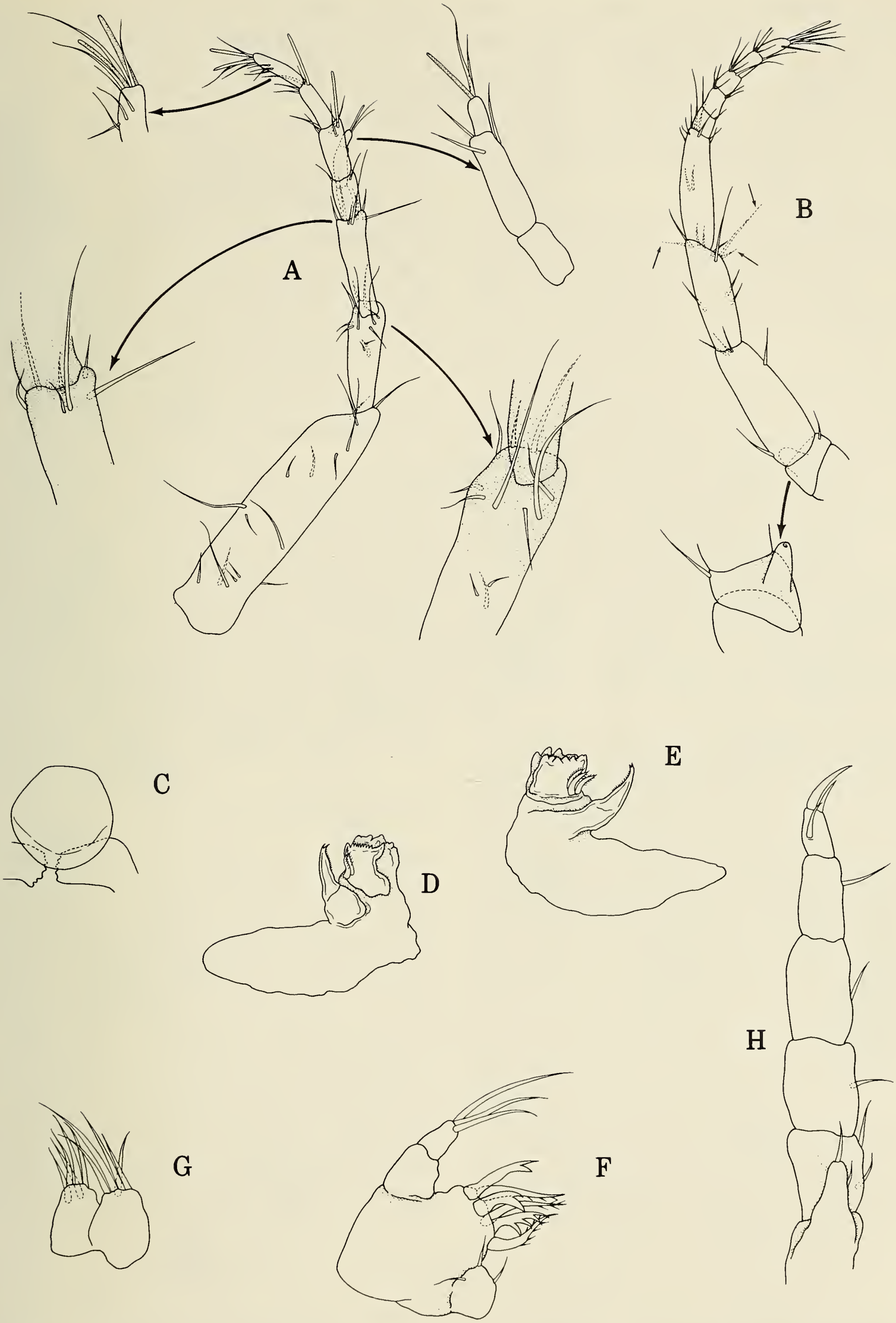
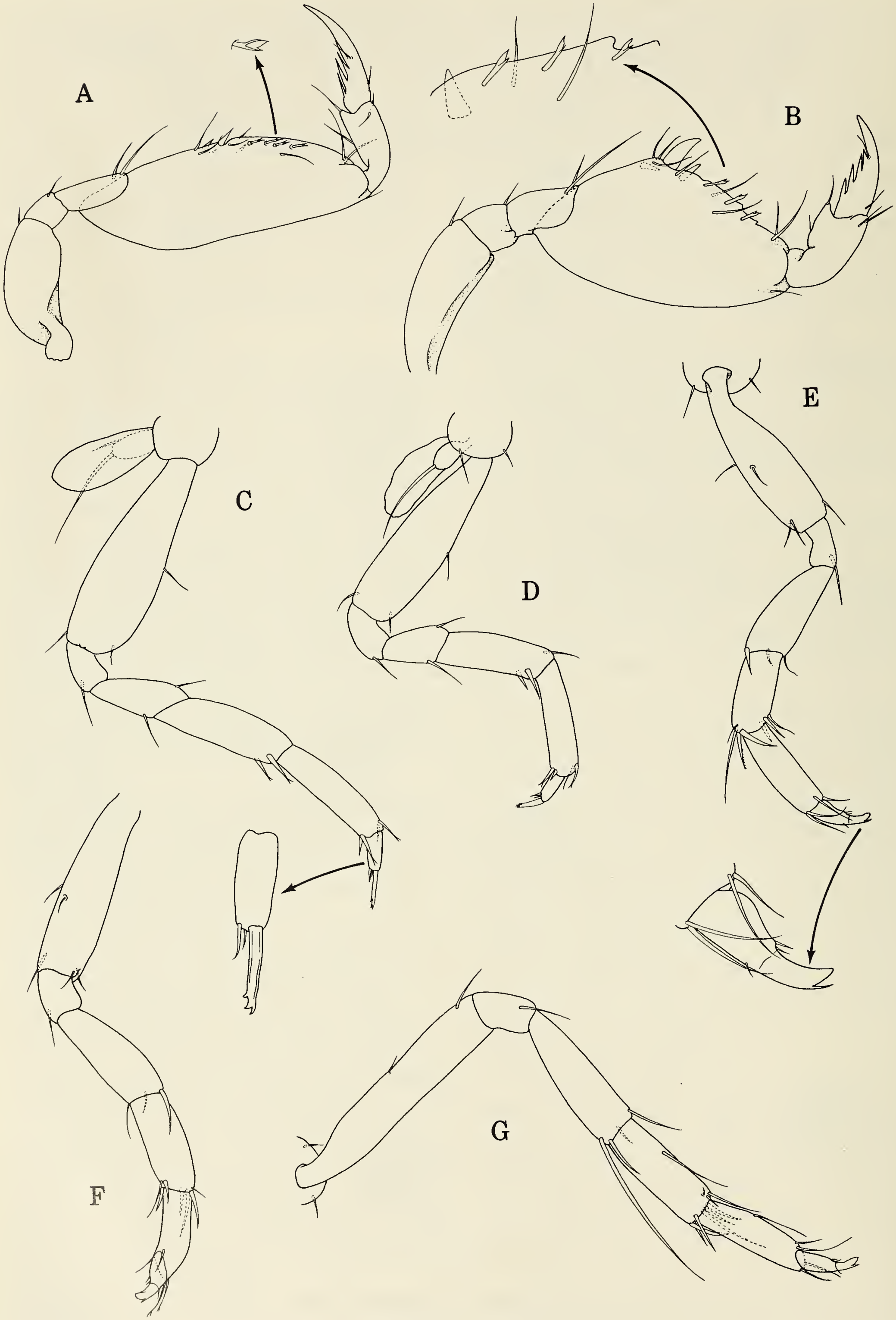


Fig. 2. *Ingolfiella fuscina,* female: A, First antenna; B, Second antenna; C, Labrum; D, Right mandible; E, Left mandible; F, First maxilla; G, Second maxilla; H, Maxilliped.


A
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stouter than those of gnathopod 1; fourth tooth distinct with 1 seta located between it and terminal part of dactylus.

Pereopod 3 (Fig. 3C) with long basis, slightly shorter than next 3 segments combined, bearing 1 anterior seta at about midlength, 1 anterodistal seta, and 1 posterodistal seta; ischium short with 1 posterodistal seta; merus with 1 anterodistal and 1 posterodistal setae; carpus bearing 2 relatively stout posterodistal setae (bifid at tips); propodus with 4 setae; dactylus carrying 2 setae and trifid spine (ungulus). Oostegite a rounded lobe with 2 setae.

Pereopod 4 (Fig. 3D) similar to pereopod 3 except carpus with 1 posterodistal seta. Oostegite with only 1 seta.

Pereopod 5 (Fig. 3E) with basis bearing 2 setae near midlength and 3 distal setae; ischium with 1 distal seta; merus more than twice length of ischium and carrying 3 setae (1 slightly spiniform); carpus with 3 slender setae and 4 spiniform setae; propodus with 4 distal setae; dactylus carrying 1 posterior and 2 anterior setules; ungulus stout and curved, equipped with slender, spiniform, accessory process. Oostegite with 1 seta, broken off in Fig. 3E.

Pereopod 6 (Fig. 3F) similar to pereopod 5.

Pereopod 7 (Fig. 3G) with slender basis bearing 2 setae (1 at midlength; other distal); ischium with 1 seta; merus with 4 distal setae, posterior seta longer than segment; carpus carrying 10 elements (7 setae and 3 spines); propodus with 5 setae; dactylus and ungulus as in pereopods 5 and 6.

Pleopods 1–3 (Fig. 4A) lamelliform with pointed distal end bearing 1 or 2 setules.

Uropod 1 (Fig. 4B) biramous; peduncle with 1 seta. Exopod tapered, 1-segmented with cuticular fold near distal end and bearing 1 seta. Endopod longer than exopod; medial surface with 1 row of long setae; lateral surface with 1 long subterminal seta; apex with 4 spiniform processes (Fig. 4B).

Uropod 2 (Fig. 4C, D) with peduncle carrying 4 rows of spinules, most trifid at tips, on medial surface. Rami curved and tapered. Exopod with 2 setae. Endopod with 4 setae.

Uropod 3 (Fig. 4E, F) small, 2-segmented; first segment with 3 setae (1 medial, 1 lateral, and 1 ventral); second segment pointed at tip, with 1 lateral seta set in notch.

Telson (Fig. 4E) a lobe with 1 seta and 2 small setules on each side.

Description of male (other than allotype).—Body similar to that of female; total body length 1.30 mm (range 1.25–1.33 mm) based on 4 specimens. All appendages as in female except those described below.

Gnathopod 1 (Fig. 5A) similar to that of female; carpus more ovoid in outline.

Gnathopod 2 (Fig. 5B, C) with robust carpus; palm with large indentation immediately distal to largest spine, and 3 triangular processes; armament as in female.

Pleopod 1 (Fig. 5D) with 1 subterminal seta.

Uropod 1 (Fig. 5E, F) similar to that of female except with terminal, dorsal, pectinate spine; spine (Fig. 5F) with 2 rows of curved needlelike processes.

Remarks.—The new species appears to be morphologically most similar to *I.* (*Hansenliella*) *kapuri* Coineau and Rao, 1972, and *I.* (*Hansenliella*) *xarifae* Ruffo, 1966. Both species have a trifid tip of the ungulus in pereopods 3 and 4 and a stout ungulus with an accessory process in pereopods 5–7 as in the new species. However, they have only three rows of spinules on uropod 2, while *I. fuscina* has four rows.

Only three species, *Ingolfiella* (*Ingolfiella*) *abyssi* Hansen, 1903, *I.* (*Trianguliella*) *macedonica* Karaman, 1959, and *I.* (*Balcanella*) *uspallatae* Noodt, 1965, have a uropod

←

Fig. 3. *Ingolfiella fuscina,* female: A, Gnathopod 1; B, Gnathopod 2; C, Pereopod 3; D, Pereopod 4; E, Pereopod 5; F, Pereopod 6; G, Pereopod 7.

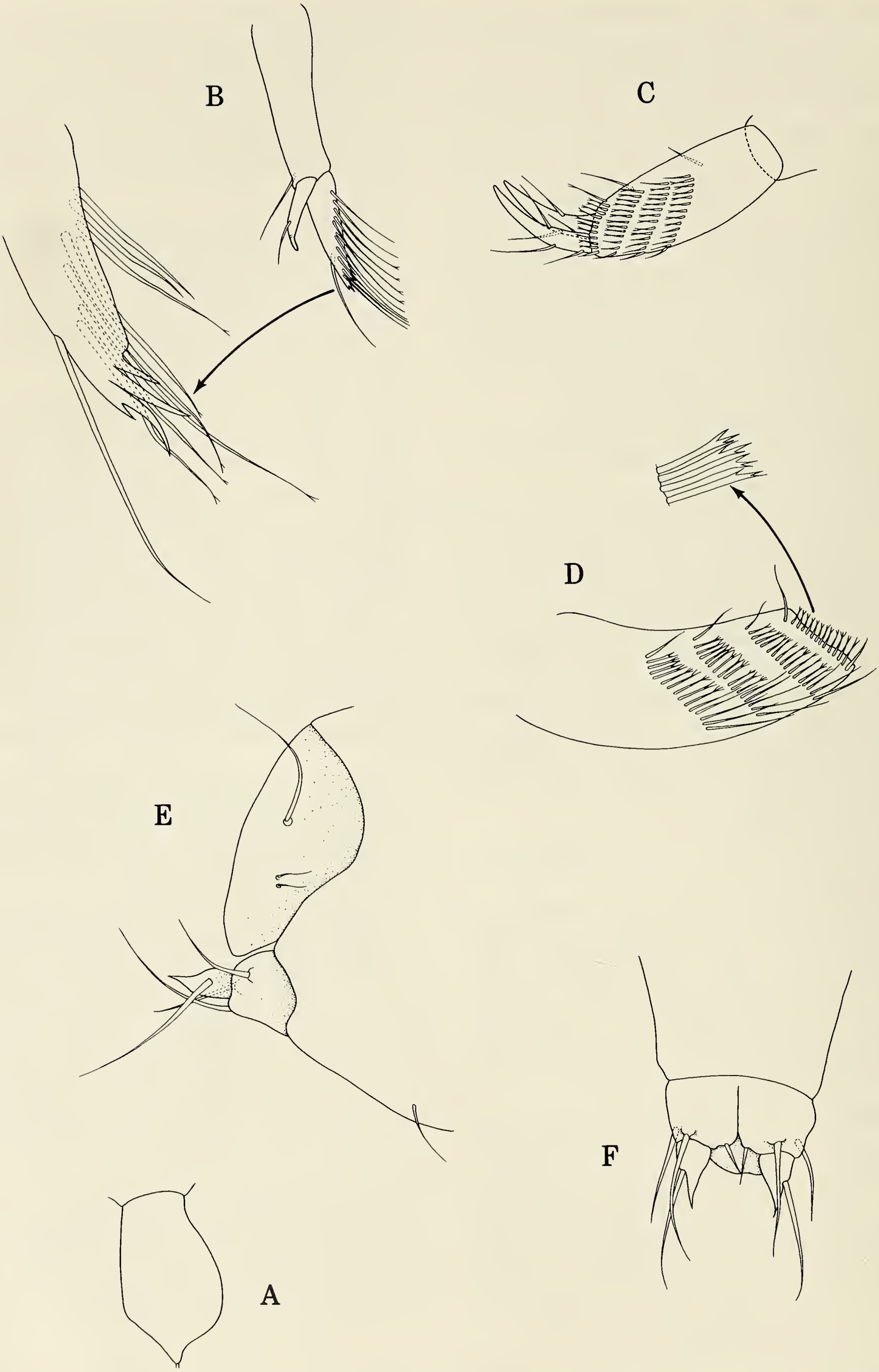

Fig. 4. *Ingolfiella fuscina,* female: A, Pleopod 1, anterior; B, Uropod 1; C, Uropod 2; D, Peduncle of uropod 2; E, Uropod 3 and telson, lateral; F, Last pleonite and uropod 3, ventral.

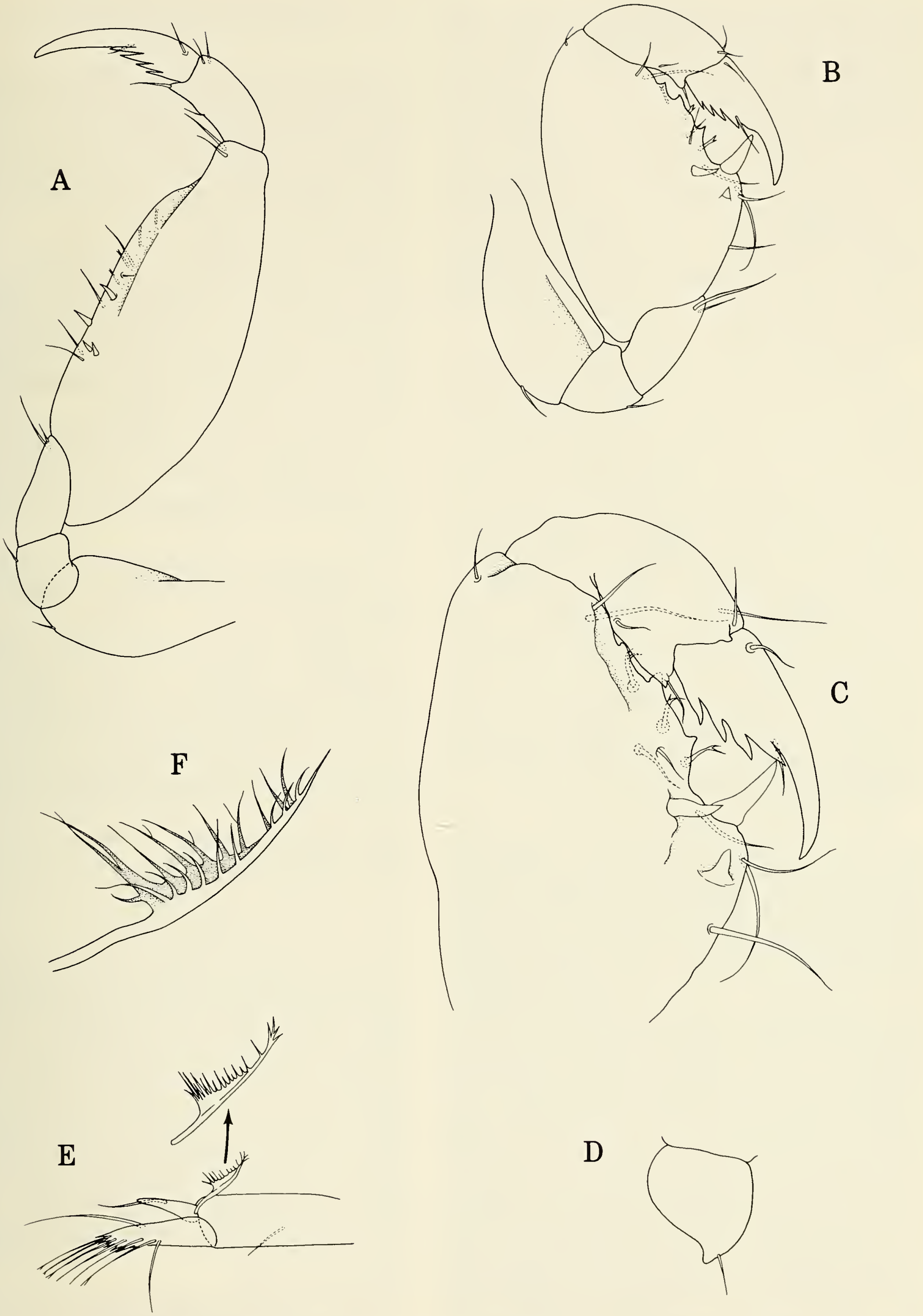

Fig. 5. *Ingolfiella fuscina,* male: A, Gnathopod 1; B, Gnathopod 2; C, Gnathopod 2, enlarged view; D, Pleopod 1; E, Uropod 1; F, Spine of uropod 1 peduncle, slightly dorsal view.

with four rows of spinules as in the new species. They can be distinguished from *Ingolfiella fuscina* by differences in the morphology of pereopods 5–7 and the shape of pleopods 1–3. Most congeners in which uropod 2 has been described differ from the new species in having three rows of spinules on this appendage. The exceptions are *Ingolfiella* (*Trianguliella*) *thibaudi* Coineau, 1968, *I.* (*Trianguliella*) *berrisfordi* Ruffo, 1974b, and *I.* (*Trianguliella*) *grandispina* Stock, 1979, which possess five rows.

Ingolfiella fuscina differs from its congeners by having the pereonites and pleonites higher than long, trifid tip of the ungulus of pereopods 3 and 4, stout ungulus with accessory process on pereopods 5–7, and four rows of spinules on uropod 2. Pleopods 1–3 of the new species differ in shape from all species of *Ingolfiella* except perhaps *I.* (*Hansenliella*) *kapuri.* The shape of the pleopod of this species could not be ascertained from the lateral view given by Coineau and Rao (1972). When present, the pleopods of species of *Ingolfiella* possess either digitiform or triangular pleopods, not acuminate as in *I. fuscina.*

The pectinate spine of uropod 1 of the male of *I. fuscina* is a sexually dimorphic character; this element is a simple seta in the female. Although the discovery of this character represents the first time sexual dimorphism in uropod 1 has been reported for ingolfiellids, sexually dimorphic spines have been described on the peduncle and endopod of the uropod of other peracarid crustaceans, e.g. several amphipods of the family Bogidiellidae by Stock (1981a) and the cumacean *Almyracuma proximoculi* Jones and Burbanck, 1959, by Duncan (1983). Duncan concluded that the male of *A. proximoculi* removes the exuvia of the female with the aid of the serrate spines on the uropod before implantation of the spermatophore on the ventrum of the female. It is not known if the pectinate spine of uropod 1 of *I. fuscina* functions in a similar way; however, its position makes it plausible.

Ingolfiella atlantisi Mills, 1967
Fig. 6

Material examined.—Holotype (probably female and not subadult male) (USNM 112805) from Woods Hole Benthic station 100 (NN.) (33°56′48″N, 65°47′00″W) from 4743–4892 m depth during R/V *Chain* cruise 58 on 1 May 1966.

Partial description.—Gnathopod 1 (Fig. 6A) with palm of carpus bearing 1 proximal triangular process, 2 stout spines, and 8 simple setae; propodus with 1 anterodistal seta; dactylus with 1 anteroproximal seta and 4 teeth along concave margin.

Gnathopod 2 (Fig. 6B) with palm bearing 2 stout spines, 6 setae, and 3 small, distal, triangular processes; dactylus with 4 distinct teeth.

Pereopods 4 (Fig. 6C) and 7 (Fig. 6D) with long, slender, sharply pointed ungulus at tip of dactylus.

Remarks.—The undissected holotype of *Ingolfiella atlantisi* is only partly redescribed. It differs from *I. fuscina* in the shape of the carpus and armament of the palm of gnathopods 1 and 2. In addition, *I. atlantisi* possesses a long, slender ungulus of the dactylus in pereopods 3–7 which is conspicuously different from those of the new species.

Discussion

Prior to the description of the new species, sexual dimorphism had been described for only two of the five subgenera of Stock (1976). *Ingolfiella fuscina* is most closely related to *I. kapuri* and *I. xarifae,* both placed in the subgenus *Hansenliella* by Stock. If the new species is included in this subgenus, the subgenera with known sexual dimorphism are: *Hanseniella* Stock, 1981b; *Trianguliella* Stock, 1976; and *Gevgeliella* Karaman, 1959.

Sexual dimorphism has played a key role in the classification of the genus (Stock 1976). In the absence of the male it is not possible to attribute most species with certainty to a particular subgenus, since three of the five "subgenera are characterized by

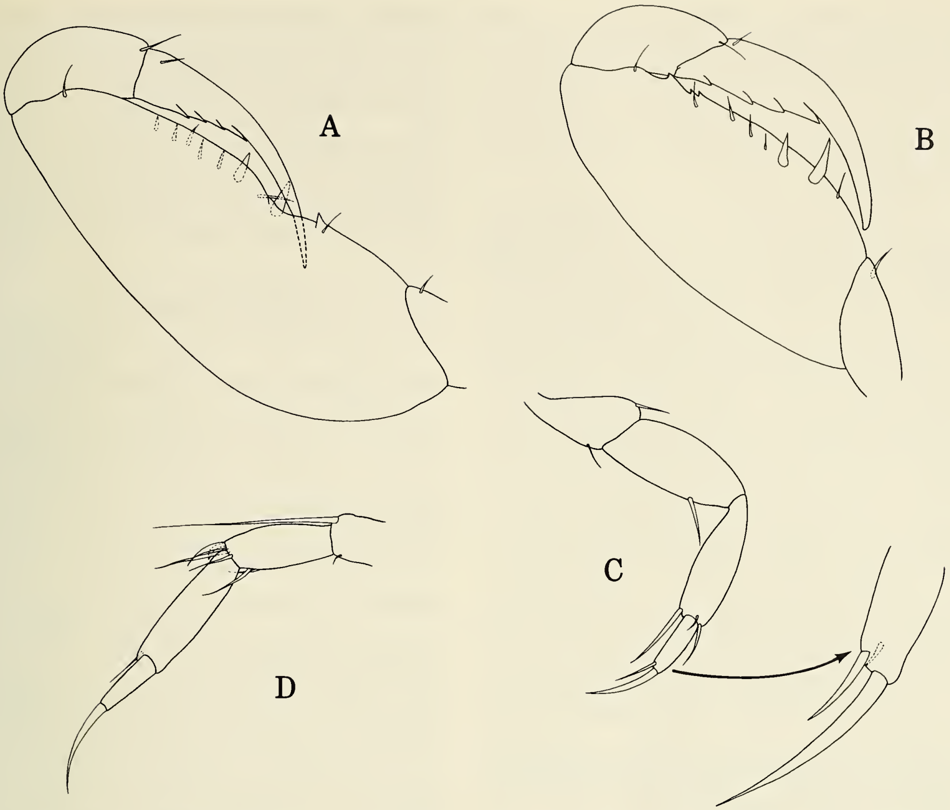

Fig. 6. *Ingolfiella atlantisi* Mills, holotype: A, Gnathopod 1; B, Gnathopod 2; C, Pereopod 4; D, Pereopod 7.

male features" (Stock 1979:95). The males are distinguished from their female counterparts by differences in gnathopod 2 and/or pleopod 1. The male gnathopod 2 has a large proximally-directed spine on the carpus in members currently recognized in the subgenus *Gevgeliella.* These males also have setae near the distal end of pleopod 1, unlike the unarmed pleopods of their females. Sexual dimorphism is expressed only in pleopod 1 in species of the subgenus *Trianguliella.* Apparently the gnathopod 2 of the male is similar to that of the female in this subgenus.

The other three subgenera *Balcanella, Ingolfiella,* and *Hansenliella* are considered plesiomorphic by Stock (1976:63) because "neither the gnathopods nor the pleopods show secondary sexual differences" (1976: 59). This statement may be questioned for two reasons: 1) Were both sexes truly present in examined material of other species reported as having no sexual dimorphism? 2) Is the absence of sexual dimorphism really plesiomorphic?

The subadult male of *I.* (*Ingolfiella*) *atlantisi* described by Mills (1967) is probably a subadult female and the sex of the single specimen of *I.* (*Ingolfiella*) *abyssi* Hansen, 1903, could not be determined (Hansen 1903:124). Similar available information is doubtful for all other *Ingolfiella* species currently belonging to the subgenera *Balcanella* and *Hansenliella* except *I.* (*Hansenliella*) *ruffoi* Siewing, 1958. Siewing (1958:99) stated that although the specimens of *I. ruffoi* had identically developed pleopods, both sexes, determined by examination of gonad cross-sections, were present. On the basis of this report, Stock (1976) concluded that sexual dimorphism is absent in the subgenus *Hanseniella.* However, the "males" of *I. ruffoi* examined by Siewing may have been subadults requiring one additional moult to become mature males with sexually dimorphic pleopods.

The genus *Ingolfiella* is the most apomorphic taxon within the entire suborder (Stock 1976, Ruffo 1985). *Metaingolfiella* Ruffo, 1969, *Trogloleleupia* Ruffo, 1974a, and *Stygobarnardia* Ruffo, 1985, possess numerous plesiomorphic characters (Ruffo 1969, 1970, 1985; Stock 1976). Sexual dimorphism has been reported for these three genera. In males of *Metaingolfiella mirabilis* Ruffo, 1969, the third pleopod is morphologically different from pleopods 1 and 2 (Ruffo 1969, 1970) while in *Trogloleleupia* and *Stygobarnardia* the first pair of pleopods are modified (Ruffo 1970, 1985). Since sexual dimorphism is present in all four genera it is reasonable to assume that sexual dimorphism, at least in the pleopods, was inherited from an immediate common ancestor and is most likely a plesiomorphic condition in the Ingolfiellidea.

Our interpretations support Ruffo (1985: 52) in questioning the classification of *Ingolfiella* at the subgeneric level. If *Ingolfiella fuscina* is included in the subgenus *Hansenliella,* to which its most closely related species reportedly belong, then the absence of sexual dimorphism can no longer be used as a diagnostic feature for the subgenus. The male of *I. fuscina* differs from the female by a stout carpus of gnathopod 2 with an indented palmar area, one seta on pleopod 1, and a pectinate spine on the peduncle of uropod 1.

The shape and armament of the appendages of ingolfiellids have been so inadequately described by most workers that meaningful comparisons within the group are at present difficult to make. Detailed redescriptions of the majority of species are needed before the validity of the five subgenera of the *Ingolfiella* and the evolutionary relationships proposed by Stock (1976) can be evaluated. Unfortunately some of the type species material (e.g. *I. acherontis, I. manni*) no longer exists or cannot be located. We suggest that the shape of the ungulus of the pereopods and morphological details of other appendages (e.g. gnathopods and mouthparts) may be useful as taxonomic characters in the future.

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DISCIAS VERNBERGI, NEW SPECIES, A CARIDEAN SHRIMP (CRUSTACEA: DECAPODA: BRESILIIDAE) FROM THE NORTHWESTERN ATLANTIC

Billy B. Boothe, Jr. and Richard W. Heard

Abstract.—*Discias vernbergi,* n. sp. is described from specimens collected in coastal waters off the southeastern United States. *Discias vernbergi* is most closely related to *D. serrifer* Rathbun, an eastern Pacific form. The uropods of both species are characterized by having the outer margin of the exopods armed with teeth; however, *D. vernbergi* can be distinguished by: (1) having fewer lateral teeth (4 to 6) on the uropodal exopod, (2) having at least two more pairs of terminal spines on the telson, and (3) by lacking a posterior middorsal process on abdominal somite 2. *Discias vernbergi* is the third species of the genus known to occur in the western Atlantic.

In his review of the family Bresiliidae, Kensley (1983) recognized six valid species of *Discias* Rathbun, 1902. The type species, *D. serrifer* Rathbun, 1902, was described from three adult females collected from the Galapagos Islands and later reported from the Juan Fernandez Islands (Balss 1922). Three other Pacific species are currently recognized: *D. exul* Kemp, 1920 (=*D. mvitae* Bruce, 1976) from the coasts of India, Kenya, South Africa, and Australia (Kemp 1920; Bruce 1970, 1976; Kensley 1981, 1983); *D. musicus* Holthuis, 1981, from the Marianas Islands; and *D. brownae* Kensley, 1983, from Australia. *Discias atlanticus* Gurney, 1939, was originally described from the western Atlantic (Bermuda), but has since been reported from East Africa (Holthuis 1951), the Red Sea (Williamson 1970) and West Africa (Bruce 1975), as well as several additional western Atlantic locations (Monod 1939, Gore and Wilson 1978, Gore 1981, Kensley 1983). *Discias serratirostris* Lebour, 1949, appears to be endemic to the northwestern Atlantic and is known from Bermuda, Florida, and Belize (Lebour 1949, Wilson and Gore 1979, Kensley 1983).

Specimens of an undescribed species of *Discias* collected during the Project Hourglass cruises off the West Coast of Florida, and MARMAP and R/V *Eastward* cruises off the coasts of Georgia and South Carolina were made available to us for study. The description of this new species is presented here.

Carapace length (CL) is measured from the postorbital angle to the posterior most part of the carapace.

Discias vernbergi, new species
Figs. 1–3

Discias sp.: Kensley 1983:3 (in key).

Material examined.—Holotype, 1 ovigerous ♀, CL 3.8 mm (USNM 221748), Hourglass sta D, 65 na mi W of Egmont Key, Florida, 27°37′N, 83°58′W, 55 m, R/V *Hernan Cortez,* 12 Sep 1967. Paratypes, FLORIDA: 1 ovigerous ♀, CL 2.7 mm and 1 ♂, CL 2.5 mm (USNM 221749), Hourglass sta M, 92 na mi W of Sanibel Island light, Florida, 26°24′N, 83°43′W, 73 m, R/V *Hernan Cortez,* 9 Mar 1967.—1 ♂ CL 2.3 mm (FSBC I 32280), Hourglass sta E, 78 na mi W of Egmont Key, 27°37′N, 84°13′W, 73.2 m, R/V *Hernan Cortez,* 2 Aug 1966.—2 ovigerous ♀♀, CL 3.0 mm and 3.1 mm (FSBC

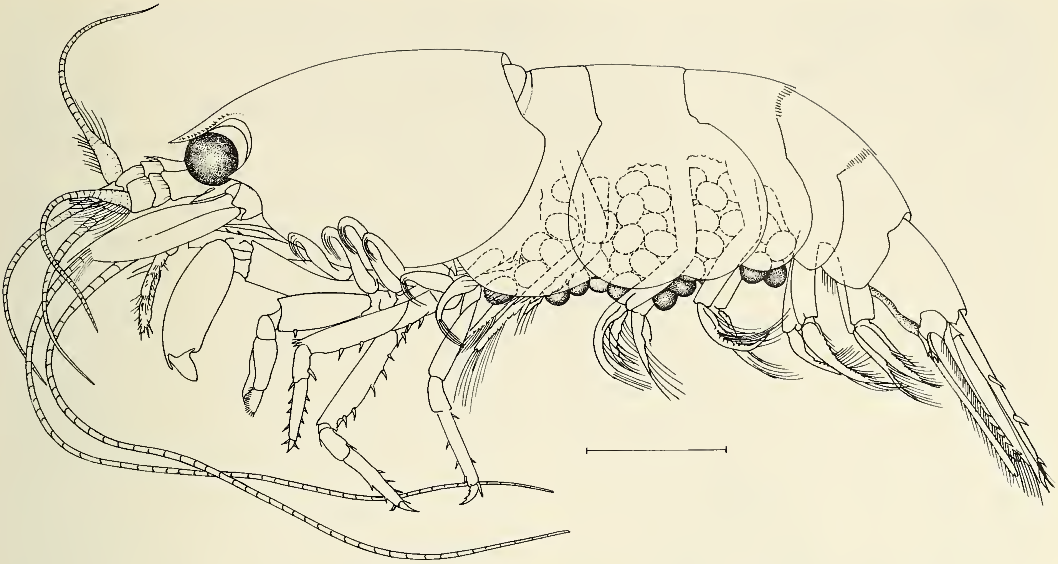

Fig. 1. *Discias vernbergi*: Lateral view of ovigerous female. Scale = 2.0 mm.

I 32281), Hourglass sta M, 92 na mi W of Sanibel Island light, 26°24′N, 83°43′W, 73.2 m, R/V *Hernan Cortez,* 6 Aug 1966.—2 ♂♂, 3 ♀♀, 1 ovigerous ♀, CL 2.5 mm, 2.3 mm, 2.3 mm, 2.0 mm, 1.7 mm and 3.0 mm, resp., (FSBC I 32282), Hourglass sta M, 92 na mi W of Sanibel Island light, 26°24′N, 83°43′W, 73 m, R/V *Hernan Cortez,* 5 Sep 1966.—1 ovigerous ♀, CL 3.6 mm (MESC 6179-10526) Hourglass sta M, 92 na mi W of Sanibel Island light, 26°24′N, 83°43′W, 73 m, R/V *Hernan Cortez,* 5 Sep 1966.—1 ♂, CL 3.5 mm (FSBC I 32283), Hourglass sta D, 65 na mi W of Egmont Key, 27°37′N, 83°58′W, 55 m, R/V *Hernan Cortez,* 12 Apr 1967.—1 ♂, CL 1.9 mm (FSBC I 32284), Hourglass sta E, 78 na mi W of Egmont Key, 27°37′N, 84°13′W, 73 m, R/V *Hernan Cortez,* 12 May 1967.—1 ovigerous ♀, CL 2.9 mm (GCRL I 86-1127), Hourglass sta M, 92 na mi W of Sanibel Island light, 26°24′N, 83°43′W, 73 m, R/V *Hernan Cortez,* 16 May 1967.—1 ♀, CL 1.7 mm (FSBC I 32285), Hourglass sta E, 78 na mi W of Egmont Key, 27°37′N, 84°13′W, 73 m, R/V *Hernan Cortez,* 6 Oct 1967.—1 ♂, CL 2.3 mm (FSBC I 32286), Hourglass sta M, 92 na mi W of Sanibel Island light, 26°24′N, 83°43′W, 73 m, R/V *Hernan Cortez,* 12 Oct 1967.—1 ♂, 1 ovigerous ♀, CL 3.2 mm and 4.1 mm, resp., (FSBC I 32287), Hourglass sta D, 65 na mi W of Egmont Key, 27°37′N, 83°58′W, 55 m, R/V *Hernan Cortez,* 21 Nov 1967. GEORGIA: 1 ovigerous ♀, CL 3.9 mm (USNM 221750), R/V *Eastward* sta E-33-M (70–71), 120 na mi E of Savannah, 32°06.8′N, 79°12.6′W, 74 m, coll. B. Boothe, 24 Mar 1971.—1 ♀, CL 3.1 mm (USNM 221751), R/V *Dolphin* sta 86 (0575273), 115 na mi E of Savannah, 32°01.5′N, 79°21.7′W, 66 m, coll. B. Boothe, 18 Sep 1975.

Specimens have been deposited in the collections of the National Museum of Natural History (USNM), Washington, D.C.; the Florida Department of Natural Resources (FSBC), St. Petersburg, Florida; the Marine Environmental Sciences Consortium (MESC), Dauphin Island, Alabama; and Gulf Coast Research Laboratory Museum (GCRL).

Diagnosis.—Rostrum narrow, acute, armed laterally with 20–30 fine teeth (serrations) on each side. Abdominal somite 2 lacking posterior, middorsal process. Mandibular palp biarticulate, with 5–13 setae on distal article. Exopod of uropod with 4–6 cuspidate teeth on distal half of lateral border. Telson with 6 pairs of terminal spines.

Description.—Carapace slightly less than ⅓ total length, smooth, without spines or teeth except for acute suborbital angle; anterior and posterior borders rounded. Rostrum short, ⅓ to ⅖ carapace length, dorsoventrally flattened, acute, increasing in width toward orbit; width at anterorbital angle ¾ length; with middorsal ridge not extending past posterior edge; shallow groove located on either side of ridge; lateral margin minutely serrate, with 18–30 spinules extending entire length to posterior part of orbit.

Eyes large, circular, amber colored in alcohol, reaching level of anterior part of rostrum.

Antennules short, flagella extending only ⅓ antennal length. Peduncle with proximal segment ⅔ peduncle length; stylocerite acute, elongate, slightly more than ⅔ length and ⅓ width of proximal segment. Upper flagellum arising from mid-segment of lateral surface of distal antennular segment; proximal segment tapering distally, thickened, composed of 6–8 fused articles, bearing 50+ twisted aesthetascs. Lower flagellum arising from distomedial edge of distal segment, slightly longer and more slender than upper; border with long setae.

Antennal flagellum long, 2–3 times length of carapace; basicerite with acute process on distal margin; scaphocerite (antennal scale) elongate, subrectangular, slightly broader at midlength than at distal end, with 40–50 long, plumose setae along mesial edge to distal end, lateral margin entire; carpocerite (fifth antennal segment) short, extending as far as distal ⅓ to ½ of scaphocerite.

Mandible deeply cleft, with incisor and molar processes and palp. Molar process longer than incisor, with numerous small teeth on both edges distally. Incisor curved, broader, with 4–6 prominent teeth on truncate distal end; lateralmost tooth smallest; anteriormost tooth of series on distal margin longest. Two-segmented palp arising lateral to base of incisor. Palp spatulate, equal in length to molar process; proximal segment slightly longer than distal; adults with 5–13 pinnate setae on “paddle-shaped” distal segment.

Maxilla 1 with broad, tapering palp and 2 lobed processes. Palp large, robust, width slightly less than ½ that of base of distal process, bearing 1–2 short, stiff, setae and 1 elongate seta. Distal process narrowly quadrate, 4 pinnate setae on lateral margin, 2 rows each with 20+ denticulate, spinelike setae on medial border; dorsal surface with 1 row of 30–40 fine, pinnate setae near medial border. Proximal process ⅓ to ½ size of distal process and more oval, with 10–20 pinnate setae on upper border and 30–40 denticulate/spinulose setae on medial edge.

Maxilla 2 somewhat rectangular, scaphognathite elongate, with basal and coxal endites, and long slender palp. Scaphognathite subrectangular, distal part 3 times as long as proximal part, with 60–80 marginal plumose setae. Basal endite bilobed, with distal lobe overlapping proximal lobe anteriorly; distal lobe oval to subtriangular, with 3–5 pinnate setae on upper, lateral margin, and two rows each of 20–30 pinnate/denticulate setae on medial border; proximal lobe subrectangular to triangular, ⅓ size of distal lobe, straight medial border bearing 2 rows each of 30–40 stiff denticulate/pectinate setae. Coxal endite rounded, overlapping proximal margin of basal endite, bearing 20–30 marginal, pinnate setae. Palp arising between bases of scaphognathite and distal part of basal endite, bearing 1 long simple seta.

First maxilliped robust, with large basal endite and well developed caridean lobe. Palp broad, arising between caridean lobe and basal endite, twisted, with 1–3 simple setae, extending slightly beyond distal part of basal endite. Caridean lobe elliptical, margin with 25–30 pinnate setae; lash elongate, arising from distomedial margin of caridean lobe just anterior to palp, with 2–

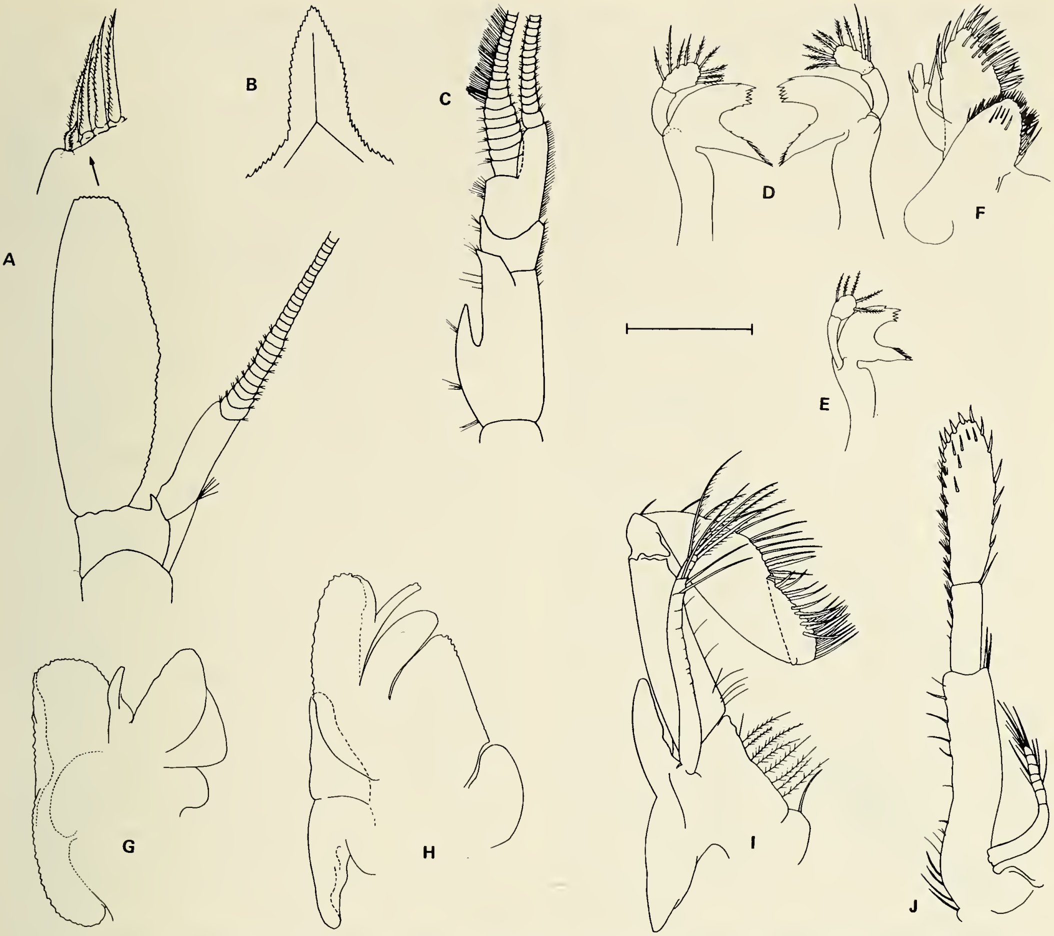

Fig. 2. *Discias vernbergi,* A–I, F–J, ovigerous female; E, male. A, Antennal peduncle with enlargement of distolateral corner of antennal scale; B, Rostrum, dorsal aspect; C, Antennular peduncle; D, Left and right mandibles; E, Right mandible; F, Maxilla 1; G, Maxilla 2; H, Maxilliped 1; I, Maxilliped 2; J, Maxilliped 3. Scale, A–C, J = 1.25 mm; D–I = 0.4 mm.

4 simple setae at apical tip, extending just beyond level of caridean lobe. Basal endite large, triangular, lateral margin with 2–3 rows each of 20–30 thick, denticulate setae; distal margin with few pinnate setae. Coxa with bilobed epipod and triangular coxal lobe. Coxal lobe small, overlapping proximal edge of basal endite, with few marginal setae. Epipod feebly elongate, located at proximal base of caridean lobe and only slightly longer than lobe.

Second maxilliped robust, with large, functional endopod, elongate exopod, and bilobed epipod. Endopod with small, triangular dactyl bearing 2 rows each with 15–20 long, stout, sharply denticulate setae on margin; propodus large, broadly triangular, with 15–20 pinnate setae on anteromedial border, 4–5 finer pinnate setae on lateral margin. Carpus small, quadrate, bearing 0–1 setae on distomedial margin; ischium and merus fused, equal in length to propodal segment, with 15–25 pinnate, plumose setae on lateral border; basal segment triangulo-quadrate, ⅓ length of ischiomeral segment, with 10–12 lateral pinnate setae. Exopod arising from distomedial border of basis, very slender, barely overreaching ischiomerus, bearing 3–5 long, plumose setae at tip. Coxa broad, with large epipod; small notch at lateral margin of coxal-basal junction. Epipod fused to entire medial edge of basis, equal in length to merus. Distomedial edge of coxa with 1–2 pinnate setae.

Third maxilliped strong, extending slightly beyond scaphocerite, with prominent exopod and twisted endopod. Basis subquadrate, with exopod and 10+ pinnate setae on medial border. Endopod 3-segmented. Terminal segment of endopod twisted, flattened, elliptical, wedge-shaped in cross-section, equal in length to antepenultimate segment and 3 times longer than broad, proximodorsal margin with 6–8 broad, stout spines, ventral margin with 5–6 longer pinnate setae; lateral aspect devoid of any setae or spines; medial surface bearing 7–8 groups of 4–6 stiff, denticulate setae per group. Penultimate segment of endopod narrow, subcylindrical, slightly bowed, devoid of any setae except 1–2 at extreme medial border; length 0.6 that of terminal segment. Antepenultimate segment twisted, bowed, with subparallel sides; medial border with 6–14 sparse, pinnate setae; 1–2 plumose setae at extreme distolateral apex. Exopod feebly elongate, with 16+ pinnate setae on distal part, reaching penultimate segment of endopod. Coxa subrhomboidal, with rigid flange on mesiolateral border and with 4–5 setae medially.

All pereopods with well-developed exopods. First pereopods twisted, bowed, extending almost to tip of scaphocerite; ischium and merus twisted, subequal, similar. Palm compressed, slightly bowed dorsally, swollen proximally, tapering toward distal end, about 3 times longer than width at proximal end; medial border with 2 rows of numerous denticulate setae, ventrally with row of stiff, denticulate setae. Dactyl compressed, suboval, slightly broader than long, with laminar cutting edge; inner aspect smoothly concave; 7–8 short, fine setae on lateral margin and 3–4 setae at distolateral edge; movable finger articulating in groove formed by bipartite processes of short fixed finger (when fully extended, cutting edge actually semicircular); fixed finger slightly upturned distally, with 1–2 short and 1 long setae on middle of outer border; ventral aspect of groove with laminar cutting edge (lacking in dorsal aspect); distal edge of fixed finger with 3–5 pinnate setae; distoventral portion of palm produced as flattened process extending beyond hinge of dactyl. Fused ischiomerus club-shaped, ¾ length of palm, with distal portion 1.5 times proximal width; medial border straight, proximal ¾ with 16–25 simple pinnate setae; extreme distolateral edge with 1–3 stiff setae; distal end, hollow, cup-shaped, accommodating proximal end of palm and carpus. Carpus small, compressed; dorsal and ventral borders each with 1–3 setae; carpus almost indiscernible, only seen in dorsal and medial view (being hidden in cup-shaped depression of proximal end of ischiomerus). Basis robust, triangular, with straight, setose ventral border, with strong exopod. Exopod with 15–20 setae distally. Coxa small but robust.

Second pereopods shorter than and not as stout as first. Palm 3–4 times longer than wide, 2.5 times length of dactyl, distally twisted, compressed, proximally subcylindrical, with numerous setae on lateral margin. Chela compressed, with very spinous teeth along cutting edges; longer and stiffer spinose teeth distally; movable finger with 14 spines; fixed finger with 11 spines and one elongate spine on medial border; hinge of fixed and movable fingers with long, sharp spine on dorsal aspect. Carpus suboval, short, stout; easily discernible and not compressed as in pereopod 1, lacking setae and spines. Ischiomerus fused, width ⅕ length, slightly longer than palm. Few short setae at ischiomeralcarpal joint; distodorsal extremity with proximal sharp spine. Basis stout, with strong exopod; 3–5 setae on ventral margin. Coxa with few ventral setae.

Third, fourth, and fifth pereopods similar, depressed; third longest, extending anteriorly to tip of chela of first; fifth shortest, weakest. Dactyl of each short, slender, tapering, ¼ length of propodus; inner margin

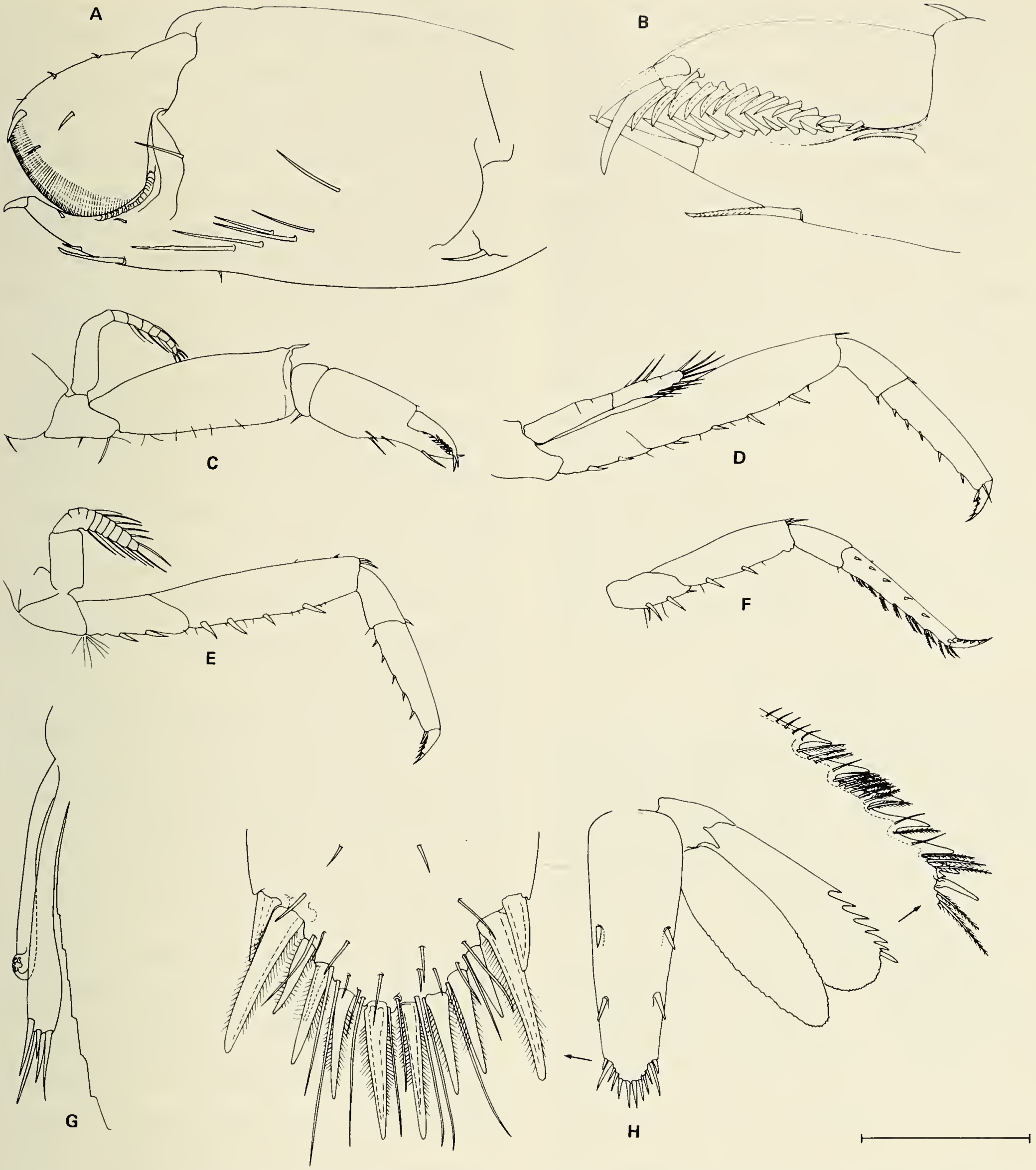

Fig. 3. *Discias vernbergi,* A–F, H, ovigerous female; G, male. A, Pereopod 1, dactyl and propodus; B, Pereopod 2, dactyl and fixed finger of propodus; C–F, Pereopods 2–5; G, Appendix masculina and appendix interna, pleopod 2; H, Telson and uropods. Scale, A = 0.6 mm; B, G = 0.3 mm; C–F, H = 1.25 mm.

denticulate, with 5–7 acute teeth; 1 long acute spine and numerous setae at propodal/dactylar joint. Dactyl of pereopod 5 rotated 180° anteriorly. Propodus moderately twisted, triangular in cross-section, twice length of carpus; ventral border with 4–6 strong spines and medial row of 4–8 groups of 1–4 denticulate setae each. Carpus subrectangular; 1–2 acute spines on distolateral portion. Merus slightly longer than length of carpus plus propodus; 4–7 spines on ventral border and smaller lateral spine at distal margin. Ischium almost equal in length to carpus; 2–3 stout spines on lateral edge; 3 setae at joint of ischium and coxa. Coxa with 2 setae at coxal/basal joint. Exopod flattened; with 20+ setae at distal third and extending to ¾ length of merus.

Pleopod 1 of male with basipodite slightly shorter than exopod; exopod tapering distally, with many plumose setae along distal margins; endopod elongate, ⅓ to ¼ length of exopod, lateral surface bearing 2–4 spines, distal margin with 5–9 long setae. Pleopod 2 of male with exopod slightly longer than basipodite, tapering distally, with numerous plumose setae; appendix masculina ½ length of exopod, with 5–7 distal plumose setae; appendix interna ⅞ length of appendix masculina, narrowly elongate, with 6–9 terminal hooks.

Abdominal pleura and tergites smooth, with numerous setae on ventral border. Abdominal segments (1–6) lacking middorsal spine on posterior margin. First 4 somites with anterior and posterior parts smoothly curved. Somite 5 with blunt, angular, posteroventral margin; ⅔ length of 6; latter ½ to ⅔ length of telson.

Telson subrectangular with 2 pairs of stiff, dorsal, submarginal spines; anterior pair located ⅓ length of telson; posterior pair located at ⅔ telson length. Posterior margin of telson with 6 pairs of terminal spines; second and innermost pairs longest; finer setae between each spine.

Uropods subelliptical; rami almost equal in length, slightly shorter than telson; acute, spinose process on distolateral margin of basis; another on distodorsal surface at same level as lateral margin of basis. Outer uropodal ramus (exopod) with 4–6 cuspidate, smoothly acute, immovable teeth on distal half of lateral margin; small, movable spine at extreme distolateral edge; fine pinnate setae dorsal to and in between teeth. Numerous plumose setae on lateral, medial, and terminal margins of exopods and endopods.

Variation.—Based on the specimens we examined during this study, the number of setae on the mandibular palp may vary with size and sex. Small specimens (less than 2.0 mm CL) of both sexes have a tear-drop shaped palp with 0–4 setae. Adult male specimens have a spatulate palp with 5–7 setae (one of the seven specimens examined had 10 setae). Ten of the 12 adult female specimens have spatulate palps with 8–13 setae, and the palps of the remaining two specimens have six setae.

The setal number also may vary depending on which side (right or left) the palp is located. Of six specimens in which both left and right palps were examined, three had different numbers of setae, with more setae found on the left palp than on the right.

Dentition on the uropodal exopods was also found to vary according to size. Smaller individuals (less than 2.0 mm CL) of both sexes have exopods with 2–3 immovable teeth, while adults of both sexes bear 4–6 teeth. Rarely does one side have a different number of teeth than the other.

Known distribution.—East coast (Georgia) and Gulf coast (west Florida) of the southeastern United States in depths of 54 to 74 meters.

Etymology.—This species is named for F. John Vernberg of the Belle W. Baruch Coastal Research Institute, University of South Carolina, in recognition of his many contributions to marine zoology.

Size and sexual maturity.—Of the 22 specimens examined, eight were males and 14 were females. Nine of the 14 females were ovigerous, with 20–50 large, oval eggs per specimen. Adult females had a size range of 2.7–4.1 mm carapace length and 10.8–15.3 mm total length; adult males, 2.3–3.5 mm carapace length and 10.1–11.4 mm total length. Immature females were those with 1.7–2.3 mm carapace length and 8.0–10.1 mm total length; the one immature male had a carapace length of 1.9 mm and a total length of 8.7 mm.

Remarks

Discias vernbergi can be distinguished from the other six species of the genus by the following combination of characters: (1) the lanceolate shape of the serrate rostrum; (2) spatulate form and number of setae on the biarticulate mandibular palp; (3) the presence, number, and position of lateral teeth on the exopod of the uropod; (4) the greater number of terminal spines on the telson, and (5) the absence of posterior middorsal process on abdominal somite 2. *Discias vernbergi* appears to be most closely related to the type species, *D. serrifer.* Both species have lateral teeth on the exopod of the uropods, a character that immediately distinguishes them from the other described species of the genus. *Discias vernbergi* differs from *D. serrifer* by: (1) lacking a posterior, middorsal process on abdominal somite 2, (2) having fewer lateral teeth on the uropodal exopods, and (3) having more terminal spines on the telson. In *D. vernbergi* there are 4–6 lateral teeth which are confined to the distal half of the exopods (Fig. 3H), whereas, in *D. serrifer* there are 8–11 lateral teeth which occur along ¾ to ⅘ the length of the exopod. There are six pairs of terminal spines on the telson of *D. vernbergi* (Fig. 3H), at least two pairs more than any of the other described species, including *D. serrifer.*

In his key to the species of *Discias,* Kensley (1983) indicated that the antennal scale of *D. vernbergi* (=*Discias* sp.) was armed with a distolateral tooth, but we were unable to recognize this structure. The subacute distolateral corner of the antennal scale could be interpreted as a vestigal tooth (see Fig. 2A), but we do not consider it as such. *Discias atlanticus* is the only species of the genus having a distolateral tooth on the antennal scale, and in this species the spine is minute and poorly developed.

Two other species, *D. atlanticus* and *D. serratirostris,* have been previously reported from North American continental waters. *Discias atlanticus* apparently has a wide tropical-subtropical distribution and has been reported from the northern and eastern Atlantic, Red Sea, western Pacific (see Kensley 1983). At present, *Discias serratirostris* and *D. vernbergi* are known only from the northwestern Atlantic region. *Discias serrifer,* which has been collected only from the Galapagos and Juan Fernandez islands (Rathbun 1902, Balss 1922) is the only species reported from the eastern Pacific. There are no records of the genus from the southwestern Atlantic. The lack of records for species of *Discias* in the southwestern Atlantic and large areas of the Pacific is probably due more to inadequate sampling in these regions than to the actual distribution pattern of the genus.

Discias vernbergi occurs at greater depths than the other described species of the genus. Off Georgia and west Florida it was taken in depths exceeding 70 m. In the eastern Gulf of Mexico, *Discias atlanticus* and *D. serrifer* are both known from depths as great as 55 m (Kensley 1983). The remaining species of the genus have been reported from depths of 33 m or less. However, these records, like the distribution data, may be an artifact of sampling.

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NOTES ON *VARICHAETADRILUS* BRINKHURST AND KATHMAN, 1983 (OLIGOCHAETA: TUBIFICIDAE)

Ralph O. Brinkhurst

Abstract.—*Varichaetadrilus nevadanus* (Brinkhurst, 1965) is regarded as a synonym of *V. minutus* (Brinkhurst 1965), and an earlier record of *V. minutus* from Alberta, Canada is recognized as pertaining to *V. pacificus* (Brinkhurst, 1986).

During the construction of a key to North American freshwater aquatic oligochaetes (Brinkhurst 1986) it was recognized that *Isochaetides nevadanus* (Brinkhurst, 1965) and *Psammoryctides* (?) *minutus* Brinkhurst, 1965, were congeneric with *Varichaetadrilus* Brinkhurst and Kathman, 1983. When an opportunity to acquire fresh material from the type locality common to both species (Lake Tahoe, Nevada/California) arose, the type material of both species was subsequently reexamined along with specimens from Alberta, Canada, originally identified as *V. minutus.*

Material examined.—*Varichaetadrilus nevadanus*: Holotype USNM 32642, 6 paratypes of which 3 immature 32643; 6 paratypes on 3 slides, 2 immature, AMNH 3670; 6 paratypes, 3 immature BMNH 1964.15.10; 5 paratypes all immature, Brinkhurst collection, all Lake Tahoe.—*V. minutus*: Holotype USNM 32639, 6 paratypes 3 immature, 32640; 6 paratypes 3 immature AMNH 3669; 4 paratypes immature BMNH 1964.15.16–19; 7 paratypes, 3 immature Brinkhurst collection, all Lake Tahoe.—*V. pacificus*: 5 paratypes Mowich Lake, Mount Rainier, Washington, 5 specimens Toolik Lake, Alaska, 4 specimens, 1 immature, Sturgeon Lake, Alberta, formerly identified as *V. minutus.* Other material: 1 mature and 14 immature specimens, Pope Beach, littoral, Lake Tahoe, coll. R. O. Schuster and E. C. Toftner, 31 Aug 1976.

Comparison of *V. minutus* and *V. nevadanus*
Fig. 1

When *V. minutus* and *V. nevadanus* were first described, slightly modified penial chaetae of a type unknown to the Tubificinae were noticed on mature specimens of *V. minutus.* A careful search for genital chaetae had followed a tentative identification of this species as a possible member of the genus *Psammoryctides* based on observation of fragments of the male ducts including the penes. Most species in that genus possess typical tubificine spermathecal chaetae. *Varichaetadrilus minutus* has penial chaetae that are wider than the normal ventrals, with foreshortened distal ends but they are otherwise recognizable as bifid chaetae. These penials are now known to be characteristic of *Varichaetadrilus* species. The second species, *V. nevadanus,* was originally placed in *Isochaeta,* but both generic assignments were clearly stated to be tentative (Brinkhurst 1965). No genital chaetae were reported for *V. nevadanus.*

The first observation made here is that penial chaetae are present on the holotype and all other specimens of *V. nevadanus.* Careful comparison of the number and variations of chaetal shape for all the somatic chaetae suggest that these two sympatric congeners are in fact synonymous. The variations in chaetal number and form that were

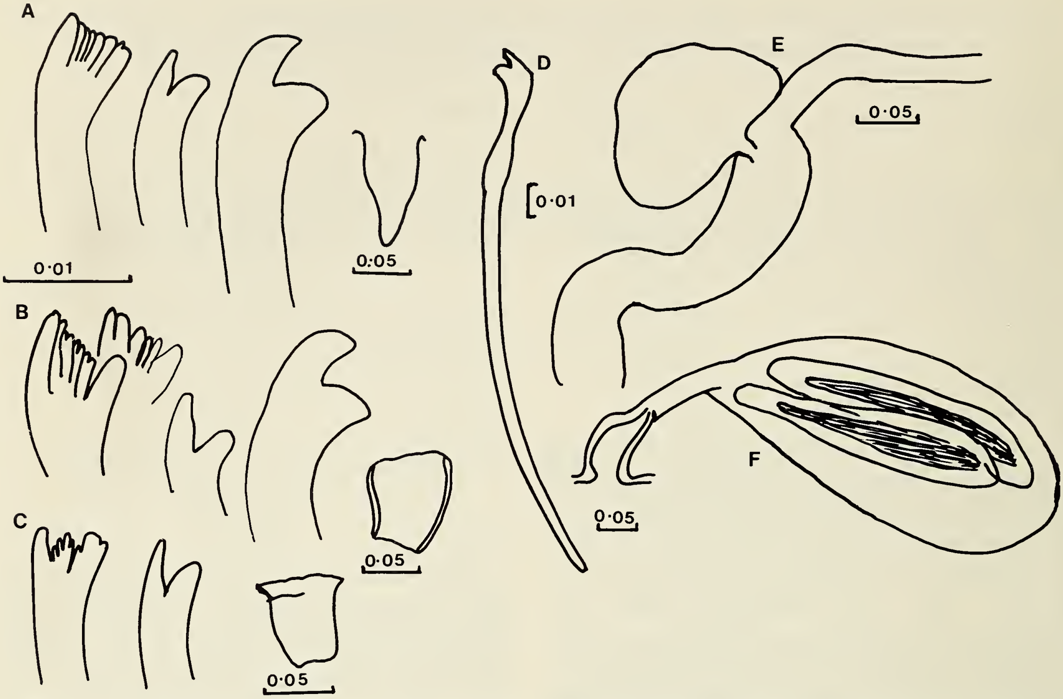

Fig. 1. *Varichaetadrilus* spp.: A, *V. minutus,* from *nevadanus* type series, left to right, pectinate, anterior ventral, and penial chaetae, penis sheath; B, Same, from *minutus* type series; C, *V. pacificus,* Alberta material, pectinate and anterior ventral chaetae, penis sheath; D–F, *V. minutus* type series: D, Penial chaetae; E, Prostate-atrium-vas deferens union; F, Spermatheca with spermatozeugmata.

supposed to separate these two species turn out to have been based on the inclusion of immature specimens in both type series. All mature specimens possess mostly 3–4 hairs and 3–4 pectinates (up to 5 of each in a few bundles) in anterior dorsal bundles but only 1–2 hairs and 1–3 bifids posteriorly. The ventral bundles contain up to 6, rarely 7, chaetae per bundle with only 2–3 posteriorly. These chaetae have upper teeth that are thinner than but not much longer than the lower when viewed laterally. Earlier illustrations by the author and by Loden (1978) suggest that the upper teeth of the ventral chaetae in *V. minutus* are considerably longer than the lower, but this cannot be confirmed from mature specimens. Both sets of types have 3–5 penial chaetae in each ventral bundle of XI, each chaeta being about 1.5 times the breadth of the normal ventrals, with short distal and long proximal ends, the teeth being somewhat inflated in contrast to normal ventrals. The large penes bear small cuticular sheaths at the distal ends. Now that the genus *Varichaetadrilus* has been established, the parts of the male ducts dissected out of the types of this material can be clearly recognized. The holotype of *V. nevadanus* has quite recognizable atria, one of the USNM paratypes has a good penis sheath, and those from the BMNH have traces of recognizable male ducts and clear penes. One of the mature specimens (labelled #3) has no penial chaetae and the fragments of male duct seem atypical. The specimen, as well as several of the immatures, may well not be conspecific and this is now indicated on the labels. Among the paratypes of *V. minutus* one specimen (#2) has good visible spermathecae, and the parts of the male duct showing the characteristic vas deferens/atrium/prostate junction are clearly visible. All of the mature specimens have penial chaetae, as do all bar the single *V. nevadanus.*

The large volume of new material from very shallow water at Popes Beach, Lake Tahoe, provided only a single mature specimen. This has short, almost cube-shaped cuticular penis sheaths and the usual penial chaetae. The dorsal chaetal bundles contain 2–4 hairs and 2–4 pectinates with thin, fairly long lateral teeth anteriorly and 1 hair and 1–2 bifids posteriorly. There are 5 ventrals in each anterior bundle, diminishing to 2 posteriorly.

Varichaetadrilus pacificus
(Brinkhurst, 1981)

Examination of the material of this species revealed that there may be as many as 7 penial chaetae in a bundle, not just 3–4 as originally described. The maximum number of somatic ventrals is increased from 6 to 7. None of the available specimens had the maximum number of hair and pectinate chaetae reported for this species (4–7 instead of up to 10). Penes with conical cuticular penis sheaths were observed in several, and in a specimen from the type locality the spermathecae were observed to have a small vestibule or swelling of the duct close to the external pore.

Discussion

All three of these species were described from very small sets of material and their status cannot be considered to be completely resolved. Both the Lake Tahoe material and the Toolik Lake collections were submitted for identification by biologists involved in ecological studies of particularly interesting sites. The Lake Tahoe set contained several species that were unknown, raising the possibility of a center of endemicity in the lake or at least in the Great Basin, and tubificids are unusual as far north as Toolik Lake in Alaska. The material available now clearly suggests that there is a single species limited to Lake Tahoe so far as we know, and as both of the names and descriptions now thought to be synonymous were published at the same time, the name *V. minutus* is retained with *V. nevadanus* as its synonym because the former appeared on an earlier page in the publication than the latter. The second species, *V. pacificus,* will be retained for the moment, with its distribution including the record from Alberta as well as those from Alaska, Oregon, and Washington. While this is based on the anatomical evidence, the distribution pattern is also sensible.

Acknowledgments

I am indebted to Dr. Bob Schuster for access to his Lake Tahoe material and to the curators of the museum collections for access to type material.

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TWO NEW SPECIES OF PARROTS (AVES: PSITTACIDAE) FROM ARCHEOLOGICAL SITES IN THE MARQUESAS ISLANDS

David W. Steadman and Marie C. Zarriello

Abstract.—Two new species of extinct parrots, *Vini sinotoi* and *V. vidivici,* are described from bones collected in Polynesian archeological sites in the Marquesas Islands. *Vini sinotoi,* the largest species in the genus, is described from 100 bones of various skeletal elements from Ua Huka, with referred material from the islands of Hiva Oa and Tahuata. *Vini vidivici* is described from two bones from Hiva Oa, with referred material from Ua Huka and Tahuata. Among congeners, *V. vidivici* is exceeded in size only by *V. sinotoi.* Bones of *Vini ultramarina,* a small species known historically only from the Marquesan islands of Ua Pou and Nuku Hiva, are reported from sites on Ua Huka and Tahuata. These species of *Vini* probably lived sympatrically on each of the Marquesas islands until after the arrival of humans about 2000 years ago. The natural distribution and diversity of parrots in Polynesia can be learned only through studies of bones from archeological or paleontological sites. Based upon osteology and plumage, the monotypic genus *Phigys* of Fiji should be merged with *Vini,* a genus that is distinct osteologically from other Polynesian parrots.

During a visit to the Bernice P. Bishop Museum in 1985, Yosihiko Sinoto and Toni Han showed the senior author a large number of unstudied bird bones from the Hane Archeological Site, Ua Huka, Marquesas, which had resided at BPBM for twenty years. Preliminary sorting of this material yielded about 8000 bird bones. In 1986, the authors visited the BPBM, completing the task of sorting the bird bones from Hane as well as from many other archeological sites in Polynesia. Among the 15,000 to 20,000 bird bones now in hand from the Hane Site are about 200 parrot bones. These are of great interest because no parrots are known historically from Ua Huka. The prehistoric avifaunas of eastern Polynesia are composed mainly of species that did not survive into historic times. For example, the parrot bones from Hane represent three species, two of which are extinct and one of which survives only on the island of Ua Pou, Marquesas.

Materials and Methods

Museum acronyms are as follows: AMNH = American Museum of Natural History; BPBM = Bernice Pauahi Bishop Museum; UCMVZ = Museum of Vertebrate Zoology, University of California, Berkeley; USNM = National Museum of Natural History, Smithsonian Institution. When feasible, osteological nomenclature follows Baumel et al. (1979). Measurements were taken with dial calipers with 0.05 mm increments, rounded to the nearest 0.1 mm.

To determine generic relationships, we examined the tarsometatarsus and tibiotarsus in one or more skeletons of each of the following genera of mainly Indo-Australian parrots (nomenclature and sequence generally follow Peters 1937): *Nestor, Chalcopsitta, Eos, Trichoglossus, Pseudeos, Domicella, Lorius, Phigys, Vini, Glossopsitta, Charmosyna, Probosciger, Calyptorhynchus, Callocephalon, Cacatua, Eolophus, Nymphicus, Psittrichas, Eclectus, Geoffroyus, Prioniturus, Tanygnathus, Psittacula, Polytelis, Aprosmictus, Alisterus, Prosopeia, Psittinus, Loriculus, Platycercus, Purpureicephalus, Barnardius, Psephotus, Neophema, Cyanoramphus,* and *Melopsittacus.* Measurements and other detailed comparisons were made on these skeletal specimens: *Vini* ("*Phigys*") *solitarius* UCMVZ 159203, USNM 277040, 277322; *V. ultramarina* USNM 76912; *V. peruviana* USNM 558033; *V. kuhlii* USNM 15432, 498417; *V. australis* AMNH 1278, 8009, USNM 319739, 319746; *Charmosyna placentis* USNM 558317; *Prosopeia tabuensis* USNM 291211, AMNH 2540; *Cyanoramphus novaezelandiae* USNM 344438, AMNH 9235.

The systematic descriptions in this paper are based mainly upon the tibiotarsus and tarsometatarsus, which are the most diagnostic post-cranial bones in Old World parrots. Among the avian fossils from the Hane Site, we have sorted out the tibiotarsi, tarsometatarsi, and most other skeletal elements of parrots. A more comprehensive account awaits the detailed sorting of the more numerous and varied bones of putative columbids (pigeons and doves), some of which closely resemble the bones of parrots.

Systematic Paleontology
Class Aves
Order Psittaciformes
Family Psittacidae
Subfamily Loriinae
Genus *Vini* Lesson, 1831

In these fossils, the tarsometatarsus agrees with that in *Vini* and differs from that in all other genera listed above, in possessing the following combination of characters that are considered relative to the size of the bone: shaft broad, though not extremely so, particularly in the proximal portion; hypotarsus very deep, with a single, large canal (in other genera, this canal may be incompletely closed, or may be separated into much smaller individual canals); foramen vasculare proximale large; inner trochlea large, joining the shaft nearly perpendicularly; middle trochlea broad although short; medial lobe of outer trochlea originates well distally from foramen vasculare distale, and protrudes well dorsally from the shaft.

The other genera of parrots that occur in Polynesia besides *Vini* are *Prosopeia* and *Cyanoramphus.* These genera were compared with the fossils in skeletal elements other than the tarsometatarsus. The fossils agree with modern species of *Vini* and differ from *Prosopeia tabuensis* as follows: rostrum—narrow medial bar of os nasale, sharp dorso-medial ridge of os premaxillare, narrow distal half of os premaxillare; mandible—shallow mandibular ramus, pointed pars symphysialis; femur—small facies articularis acetabularis, slender shaft; tibiotarsus—shallow shaft, although much expanded laterally in distal portion, outer condyle short and shallow; tarsometatarsus—proximal end deep with large, single hypotarsal canal expanded dorso-ventrally, shaft broad, especially in proximal portion, ventral surface of shaft concave, medial lobe of outer trochlea expanded dorso-ventrally, ventral side of medial trochlea broadly excavated in distal aspect.

The fossils agree with modern species of *Vini* and differ from *Cyanoramphus novaezelandiae* as follows: rostrum—large nares, sharp dorso-medial ridge of os premaxillare, narrow distal half of os premaxillare; mandible—shallow mandibular ramus, different overall shape and size of articular region, different placement of foramen in surangular region, pointed pars symphysialis; femur—small facies articularis acetabularis, small crista trochanteris; tibiotarsus—narrow and shallow shaft, although much expanded medio-laterally near distal end, both


A
B
C
D
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condyles short and shallow; tarsometatarsus—proximal end deep with hypotarsal canal complete, shaft broad, ventral surface of shaft concave, foramina vascularia proximalia large, inner trochlea large, medial trochlea broad, lateral lobe of outer trochlea long.

Vini sinotoi, new species

Figs. 1, 2

Holotype.—Complete tarsometatarsus, BPBM 162590, Area A, Square R108, Layer IV, Hane Site (MUH-1), Ua Huka, Marquesas Islands; Y. H. Sinoto and associates, Jul 1964.

Topotypical paratyes.—Hane Site, Ua Huka (Area A, various squares, Layers II–V, with most specimens from Layer IV; Area B, various squares, Layers V, VI). Collected by Y. H. Sinoto and associates in 1964 and 1965. 6 coracoids, BPBM 162744, 163298, 165512, 165533, 165534, 165566. 1 scapula, BPBM 165535. 5 humeri, BPBM 162990, 163288, 163300, 165510, 165588. 33 tibiotarsi, BPBM 162592, 162593, 162745–162749, 162992, 162993, 163232, 163233, 163289, 165502, 165513–165518, 165536, 165548, 165550, 165551, 165553, 165567, 165568, 165576, 165577, 165591, 165606, 165619, 165620, 165622, 165626. 49 tarsometatarsi, BPBM 162591, 162750–162755, 162994, 162995, 163042, 163043, 163151, 163285–163287, 165503, 165519–165523, 165537–165539, 165549, 165554–165558, 165563, 165564, 165569–165573, 165578–165581, 165583, 165610, 165611, 165621, 165628, 165631–165634, 165641, 165642. 1 pedal phalanx, BPBM 163290. Tentatively referred material: rostrum, BPBM 165531. 2 quadrates, BPBM 162742, 165597. 4 mandibles, BPBM 162743, 165562, 165584, 165638. 3 sterna, BPBM 162991, 165532, 165547.

Other paratyes.—Hanatekua Shelter No. 2 Site (MH-11; also known as MH-3-12), Hiva Oa, Marquesas Islands; P. Bellwood, Dec 1967: 1 coracoid, BPBM 165645, Excavation F3, 100–120 cm depth, Layer 10b (pre-occupational Layer). 1 tibiotarsus, BPBM 166067, Excavation E2-F2, 100–150 cm depth, Layer 10b (pre-occupational Layer).

Hanamiai Site, Tahuata, Marquesas; B. Rolett, 1985: 1 rostrum, BPBM 166062, Square N11, Layer H32 (depth 245–250 cm). 1 carpometacarpus, BPBM 166065, Square M12, Layer H22a (depth 235–240 cm).

Diagnosis.—Larger than other species of *Vini* in all elements (Tables 1, 2). Hypotarsus relatively deeper than in others. Distal lobe of outer trochlea of tarsometatarsus protrudes dorsally from shaft relatively less than in *V. kuhlii, V. australis,* or *V. peruviana.* Area between the middle and outer trochleae less deeply excavated than in *V. kuhlii* or *V. ultramarina.* Lateral expansion of distal end of tibiotarsus begins more proximally to the tuberculum of the medial side of the shaft, just proximal to the pons supratendineus, than in *V. vidivici, V. solitarius, V. kuhlii,* or *V. peruviana,* wherein this expansion begins at the tuberculum.

Etymology.—Named for Dr. Yosihiko H. Sinoto, in recognition of his many accomplishments in the archeology of eastern Polynesia, particularly in the Marquesas Islands. The faunal material excavated by Dr.

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Fig. 1. The tarsometatarsus of selected Pacific parrots, in dorsal aspect: A, *Vini sinotoi* new species, holotype, BPBM 162590; *B, *V. sinotoi* new species, paratype, BPBM 163043 (outer trochlea damaged); *C, *Vini vidivici* new species, holotype, BPBM 165647; D, *V. solitarius* male, USNM 277040; E, *V. solitarius,* female, USNM 277322; F, *V. kuhlii,* female, USNM 498417; G, *V. ultramarina,* no sex, USNM 76912; H, *V. ultramarina,* no sex, BPBM 162588; I, *V. australis,* male, AMNH 8009; J, *V. peruviana,* male, USNM 558033; K, *Prosopeia tabuensis,* female, AMNH 2540; L, *Cyanoramphus novaeselandiae,* male, AMNH 9235; (* = mirror image of actual specimen. Scale bar = 1 cm).

Fig. 2. The tarsometatarsus of selected parrots, in ventral aspect. Same specimens and sequence as in Fig. 1. Scale bar = 1 cm.

Sinoto provides crucial evidence for understanding past relationships between animals and people on islands.

Vini vidivici, new species
Figs. 1, 2

Holotype.—Complete tarsometatarsus, BPBM 165647, Excavation E2-F2, 100–140 cm depth, Layer 10b (pre-occupational Layer), Hanatekua Shelter No. 2 Site (MH-11; also known as MH-3-12), Hiva Oa, Marquesas Islands; P. Bellwood, 19 Dec 1967.

Topotypical paratype.—1 tibiotarsus, BPBM 165646, same locality as Holotype.

Other paratypes.—Hane Site, Ua Huka, Marquesas Islands (Area A, various squares, Layers III–V; Area B, various squares, Layers V, VI); Y. H. Sinoto and associates, 1964–1965: 9 coracoids, BPBM 162986–162989, 163231, 165508, 165560, 165574, 165575. 3 humeri, BPBM 165561, 165582, 165587. 1 carpometacarpus, BPBM 162944. 7 tarsometatarsi, BPBM 162763, 162985, 165501, 165543, 165565, 165636, 165637. 2 tentatively referred mandibles, BPBM 165624, 165625.

Hanamiai Site, Tahuata, Marquesas Islands; B. Rolett, 1985: 1 coracoid, BPBM 166064, Square M11, Layer H27 (depth 232–242 cm). 2 tarsometatarsi, BPBM 166059, Square K9, Layer G/H 15 (depth 230–240 cm), BPBM 166061, Square M11, Layer H27 (depth 232–242 cm).

Diagnosis.—Larger than in any species of *Vini* except *V. sinotoi* (Tables 1, 2). Distal lobe of outer trochlea of tarsometatarsus protrudes dorsally from the shaft relatively less than in all except *V. sinotoi.* Lateral expansion of distal end of tibiotarsus begins at the tuberculum on the medial side of the shaft, just proximal to the pons supratendineus (begins more proximally in *V. sinotoi* and *V. australis*).

Etymology.—A *jeu de mots* rooted in the Latin declaration "Veni, vidi, vici," Julius Caesar's announcement to the senate of his victory at Zela over Pharnaces, King of Pontus, in 47 B.C. (Evans 1968:722). The meaning, "I came, I saw, I conquered," may be projected into the prehistoric situation in the Marquesas and elsewhere in Polynesia, where people came to an island, saw the native parrots, and then conquered them, leaving behind only the bones.

From the Hanamiai Site are a pedal phalanx (BPBM 166060, square J11, Layer G/H15, depth 230–240 cm) and an ungual phalanx (BPBM 166066, square M11, Layer H30, depth 250–255 cm) that pertain either to *V. vidivici* or to *V. sinotoi.* Other than being much larger than in *V. ultramarina,* these specimens have no diagnostic characters.

Vini ultramarina (Kuhl, 1820)
Figs. 1, 2

Referred material.—Hane Site, Ua Huka, Marquesas Islands, (Area A, various squares, Layers III–V; Area B, various squares, Layers V, VI); Y. H. Sinoto and associates, 1964–1965: 1 scapula, BPBM 165598. 4 coracoids, BPBM 162977, 163291, 165524, 165525. 9 humeri, BPBM 163292, 165540, 165585, 165593, 165594, 165599–165601, 165618. 2 carpometacarpi, BPBM 165526, 165592. 6 femora, BPBM 162766–162768, 163041, 165527, 165544. 17 tibiotarsi, BPBM 162759, 162760, 162978–162981, 165506, 165589, 165602–165605, 165607, 165608, 165623, 165627, 165640. 26 tarsometatarsi, BPBM 162761, 162762, 162764, 162765, 162982–162984, 163293, 165504, 165505, 165541, 165542, 165559, 165590, 165596, 165612–165617, 165629, 165630, 165635, 165643, 165644.

Hanamiai Site, Tahuata, Marquesas Islands; B. Rolett, 1985: 1 mandible, BPBM 166057, Square I10, Layer D6 (depth 150–160 cm). 1 sternum, BPBM 166063, Square L11, Layer I37 (depth 260–265 cm). 1 humerus, BPBM 166058, Square I10, Layer F9 (depth 180–190 cm).

Table 1.—Measurements of the tarsometatarsus of selected parrots (in mm), with mean, range, and sample size. Standard deviation is provided for samples of 10 or more. DE = Distal End; FVD = Foramen Vasculare Distale; FVP = Foramen Vasculare Proximale. F = female. M = male. U = sex unknown.

	Total length	Length: FVP to DE	Length: FVP to FVD	Proximal width	Least width of shaft	Least depth of shaft	Distal width
Vini sinotoi	22.8+ ± 0.8	18.7+ ± 0.7	14.6 ± 0.7	6.8+	3.5 ± 0.1	2.1 ± 0.1	9.5+
Hane Site, Ua Huka	21.6–24.0+	17.7–20.1	13.2–15.9	6.5–7.5+	3.2–3.8	1.8–2.3	9.2–9.6+
	10	12	24	4	34	35	3
Vini vidivici	18.3	15.0	11.5	5.5	2.6	1.6	7.4
Hanatekua Shelter No. 2 Site, Hiva Oa	1	1	1	1	1	1	1
Vini vidivici	—	16.9	13.4	6.6	3.0	2.0	—
Hanamiai Site, Tahuata		1	13.0–13.8	1	2.9–3.0	2.0	
			2		2	2	
Vini vidivici	17.0	13.5	10.7	5.0+	2.5	1.5	—
Hane Site, Ua Huka	1	1	10.2–11.2	1	2.4–2.6	1.4–1.6	
			3		6	6	
Vini solitarius	15.3	12.4	9.8	4.6	2.0	1.4	6.2
Modern specimens	15.2–15.4	12.4–12.5	9.8	4.5–4.6	2.0–2.1	1.4–1.5	6.1–6.2
Viti Levu, Fiji (M)	2	2	2	2	2	2	2
Taveuni, Fiji (F)							
Vini kuhlii	16.0	13.4	10.6	4.4	2.0	1.2	6.0
Modern specimens	15.9–16.1	13.3–13.6	10.4–10.9	4.3–4.5	1.9–2.1	1.2	6.0–6.1
Washington Island (F, U)	2	2	2	2	2	2	2
Vini ultramarina	14.3	12.1	9.6	4.1	1.9	1.2	5.7
Modern specimen	1	1	1	1	1	1	1
Marquesas (exact island unknown; U)							
Vini ultramarina	15.1	12.6	10.1 ± 0.4	4.3+	2.0 ± 0.1	1.2 ± 0.1	5.7+
Hane Site, Ua Huka	14.5–15.6	11.9–13.1	9.2–10.8	3.9+–4.4+	1.9–2.2	1.1–1.4	5.5+–5.9+
	6	6	15	5	27	27	4
Vini australis	13.7	11.4	8.9	3.9	1.8	1.2	5.4
Modern specimens	13.3–13.9	11.2–11.7	8.5–9.3	3.8–3.9	1.6–1.9	1.1–1.2	5.3–5.5
Upolu, Western Samoa (2M),	4	4	4	4	4	4	4
Niuafo'o, Tonga (2U)							
Vini peruviana	13.8	11.9	9.3	3.4	1.5	0.9	5.0
Modern specimen	1	1	1	1	1	1	1
Captive (M)							

Table 2.—Measurements of the tibiotarsus of selected parrots (in mm), with mean, range, and sample size. Standard deviation is provided for samples of 10 or more. CF = Crista Fibularis; DE = Distal End; PE = Proximal End; PS = Pons Supratendineus. F = female. M = male. U = sex unknown.

	Length: DE of CF to DE	Length: DE of CF to PE of PS	Least width of shaft	Least depth of shaft	Distal width	Height of condylus medialis	Depth of condylus medialis	Depth of condylus lateralis
Vini sinotoi	32.4	28.1	2.6	2.2 ± 1.0	6.4	4.6 ± 0.2	5.3	3.9
Hane Site, Ua Huka	31.3–33.4	27.0–29.5	2.3–3.0	2.0–2.4	6.3–6.5	4.2–4.9	5.0–5.8	3.9
	4	6	9	25	7	13	5	2
Vini vidivici	25.6	22.0	2.2	1.6	5.4	3.6	4.3	3.4
Hanatekua Shelter No. 2, Hiva Oa	1	1	1	1	1	1	1	1
Vini solitarius	23.0	19.6	2.0	1.5	4.3	2.9	3.6	2.9
Modern specimens	1	1	1	1	4.2–4.4	2.9	3.5–3.8	1
Viti Levu, Fiji (M)					2	2	2	
Taveuni, Fiji (F)								
Vini kuhlii	23.8	21.2	1.6	1.2	4.4	2.8	3.4	2.8
Modern specimens	23.4–24.3	20.7–21.6	1.6–1.7	1.2	4.3–4.4	2.8	3.4–3.5	2.8–2.9
Washington Island (F, U)	2	2	2	2	2	2	2	2
Vini ultramarina	—	—	1.7	1.1	—	2.9	3.0	—
Modern specimen			1	1		1	1	
Marquesas (exact island unknown; U)								
Vini ultramarina	—	21.0	1.6	1.3 ± 0.1	4.2	2.8	3.3	2.6
Hane Site, Ua Huka		1	1.5–1.7	1.2–1.5	4.0–4.3	2.5–3.2	1	2.5–2.9
			6	10	3	5		3
Vini australis	20.7	18.4	1.6	1.2	3.6	2.5	3.0	2.3
Modern specimens	20.5–21.0	18.3–18.6	1.5–1.6	1.2–1.3	3.5–3.8	2.5–2.6	3.0	2.2–2.3
Upolu, Western Samoa (2M),	4	4	4	4	4	4	4	4
Niuafo'o, Tonga (2U)								
Vini peruviana	19.6	17.6	1.4	1.0	3.0	2.4	2.8	2.2
Modern specimen	1	1	1	1	1	1	1	1
Captive (M)								

Discussion

Systematics and osteology.—The large size of *Vini vidivici* and especially of *V. sinotoi* suggested at first that these forms may belong in *Cyanoramphus,* the only other genus of psittacid recorded from eastern Polynesia. For this reason, more detailed osteological comparisons were made between *Vini* and *Cyanoramphus,* as well as the geographically next closest genus of parrot, *Prosopeia* of Fiji and Tonga (see "Systematic Paleontology"). These comparisons show that the fossils clearly pertain to *Vini* and are distinct from *Cyanoramphus* or *Propsopeia. Charmosyna,* a polytypic genus that occurs from Fiji west through the New Guinean region, is also distinct from *Vini,* at least in the single species of *Charmosyna* available (see "Generic Diagnosis"). Our comparisons for *Cyanoramphus* are based upon *C. novaezelandiae* of New Zealand, as the only known skeleton of *C. zealandicus* of Tahiti (reported by Schauenberg 1970) was unavailable. Similarly, the comparisons for *Charmosyna* are based upon *C. placentis* of the Moluccas rather than *C. amabilis* of Fiji, for which no material is available.

The monotypic genus *Phigys* accommodates the species *solitarius* of the Fijian Archipelago. We found no characters in the tibiotarsus or tarsometatarsus to distinguish *Phigys* from any species of *Vini.* The plumage of *Phigys* also resembles that of *Vini* in both color and pattern (see duPont 1976: plate 18, or Forshaw 1977:72–73). Therefore we recommend synonymizing the genus *Phigys* G. R. Gray, 1870, with *Vini* Lesson, 1831.

Although *Vini* is distinct osteologically from other genera of parrots, the species within *Vini* are rather uniform osteologically, with differences in size and occasionally in proportions being the only diagnostic features at the species level. We had no skeleton of *V. stepheni,* a species known only from Henderson Island. The tarsal measurements of skins of *V. stepheni* (16–18 mm, n = 8) resemble those of *V. kuhlii* (17–18.5 mm, n = 25; Holyoak and Thibault 1984:123–124), so we are confident that *V. stepheni* is much smaller than either *V. sinotoi* or *V. vidivici.*

The parrot bones from the archeological sites on Ua Huka, Hiva Oa, and Tahuata permit an assessment of species-level relationships, although they are not adequate for analysis of intraspecific variation. The limited sample suggests that there may be interisland differences in size, with both *V. sinotoi* and *V. vidivici* being larger on Hiva Oa and Tahuata than on Ua Huka (Table 1).

Extinction and biogeography.—The stratigraphic association of bones of extinct parrots with cultural materials shows that these species survived until after the arrival of Polynesians. A brief review of the chronology and stratigraphy of the archeological sites permits an assessment of the time of extinction. A discussion of the causes of extinction of parrots and other birds in the Marquesas will be presented in a future publication.

The Hane Site on Ua Huka, known also as the Hane Dune Site, has provided much of the basis for the four proposed cultural phases of the Marquesas (Sinoto 1966, 1970, 1979). The Hane Site records the earliest known aspects (Phase 1, Initial Contact) of Polynesian culture in the Marquesas (beginning about A.D. 300 according to Sinoto, or about 200 B.C. or earlier according to Kirch 1986). In his analysis of the faunal material from Hane and other sites in the northern Marquesas, Kirch (1973: see especially pp. 27–37) reported an abundance of bird bones (not further identified) in the strata of Phase 1, with very few bird bones in the strata that represent Phase 2, (A.D. 600–1300), and none in the strata of Phase 3 (A.D. 1300–1600) or Phase 4 (A.D. 1600–1800). Phase I of Marquesan culture is represented by Layers III–V of Area A and Layer VI of Area B (Kirch 1973:27). The bones of extinct parrots, as well as those of other extinct birds yet to be described, occur only in stratigraphic Layers II through V of Area A and Layers V and VI of Area B. Thus nearly all of the parrot bones are from Phase I Layers, although a few bones of each of the three species occur in strata assigned to Layer II of Area A and Layer V of Area B, both of which represent Phase 2 of Marquesan culture. Unfortunately, precise stratigraphic data were lost for some (less than 5%) of the Hane bird bones sometime between 1964 and 1984. Nevertheless, the data at hand indicate that the extinction of most landbirds on Ua Huka, including the parrots, occurred within the first millenium of human settlement.

The parrot bones from the Hanatekua Shelter No. 2 Site, Hiva Oa, are from preoccupational levels (Y. H. Sinoto, pers. comm.). There is no radiocarbon chronology for this site (Bellwood 1972).

From the Hanamiai Site, Tahuata, the specimens of *Vini sinotoi* and *V. vidivici* are from Layers G/H and H, whereas those of *V. ultramarina* are from Layers D, F, and I. "I" is the lowermost Layer in this well stratified site. Radiocarbon ages (in years B.P.) on charcoal for the Hanamiai Site are 130 ± 100 (Layer B), 620 ± 90 (Layer F), and 850 ± 60 and 1250 ± 100 (Layer G) (B. Rolett, pers. comm.). Additional radiocarbon ages are pending. The stratigraphic distribution of parrots at Hanamiai suggests that *V. ultramarina* survived longer on Tahuata than its larger, extinct congeners, although all three co-existed at one time. The possible longer survival of *V. ultramarina* on Tahuata is in accord with the fact that this small species survived into historic times on two islands in the Marquesas (Nuku Hiva, Ua Pou), whereas the two larger species of *Vini* apparently became extinct before European contact.

The historical distribution of species of *Vini* outside of the Marquesas suggests that certain of these species as well have not survived on all of the islands that once made up their natural ranges. For example, a fossil sternum from a cave on Mangaia, southern Cook Islands, has been referred to *Vini* cf. *V. kuhlii* (Steadman 1985), a species previously known only from Rimatara and Tubuai, 480 km east-southeast of Mangaia. In light of the historic or prehistoric extirpations from certain islands of *V. kuhlii, V. ultramarina, V. australis,* and *V. peruviana,* and the complete losses of *V. sinotoi* and *V. vidivici,* we might expect additional undescribed species of *Vini* to show up in future archeological or paleontological excavations in Oceania. At a minimum, we can expect new island records for the known species. One or more species of *Vini* probably once existed throughout the many islands of Polynesia that are not inhabited by parrots today.

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A NEW SPECIES OF STOMATOPOD, *EURYSQUILLA PUMAE* (CRUSTACEA: STOMATOPODA: EURYSQUILLIDAE), FROM THE GULF OF CALIFORNIA, MEXICO

Michel E. Hendrickx and José Salgado-Barragán

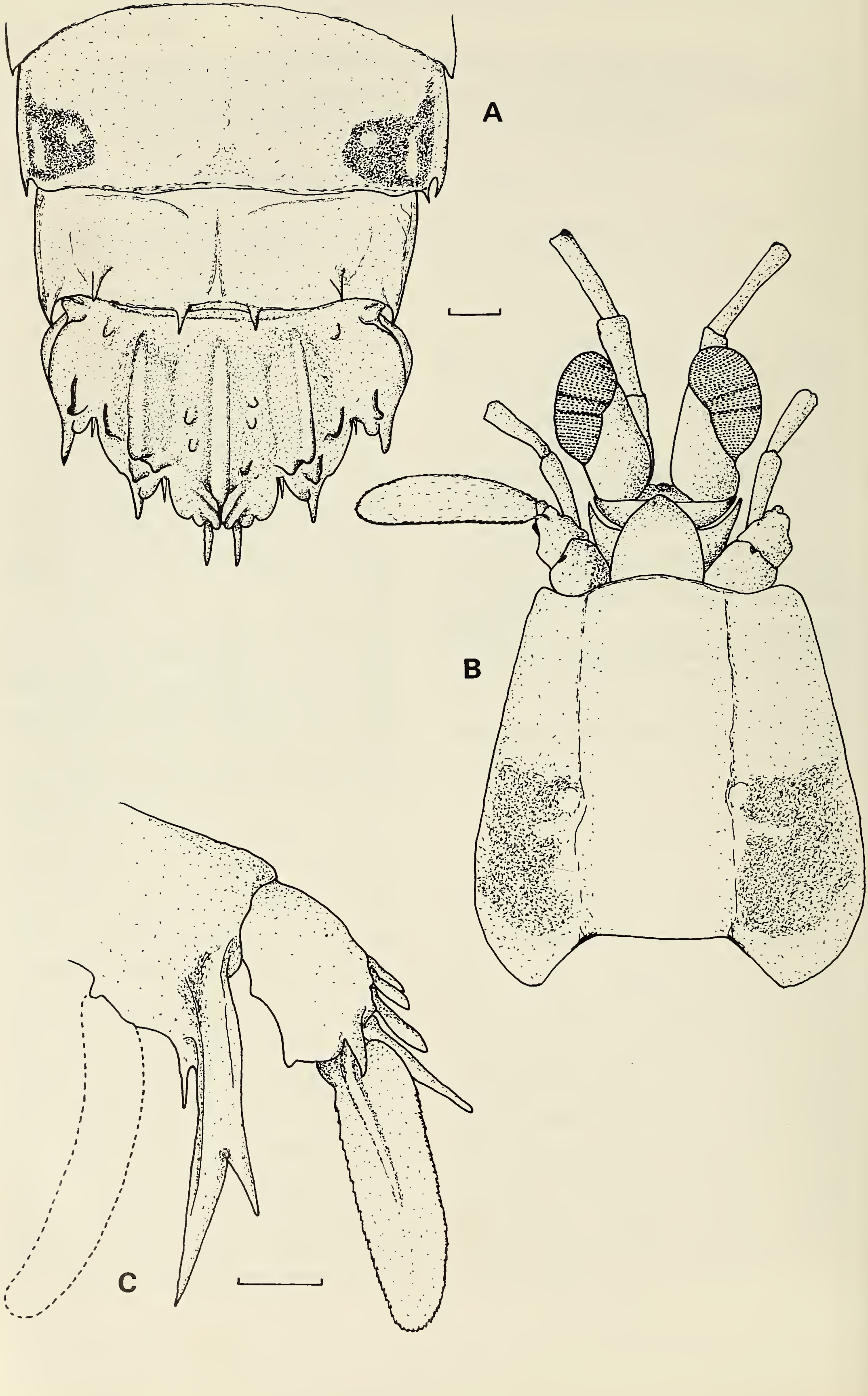
Abstract.—A new species of the stomatopod genus *Eurysquilla* Manning, *E. pumae,* is described from the Gulf of California, Mexico.

Two species of the genus *Eurysquilla* Manning, *E. veleronis* (Schmitt) and *E. solari* Manning, are known from the Eastern Pacific. Up to now, only the former has been collected along the coast of Mexico, where it is commonly found on sandy substrates between 29 and 118 m (Hendrickx and Salgado-Barragán 1987).

During sampling activities of the B/O *El Puma* in the Gulf of California, Mexico (CORTES Project), in Mar 1985, a male specimen of *Eurysquilla* sp. was collected by trawl. The specimen, which appears to be distinct from *E. veleronis,* was latter compared with type material of *E. solari* at the USNM and identified as an undescribed species.

Eurysquilla pumae, new species
Fig. 1

Diagnosis.—Cornea subglobular, not bilobed, set obliquely on eyestalk; eyestalk almost cylindrical, little inflated near external base. Ocular scales broad, slightly sloping backward (rising forward), with rounded anterolateral corners. Antennal processes acute, directed forward, tip reaching anterior margin of ocular scales. Rostrum triangular, without terminal spine, longer than wide. Raptorial claw with 7 teeth on dactylus. Five epipodites. Sixth and seventh thoracic segments with posterolateral angle slightly produced backward, rounded; 8th thoracic segment laterally rounded. Posterolateral angles of abdominal somites 1, 2, and 3 rounded; 4th with acute angle but no spine. Posterior spine present on marginal carina of 5th segment (smaller submarginal spine also present on right side), and on marginal, intermediate, and submedian carinae of 6th segment. Telson broader than long, with strong median carina ending in spine and one pair of strong, continuous carinae, parallel to median, slightly converging towards telson anterior margin but falling short of it; in between these carinae, and parallel to them, 2–3 strong blunt tubercles (2 on left side, 3 on right side of median carina); strong conical tooth present close to inner distal extremity of each of paired intermediate carinae; parallel to intermediate continuous carina, on outer side of telson, 2 tubercles, well separated from each other, anterior one round and strong, close to telson anterior margin, posterior tubercle elongate, reaching approximately to distal end of intermediate carina. Marginal carina of telson well marked. Short carina on basis of lateral tooth, its posterior end bent outwards; strong tubercle on intermediate tooth; a little elevated, obliquely set carina on submedian tooth. Inner intermediate denticle elongated, with very short inner sinus; outer intermediate denticle much shorter, thickened on posterior margin and slightly upturned. Inner lateral denticle inconspicuous, outer one a rounded lobe. Proximal segment of exopod of uropod with 7 movable spines (one broken off). Basal prolongation of uropod relatively thick, with 3 spines, median terminal spine strongest, inner proximal spine shortest; inner margin smooth.


A
B
C

Color.—Preserved specimen shows carapace with large patch of black pigment close to posterolateral corners; posterolateral corners of 1st abdominal segment with black patch of pigment, subtriangular in shape. Conspicuous black mark on posterolateral corner of 6th segment, suboval, with light linear longitudinal band about ⅓ away from outer margin of mark, and circular spot close to inner border. Median portion of all thoracic and abdominal somites with median patch of black pigment. Base of lateral teeth of telson, posterior center of telson and last segment of both exopod and endopod of uropod black.

Measurements.—Only one specimen collected, a male of 34 mm (total length).

Holotype.—Reference Collection of Estación Mazatlán, UNAM, EMU-2415.

Distribution.—Known only from the type locality, off Estero Tastiota, Sonora (28°17'N, 111°37'W), Gulf of California, Mexico. Collected at 34–37 m, on sandy bottom.

Etymology.—The species is named for the Oceanographic Vessel *El Puma,* of the Universidad Nacional Autónoma de México.

Discussion.—*Eurysquilla pumae* can be distinguished from *E. veleronis,* the other species present in the area, by its much smaller rounded, not elongated cornea which is not as strongly bilobed as in *E. veleronis. Eurysquilla solari,* a species with a smaller eye than *E. veleronis* (but bilobed and larger than that of *E. pumae*) has a spiny rostrum and long, acute antennal processes that clearly overreach the ocular scales.

The telsons of the three species of *Eurysquilla* known from the East Pacific differ in the complexity of their dorsal sculpture. *Eurysquilla solari* has the most elaborate pattern with, in addition to the median carina, a series of three lateral carinae that are strong and tuberculate; also present is a patch of ridges and tubercles on the base of both the intermediate and the lateral teeth (Manning 1970). In *E. veleronis,* the sculpture are rather reduced when compared to *E. solari,* but three pairs (two well defined, a third one less so) of lateral carinae can still be distinguished; the tubercles are also less conspicuous (Schmitt 1940). In *E. pumae,* a further reduction of the carinae complex can be observed, and there is only one clearly marked, very strong dorsal pair of carinae parallel to the median one (not tuberculate), the rest being reduced to a few tubercles. *Eurysquilla solari* is also the only species that has a posterior spine on the marginal carina of the 4th abdominal segment and a well defined intermediate spine on the 5th (Manning 1970). The small marginal inner spine on the basal prolongation of the uropod, present in both *E. veleronis* and *E. pumae,* is absent in *E. solari.*

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Fig. 1. *Eurysquilla pumae,* holotype: A, Fifth and sixth abdominal somites and telson; B, Anterior part of the body; C, Uropod in ventral view. Scale bar = 1.0 mm. (Setae omitted.)

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A NEW SPECIES OF *CHEVALIA* FROM THE CARIBBEAN SEA (CRUSTACEA: AMPHIPODA)

J. L. Barnard and J. D. Thomas

Abstract.—A new Caribbean species, *Chevalia carpenteri* is described; heretofore only one species of the genus was known, but we have examined material that suggests morphs may represent distinct species or subspecies. We report *C. mexicana* and extend its range from the northern Gulf of Mexico to Belize. Our new species differs from the world complex of *C. aviculae* morphs in the ovate article 2 of pereopods 5–7 and the posteriorly flat epimera with large notches.

Chevalia has heretofore been monotypic, the type species being *C. aviculae* Walker (1904) from Ceylon. Two other species, *Chevalia mexicana* Pearse (1913) from the Gulf of Mexico and *Neophotis inaequalis* Stout (1913) from California were synonymized with *C. aviculae* by Shoemaker (1942) and J. L. Barnard (1962, 1970). *Chevalia mexicana* is redescribed from specimens collected at Belize and reexamination of type material in Smithsonian Institution. A strongly distinct new species from the Florida Keys and Belize is described and some previous materials reported as *C. aviculae* from California, Hawaii, and the Galapagos Islands, are reviewed. This new study suggests that *C. aviculae* has minutely distinct populations in those places but the type material from Ceylon remains obscure and an elaboration of possible species of subspecies around the tropics is not possible. A new diagnosis of the genus and a key to these taxa is presented below.

Methods

Two diagnoses each are given for *Chevalia mexicana* and *C. carpenteri* to compare each with the superspecies complex of *C. aviculae* and with the (presumably specific) divisions of *C. aviculae* not yet possible to implement.

Legend

Capital letters as follows refer to parts; lower case letters to the left of capital letters refer to specimens noted in legends; lower case letters to right of capitals refer to adjective modifications in list: B, body; C, coxa; D, dactyl; F, accessory flagellum; G, gnathopod; I, inner plate or ramus; L, labium; M, mandible; O, outer plate or ramus; P, pereopod; Q, pleopod; R, uropod; S, maxilliped; T, telson; U, labrum; W, urosome; X, maxilla; Y, gill; Z, oostegite; l, left; r, right.

Chevalia Walker

Chevalia Walker, 1904:288 (*Chevalia aviculae* Walker, 1904, monotypy).—J. L. Barnard, 1969:271.

Neophotis Stout, 1913:652 (*Neophotis inaequalis* Stout, 1913, monotypy).

Diagnosis.—Corophiidean with fleshy telson; article 2 of antenna 1 longer than article 1, article 3 shorter than 1, accessory flagellum 2–3 articulate; antenna 2 slightly shorter than antenna 1; labrum weakly excavate below; incisors and laciniae mobiles serrate, rakers about 4, palp article 3 slightly shorter than 2, thinly clavate, with ABDE setae; inner lobes of labium large and fleshy; inner plate of maxilla 1 present but small and poorly armed, outer plate with 10–11 spines, palp 2-articulate, article 1 short; inner plate of maxilla 2 with oblique facial row of setae; plates of maxilliped thin, outer with sparse but large medial spines, palp thin, dactyl stubby, multi-armed; coxae small, disjunct, coxae 1–2 larger than 3–7; gnathopods of sexes alike, gnathopod 1 feeble, almost simple, carpus elongate; gnathopod 2 large, carpus short and lobate, propodus large, subrectangular, palm weakly oblique or transverse, defined by tooth, dactyl thick; locking spines of pereopods 6–7 comprised of one short thick spine and one elongate thin seta, often on pereopod 5 both thin and short, on pereopods 3–4 both long and seta-like; dactyls of pereopods 3–4 simple, of pereopods 5–7 strongly bent and with large outer tooth; pereopods 5–7 short but increasingly elongate, feeble; oostegites absent on coxa 2 (and occasionally coxa 3), thin, strap-shaped, sparsely setose; branchiae thin, on coxae 2–6; epimera simple; urosomites 1–2 fused, urosomite 3 free; outer rami of uropods 1–2 shortened, armed apically, inner rami styliform and unarmed apically; uropod 3 short, rami subequal, thin, setose only apically; telson short, as broad as long, squared, well setose dorsally.

Key to the Taxa of *Chevalia*

1. Article 2 of pereopods 5–7 ovate, not produced posteroventrally, epimera 1–3 straight behind, with distinctly strong posteroventral notch, coxal gill 2 shortened, oostegites 2 pairs .... *carpenteri*
– Article 2 of pereopod 7 subquadrate, produced or squared posteroventrally, epimera 1–3 convex behind, with weak notch or none, coxal gill 2 not shortened, oostegites 3 pairs ..... *aviculae* complex 2
2. Palm of gnathopod 2 transverse .. 3
– Palm of gnathopod 2 oblique 4
3. Palm of gnathopod 2 with deep sinus near dactylar hinge, article 2 of pereopod 7 obtusely lobate, antennae and mandibular palp ordinary .... HAWAII
– Palm of gnathopod 2 lacking sinus, article 2 of pereopod 7 quadrate, antennae and mandibular palp immense ....(MADAGASCAR, WEST ATLANTIC) *mexicana*
4. Coxa 1 with sharply attenuate anteroventral apex .... (CEYLON, type) *aviculae*
– Coxa 1 blunt and not attenuate apicoventrally 5
5. Article 2 of pereopod 7 with protuberant posteroventral lobe, hinge notch of palm deep .... GALAPAGOS + FIJI
– Article 2 of pereopod 7 quadrate, hinge notch of palm weak .... (CALIFORNIA) *inaequalis*

Chevalia aviculae Walker, Superspecies

Diagnosis.—Article 3 of antenna 1 about 0.70–0.75 times as long as article 1; accessory flagellum 2–3 articulate, article 1 short or long (2-articulate and article 1 long in California, Galapagos, Hawaii, but 3-articulate with article 1 short in western Atlantic =*mexicana*). Coxal gill 2 almost as long as other gills. Three pairs of oostegites present (on coxae 3–5). Article 2 of pereopods 5–7 pyriform, with extended or produced posteroventral corner (especially on pereopod 7); article 5 of pereopods 5–7 with 1 (rarely 2) main emergent spine(s); article 4 of pereopod 7 slender (type and Galapagos) or broad in California–Hawaii. Epimer 1–3 with convex posterior margin, posteroventral notch tiny or absent. Apex of outer ramus on uropod 2 with 5–6 subsidiary spines, some of these directly basal to 3 main distal spines.

Chevalia aviculae Walker

Chevalia aviculae Walker, 1904:288–290, pl. 7, fig. 50, pl. 8, fig. 50; 1909:341.—K. H. Barnard, 1916:252; 1937:169, fig. 15.

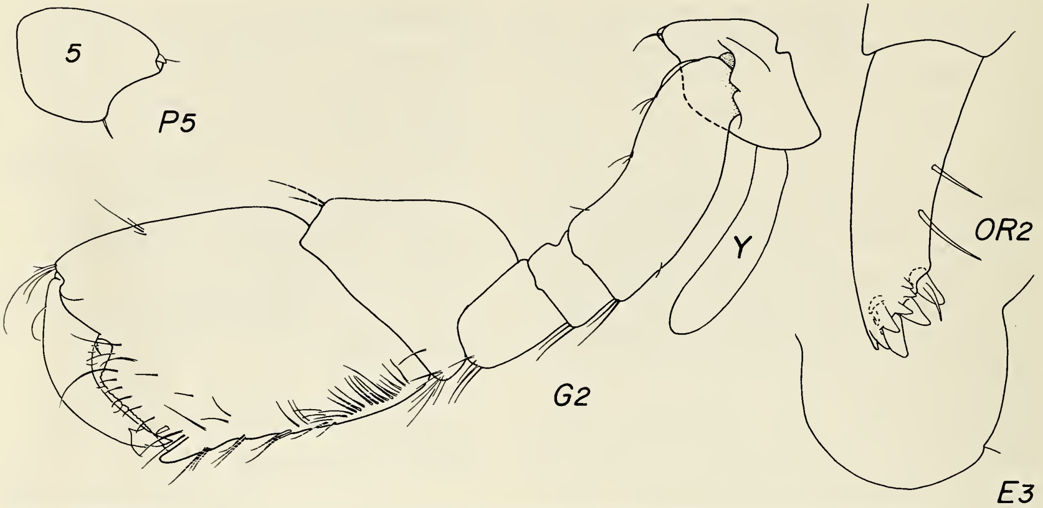

Fig. 1. *Chevalia* sp., Galapagos, male "p."

Diagnosis.—Accessory flagellum 2-articulate, article 1 elongate (Walker probably overlooked tiny article 2); anteroventral corner of coxa 1 attenuate and sharp; coxa 2 [?weakly excavate ventrally]; palm of gnathopod 2 oblique, notch near hinge absent; article 2 of pereopod 7 with weakly protuberant posteroventral corner, article 4 slender. [Unknown are gills, oostegites and minute details on outer ramus of uropod 2.]

Distribution.—Indian Ocean.

Chevalia inaequalis (Stout), California

Neophotis inaequalis Stout, 1913:653.
Chevalia aviculae: Shoemaker, 1942:39.—J. L. Barnard, 1962:17, fig. 5.—Conlan, 1983:61, fig. 32.

Diagnosis.—Accessory flagellum 2-articulate, article 1 shortened; anteroventral corner of coxa 1 blunt; coxa 2 weakly excavate or flat ventrally; palm of gnathopod 2 oblique, notch near hinge moderate; article 2 of pereopod 7 not protuberant at posteroventral corner, article 4 stout; outer ramus of uropod 2 with 2 marginal setae.

Material.—Allan Hancock Foundation *Velero IV* 5164 (reexamination of material reported by J. L. Barnard 1962).

Distribution.—British Columbia to outer Baja California.

Chevalia sp., Galapagos
Fig. 1

Chevalia aviculae: J. L. Barnard, 1979:24.

Diagnosis.—Accessory flagellum 2-articulate, article 1 elongate; anteroventral corner of coxa 1 blunt; coxa 2 weakly excavate or convex ventrally; palm of gnathopod 2 oblique, notch near hinge deep; article 2 of pereopod 7 protuberant at posteroventral corner, article 4 stout; outer ramus of uropod 2 with 2 marginal setae.

Material.—JLB Galapagos 40 (reexamination of material reported by J. L. Barnard 1979).

Distribution.—Galapagos Islands.

Chevalia sp., Fiji

Chevalia aviculae: Myers, 1985:76–80, fig. 59.

Diagnosis.—Accessory flagellum 2-articulate, article 1 elongate; anteroventral corner of coxa 1 blunt; coxa 2 almost straight ventrally; palm of gnathopod 2 oblique, notch near hinge moderate to strong; article 2 of pereopod 7 protuberant at posteroventral corner, article 4 slender; outer ramus of uropod 2 with 1 marginal seta.

Distribution.—Fiji.

Chevalia sp., Hawaii

Chevalia aviculae: J. L. Barnard, 1970:166–167, fig. 105.

Diagnosis.—Accessory flagellum 2-articulate, article 1 elongate; anteroventral corner of coxa 1 blunt; coxa 2 weakly excavate or convex ventrally; palm of gnathopod 2 transverse, notch near hinge deep; article 2 of pereopod 7 strongly protuberant at posteroventral corner, article 4 slender; outer ramus of uropod 2 with 2 marginal setea.

Material.—JLB Hawaii 6 (reexamination of original material, see J. L. Barnard 1970).

Chevalia mexicana Pearse
Figs. 2–3

Chevalia mexicana Pearse, 1913:374–376, fig. 5.

?*Chevalia aviculae*: Shoemaker, 1921:101.—?Ledoyer, 1982:198, fig. 68.

Diagnosis (comparison to *C. aviculae* superspecies and *C. carpenteri*).—Article 3 of antenna 1 about 0.70 times as long as article 1; accessory flagellum 3-articulate, article 1 short. Coxal gill 2 almost as long as other gills. Three pairs of oostegites present (on coxae 3–5). Article 2 of pereopods 5–6 ovate, of pereopod 7 rectolinear, lacking extended or produced posteroventral corner on pereopod 5, but with squared posteroventral corner on pereopods 6–7, article 5 of pereopods 5–7 with 2 main emergent spines; article 4 of pereopod 7 slender. Epimera 1–3 with weakly convex posterior margin, posteroventral notch obsolescent. Apex of outer ramus on uropod 2 with 5+ subsidiary spines directly basal to 3 main distal spines.

Diagnosis (comparison to species in *C. aviculae* complex).—Accessory flagellum 3-articulate, article 1 shortened; anteroventral corner of coxa 1 blunt; coxa 2 weakly excavate ventrally; palm of gnathopod 2 almost transverse, notch near hinge weak or absent; article 2 of pereopod 7 not protuberant at posteroventral corner, article 4 slender; outer ramus of uropod 2 with 1 marginal seta.

Antenna 1 unlike other species, about 1.5 times as long as head plus first 4 pereonites together, in *C. mexicana* antenna 1 about 2.3 times as long as "comparative," antenna 2 concomitant and mandibular palp similarly elongate (mandibular palp cleans antennae); inner basal margin of dactyl on gnathopod 2 with hump.

Description of female "w" 4.77 mm.—As in illustrations; primary flagellum of antenna 1 with one aesthetasc on each article except 1, 8, and 10, and one tiny one on article 11; gnathopod 2 with smooth transverse palm, dactyl as long as palm, medial face of article 5 lacking tiny prickles; 3 pairs of oostegites very thin, sparsely setose; ratio of peduncle to outer ramus to inner ramus on pleopods = 30:45:39, outer rami with 10 articles, inner with 8–9, peduncle with 2 coupling hooks, one apical seta (remote from coupling hooks); outer ramus of uropod 1 with lateral and medial fine serrations distally, these absent on outer ramus of uropod 2, this ramus with 1 marginal seta; inner ramus of uropod 2 with large lateral serrations, each small tooth subserrate.

Male "v" 3.75 mm.—Like female but body smaller and armaments therefore fewer.

Distinctions from C. carpenteri.—Palp of mandible elongate; palp of maxilla 1 with 3 outer facial setae, inner plate of maxilla 2 shortened; outer rami of uropods 1–2 of *C. aviculae* superspecies-form in presence of 5+ subsidiary spine-teeth.

Illustrations.—Following parts like *C. carpenteri* and therefore neither described nor illustrated: posterior body, urosome, pleon, upper and lower lips, maxilla 1, maxilliped (but inner plate with 6 medial setae),

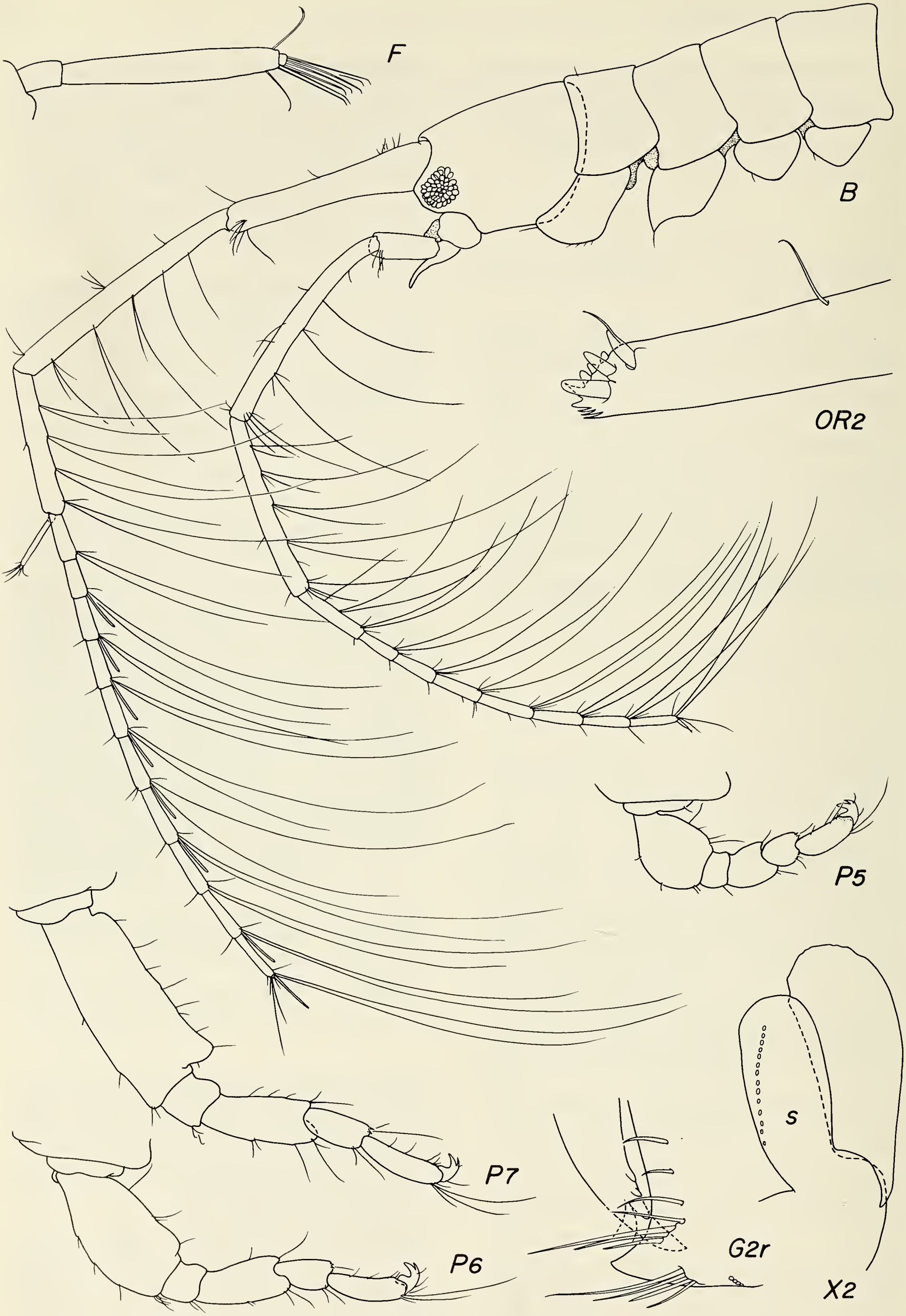

Fig. 2. *Chevalia mexicana,* female "w."

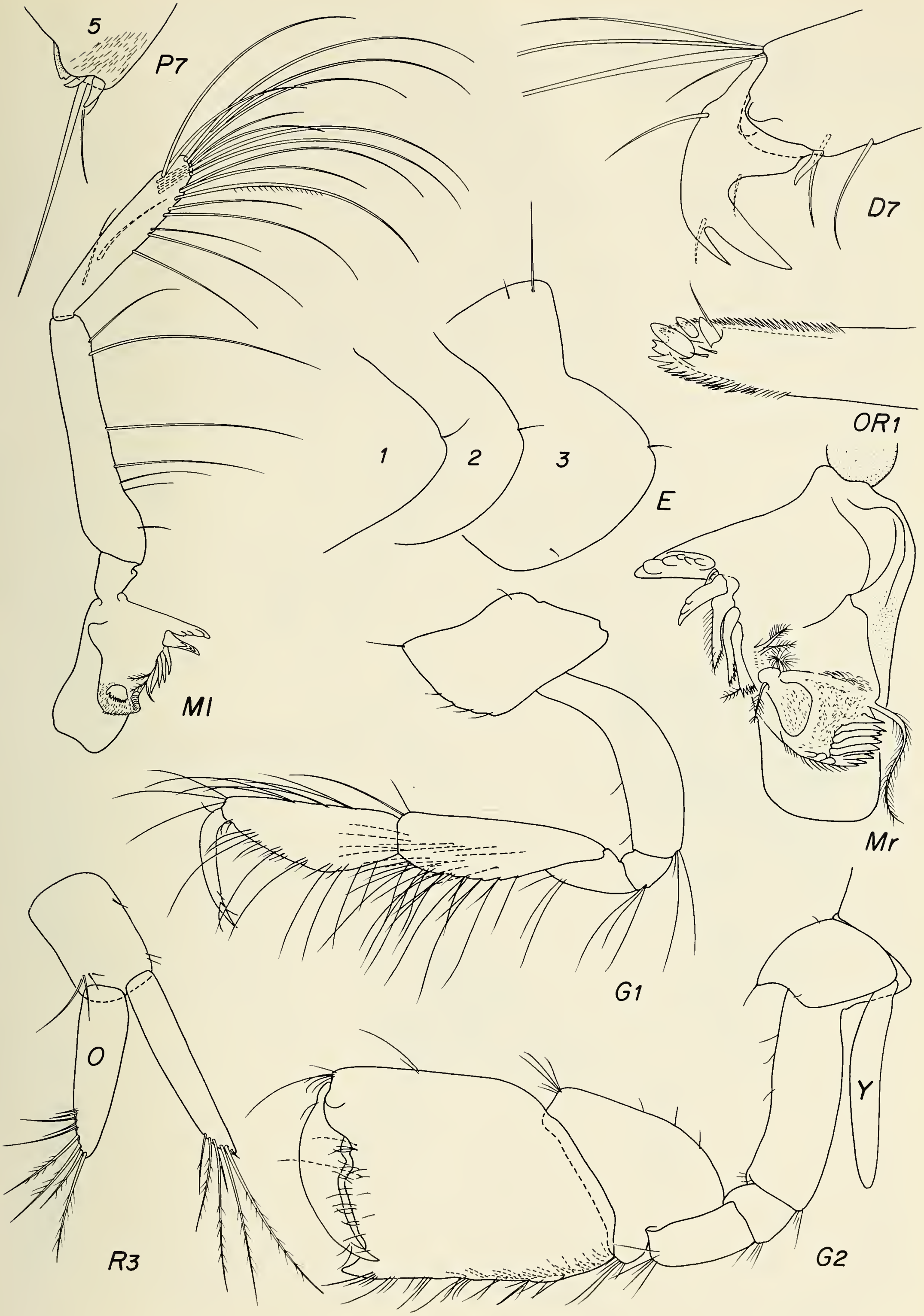

Fig. 3. *Chevalia mexicana*, female "w."

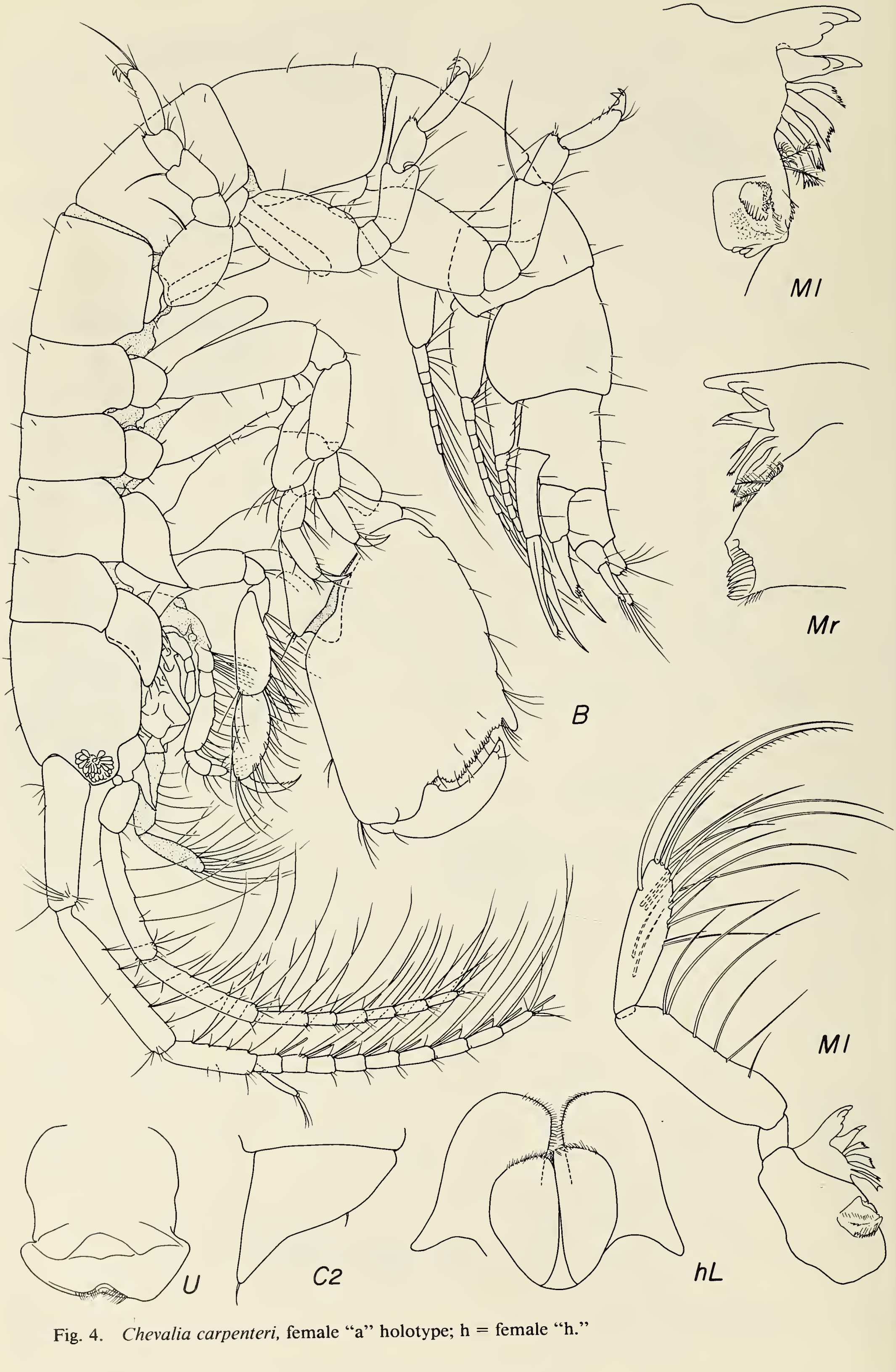

Fig. 4. *Chevalia carpenteri,* female "a" holotype; h = female "h."

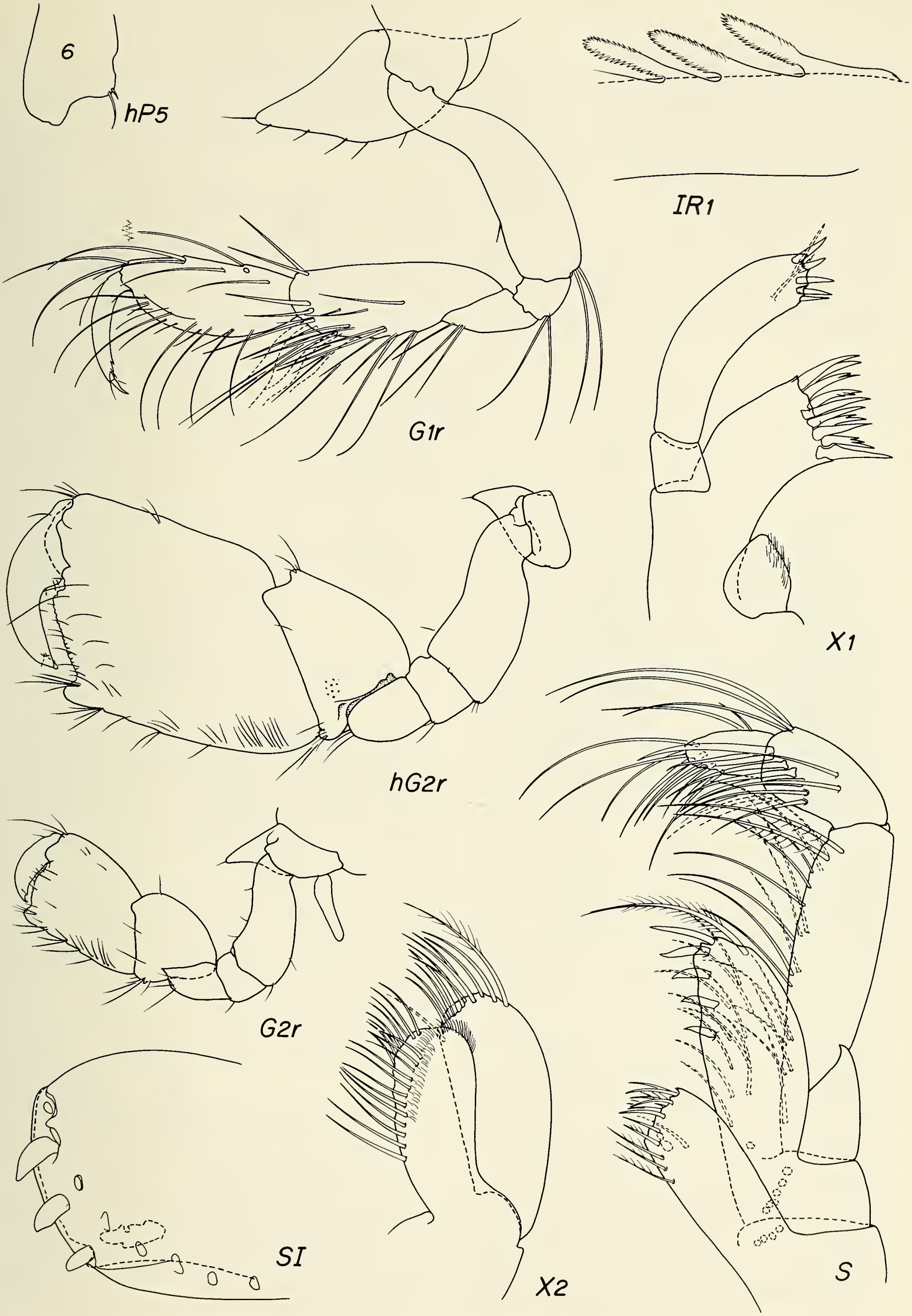

Fig. 5. *Chevalia carpenteri,* female "a" holotype; h = female "h."

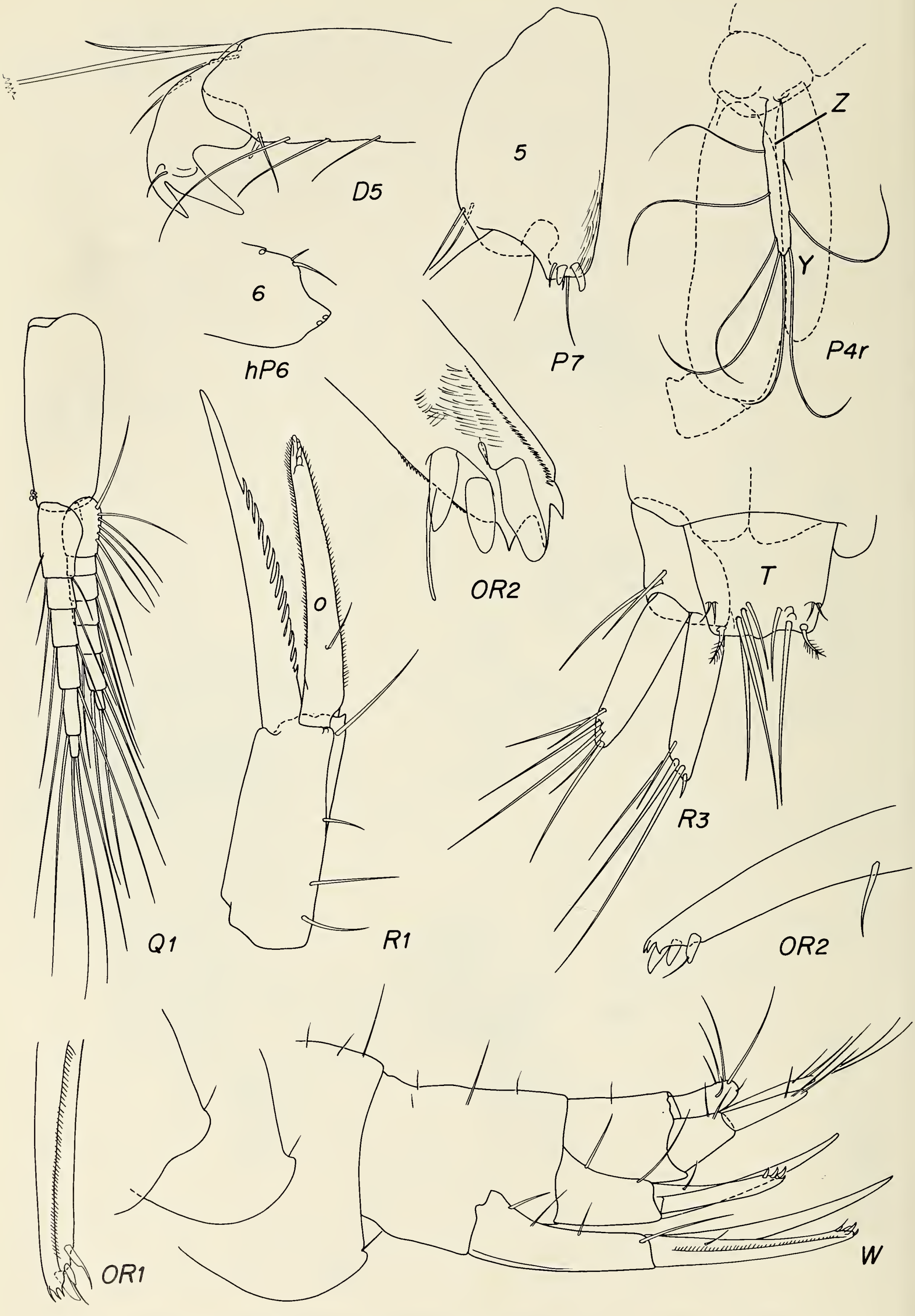

Fig. 6. *Chevalia carpenteri,* female "a" holotype; h = female "h."

pereopods 3–4 (but article 6 with 4 posterior setae besides locking setae), uropods 1–2 peduncular setae shorter, outer rami with 2 and 1 setae respectively), telson (but with 2 rows of 5 dorsal setae).

Type locality.—South of Panama City, Florida, 29°16′30″N, 85°32′00″W, Albatross sta 2369, 25 to 27 fms.

Material.—USNM 195160, JDT Belize 82B, Carrie Bow Cay, reef crest, outer edge, depth 60 feet, *Halimeda* in coral rubble, coll. J. D. Thomas, male "v" 3.75 mm and female "w" 4.77 mm.

Relationship.—Having characters of the *C. aviculae* form (multitoothed outer rami of uropods 1–2) as well as of *C. carpenteri* (presence of 2 spines on posterodistal article 5 of pereopods 5–7). See key.

Distribution.—Northern Gulf of Mexico to the Lesser Antilles, Barbados, and Belize, 0–50 m; ?Madagascar.

Chevalia carpenteri, new species
Figs. 4–6

Diagnosis.—Article 3 of antenna 1 about 0.60 times as long as article 1; accessory flagellum 3-articulate, article 1 short. Coxal gill 2 half as long as other gills. Two pairs of oostegites present (on coxae 4–5). Article 2 of pereopods 5–7 ovate, lacking extended or produced posteroventral corner; article 5 of pereopods (5) 6–7 with 2 main emergent spines; article 4 of pereopod 7 slender. Epimera 1–3 with straight posterior margin, posteroventral notch strong. Apex of outer ramus of uropod 2 with 2–3 subsidiary spines, none of these directly basal to 3 main distal spines.

Description of holotype, female "a" 4.64 mm.—As in illustrations; primary flagellum of antenna 1 with one aesthetasc on each article; gnathopod 2 with weakly serrate oblique palm, dactyl shorter than palm, medial face of article 5 with tiny prickles; right gnathopod 2 abnormally stunted, regenerant; 2 pairs of oostegites very thin, sparsely setose; ratio of peduncle to outer ramus to inner ramus on pleopods = 23:24:29, outer rami with 7 articles, inner with 6, peduncle with 2 coupling hooks, one apical seta (not near coupling hooks); outer ramus of uropod 1 with lateral and medial fine serrations, these absent on outer ramus of uropod 2, this ramus with 1 marginal seta; inner ramus of uropod 1 with large lateral serrations, each small tooth subserrate.

Holotype.—USNM 195157, female "a" 4.64 mm.

Type locality.—JDT Belize 105, Carrie Bow Cay, Belize, sand bores near Wee Wee Cay, 1 m, formalin wash of algal/invertebrate covered coral rubble, 21 Jul 1984, coll. J. D. Thomas.

Material.—The type locality, female "b" 2.96 mm, female "c" 2.54 mm, female "d" 2.79 mm, female "e" 3.04 mm, female "f" 2.51 mm, female "g" 1.93 mm, female "h" 3.16 mm; Florida Keys, Looe Key Reef, forereef, formalin wash of coral rubble, 5 m, 8 Oct 1983, coll. J. D. Thomas, female "n" 2.37 mm.

Etymology.—Named for Michael R. Carpenter, Smithsonian Institution, whose assistance in field endeavors has been invaluable.

Relationship.—Differing from the complex of morphs in *C. aviculae* by the ovate article 2 of pereopods 5–7 and the posteriorly straight epimera with large notches. As far as we can determine (except for *C. mexicana*) in the morphs of *C. aviculae* we have observed, our new species differs in the presence of two tiny spines on the posterodistal apex of article 5 on pereopods 6–7 in contrast to one spine in the type species of the genus. Also, the new species has only two to three subsidiary spines or teeth on the outer ramus of uropod 2 in contrast to five to six in *C. aviculae,* has only two pairs (versus three) of oostegites, and gill 2 is shortened. Coxa 2 appears to be more sharply attenuate anteroventrally then in any of the morphs of *C. aviculae.*

Acknowledgments

We thank Dr. Klaus Rützler and Mike Carpenter of Smithsonian Institution for field support on Carrie Bow Cay, Belize. We thank Linda B. Lutz of Vicksburg for inking our plates. The second author was supported by NSF Grant BSR-8515186. This is contribution 193 from the Smithsonian Reef and Mangrove Project, Carrie Bow Cay, Belize.

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PINNOTHERIDS (CRUSTACEA: DECAPODA) AND LEPTONACEANS (MOLLUSCA: BIVALVIA) ASSOCIATED WITH SIPUNCULAN WORMS IN HONG KONG

Raymond B. Manning and Brian Morton

Abstract.—The intertidal soft-bottom sipunculans *Sipunculus nudus* Linnaeus and *Siphonosoma cumanense* (Keferstein) in Hong Kong each have a pair of commensal associates, one leptonacean bivalve and one pinnotherid crab, inhabiting their burrows. With the former are the bivalve *Fronsella ohshimai* Habe and members of a new genus and species of pinnotherid crab, *Indopinnixa sipunculana,* and with the latter are the bivalve *Nipponomysella subtruncata* (Yokoyama) and the crab *Mortensenella forceps* Rathbun. The bivalves occur in mean numbers of 5 (range 1–9) and 3.3 (range 1–7)/host, respectively, and the crabs either singly or in pairs. The pairs of associates seem mutually exclusive of each other, with regard to both inter- and intra-host specificity.

Two sipunculans, *Sipunculus nudus* Linnaeus and *Siphonosoma cumanense* (Keferstein), build deep burrows on Hong Kong's soft, muddy shores. Over the course of a number of field trips by one of us (B.M.) to such a sipunculan habitat at Tai Tam Bay on the south coast of Hong Kong Island [22°15′N, 114°11′E], a number of specimens of each of these species has been collected, and two species of commensals have been found in association with each of them. Morton and Morton (1983:204) listed the leptonid bivalve *Fronsella ohshimai* Habe (Montacutidae) and the pinnotherid crab *Asthenognathus inaequipes* Stimpson as associates of *Sipunculus nudus*; we describe the pinnotherid here as a new genus and species. Morton and Morton (1983:204) also listed the leptonid bivalve *Nipponomysella subtruncata* (Yokayama) (Montacutidae) and the pinnotherid crab *Pinnixa rathbuni* Sakai as associates of *Siphonosoma cumanense*; here we correct the identity of the crab to *Mortensenella forceps* Rathbun. This note provides further information on these commensal associations.

Materials and Methods

Sipunculan burrows were identified by their surface apertures, and sometimes digging would expose their deep, fast-burrowing inhabitants. When a sipunculan was obtained, the burrow wall was examined for possible associates. No records were kept in cases where the associate could not be linked positively to the burrow owner. In this way, definite associations have been established. As it was impossible, however, to trace accurately every burrow and collect every associate, the data presented here should be regarded as provisional.

The crab specimens reported below have been deposited in the National Museum of Natural History, Smithsonian Institution, Washington (USNM).

Results

The Pinnotherid Crabs

Indopinnixa, new genus

Definition.—Carapace much wider than long; integument firm; front narrow, with

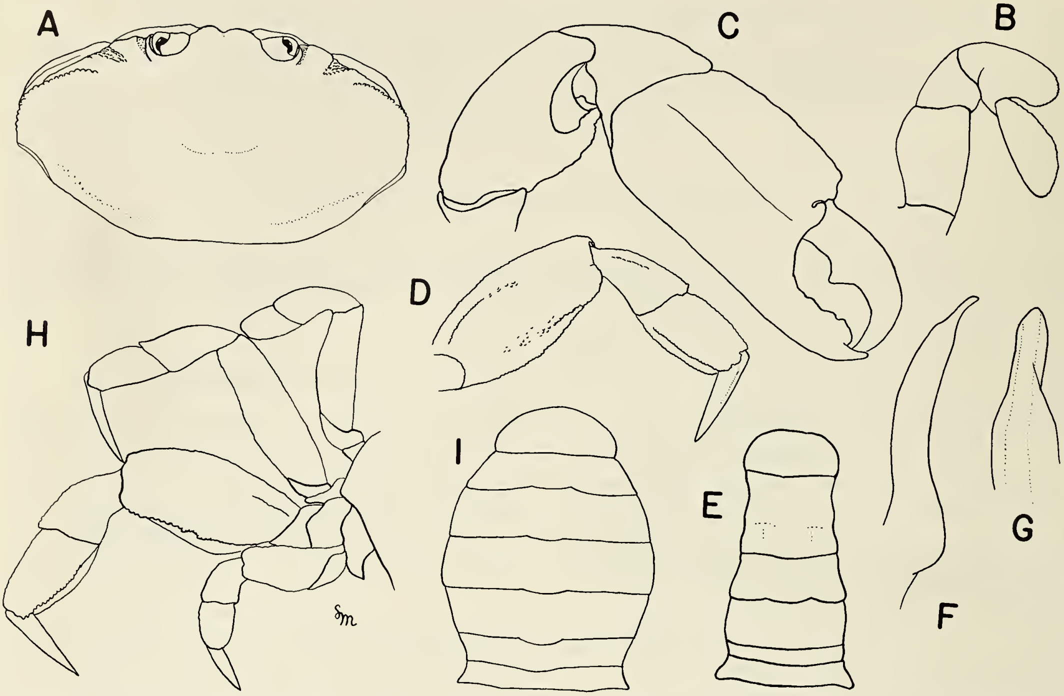

Fig. 1. *Indopinnixa sipunculana.* Male, Hong Kong: A, Carapace; B, Third maxilliped; C, Cheliped; D, Fourth pereopod; E, Abdomen; F, Gonopod; G, Apex of gonopod. Female, Hong Kong: H, Second to fifth pereopods; I, Abdomen.

median groove. Orbit broadly ovate, with wide inner hiatus partly occupied by basal antennal article. Antennules folded into wide fossettes, joined medially under front. Eyestalks very short. Ischium of third maxilliped short, merus much longer, both slender; palp articulated to summit of merus, distal article arising on inner side of second article. Chelipeds moderately large, hand large, compressed. Third walking leg (P4) stout, largest of all walking legs; first and second walking legs (P2, P3) very slender, fourth and fifth legs (P4, P5) stout. Abdomen of male 6-segmented, fifth and sixth segments fused; seventh segment short, broader than long. Female abdomen 7-segmented. Gonopod simple, tapering distally.

Type species.—Indopinnixa sipunculana, new species.

Etymology.—The generic name is derived from the Greek combining form, "indo-," and the generic name *Pinnixa.* The gender is feminine.

Remarks.—Indopinnixa, which now contains only the type species described below, differs from *Pinnixa* sensu stricto in the form of the male abdomen, which is composed of seven free segments in *Pinnixa,* six segments in *Indopinnixa,* because the fifth and sixth segments are fused.

Indopinnixa sipunculana, new species
Fig. 1

Pinnixa rathbuni.—Morton and Morton, 1983:78, 204. [Not *P. rathbuni* Sakai, 1934.]

Material.—Tai Tam, Hong Kong, Jun 1977, in burrows of *Sipunculus nudus,* leg. B. Morton, 1 male, holotype, USNM 221697.—Same data except date, 20 Jun 1974, 1 ovigerous female, paratype, USNM 222500.

Description.—Carapace 1.83 (male) to 2.15 (female) times broader than long, punctate dorsally, lacking transverse ridge across posterior part. Branchial regions each crossed by low, tuberculate ridge, falling short of orbit. Front bilobed. Anterolateral margin with 2 tomentose depressions visible dorsally, lateral to orbit, depressions connected ventrally, defining smooth, tear-shaped area lateral to orbit. Regions of carapace poorly marked, with transverse median depression, and, on each side, a shallow groove parallel to posterolateral margin.

Chelipeds of male subequal (of female unknown), cheliped with fixed finger in same plane as palm, not deflected ventrally, movable finger (measured dorsally) slightly shorter than palm, latter smooth dorsally, about as long as high, with longitudinal ridge on outer surface. Fingers gaping, movable finger smooth dorsally, curved, tip crossing that of fixed finger, with triangular tooth on opposable margin. First 2 walking legs slender, first short, second about as long as third. Third walking leg largest in both sexes, propodus 1.5 to 1.7 times longer than high, ventral (opposable) margin bicarinate, tomentose; merus 2 times as long as high; dactylus smooth, neither carinate nor tuberculate dorsally. Fourth walking leg stout, extending about to end of merus of third. Walking legs with some plumose setae on dorsal and ventral margins.

Male abdomen of 6 segments, fifth and sixth fused; telson short and broad. Female abdomen of 7 segments, lacking transverse line of hairs on posterior margin of second segment. Male gonopod simple, tapering distally, as figured.

Size.—Carapace length of male 2.3 mm, of ovigerous female 2.0 mm; carapace width of male 4.2 mm, of ovigerous female 4.3 mm. Ova measure 0.3 mm.

Remarks.—Initially we identified this species with *Pinnixa penultipedalis* Stimpson (1858:108; 1907:143), a species originally described from Hong Kong. However, Stimpson's species was characterized by him as having a smooth and glossy carapace with a distinct transverse ridge posteriorly, a small palm on the cheliped, a very broad merus on the third walking leg (height $\frac{4}{5}$ length), and a line of setae on the posterior margin of the second somite of the abdomen in the female. Our species differs in numerous features: it lacks a distinct ridge posteriorly on the carapace, the surface of the carapace is punctate, not smooth, there is a distinct tuberculate ridge on each branchial region, the palm of the cheliped is large, and the posterior margin of the second abdominal somite in the female is not setose.

Indopinnixa sipunculana also resembles the species identified by Shen (1937:298) with *Pinnixa penultipedalis* Stimpson, especially in the shape of the carapace and the general proportions of the walking legs. Shen's species, which probably is undescribed, differs from *P. penultipedalis* and resembles *I. sipunculana* in lacking a distinct ridge across the posterior part of the carapace. Our species differs from Shen's in having a tuberculate ridge across each branchial region as well as a strong tooth on the cutting edge of the dactylus of the cheliped. Our species further differs in lacking dorsal tubercles on the palm and movable finger of the cheliped and on the upper margin of the dactyls of the walking legs, as well as the line of setae on the posterior margin of the second abdominal segment of the female. Further, the eyes of our species are shorter and the merus of the third walking leg is not nearly so high as in Shen's species.

Indopinnixa sipunculana also is similar to the species from Inhambane, Mozambique, identified by Barnard (1955:19) with *Pinnixa penultipedalis,* to our knowledge the only other record of a pinnotherid crab living with a sipunculan. Barnard's species, which, like Shen's, is probably undescribed, has a sharp ridge across the posterior part of the carapace and lacks the tuberculate branchial ridges as well as the toothed dactylus on the cheliped. Barnard's species fur-

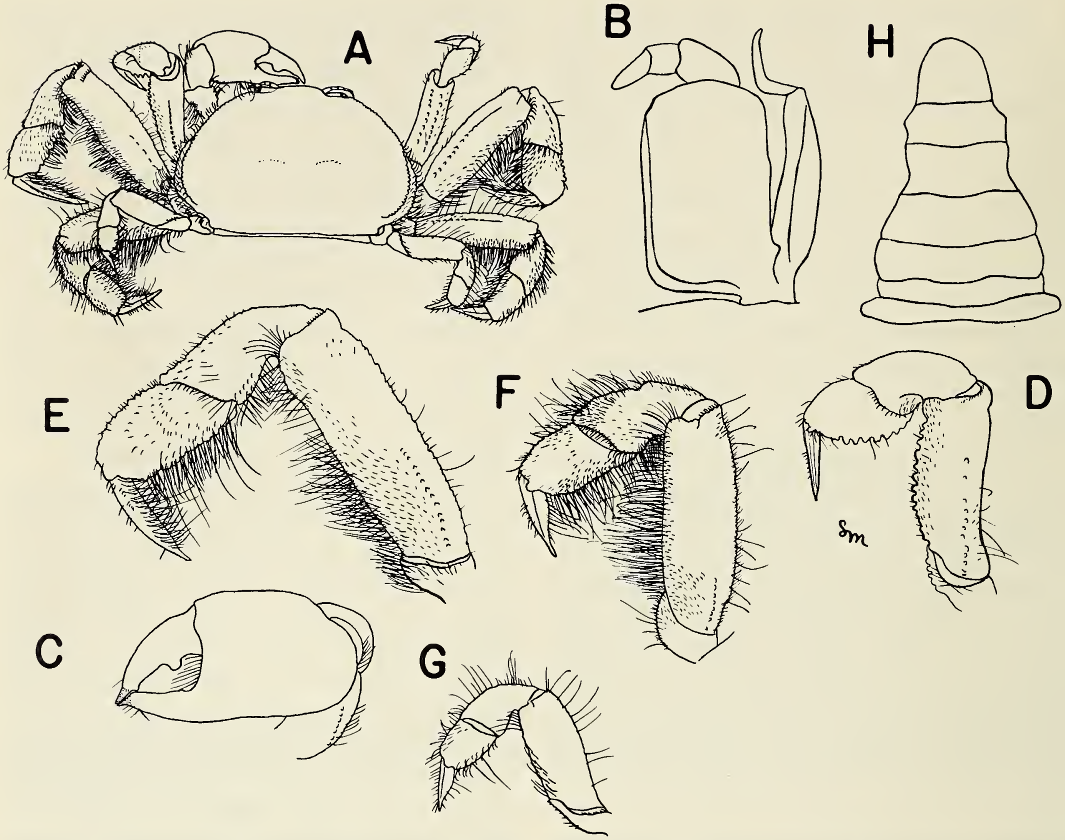

Fig. 2. *Mortensenella forceps* Rathbun, 1909. Male, Hong Kong: A, Dorsal view; B, Third maxilliped; C, Cheliped; D, Second pereopod; E, Third pereopod; F, Fourth pereopod; G, Fifth pereopod; H, Abdomen.

ther differs in having three segments on the male abdomen fused, rather than two as in *I. sipunculana.*

Excluding *Pinnixa brevipes* H. Milne Edwards, 1853, from Madagascar, which may not be a *Pinnixa* (see comments in Serène (1964:277) and Schmitt, McCain, and Davidson (1973:103), for references), and records of the American *Pinnixa faba* (Dana, 1851) from Australia and Tasmania, which may be erroneous (see Rathbun 1918:142), five species of *Pinnixa* are known from the Indo-west Pacific. All five have been reported from Japan and were treated by Sakai (1976:583). Three of the five species, *P. balanoglossana* Sakai, 1934, *P. haematosticta* Sakai, 1934, and *P. penultipedalis* Stimpson, 1858, have a distinct ridge across the posterior part of the carapace and can be distinguished from *I. sipunculana* on this feature alone.

The other two species, *P. rathbuni* Sakai, 1934, and *P. tumida* Stimpson, 1858, lack distinct branchial ridges, and can be distinguished from *I. sipunculana* on this feature. So far as we can tell, the male abdomens of both of those species are made up of seven free segments; see Yokoya (1928: fig. 6 (*P. rathbuni*) and fig. 7 (*P. tumida*)).

Morton and Morton (1983:78, 204) reported that the entoproct *Loxosomella* occurs on *Indopinnixa sipunculana.*

Etymology.—The specific name alludes to the association of this species with sipunculan worms.

Mortensenella forceps Rathbun, 1909
Fig. 2

Mortensenella forceps Rathbun, 1909:111; 1910:337, fig. 21, pl. 1, fig. 18.—Dai, Feng, Song, and Chen, 1980:137, fig. 9.—Morton and Morton, 1983:177, 204, fig. 9.14.
Asthenognathus inaequipes.—Morton and Morton, 1983:204. [Not *A. inaequipes* Stimpson, 1858.]

Material.—Tai Tam, Hong Kong; in burrows of *Siphonosoma cumanense,* 19 Dec 1974, leg. B. Morton, 1 male, 1 female, USNM 222501.

Size.—Carapace length of male 5.0 mm, of female 4.6 mm; carapace width of male 8.0 mm, of female 7.5 mm.

Remarks.—These specimens agree well with the accounts of this species given by Rathbun (1909, 1910) and Dai et al. (1980) except that figures given in each of those accounts show the third maxilliped to have an indistinct suture between the ischium and merus; no suture is visible in either of our specimens.

Rathbun's material, from Koh Chang, Thailand, was taken from very shallow water, "outside mangroves." Morton and Morton (1983) recorded this species from Hong Kong as an associate of the echiuroid worm *Ochetostoma erythrogrammon* Leuckart and Rüppel, 1828. The material reported by Dai et al. (1980) was taken off Hainan Island, China; no host was recorded by those authors. These are the only records of this species known to us.

The Sipunculans and Their Associates

Sipunculus nudus Linnaeus

Two associates were found with this species: the leptonacean bivalve *Fronsella ohshimai* Habe, 1958, and an undescribed genus and species of pinotherid crab (Table 1, Fig. 3). The bivalve is an unusual commensal in that it often attaches directly to the host. Up to nine individuals have been recorded attached to a single host by byssal threads, apparently on the posterior valve margins. The brachyuran *Indopinnixa sipunculana* also has been recorded regularly in the burrows, usually as solitary individuals. Ovigerous females of the crab were taken in June of 1974 and 1982. In only one instance (June 1982) were bivalve and crab simultaneously recorded in the same burrow. Mean numbers of bivalves and crabs per host were 5 (range 1–9) and 1, respectively.

Table 1.—Records of the occurrences of burrow associates of *Sipunculus nudus* and *Siphonosoma cumanense* from Tai Tam Bay, Hong Kong (M = male, F = female, ovig. = ovigerous).

	S. nudus		*S. cumanense*	
Date	*Fronsella ohshimai*	*Indopinnixa sipunculana*	*Nipponomysella subtruncata*	*Mortensenella forceps*
20/6/74		1M		
20/6/74		1F ovig.		
20/6/74		1F ovig.		
20/6/74		1F ovig.		
20/6/74			3	
20/6/74			2	
19/12/74	3			
19/12/74				1M, 1F
2/6/77		1M		
2/6/77		1M		
2/6/77	1			
2/6/77		1M		
2/6/77			3	
2/6/77			4	
23/4/79			1	
23/4/79			4	
23/4/79		1M		
26/8/80	9			
26/8/80	7			
26/8/80				1M
26/8/80			7	
21/6/82	8	1F ovig.		
30/1/84	2			
30/1/84			5	
30/1/84			2	
30/1/84			2	
Mean	5	1	3.3	1.5

Siphonosoma cumanense (Keferstein)

Two associates were recorded with this species: the leptonacean bivalve *Nipponomysella subtruncata* (Yokoyama) and the pinnotherid crab *Mortensenella forceps*

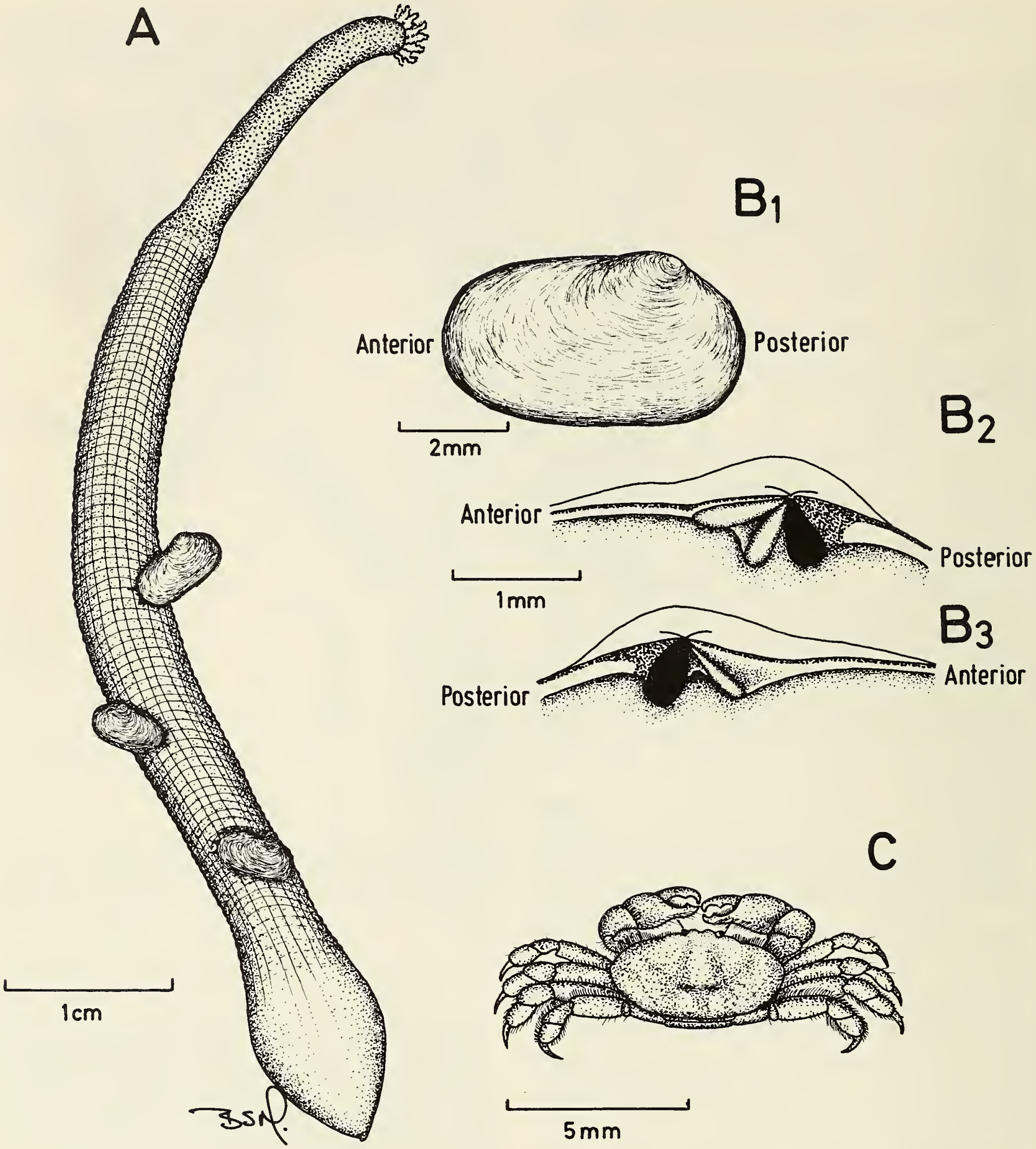

Fig. 3. A, *Sipunculus nudus* with 3 specimens of *Fronsella ohshimai* attached. B, *Fronsella ohshimai*: B1, External view of left shell valve; B2, Interior view of hinge plate of right shell valve; B3, Interior view of hinge plate of left shell valve. C, *Indopinnixa sipunculana*.

Rathbun (Table 1, Fig. 4). The former lies laterally adpressed, but not attached byssally, against the burrow wall. Up to seven individuals were recorded from a single burrow. The crab *Mortensenella forceps* was recorded from the burrows on two occasions. On 26 August 1980 a single male was collected, and on 19 December 1974 a pair of crabs was taken. Mean numbers of bivalves and crabs per host were 3.3 (range 1–7) and 1.5, respectively.

Discussion

Sipunculans are well known as hosts of leptonacean bivalves. Boss (1965) and Ste-

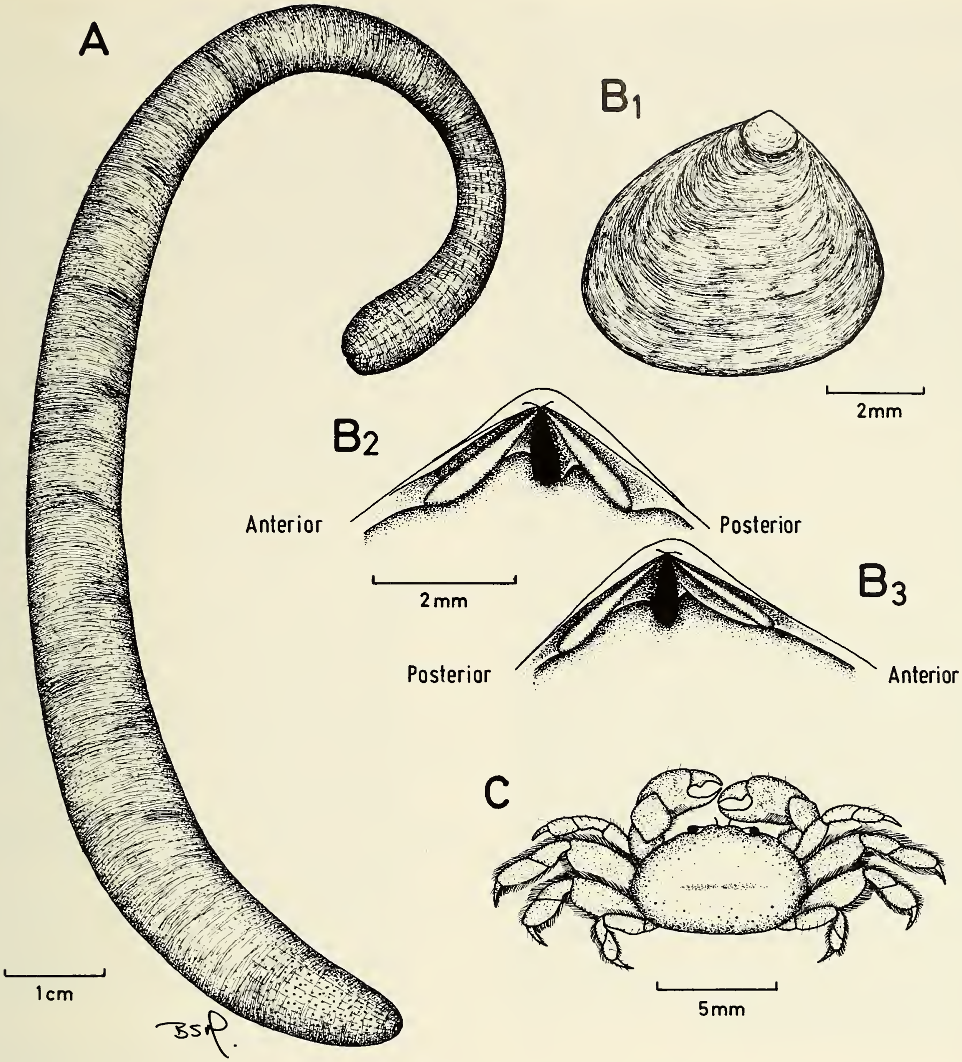

Fig. 4. A, *Siphonosoma cumanense.* B, *Nipponomysella subtruncata*: B1, External view of left shell valve; B2, Interior view of hinge plate of right shell valve; B3, Interior view of hinge plate of left shell valve. C, *Mortensenella forceps.*

phen and Edmonds (1972) have reviewed much of the literature detailing such associations. The most detailed study of such an association, i.e., *Mysella cuneata* (Verrill and Bush) with *Phascolion strombi* (Montagu), is that of Gage (1968). Both of the leptonaceans found with sipunculans in Hong Kong have been recorded from the same hosts elsewhere. *Fronsella ohshimai* is a known associate of *Sipunculus nudus* from Japan (Habe 1958, 1961, 1964, 1977; Koyama et al. 1981); as in Hong Kong, it attaches to the worm by byssal threads. Similarly, *Nipponomysella subtruncata* is known to be a commensal of *Siphonosoma cumanense* elsewhere, e.g., Utinomi (1972) as *Mysella subtrucata* [sic]. Koyama et al. (1981) reported it, possible erroneously, to be associated with *Sipunculus nudus.*

In Hong Kong, these two bivalves occur

in groups of, on the average, 5 for *F. ohshimai* and 3.3 for *N. subtruncata.* They almost certainly capitalize on the flow of oxygenated water through the burrow, and, concomitantly, on suspended food particles.

Herein we have corrected identifications by Morton and Morton (1983) of the pinnotherid crabs also inhabiting the burrows of the two sipunculans.

Of interest is that each sipunculan has a pair of associates that are different from, and mutually exclusive of, the other pair. Furthermore, each of the pairs of associates seems mutually exclusive, so that each sipunculan possesses either a bivalve, in varying numbers, or a crab, either singly (more commonly) or as a pair. What determines selective burrow occupation is unknown, but it seems possible that the more active crabs may inhibit establishment of the more sedentary bivalves. There is no other information on this aspect of such relationships, Stephen and Edmonds (1972), for example, not recording crabs as sipunculan associates and giving few examples of multiple commensalism, e.g., the annelid, bivalve and entoproct associates of *Phascolion strombi* (Montagu), but not mutual exclusivity. The Hong Kong sipunculans and their associates may have much to offer in gaining an understanding of these poorly understood taxa and neglected phenomena.

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THE PYCNOGONIDA TYPES OF H. V. M. HALL

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Abstract.—The five recently rediscovered pycnogonid types described by Harry V. M. Hall (1912, 1913) are reexamined in terms of current literature and synonymies. One species remains valid as originally named (*Anoplodactylus californicus*), two remain valid under different but currently accepted genera (*Nymphopsis spinosissima, Callipallene californiensis*), and two are reduced to synonymy under previously named species (*Ammothea nudiuscula* as *Achelia alaskensis,* and *Ammothella biunguiculata* var. *californica* as *A. biunguiculata*). The name *Anoplodactylus californicus* Hall, 1912, takes precedence over the frequently encountered *A. portus* Calman, 1927, which is reduced to a synonym.

Harry V. M. Hall published two short papers (1912, 1913) describing four new pycnogonid species and one new variety, all from California. He named these five *Anoplodactylus californicus, Ammothella biunguiculata* var. *californica, A. spinosissimus, Ammothea nudiuscula,* and *Pallene californiensis.* These species have been largely ignored or sometimes reported in the literature, but have never had the benefit of reexamination in light of current literature, nor have Hall's specimens ever been available for comparison. Hall did not deposit the species in the Museum of the University of California (Berkeley) as he stated (1913: 127), and they were therefore regarded as lost. Hedgpeth (1939:461–463, fig. 2m–r) even named a neotype and redescribed one of the species and listed several other of Hall's species as part of the California fauna while republishing Hall's inadequate figures for three of them. Hedgpeth, in California, could not find Hall's types either.

The estate of Leon J. Cole donated to the National Museum of Natural History in 1939 Cole's pycnogonid literature, files, types on slides and in alcohol, and other miscellaneous specimens. A bottle of Cole's types in alcohol was subsequently misplaced and lost, and has only recently come to light. This most important bottle of the Cole collections contains all of Cole's types and other specimens not mounted on slides and also contains most of the material published by Hall in 1913 (127–142). The Hall labels are presumably in his handwriting and not Cole's, many examples of which are available for comparison in Cole's files and with his specimens. Hall (1912:91, 1913: 128) acknowledged the assistance of Cole in his work on the pycnogonids of California and he presumably sent Cole his later material for examination. Cole evidently kept this material with his own specimens and it subsequently came to the National Museum upon his death. There are specimens of all five of the above species, identified by Hall, along with several others listed in his 1913 paper, including the types of the two species he described therein. The discovery of this long-lost material finally permits clarification of the status of Hall's species, some 75 years after they were originally described.

Achelia alaskensis (Cole)

Ammothea alaskensis Cole, 1904:266–268, pl. 12, fig. 4, pl. 17, figs. 4–12.—Losina-Losinsky, 1933:59–60, fig. 10.—Schmitt, 1934:70.—Exline, 1936:421.—Okuda,

1940:73–86, figs. 1–10.—Losina-Losinsky, 1955:160, pl. 42, fig. 6.
Ammothea (*Achelia*) *alaskensis*: Schimkewitsch, 1929:151–156, figs. 42,45.—Ohshima, 1933:144–146, fig. 1; 1936:866.
Achelia alaskensis: Hedgpeth, 1949:289 [text].—Utinomi, 1954:14, figs. 6–7.—Losina-Losinsky, 1961:91.—Utinomi, 1971:329.—Kim and Hong, 1986:44–46, fig. 7.
Ammothea nudiuscula Hall, 1913:135–137, pl. 3, figs. 1–8.—Hilton, 1939a:32.—Hedgpeth, 1941:256 [key], pl. 10.—Hilton, 1942g:93.
Achelia nudiuscula: Hedgpeth, 1964:208 [key], fig. 94b.
Achelia gurjanovii Losina-Losinsky, 1961: 93–95, fig. 18.

Material examined.—Holotype (*Ammothea alaskensis* Cole, 1904), male, Orca, Alaska; Allotype, female, Orca; Paratypes, 2 females, Popof Island, Alaska; Holotype (*Ammothea nudiuscula* Hall, 1913), female; San Francisco, California.

Remarks.—I can find no reference in Cole's papers or notes in which he identified or recognized Hall's species as his previously described Alaskan species. The slight differences between Hall's specimen and that figured by Cole are evident in the variation among the three females in Cole's type lot. Almost all of Cole's later work on pycnogonids treated Atlantic species, as he was based for field work on the Atlantic coast of America or Bermuda and did not publish again on California species.

This species is conspicuous among the bewildering numbers of *Achelia* species found in northwestern North America by its lack of heavily setose or tuberculate lateral processes. The lateral processes, aside from bearing one or two tiny anterolateral setae, are usually without other adornment. The four terminal segments of the palp are always short, only about as long as their widths, and the first coxae each bear a single dorsodistal tubercle which is broad but only slightly longer than its width. The legs are quite setose in the male but much less so in the female, and the abdomen is most often carried horizontally. The ocular tubercle is shorter than its basal width. The distal tubercle on each chelifore first segment is variously pointed, rounded, or a low swelling in the several types examined, but is always more acutely pointed in the male.

I tentatively place *Achelia gurjanovii* Losina-Losinsky in this synonymy even though the type figures are rather diagramatic and I have no specimens bearing this name. The proboscis of Losina-Losinsky's specimen (1961:94, fig. 18A) is narrower than that of the material in hand; there are apparently randomly-placed small lateral process tubercles, and a full segmentation line exists between the first and second trunk segments which is not evident or only faintly present in Cole's material. There is a great similarity between Losina-Losinsky's figures of the appendages and those of Cole (1904, pl. 17). The ovigers and legs are almost exactly the same, but the palp segments of *A. gurjanovii* are slightly longer and more slender. I consider these differences to be those of geographically different populations, particularly in a genus in which some species display enormous variation (e.g., *A. assimilis* (Haswell)). This question must be settled by collection and comparison of fresh material of *A. gurjanovii* and *A. alaskensis* from both sides of the northern Pacific.

The distribution of this species, as proposed above, is now known to be from the mid-California coast through Alaska and the Russian and Korean coasts to the middle of Japan, in littoral habitats to as deep as 180 meters.

Ammothella biunguiculata (Dohrn)

Ammothea bi-unguiculata Dohrn, 1881:26, 105, 158–160, pl. VIII, figs. 1–3.
Ammothella biunguiculata: Stock, 1974:12–13 [literature], fig. 1.
Ammothella biunguiculata var. *californica*

Hall, 1912:93–95, figs. 50, 52A, E, G, K; 1913:130, 132 [key].—Hilton, 1915a:68; 1915b:204; 1920:93.

Material examined.—Topotypes, 81 specimens, Laguna Beach, California, NW of pier under stones, coll. H. V. M. Hall, Jul 1912.

Remarks.—Hilton carried Hall's trinomial through several of his superficial papers, but it was Hedgpeth (1941:259) who first proposed that Hall's species was a synonym of Dohrn's species without the varietal designation. Stock (1974:95) combined all three varieties under Dohrn's species, to which I agree. If the varieties of this species were to be maintained, then the genus *Achelia* would, by the same reasoning, be crowded with varieties or subspecies unnecessarily encumbering the many variable species of this genus.

This species has been found in many shallow localities of the oceans of the world and may eventually become known as a pantemperate species. It is known to be distributed from the littoral to 135 meters.

Nymphopsis spinosissima (Hall)

Ammothella spinosissima Hall, 1912:95–99, figs. 51, 52B, D, H; 1913:130, 132 [key].—Schmitt, 1934:69.—Hilton, 1915a:68; 1915b:204; 1920:93; 1939a:32.

Nymphopsis spinosissimus: Hedgpeth, 1939: 461–463, fig. 2m–r [Neotype].—Hilton, 1939b:72, fig. 3; Hedgpeth, 1941:256 [key], pl. 11.

Nymphopsis spinosissima: Hilton, 1942b: 278, 300–302, fig. 44; 1943:98.—Hedgpeth, 1951:110.—Stock, 1955:253.—Hedgpeth, 1964:206, fig. 94f.

Material examined.—Topotypes (*Ammothella spinosissima* Hall, 1912), 2 females, Laguna Beach, California, NW of pier in tide pool, coll. Metz, Jul, 1912; Neotype (*Nymphopsis spinosissimus*: Hedgpeth, 1939), male, Corona Del Mar, California, coll. G. E. MacGinitie, 27 Mar 1938, in 22–31 meters; also other specimens reported on by Hilton and Hedgpeth.

Remarks.—The type specimen described by Hall in 1912 was not among the Cole and Hall types and presumably has been lost. Hedgpeth's male neotype therefore remains valid for this easily recognized species. Hall's topotypes can not be regarded as type material as they were collected subsequent to the original description. Hedgpeth's (1939) figures of this species are adequate to allow its differentiation from the other known California species, *N. duodorsospinosa* Hilton which has two prominent dorsal trunk tubercles instead of the three found on this species.

The distribution of this shallow-water (0–31 m) species now extends from the state of Washington to southern California, but it has not been found yet along the west coast of Mexico where its place is apparently taken by *N. duodorsospinosa.*

Anoplodactylus californicus Hall

?*Nymphon dubium* Nicolet in Gay, 1849: 307; 1854: fig. 10.

Anoplodactylus californicus Hall, 1912:91–93, figs. 49, 52D, F, I, J; 1913:129–130, pl. 4, figs. 14–16.—Hilton, 1915a:69; 1915b:201, 205; 1916:27 [text]; 1920:93; 1939a:29.—Marcus, 1940:40 [key].—Hilton, 1942b:277 [list], 286–288, pl. 38; 1942d:72.

Anoplodactylus californiensis [sic]: Hedgpeth, 1941:257 [key], pl. 11.

Anoplodactylus portus Calman, 1927:405–408, fig. 103.—Sawaya, 1950:70 [key].—Stock, 1954:128; 1955:238–239; 1958a: 4; 1958b:140–141; 1962:218.—Lipkin and Safriel, 1971:9.—Stock, 1975:1052–1053, fig. 41b–e.—Child, 1975:201.—Birkeland et al., 1976:158.—Child, 1978: 133–144, figs. 1–4; 1979:58–59.—Stock, 1979:15.—Child, 1982:373.

Anoplodactylus robustus Hilton, 1939a:28–29 [non *A. robustus* (Dohrn, 1881)];

1942a:288–291, pl. 39; 1942d:72.—Hedgpeth, 1941:257 [key].
Anoplodactylus carvalhoi Marcus, 1940:50–54, fig. 3a–k.—Hedgpeth, 1943:46; 1948:230–232, fig. 30e–g.—Sawaya, 1950:70 [key].—Bourdillon, 1955:592–593, pl. 1, figs. 9–10.
Anoplodactylus projectus Hilton, 1942c:45–47, fig. 3; 1942d:72.
[non *Anoplodactylus portus* Calman var. *chilensis* Hedgpeth, 1961:5–7, fig. 2].

Material examined.—Topotypes (*Anoplodactylus californicus* Hall, 1912), 2 males with eggs, 1 male, 5 females, Laguna Beach, California, NW of pier, coll. Hall and Metz, 16 Jul 1912. Also many specimens identified as *A. portus* from California.

Remarks.—It is unfortunate that Hall carried his wide use of geographical epithets to this species because it is now known to be pantemperate-pantropical in distribution, predominantly in shallow water. It is not surprising that this species turns out to be widely known, first, because of Hall's poor figures of his type which render it almost impossible to compare with other species, and second, because Cole was presumably the only other pycnogonid specialist to see the specimens, if he indeed examined them at all. Cole never published on pycnogonids of California after Hall's 1912 description of the species and he was no longer working on pycnogonids by the time Calman (1927) published this species as *A. portus.*

The species is easily recognized by its robust appearance, very hirsute oviger strigilis, tiny distally pointing cement gland tube, long sex pore tubercles on the second coxae in male specimens, and the peculiar alar processes placed proximoventrally on the female proboscis. While none of these characters is unique to this species, no others, at least along the California coast, share this set of characters.

The description and figures of *A. portus* Calman var. *chilensis* Hedgpeth (1961:5–7, fig. 2) do not fit well with this species. The major differences occur in the oviger, a rather stable character in this genus as it is in most Pycnogonida. In Hedgpeth's variety, the oviger segment lengths are different from typical specimens and the terminal segment is not heavily setose. The female lacks the typical palp buds but has the proboscis alar processes, both of which are quite prominent in this species. The propodal heel has one major spine while both Hall's and Calman's type specimens have two heel spines. These differences are not in themselves conclusive proof that the Chilean material is a different species, particularly without examining the Chilean specimens first hand, but it would not be surprising if, with more material, this variety were eventually to be called *A. chilensis.*

Callipallene californiensis (Hall)

Pallene californiensis Hall, 1913:131, 133–135, pl. 4, figs. 9–13.—Hilton, 1915a:67; 1916b:465, fig. 6; 1920:93.
Palene [sic] *californiensis*: Hilton, 1915b:204; 1939a:29.
Callipallene californiensis: Hedgpeth, 1941:257 [key], pl. 11.—Hilton, 1942b:277, 281–282, pl. 36; 1942c:38.—Correa, 1948:6 [key].—Hedgpeth, 1964:204 [key].
Callipallene solicitatus Child, 1979:44–46, fig. 15.

Material examined.—Holotype (*Pallene californiensis* Hall, 1913), male, Laguna Beach, California, Mussel Point, Cowards Cove, under stones in channel, coll. Hall, 15 Aug 1912; Holotype (*Callipallene solicitatus* Child, 1979), male, Isla del Espiritu Santo, Bahía Ballenas, Baja California (Gulf side), Mexico, coll. J. L. Barnard, 28 Nov 1971; also, the Mexican and Panamanian paratypic series, and twenty specimens collected by W. A. Hilton between 1914 and 1934 in southern California.

Remarks.—This species has been obscure in the literature with most authors subsequent to Hall accepting his description and figures (and sometimes reproducing the figures) without adding further to the description or information. It has not been commonly found in California and until the species was redescribed (as *C. solicitatus* Child, 1979), no adequate figures of all diagnostic characters had been published.

The species has a relatively short neck, a very setose and spinose propodus bearing four or five heel spines, a large setose apophysis on the male fifth oviger segment, and many small chela finger teeth.

In its more southern range (Panama), as far as its range is known, it apparently prefers subtidal depths and has been found on settling plates in 8 to 10 meters and on subtidal *Balanus* colonies. In California and Mexico, most of the captures appear to be intertidal with some listed as "on rocks."

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FURTHER RECORDS OF MARINE ISOPOD CRUSTACEANS FROM THE CARIBBEAN

Brian Kensley

Abstract.—Five species of isopods are described from Belize. The anthurid *Mesanthura bivittata,* new species, is characterized primarily by its double-barred dorsal color pattern. The idoteid *Miratidotea bruscai,* new genus and species, is characterized chiefly by possessing a pleon consisting of two complete and two incomplete pleonites plus pleotelson. The cirolanid *Anopsilana jonesi,* new species, can be distinguished by its non-projecting pentagonal frontal lamina and a color pattern having a dark central area on the pereonites. *Eurydice personata* (family Cirolanidae), often confused with *E. convexa* and *E. littoralis,* is characterized by the possession of a slender, lanceolate frontal lamina. The new cirolanid genus and species *Xylolana radicicola,* taken from dead mangrove roots, features a fused rostrum and frontal lamina, a strongly projecting clypeus, an overlapping fourth pleonite, distally articulating copulatory stylet, and a produced uropodal sympod. The sphaeromatid *Paraleptosphaeroma glynni,* described from Pacific Panama, is recorded for the first time from the Caribbean.

Anyone following the literature on Caribbean marine isopods will have noted a series of my papers, appearing at irregular intervals, and often covering material from Belize. No doubt the question has been raised: why this dribble of short papers, instead of a single comprehensive work? In compiling a guide to the marine isopods of the Caribbean, I am attempting to deal with as many species as possible, and as new material becomes available, it has been necessary to publish new species before including them in the abovementioned guide. A further factor has contributed to this plethora of titles, viz. continued sampling in the area around Carrie Bow Cay, Belize, over the past nine years. With such concentrated sampling, it is inevitable that rarer species eventually are collected, and that as more and more specialized habitats are investigated, new species will be revealed. As an example of the latter case, see the description in this paper, of a new genus and species, collected less than one hundred meters from the field laboratory on Carrie Bow Cay. This was the first time, however, that the root-mat of the seagrass *Syringodium* had been sampled. No doubt similar concentrated collecting in other areas of the Caribbean will reveal yet more undescribed forms, and this trickle of taxonomic papers will perforce continue.

Family Anthuridae

Mesanthura bivittata, new species

Figs. 1, 2

Material.—Holotype, USNM 221718, ovig. ♀ TL 7.8 mm. Paratypes, USNM 221719, 1 non-ovig. ♀ TL 7.8 mm, 2 ♂ 5.2 mm, 6 immature specimens 3.0–4.8 mm. Twin Cays, Belize, in red mangroves, 1–2 m, coll. G. Hendler 28 Mar 1980.

Description.—Non-ovigerous female: Proportions C < 1 = 2 > 3 < 4 = 5 = 6 > 7. Cephalon with low rounded rostrum; large well pigmented dorsolateral eyes. Articular hollow between pereonites 1 and 2, and 2 and 3. Pleonites 1–5 fused, subequal to per-

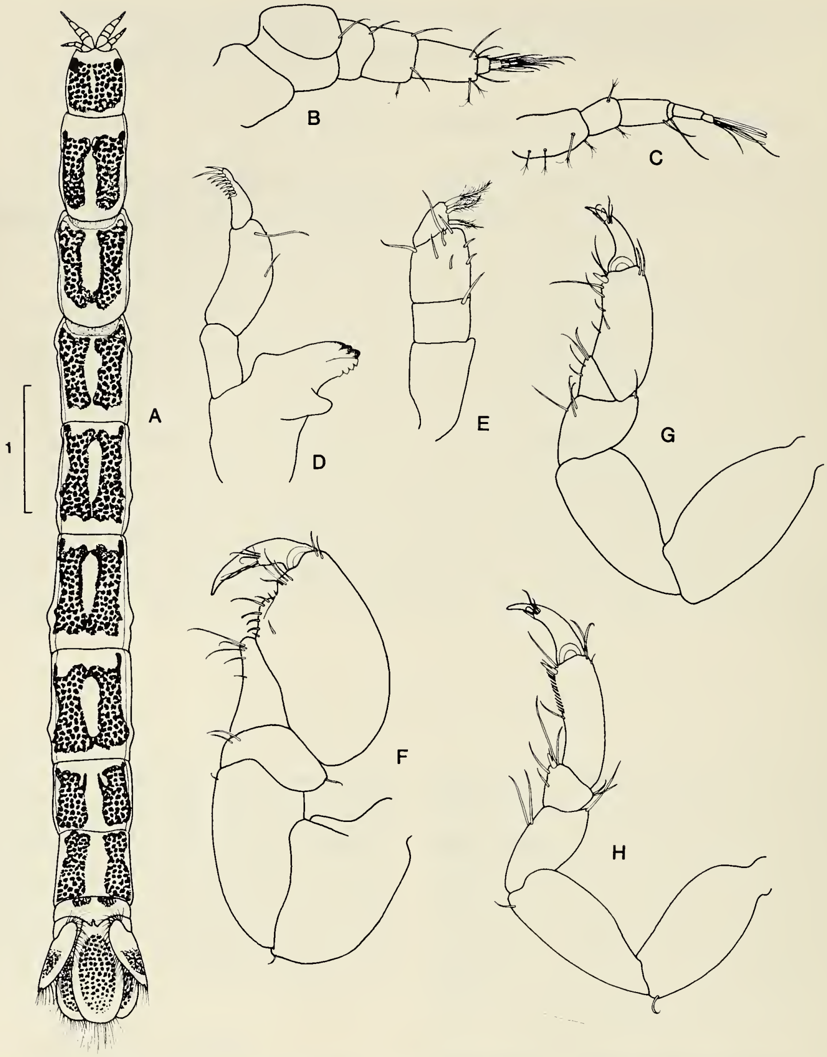

Fig. 1. *Mesanthura bivittata,* ovigerous female: A, Entire animal in dorsal view; B, Antenna; C, Antennule; D, Mandible; E, Maxilliped; F, Pereopod 1; G, Pereopod 2; H, Pereopod 7.

eonite 7 in length; pleonite 6 dorsally free, with small middorsal notch in posterior margin. Telson widest at midlength, posterior margin broadly rounded and bearing numerous elongate simple setae.

Antennular peduncle of 3 articles, basal article longest and broadest; flagellum of 3 articles, terminal article bearing 3 aesthetascs. Antennal peduncle of 5 articles; flagellum of 4 short setose articles. Mandibular palp of 3 articles, terminal article with 8 or 9 spines; incisor of 3 sclerotized cusps; lamina dentata with 4 serrations. Maxilliped lacking endite; palp of 3 articles, terminal article narrower than preceding article, bearing 3 stout fringed setae on medial margin. Pereopod 1, carpus distally rounded; propodus expanded, palm with rounded lobe in proximal half bearing few marginal setae; unguis subequal to rest of dactylus in length. Pereopod 2, carpus short, triangular, lacking free anterior margin; propodus not expand-

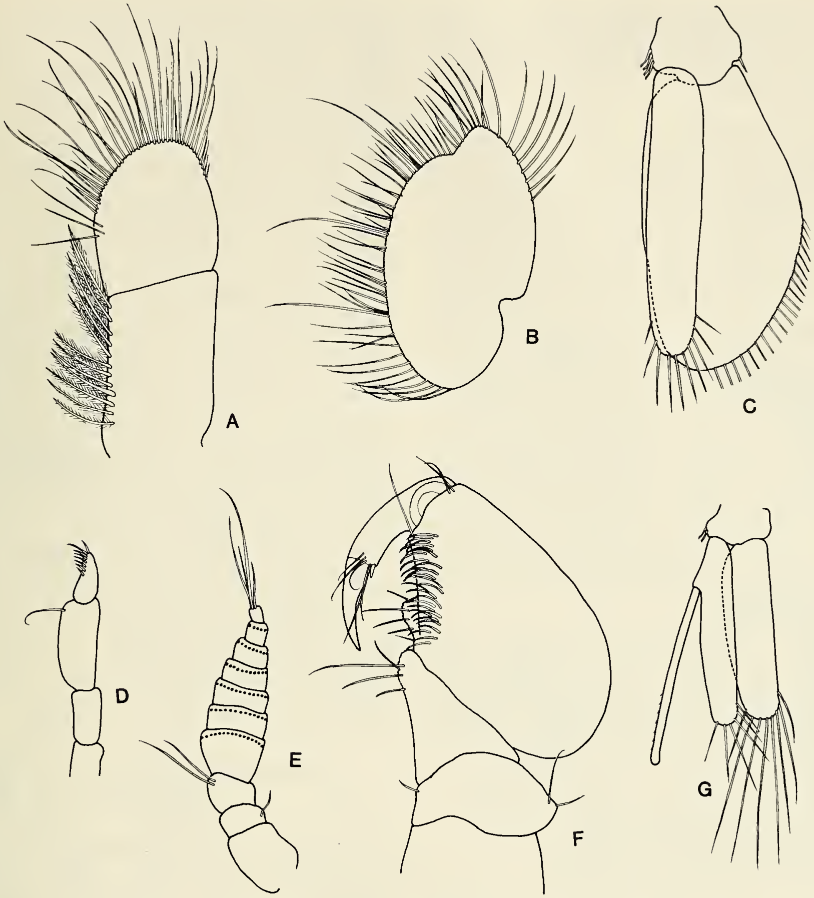

Fig. 2. *Mesanthura bivittata,* ovigerous female: A, Uropodal endopod and sympod; B, Uropodal exopod; C, Pleopod 1. Male: D, Mandible; E, Antennule, aesthetascs indicated by insertions only; F, Pereopod 1; G, Pleopod 2.

ed, bearing single short posterodistal spine. Pereopods 4–7, carpus with anterior margin shorter than posterior, latter with single sensory spine; propodus with row of short spinules in distal half of posterior margin plus single sensory spine. Pleopod 1, exopod operculiform, subequal in length but 3 times wider than endopod; latter with 10 distal plumose setae. Uropodal exopod with notch in distal margin; most of margin bearing elongate setae; endopodal distal margin broadly rounded, bearing numerous elongate setae.

Male: Antennular flagellum of 7 articles, first 6 bearing distal band of aesthetascs. Mandible consisting of palp attached to short featureless basal structure. Pleopod 2, endopod with copulatory stylet articulating in proximal half, slender, cylindrical, distally rounded, reaching well beyond apex of ramus.

Color pattern.—Similar in male and female. Large dark-brown chromatophores arranged in broad patch on cephalon stretching from eyes to posterior margin, with narrow elongate gap along midline; pereonites 1–6 with 2 broad elongate bands separated by fairly wide gap, bands touching anteriorly and/or posteriorly; pereonite 7 and fused pleonites 1–6 each with 2 widely separated bands. Pleonite 6 with 2 small patches. Telson with elliptical patch becoming posteriorly obsolete. Uropods with broad patch on each.

Remarks.—*Mesanthura bivittata* is the eighth species of the genus to be recorded from the Caribbean and/or the Florida Keys. *Mesanthura looensis* Kensley and Schotte, 1987, like the present species, possesses eight spines on the third article of the mandibular palp. Ovigerous at 10 mm, the Floridean species does not have the distinctive double-bar pattern seen in *M. bivittata. Mesanthura pulchra* Barnard, which has 10 spines on the mandibular palp, while having pigment patches with a central gap, does not have the well defined double-bar. The remaining five species have radically different color patterns and different numbers of mandibular spines.

Etymology.—The specific name is derived from the Latin, meaning 'two ribbons,' and refers to the double band of pigment that characterizes this species.

Suborder Valvifera
Family Idoteidae
Miratidotea, new genus

Diagnosis.—Antennal flagellum of single clavate article. Maxillipedal palp of 4 articles. Pleon consisting of 2 complete pleonites, 2 incomplete pleonites, plus pleotelson. Uropods uniramous.

Type species.—*Miratidotea bruscai,* new species. Gender: masculine.

Remarks.—Brusca (1984) placed the subfamily Idoteinae (to which the present genus and species clearly belong) on a sound taxonomic footing, with a phylogenetic analysis of the group. Using in particular the form of the pleon, this author presented a schematic plan (fig. 3) of the possible phylogenetic pathways that gave rise to the approximately 21 known genera of the subfamily. In this plan Brusca postulated several stages for which no forms are yet known. The present species clearly fits one of these postulated forms in the Lineage A, with its pleon consisting of 2 complete and 2 incomplete pleonites plus pleotelson. This pleonal formula places the present species phylogenetically close to *Cleantioides* Kensley and Kaufman, and indeed the similarities between these two genera, in antennal, mouthpart, pereopodal, and uropodal structure, are marked. Apart from the pleonal structure and minor proportional differences in the appendages, the main difference between *Miratidotea* and *Cleantioides occidentalis* (Richardson) lies in the pleotelson. In the latter, the dorsal margin of the planiform posterior pleotelson consists of two broadly rounded lobes (in dorsal view), barely projecting when seen in lateral view. In *Miratidotea,* these lobes are subacute, and project markedly in lateral view.

Etymology.—The generic names derives from the Latin 'miratio,' a surprise, plus 'idotea,' the frequently-used suffix taken from the family name Idoteidae.

Miratidotea bruscai, new species
Figs. 3, 4

Material.—Holotype USNM 221720, ovig. ♀ TL 13.0 mm; paratypes USNM 221721, 2 ovig. ♀ TL 10.2 mm, 11.5 mm; Carrie Bow Cay, Belize, from root-mat of seagrass *Syringodium filiforme* in 1.5 m depth, coll. B. Kensley, 11 Dec 1986.

Description.—Ovigerous female: Body elongate-cylindrical, about 6 times longer than wide. Anterior margin of cephalon with tiny midline notch in dorsal view. Eyes dorsolateral, reniform. Sparsely scattered setae over most of dorsal integument, but dense on posterior margin of pereonite 7 and coxa 7, and anterolateral pleon. Pereonite 1 and coxa fused; coxae 2–4 about half lateral length of pereonite, elongate-oval in shape; coxae 5–7 produced posteriorly into triangular subacute lobe. Pleonites 1 and 2 complete, subequal, ventrally tapering to narrowly-rounded free margin; pleonite 3 incomplete, with narrowly-rounded free

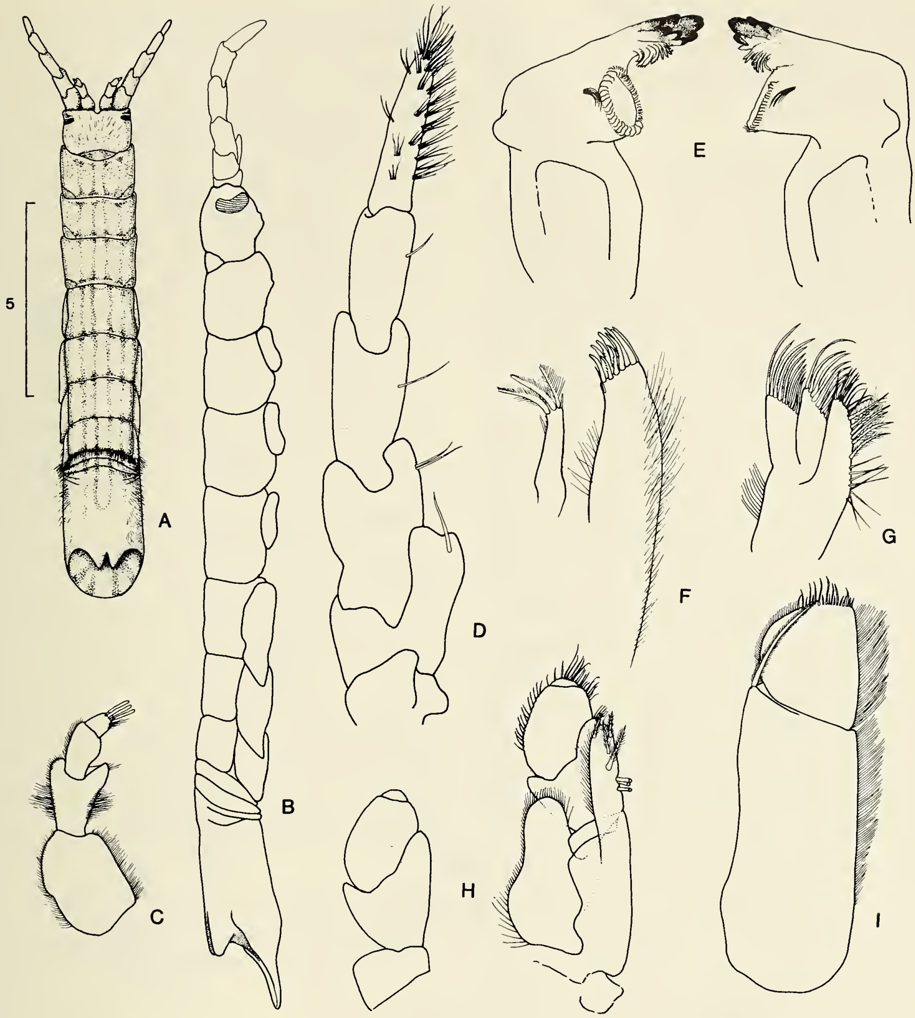

Fig. 3. *Miratidotea bruscai,* ovigerous female: A, Holotype in dorsal view; B, Whole animal in lateral view; C, Antennule; D, Antenna; E, Left and right mandibles; F, Maxilla 1; G,Maxilla 2; H, Maxilliped, with palp shown separately; I, Uropod.

ventral margin; pleonite 4 incomplete, lacking free ventral margin. Posterior planiform area of pleotelson with dorsal margin armed with 2 triangular submedian subacute posteriorly-directed lobes; ventral margin broadly rounded and forming posterior margin of pleotelson.

Antennule with 3-articled peduncle, basal article broadest and longest; article 2 triquestrous, distally hollowed for articulation of article 3; flagellum of single article about half length of peduncle article 3, bearing 3 distal aesthetascs. Antenna with peduncle of 5 articles, article 2 produced ventrally into broad lobe; flagellum of single clavate article bearing numerous ventrodistal setae. Mandible lacking palp; incisor of 4 cusps; lacinia of 3–4 cusps; 8 spines in spine-row; molar stout, distally with flattened circular surface. Maxilla 1, inner ramus with 3 distal fringed setae; outer ramus with about 10 distal spines, some of which serrate. Maxilla

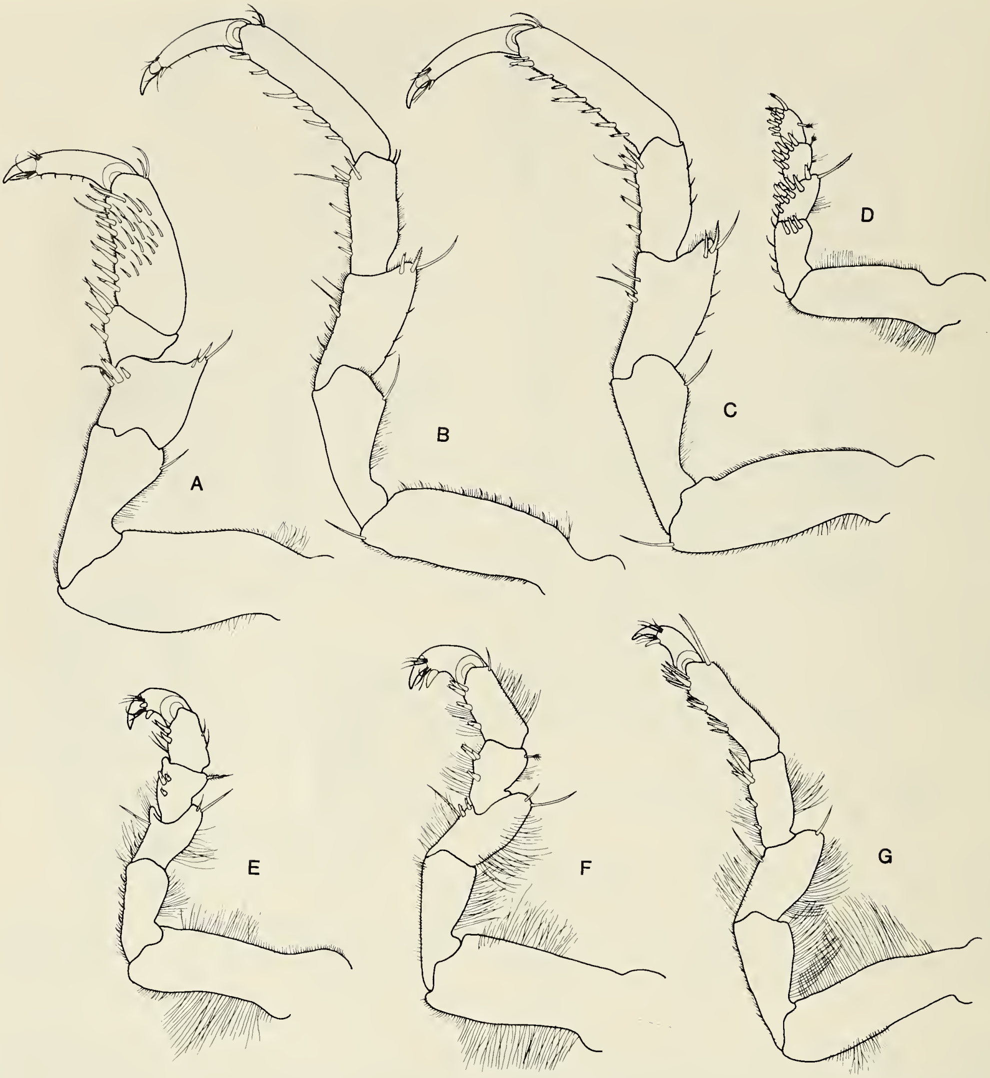

Fig. 4. *Miratidotea bruscai,* ovigerous female: A, Pereopod 1; B, Pereopod 2; C, Pereopod 3; D, Pereopod 4; E, Pereopod 5; F, Pereopod 6; G, Pereopod 7.

2, both lobes of outer ramus bearing numerous fringed spines; inner ramus with simple and sparsely fringed spines along mesial margin. Maxillipedal endite bearing 3 coupling hooks, several distal fringed spines; palp of 4 articles, article 2 longest and broadest, terminal article short. Pereopod 1, merus with 3 posterodistal spines; carpus triangular, with 4 posterodistal spines; propodus somewhat expanded, with 7 spines on posterior margin and numerous smaller spines on mesial surface; unguis about half length of rest of dactylus. Pereopods 2 and 3 similar, longer than pereopod 1; merus with 2 anterodistal fringed spines; carpus roughly rectangular, with 5 sensory spines and one fringed spine on posterior margin; propodus elongate-rectangular, with 6 or 7 spines on posterior margin. Pereopod 4 short, equal in length to ischium and basis of pereopod 3; ischium with 3 distal spines; merus with 9 spines on posterodistal surface; carpus with 8 spines on posterodistal surface; propodus with 7 spines on posterodistal surface; dactylus reduced to length of a spine but distally corneous. Pereopod 5, basis, ischium, and merus with elongate setules; carpus with 3 spines on posterior margin; propodus with 2 posterior spines; dactylus strongly hooked, approaching biunguiculate state. Pereopod 6 with elongate setules on basis, ischium, and merus; merus with 2 posterodistal spines; carpus with 4 posterodistal spines; propodus with 5 posterodistal spines; dactylus hooked, biunguiculate. Pereopod 7, elongate setules on basis, ischium, and merus; posterior margin of carpus with 2 separate, and clump of 4 spines on posterior margin; propodus with 3 clumps of spines on posterior margin; dactylus hooked, biunguiculate. Uropod with single ramus slightly less than half length of sympod, latter with elongate fringed seta at outer distal angle.

Color pattern.—Dorsal integument overall red-brown, with 6 darker longitudinal stripes running from pereonite 1 onto pleon. Cephalon with faint reticulation of color. Posteroventral area of pleotelson with 4 faint darker rays of brown.

Etymology.—The species is named for Dr. Richard C. Brusca, as a small recognition of his valuable contributions to isopod research.

Family Cirolanidae

Anopsilana jonesi, new species

Figs. 5, 6

Material.—Holotype, USNM 221722, ♂ TL 6.2 mm, paratypes, USNM 205679, 3 ♂ 5.6–6.7 mm, 5 non-ovig. ♀, 5.0–6.5 mm, 6 juvs. 2.2–4.5 mm, Sapodilla Lagoon, Sittee River, Belize, amongst red mangrove roots, coll. K. Fauchald, 9 Dec 1986.—Paratypes, USNM 205680, 2 ♂ 6.0–7.5 mm, 4 ovig. ♀ 5.4–6.0 mm, 17 juvs. 2.0–5.2 mm, Salt Creek, north of Dangriga, Belize, between red mangroves in 1 m, 31‰, 32°C, coll. M. Jones, 16 May 1977.—Paratypes, USNM 205681, 4 ♂, 5.1–7.4 mm, 6 ♀, 5.0–7.0 mm, Anderson Lagoon, Sittee River, Belize, from amongst barnacles and mussels on red mangrove roots, coll. K. Fauchald, 11 Dec 1986.

Description.—Male: Body 2.6 times longer than wide, widest at pereonites 5 and 6. Cephalon somewhat sunken into pereonite 1, with small rostral point between antennular bases; eyes large, dorsolateral; three low dorsal tubercles near posterior margin; frontal lamina narrow-pentagonal, distal margin not projecting. Pereonite 1 with 4–6 low tubercles near posterior margin; pereonites 2–7 with several low submedian ridges. Coxae 2 and 3 narrow, posteriorly rounded; coxae 4–7 broader, posteroventrally somewhat produced to subacute apex. Pleonites 1–3 with free ventral margins rounded; pleonite 4 lacking free ventrolateral margins, with 2 low submedian tubercles on posterior margin. Pleotelson broadly triangular, posterior margin rounded, bearing 8–10 apical spines and numerous setae.

Antennular peduncle of 2 articles, basal article broader but slightly shorter than distal article; flagellum of 9–12 articles, distal 7–9 articles each bearing 1–3 aesthetascs. Antennal peduncle of 5 articles, 3 basal articles short, together equal in length to article 4, articles 4 and 5 subequal in length; flagellum of about 30 articles, reaching posteriorly to anterior of pereonite 5. Mandibular palp directed anteriorly, of 3 articles, article 2 longest, bearing about 12 fringed spines, article 3 with comb of about 16 spines on outer margin; incisor of 3 strong sclerotized cusps; lacinia having 5 cusps; 4 spines in spine-row; molar narrowly triangular, with row of short marginal spines. Maxilla 1, inner ramus with three stout setae; outer ramus with about 10 sclerotized spines, some of which spinulose, plus 1 central seta. Maxilla 2, 2 lobes of outer ramus short, outer bearing 4 spines, inner with 7–11 spines; inner ramus with 6 distal simple spines and 6–8 fringed proximal spines. Maxilliped, endite short, barely reaching beyond basal

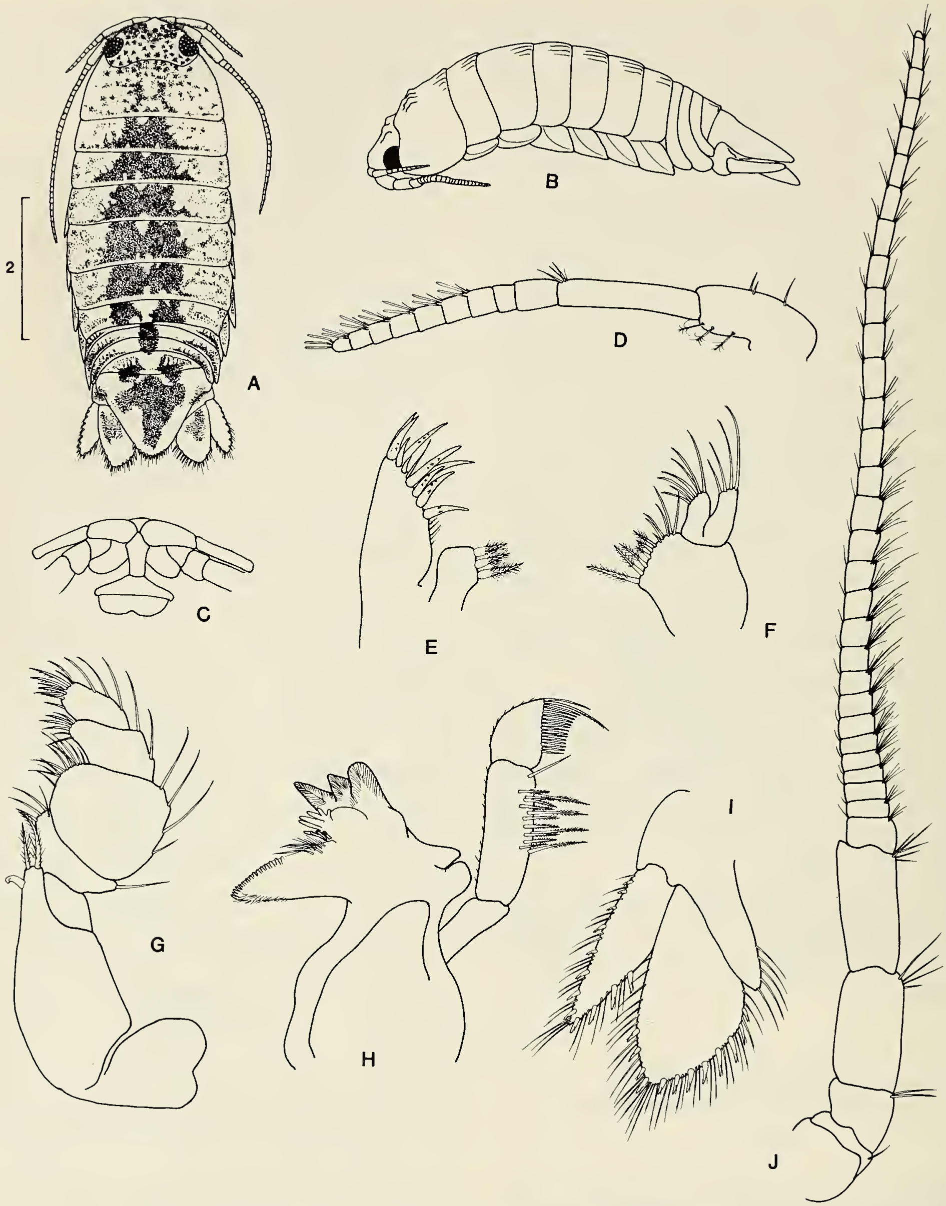

Fig. 5. *Anopsilana jonesi,* male: A, Entire animal in dorsal view; B, Entire animal in lateral view; C, Frontal lamina and clypeus; D, Antennule; E, Maxilla 1; F, Maxilla 2; G, Maxilliped; H, Mandible; I, Uropod; J, Antenna.

palp article, with 2–3 distal fringed setae and 1 or 2 coupling hooks; palp of 5 articles, article 3 longest and broadest; articles 3–5 each with group of mediodistal spines. Pereopods increasing in length posteriorly. Pereopod 1, merus with row of 6 blunt spines; carpus short, with almost no free anterior margin, bearing single sensory spine posterodistally; propodus with spine at midlength and single posterodistal spine. Pereopod 2 and 3 similar, ischium with 3 posterodistal spines and single large antero-

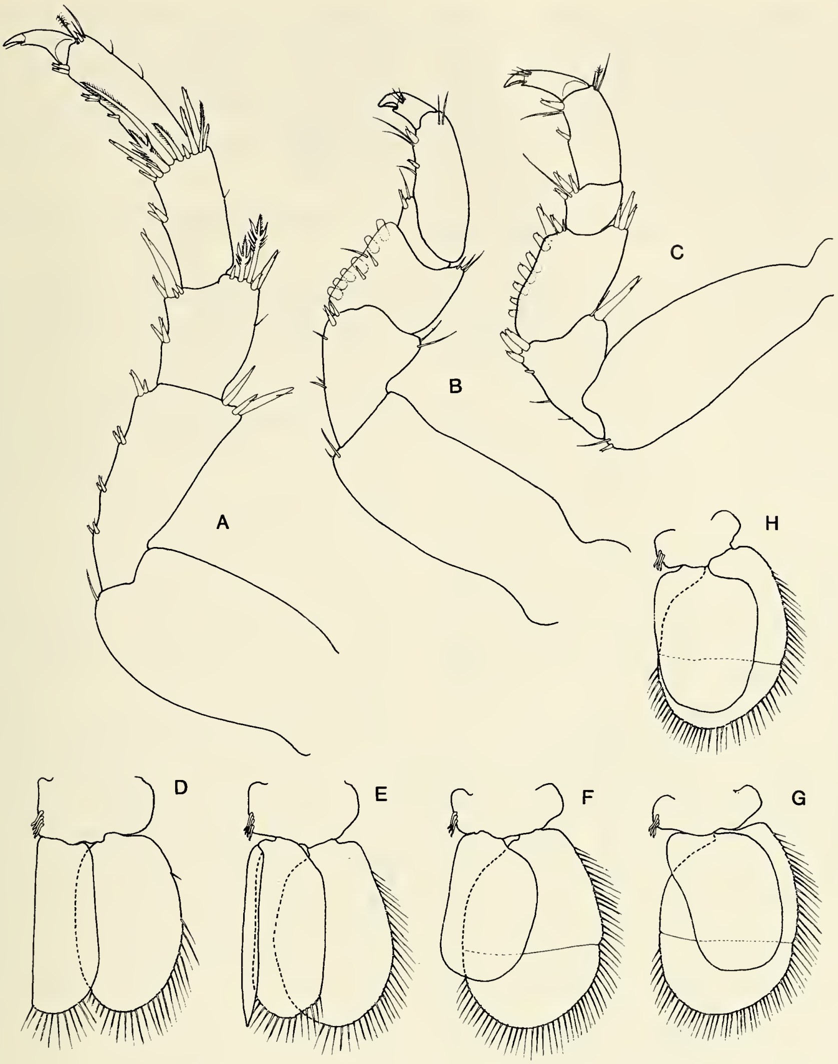

Fig. 6. *Anopsilana jonesi,* male: A, Pereopod 7; B, Pereopod 1; C, Pereopod 2; D, Pleopod 1; E, Pleopod 2; F, Pleopod 3; G, Pleopod 4; H, Pleopod 5.

distal spine; merus with row of 8 blunt spines on posterior margin and 3 anterodistal sensory spines; carpus about half length of propodus, with 3 posterodistal spines; propodus with single spine at midlength and another distally on posterior margin; unguis about half length of rest of dactylus. Pereopods 4–7 similar; ischium with 4 pairs of spines on posterior margin, 3 spines anterodistally; merus with 2 groups of spines on posterior margin, group of sensory and serrate spines anterodistally; carpus rectangular, with pair of spines on posterior margin, plus dense cluster of sensory and serrate spines along distal margin; propodus elongate-rectangular, with few spines along posterior margin. Pleopod 1, endopod parallel-sided, narrower than ovate exopod. Pleopod 2, copulatory stylet apically acute, reaching slightly beyond, and articulating at base of, endopod; exopod ovate. Pleopods 3–5, endopods narrower and shorter than exopods, lacking marginal setae; exopods broadly ovate, biarticulate, with marginal setae. Uropodal sympod produced along medial margin of endopod, bearing few distal setae; endopod widening distally, reaching beyond pelotelsonic apex, with about 12 marginal spines plus numerous setae; exopod narrow, lanceolate, apically acute, with 10–12 marginal spines.

Female: Essentially similar to male, but lacking tubercles and ridges on cephalon, pereonites, and pleonite 4. Setae on antennal flagellum shorter than in male.

Color pattern.—Similar in both sexes. Dorsal integument of cephalon and pereonite 1 with scattered brown chromatophores; pereonites 2–7 with solid central area, laterally with scattered chromatophores; pleonites 1–3 with middorsal patch of pigment; pleonite 4 and basal pleotelson with 2 patches, plus large irregular central blotch on pleotelson; uropodal endopod with irregular central patch.

Remarks.—The approximately nine known species of *Anopsilana* (see Bruce 1986) can be grouped into those occurring in freshwater caves (generally unpigmented and eyeless), and those pigmented forms such as *A. browni* (Van Name), *A. luciae* (Barnard), and *A. oaxaca* Carvacho and Haasmann, which occur in estuaries. The present species belongs to the latter group, and indeed, was caught along with single specimens of *A. browni* from Anderson Lagoon in the Sittee River and from Salt Creek. The two species may be separated by three easily seen features. 1. The color pattern, that of *A. browni* lacking the solid middorsal area on the pereon. 2. The frontal lamina, which in *A. browni* is distally broadly rounded and strongly projecting. 3. The strong double tubercles on the cephalon and rows of rounded tubercles on the pereonites and pleonites of male *A. browni*, contrasted with the three low tubercles on the cephalon and the low ridges on the pereonites of male *A. jonesi.*

Etymology.—The species is named for Dr. Meredith Jones, of the Department of Invertebrate Zoology, Smithsonian Institution, who collected the first specimens of this species along with numerous other isopods from localities in the Caribbean.

Eurydice personata, new species
Figs. 7, 8

Material.—Holotype, USNM 211436, 1 ♂, 6.0 mm, paratypes, USNM 128314, 19 ♂, 5.0–6.0 mm, 4 ovig. ♀, 5.1–6.4 mm, 6 non-ovig. ♀, Mona Island, Puerto Rico, 40–50 ft, coll. R. Menzies and P. Glynn, 10 May 1966.—USNM 211435, 63 ♂, 3.5–4.5 mm, 1 ovig. ♀, 5.0 mm, 95 non-ovig. ♀, Bahamas north of Bimini Is., 1–2 m, coll. M. Jones, 22 Aug 1962.—USNM 111388, 2 ovig. ♀, 4.1 mm, Bahamas, surface plankton tow at night, coll. J. McCain, 14 Jul 1964.—USNM 60689, 3 ♂, 3.5–4.5 mm, 2 non-ovig. ♀, Bermuda, 27 Sep 1933.—USNM 65871, 1 non-ovig. ♀, Bigie Bay, Haiti, 23 Apr 1930.—USNM 221547, 38 ♂, 4.5–4.8 mm, 6 ovig. ♀, 4.9–5.8 mm, Grande Cay, Cuba, 19 Apr 1937.—USNM 86369, 7 juvs., off Miami, Florida, Jun 1942.—USNM 225445, 1 ovig. ♀, 5.6 mm, off Georgia, 27 m, 14 May 1981.—USNM 225440, 1 non-ovig. ♀, off Georgia, 18 m, 28 Jul 1981.—USNM 225448, 1 juv., off South Carolina, 34 m, 27 Jul 1981.—USNM 225450, 1 ♂, 1 non-ovig. ♀, 1 juv., off Georgia, 26 m, 12 Aug 1981.

Description.—Male: Body about 4 times longer than greatest width. Coxae of pereonites 2–7 ending in acute denticle. Pleonites 2–5 posteroventrally acute. Pleotelson wider than middorsal length, with anterior hollow; posterior margin between notches slightly convex, with 2 pairs of spines, inner pair longer than outer, between 5 and 6 times longer than wide. Cephalon lacking rostrum; frontal lamina narrow, lanceolate, distally acute; clypeus broadly triangular, distally acute and projecting anteroventrally; eyes large, lateral, reaching to ventral surface.

Fig. 7. *Eurydice personata*: A, Adult in lateral view; B, Antennule; C, Antennal peduncle; D, Antennal flagellar article enlarged; E, Pleotelson; F, Mandible; G, Maxilla 1; H, Maxilla 2; I, Maxilliped; J, Pereopod 1; K, Pereopod 7; L, Male pleopod 1; M, Male pleopod 2.

Antennular peduncle with article 2 at right angle to article 1; flagellum of 6 articles, article 2 longest, bearing series of aesthetascs. Antennal peduncle of 4 articles, article 3 with 4–6 slender spines distally; flagellum reaching posteriorly to level of pereonite 7, articles with plicate organ about half length of article. Mandibular palp of 3 articles, article 2 longest, article 3 with comb of 10 distal setae. Maxilla 1, outer ramus with 12 distal spines, some being spinulose. Maxilla 2, inner ramus short, truncate, with 4 proximal fringed setae and 5 distal simple setae; inner and outer lobes of outer ramus with 3 and 5 fringed setae respectively. Maxillipedal endite reaching to middle of palp article 2, with distal fringed setae reaching to palp article 4; palp with article 3 widest and longest. Pereopod 1–3 similar, prehensile; ischium with anterodistal extension bearing single spine, 2 acute and 2 blunt spines posterodistally; merus with single short anterodistal spine, 1 acute and 5 blunt spines on posterior margin; carpus lacking free anterior margin, with 2 posterodistal spines; propodus with 3 spines on posterior margin plus stout posterodistal specialized spine. Pereopods 4–7 similar, becoming more elongate posteriorly, ischium, merus, carpus, and propodus each bearing clumps of sensory spines on anterior and posterior margins. Pleopod 2, endopod with copulatory stylet clavate, distally blunt, reaching by one-fifth of its length beyond ramus. Uropodal exopod ovate, five-sixths length of endopod; latter with broadly truncate distal margin.

Female: Essentially similar to male, but body proportionally slightly broader.

Color pattern.—Entire dorsum except posterior three-fourths with dense brown pigmentation; sternites, pereopods (except propodi and dactyli), and pleopodal sympods pigmented (based on Georgia and South Carolina material).

Etymology.—The specific name is derived from the Latin *personatus,* meaning wearing a mask, and refers to the fact that this species has been masquerading as either of two other species of *Eurydice.*

Remarks.—Examination of the material of three western Atlantic species of *Eurydice* in the Smithsonian's collections, and perusal of the literature, let to some confusion in my attempts to separate these species. Closer observation revealed that an undescribed species had previously been misidentified either as *E. convexa* or *E. littoralis. Eurydice personata,* the new species, while superficially very similar to *E. convexa* Richardson, 1900 (=*E. littoralis* Moore, 1901), can most easily be distinguished by its slender lanceolate frontal lamina. The following table provides further means for separating the three species occurring in the Florida Keys and Caribbean.

	E. convexa Richardson, 1900	*E. piperata* Menzies & Frankenberg, 1966	*E. personata,* new species
Frontal lamina	truncate, faintly bilobed	truncate, faintly bilobed	lanceolate acute
Pleotelson			
apex	convex	truncate to faintly convex	faintly convex
spines	4, moderate length	4, very short	4, elongate
♂ antennal plicate organ	⅕ length of article	⅙ length of article	½ length of article

Xylolana, new genus

Diagnosis.—Frontal lamina and rostrum fused, broad, separating antennular bases. Clypeus conical, projecting. Antennular peduncle of 3 articles; antennal peduncle of 5 (?4) articles, articles 3–5 subequal in length. Mandibular palp directed anteriorly. Max-

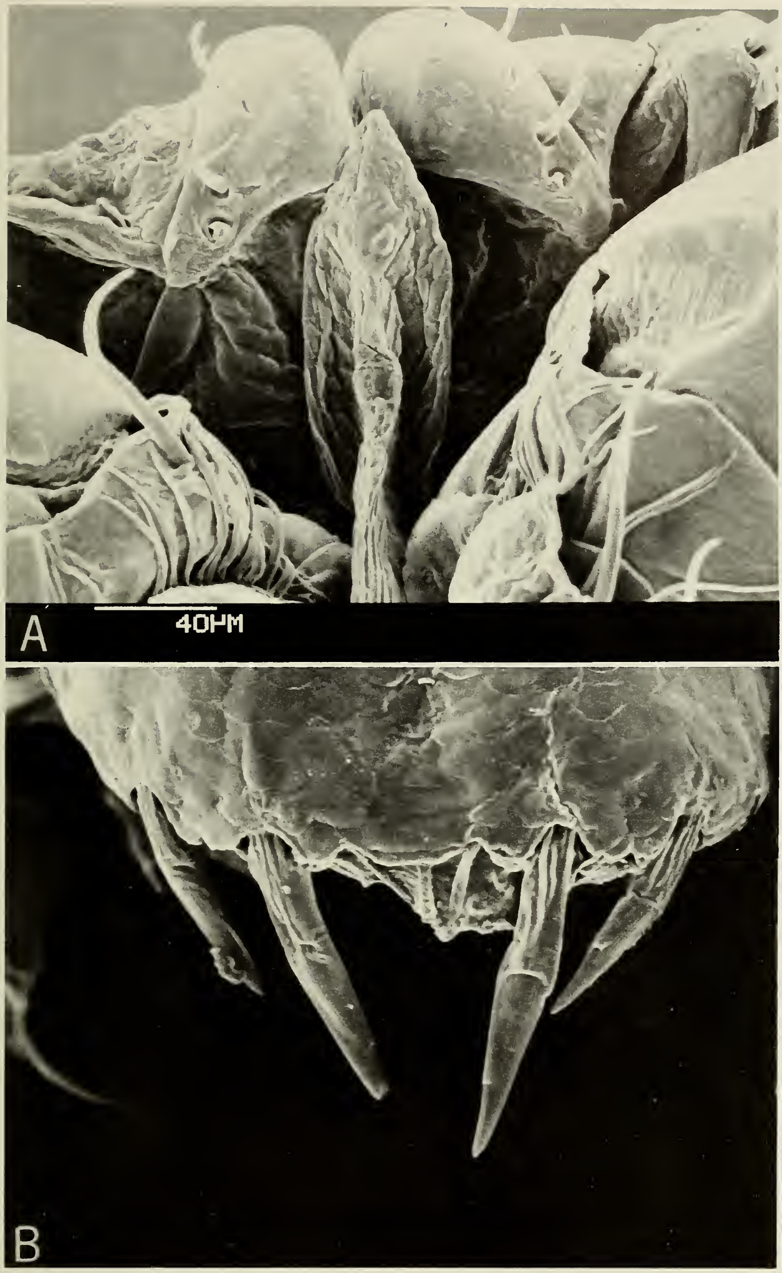

Fig. 8. *Eurydice personata*: A, Frontal lamina; B, Apex of pleotelson.

illipedal endite reduced, lacking coupling hooks. Pereonite 1 twice length of pereonite 2. Pereopods 1–3 with meri not anterodistally produced. Pereopods 4–7, articles not flattened, lacking natatory setae. Short penes present on sternite of pereonite 7. Pleopod 2 in male with copulatory stylet articulating in distal half of mesial margin of endopod. Pleopods 3–5, exopod biarticulate; endopod lacking marginal setae. Pleonite 5 lacking free lateral margin, overlapped laterally by pleonite 4. Uropodal sympod produced along mesial margin of endopod.

Type species.—*Xylolana radicicola*, new species.

Etymology.—The generic name is derived from the Greek word *xylon* for wood, referring to the woody habitat of the animal, plus the commonly-used suffix 'lana,' derived from *Cirolana*, originally an anagram of Carolina.

Remarks.—Discovery of an apparently specialized and highly adapted species such as the one under discussion, immediately exposes a gap in our knowledge of the taxonomy of the cirolanids. (With few exceptions, this gap is present in most of the major isopod groups.) With no phylogenetic analysis at the generic level, there is no way of knowing which characters are apomorphic and which plesiomorphic. Separation of genera, while probably reflecting the phylogenetic relationships fairly well, is thus a shaky and somewhat subjective process. Well defined and long-understood genera such as *Eurydice* will present little problem, but with unusual and adapted forms such as the present species, generic placement becomes very difficult. Has a projecting clypeus evolved more than once? Is the condition with pleonite 4 overlapping pleonite 5 apomorphic? These and other similar questions arise in trying to place the present material.

The projecting clypeus would indicate affinity with the Eurydicinae, while the lateral overlapping of pleonite 5 by pleonite 4 would indicate the Cirolaninae. Features such as the fusion of the rostrum and frontal lamina, the medially-articulating copulatory stylet, and the lack of marginal setae on the endopods of pleonites 3–5, however, all indicate a stronger affinity with the Eurydicinae. Within the latter subfamily, the present species does not agree with the definitions of any of the genera. Using the available keys to the Cirolanidae also proves unsatisfactory. For example, using Bruce's 1986 key, the present species runs down to *Eurylana*, from which it differs in several features. There seems to be no choice but to describe a new genus for this material, in which small size and choice of habitat might well have dictated several of the specialized features.

Xylolana radicicola, new species

Material.—Holotype, USNM 211437, ♂ 2.6 mm, paratypes, USNM 211438, 1 ovig. ♀ (cephalon plus anterior 4 pereonites only), 1 non-ovig. ♀ (cephalon missing), 1 non-ovig. ♀, 1.9 mm (SEM specimen), from dead in-situ red mangrove prop roots, 1 m, Twin Cays, Belize, coll. K. Rützler, Feb 1987.—Paratype, USNM 211439, non-ovig. ♀, 3.3 mm, from dead in-situ red mangrove prop roots, 1 m, Twin Cays, Belize, coll. B. Kensley, 12 Dec 1986.

Description.—Male: Body about 4 times longer than greatest width (at pereonites 4 and 5). Cephalon sunken into pereonite 1, with large well pigmented eyes; area between posterior margin and line joining posterior margins of eyes somewhat inflated; antennular bases separated by broad, flattened, fused rostrum and frontal lamina. Clypeus narrowly conical, projecting distally. Pereonite 1 about twice length of pereonite 2. Coxae of pereonites 2 and 3 posteriorly rounded; of pereonites 4–7 becoming progressively more produced and elongate posterodistally. Pleonites 1–3 short; pleonite 4 laterally broad, overlapping pleonite 5 and base of pleotelson, with oblique row of plumose setae; pleonite 5 short, lacking free lateral margin. Pleotelson basally broad with faint rounded middorsal ridge, becoming abruptly narrowed from base of uropodal sympod, tapering slightly to broadly rounded posterior margin.

Antennular peduncle of 3 articles, article 3 longest; flagellum of 6 articles, articles 3–5 each bearing 2 aesthetascs, terminal article with single aesthetasc. Antennal peduncle of 4 articles, article 4 only slightly longer

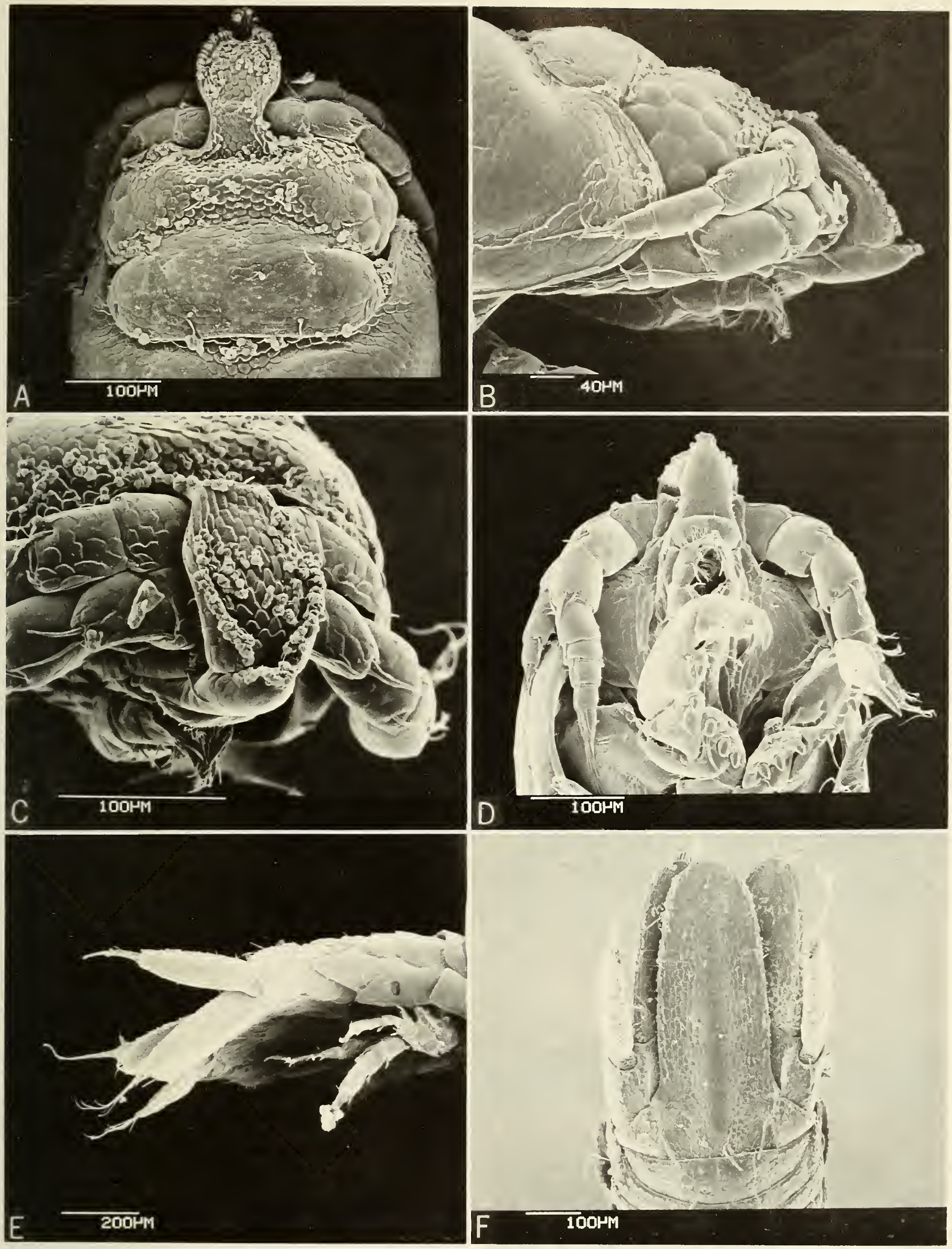

Fig. 9. *Xylolana radicicola,* paratype: A, Cephalon in dorsal view; B, Cephalon in lateral view; C, Cephalon in oblique-anterior view; D, Cephalon in ventral view; E, Pleon in lateral view; F, Pleotelson and uropods in dorsal view.

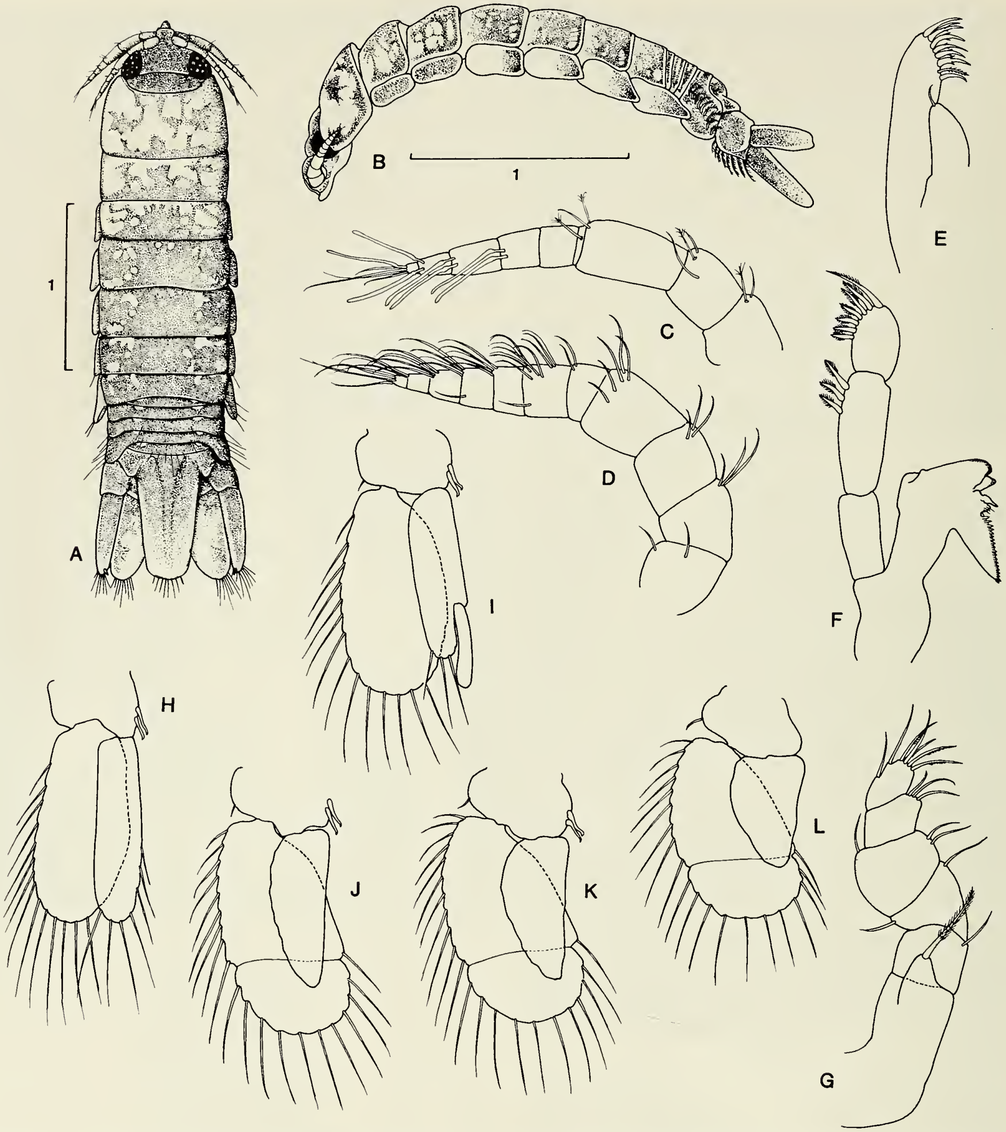

Fig. 10. *Xylolana radicicola,* male paratype: A, Adult in dorsal view; B, Adult in lateral view, pereopods and pleopods not shown; C, Antennule; D, Antenna; E, Maxilla 1; F, Mandible; G, Maxilliped; H, Pleopod 1; I, Pleopod 2; J, Pleopod 3; K, Pleopod 4; L, Pleopod 5.

than 2 preceding articles; flagellum of 7 setose articles. Mandibular palp of 3 articles, article 2 longest, with 3 fringed spines distally, article 3 with 7 fringed spines becoming more elongate distally; body of mandible somewhat elongate, incisor of 2 rounded cusps; lacinia and spine row reduced; molar triangular, with row of marginal spines. Maxilla 1, outer ramus with 9 distal spines; inner ramus with single distal seta. Maxillipedal endite short, reaching to middle of palp article 1, with single distal seta; palp of 5 articles, article 3 longest and widest. Pereopods 1–3 similar, becoming progressively shorter posteriorly. Pereopod 1, merus with 1 acute and 4 rounded spines

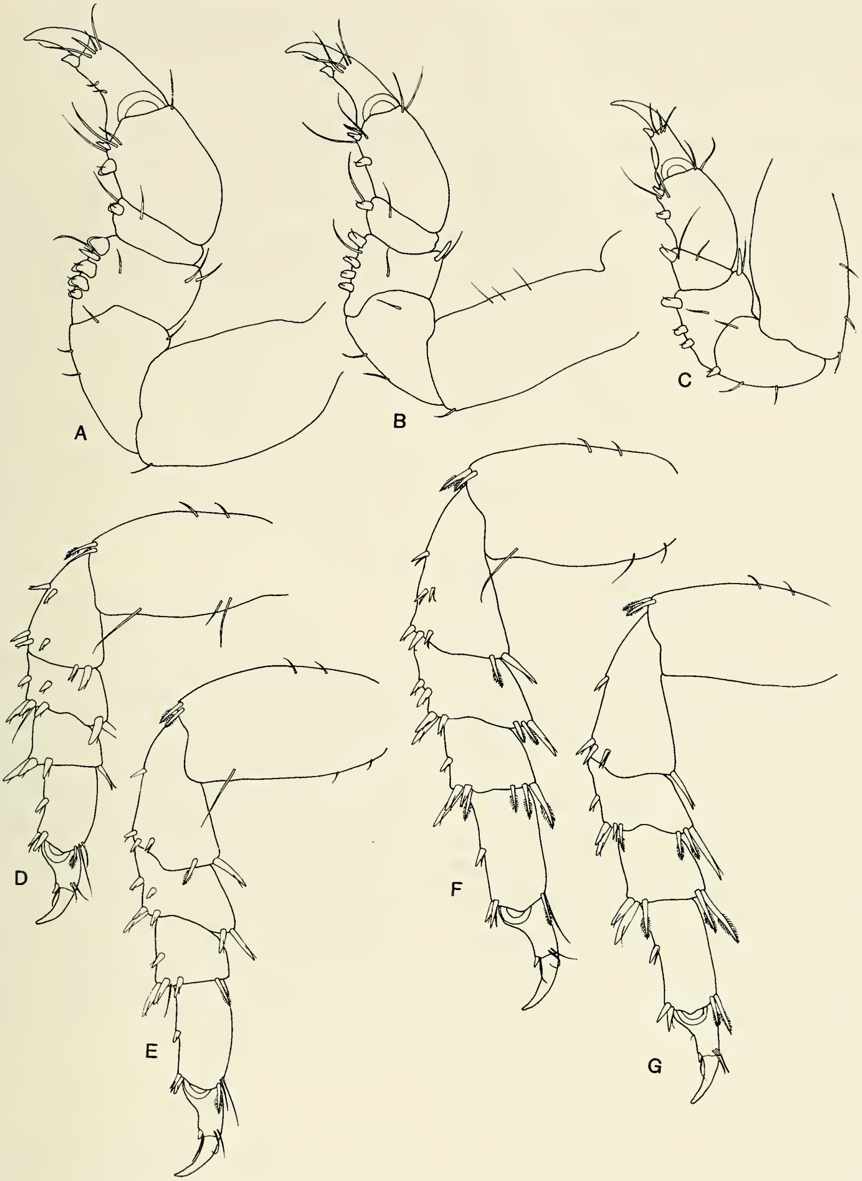

Fig. 11. *Xylolana radicicola,* male paratype: A, Pereopod 1; B, Pereopod 2; C, Pereopod 3; D, Pereopod 4; E, Pereopod 5; F, Pereopod 6; G, Pereopod 7.

on posterior margin; carpus with very short free anterior and posterior margins, with single spine on posterior margin; propodus slightly inflated, with 2 spines on posterior margin; dactylus with strong secondary unguis. Pereopods 2 and 3, merus with anterodistal spine. Pereopods 4–7 similar, becoming more elongate posteriorly; basis with 2 posterodistal spines; ischium, merus, carpus, and propodus with groups of anterodistal and posterodistal spines plus few scattered spines on posterior surfaces; unguis about equal in length to rest of dactylus, with small secondary unguis. Penes on sternite of pereonite 7 short, about twice longer than wide, separate. Pleopod 1, endopod half width and subequal in length to exopod. Pleopod 2, endopod half width but about one-fourth shorter than exopod, with clavate copulatory stylet articulating in distal half of mesial margin. Pleopods 3–5 similar, exopod broad, biarticulate, with marginal plumose setae; endopod triangular, shorter than exopod, lacking marginal setae. Uropodal sympod produced along mesial margin of endopod; latter ovate, distally broadly rounded, wider and slightly longer than distally subtruncate exopod, latter with single short mesiodistal spines.

Female: Very similar to male. Antennular flagellum of 4 articles.

Color pattern.—Dorsum with strong purple-brown pigmentation. Cephalon almost solidly pigmented; pereonite 1 with scattered patches; pigment becoming denser posteriorly; pleonites, pleotelson, and uropods fairly densely pigmented; coxae of pereonites 4–7 with only posterior half pigmented.

Habitat.—The five specimens of this species were collected on two occasions, from the same locality. The specimens came from the washings of dead but in situ red mangrove prop roots. These roots, while still submerged, have lost most of the epiphytes and epizooites found on live roots. The dead roots were broken up in a bucket of seawater, well rinsed, and the washings screened. In addition to the new cirolanid genus, the washings contained numerous polychaete worms, pycnogonidans, harpacticoid copepods, amphipods, tanaidaceans, *Nebalia* sp., plus gnathiid, sphaeromatid, limnoriid, anthurid, and corallanid isopods. All these organisms were living either on or under the decaying and flaking outer layers of the roots, or in the hollowed and tunneled inner tissues.

Etymology.—The specific name, meaning 'dwelling in roots.' refers to the habitat of the species.

Family Sphaeromatidae
Paraleptosphaeroma glynii Buss and Iverson

Paraleptosphaeroma glynni Buss and Iverson, 1981:2, figs. 1–11.

Material.—USNM 205682, 6 specimens (incl. 2 ovig. ♀), Smithsonian-Bredin Expedition sta 75-59, Portsmouth, Dominica, amongst boulders, rocks, and dead coral in 0.5 m, 19 Apr 1959.

Previous records.—Punta Paitilla, Pacific Panama, intertidal.

Remarks.—This is the first Atlantic record of this monotypic genus and is therefore one of the few species of isopods known to occur on both sides of the Isthmus of Panama.

Acknowledgments

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STUDIES OF THE *LEPIDAPLOA* COMPLEX (VERNONIEAE: ASTERACEAE). I. THE GENUS *STENOCEPHALUM* SCH. BIP.

Harold Robinson

Abstract.—The genus *Stenocephalum* Schultz-Bip. is resurrected for a group of five tropical American species related to the genus *Lepidaploa.* The two genera differ from *Vernonia* and are like each other in the form of their lophate pollen with "rhizomatous" columellae under the crests. The resurrected genus is distinguished structurally and functionally from *Lepidaploa* by fewer flowers in the heads. The surface of the pollen also has more numerous areolae, and the bases of the styles usually lack a node.

The establishment of a series of reliable and useful phyletic generic concepts in the tribe Vernonieae has already progressed considerably from the traditional core concept of Bentham and Hooker (1873) and Hoffmann (1890–94) that had numerous segregates based primarily on pappus variations. A major advance was that of Jones (1977) in recognizing basic differences in chemistry and chromosome number between New and Old World groups. Within the broad hemispheric groups are many genera, some of which have already been recognized in the traditional treatments, while others still reside in the synonymy of *Vernonia.* The present series of studies is aimed at the restoration or naming as new of many of the genera of the *Lepidaploa* complex that have been placed in the genus *Vernonia.*

The paleotropical elements of the tribe are phyletically remote from typical *Vernonia* in eastern North America, and are thus more easily justified at the generic level on the basis of the Jones' (1977) results. Some such genera recently resurrected include *Distephanus* Cass. and *Gymnanthemum* Cass. (Robinson and Kahn 1986), with the former not even fitting the broad concept of *Vernonia.* The neotropical elements fall into the same broad chemical and cytological group as typical *Vernonia,* but they also require segregation to a degree exceeding that found in the traditional tribal concepts. Many of the necessary additional segregates such as *Critoniopsis* Sch. Bip. (Robinson 1980) are at least as phyletically distinct as traditional genera like *Piptocarpa* R. Br. and *Pollalesta* H.B.K. Many small segregates remain to be recognized, but the largest number of neotropical species involved belong to the *Lepidaploa* group. Six genera, *Lepidaploa* (Cass.) Cass., *Stenocephalum* Sch. Bip., and four as yet unnamed, are to be treated in a series of studies of which the present resurrection of *Stenocephalum* is the first.

Significant Characters

Number of flowers in the head.—In the series of five genera, *Stenocephalum* Schultz-Bip. is notable for the comparative accuracy of delimitation at the time it was first published (Schultz-Bipontinus 1863). The paper in which the genus was described dealt mostly with genera with reduced numbers of flowers in the heads such as *Lychnophora* Mart. and *Eremanthus* Less. The reduced number of flowers appears to have been the primary reason Schultz (1863) elevated *Stenocephalum* to generic level while leaving related forms in *Vernonia.* No phyletic considerations were evident in the work of Schultz, and the reduced number of flowers seems to have been regarded as a violation of the limits of *Vernonia. Stenocephalum* was relegated to the level of a section in *Vernonia* by Baker (1873) and has remained under the latter genus until the present. It was made a subsection by Jones (1979).

The present concept of *Stenocephalum* is more refined, and the relationship to other groups is now more evident. Even though the genus has no close relationship to the Lychnophorinae, the number of flowers in the head remains one of the most important characters in the delimitation of the genus. The heads contain usually 4–7 flowers, and rarely as many as 10. The characteristic number is lower than that in any of the other members of the *Lepidaploa* complex and moreover is reduced in proportion to the total of 15–22 involucral bracts in the heads. The reduction results in a lower proportion of flowers in four of the five species of *Stenocephalum* than the ⅖ to ½ ratio seen in most of *Lepidaploa.* The other exceptions in the group all have much larger numbers of both flowers and bracts. The ratio clearly distinguishes *Stenocephalum* from typical *Vernonia* which has more flowers and nearly equal numbers of bracts and flowers in the heads.

The reduced number of flowers in the head prevents some of the types of floral displays most common in the Vernonieae. In many members of the tribe the peripheral flowers spread in a manner resembling rays, a feature particularly notable in typical *Vernonia* and *Stokesia.* In *Centratherum* and some species like *Vernonia santosii* H. Robins. the zone of peripheral flowers is differentiated by maturing while the inner flowers remain unopened. The inner flowers open on another day with a distinctly unraylike appearance. These strategies are difficult if not impossible in the smaller heads of *Stenocephalum,* and in many cases the flowering heads are very unimpressive. Only *S. tragiaefolium* seems to furnish a notable floral display, caused by the massed effect of the whole inflorescence. One assumes that the limited floral presentation would have some effect on attraction of pollinators, but field observations remain to be made.

Disposition of heads.—The genus *Stenocephalum* consists entirely of species that have sessile heads at the nodes. The cymose structure is basically like that of *Lepidaploa* with none of the pedicellate modifications of the heads seen in either of the related unnamed genera. The heads may be isolated at separate, rather remote nodes as in the type species *S. apiculatum* or *S. jucundum,* clustered on short lateral branches as in *S. megapotamicum,* or more closely massed in a terminal inflorescence as in *S. tragiaefolium.* The variation of disposition of heads in the genus seems to be a significant factor in speciation. The two species, *S. apiculatum* and *S. jucundum,* that show similar displays have nearly complete geographical isolation.

Style base.—As noted in the study of *Distephanus* (Robinson and Kahn 1986), stylar nodes are widely distributed in the neotropical Vernonieae. Stylar nodes are particularly characteristic of *Lepidaploa,* often being quite marked as disc-like extensions at the base of the style just above the nectary. The node is lacking, however, in one related group that has previously been placed in *Vernonia* series *Buddleiifoliae,* and it is also poorly developed or lacking in the genus *Stenocephalum.* While most species have no node, a hint of basal differentiation is seen in some *S. megapolitanum* and a small but distinct basal rim is seen in *S. tragiaefolium.*

Achene structure.—The carpopodium of *Stenocephalum* was mentioned by Schultz (1863) as being large. The size is not unusual in the Vernonieae but the structure is uniform for all five species. The shape is short-cylindrical except for the rounding of the basal margins. The upper edge of the differentiated structure is only slightly irregular at or below the level of the lowest setulae.

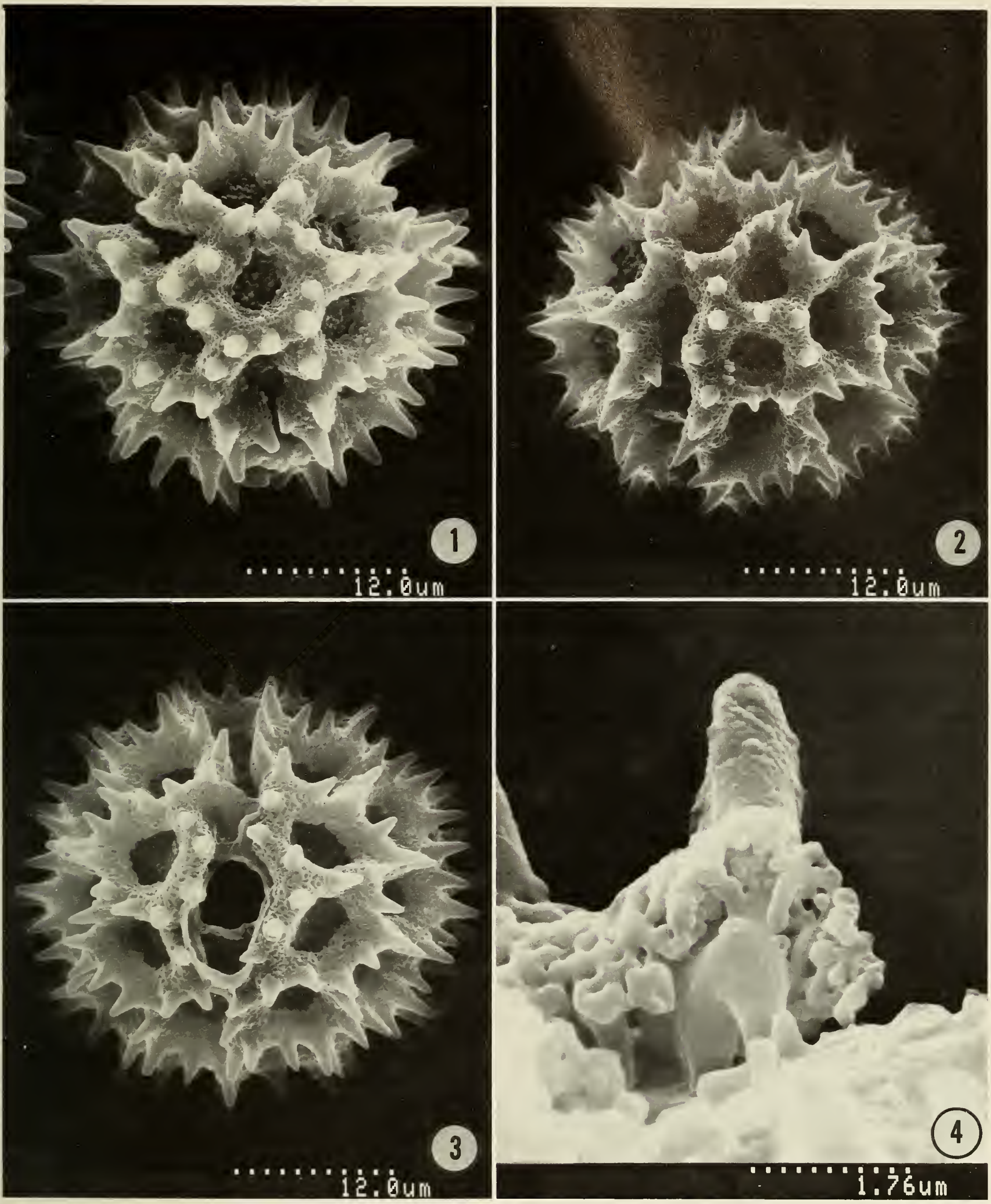
In contrast to the carpopodium, the achene wall structure in *Stenocephalum* varies extensively in setulosity and form of surface cells. The setulae seem characteristically somewhat contorted and uneven at the tips. One of the cells may project far beyond the other, or some setulae may be uniseriate from at or near the base. The ribs seem most prominent in *S. jucundum, S. megapotanicum* and *S. hystrix* where they stand out from the surface and separate the setulose areas into distinct bands. The ribs are weaker and the setulae more densely cover the surface in *S. apiculatum* and *S. tragiaefolium.* The ribs are particularly weak in the latter species and occasionally there are less than ten. In the type species, *S. apiculatum,* the cells of the intercostal region seem lax with weak walls that are scarcely observable under the microscope. The cells are most readily noticeable by the manner that they peel away with their imbedded setular bases from the thicker-walled elongate cells below. There are no other differentiated cells evident in this surface. The Central American and northern South American *S. jucundum* has surface cells that are similar to those of the type but they are much firmer and more easily seen. The three remaining species are seen to have thicker-walled elongate cells in immediate connection with the setular bases. All three species show islands of differentiated idioblasts with cells occurring singly or in a series of two to three. The latter pattern is one also seen in many species of *Lepidaploa.*

Pollen.—All members of the genus *Stenocephalum* show uniformity in their pollen and its general features differ only in details of areolation. The grains are of the type redefined here as *Lepidaploa*-type with the ridges of the lophate grains subtended by a horizontal "rhizome." The whole structure seems to easily peel away from the footlayer (Fig. 4). The grains of the type species shown (Figs. 1–4) differ from other *Lepidaploa* type pollens in the height of the crests and the exposure of the basal columellae, but the differences are ones of degree.

In form of areolation all the grains fall generally in the C-type which has areoles at the poles. The structure is unlike the C-type of *Lepidaploa,* however, in the extra number of areolae in the intercolpar region (Figs. 1–3). Observations under the light microscope indicate that none of the other species are as extreme in the number of areolae as the type species that is shown, but all have at least some extra, there often being three across the intercolpar region. The higher number of areolae and the presence of polar areolae is a combination unknown in *Lepidaploa.*

Relationship of *Stenocephalum*

The form of the pollen in *Stenocephalum* clearly indicates a phyletic position near *Lepidaploa.* This is advanced over the more primitive pollen type seen in such genera as *Stokesia* where the basal columellae each reach the footlayer individually. The presence of a trace of stylar node in *S. tragiaefolium* and the presence of idioblasts on the surface of the achene in three species of *Stenocephalum* also indicate a position close to *Lepidaploa.* The positions of the heads can also be interpreted as an seriately innovating cyme as in *Lepidaploa.* Nevertheless, the species potentially closest to the outgroup, *S. tragiaefolium* already shows some increase in the number of areolae on the pollen grains and already has the number of flowers in the head reduced to the point where the whole inflorescence is needed for floral display. Within *Lepidaploa* there is no species that seems particularly close to *Stenocephalum.* A species of the general *Lepidaploa* relationship that was initially thought to be related to *Stenocephalum, Vernonia regis* H. Robins., has enough flowers to fall completely within the *Lepidaploa* flower/bract ratio, a carpopodium on the achene with a more conical shape, much denser and straighter setulae on the achene



Figs. 1–4. Pollen of *Stenocephalum apiculatum* (Martius in DC.) Schultz-Bip. 1–3, dotted lines = 12 μm; 4, dotted line = 1.76 μm. 1, Polar view showing polar areole; 2, Oblique view showing half of intercolpus with complete median transverse row of three areoles; 3, Colpar view; 4, Broken section of crest showing details of "rhizomatous" columellae and attachment of perforated tectum.

with more equal tips, a well-developed node at the base of the style, and type-B pollen.

Stenocephalum Schultz-Bip.

Stenocephalum Schultz-Bip., Pollichia 20/21:385. 1863, type *Vernonia apiculata* Mart. ex DC.
Vernonia sect. *Stenocephalum* (Schultz-Bip.) Baker in Mart., Fl. Bras. 6(2):25. 1873.
Vernonia subsect. *Stenocephalum* (Schultz-Bip.) S. B. Jones, Rhodora 81:437. 1979.

Plants herbaceous, perennial, erect to 0.3–1.0 m tall, with little or no vegetative branching above the base. Leaves linear to broadly oblong, ovate or obovate, discolorous, dark green and densely to evanescently pilose above, pale tomentose below. Inflorescence cymose, heads single or grouped at primary nodes or densely clustered on lateral branches. Heads cylindrical; involucral bracts ca. 15–22 in 3–4 graduated series, with pungent usually narrowly acuminate tips (short cuspidate in some *S. megapotamicum*), slightly to distinctly recurved; flowers 4–7(–10) in a head; corollas lavender, with or without hairs at tips of lobes; anther thecae having shields of median endothecial cells variously radial or looped with multiple nodes, anther appendage glabrous; style base without or with only slight node. Achenes with ten ribs weakly to strongly developed, intercostal surface with surface of lax cells or with firmer cells intermixed with some idioblast clusters; setulae appearing evenly distributed in species with weak ribs, otherwise restricted between ribs, with often unequal and contorted tips, rarely uniseriate from base; carpopodium short-cylindrical, rounded only at basal margin; pappus of short outer squamellae and numerous inner capillary bristles. Pollen grains (40–)45–48(–50) μm in fluid, distinctly lophate with "rhizomatous" columellar structure under crests, exine easily stripping away from footlayer, lophate pattern of general C-type with polar areoles but differing by extra intercolpar areoles (up to 9).

Key to the Species of *Stenocephalum*

1. Cauline and primary branch leaves broadly ovate to obovate, distinctly narrowed at base 2
2. Heads laxly disposed along stems and branches, usually solitary in or near axils; leaves ovate (Central America, N. South America) . . . . *S. jucundum*
2. Heads congested near apex of plant; leaves mostly obovate (Brazil) . . . . *S. tragiaefolium*
1. Cauline leaves narrowly oblong with broadened bases or linear throughout, broader bladed leaves restricted to basal rosette 3
3. Cauline leaves linear throughout, narrow at base (Paraguay) . . *S. hystrix*
3. Cauline leaves linear to oblong with oblong or broadened bases 4
4. Inflorescence laxly branched with heads mostly solitary in successive axils; involucral bracts ca. 20, with narrowly acuminate tips; flowers ca. 4 in a head (Brazil, Venezuela) . . . . *S. apiculatum*
4. Inflorescence often profusely branched with heads distinctly clustered in axils or on short branchlets; involucral bracts ca. 15, with shortly acuminate or cuspidate tips; flowers ca. 6–7 in a head (Argentina, Brazil, Paraguay, Uruguay) . . . . *S. megapotamicum*

The species of *Stenocephalum* recognized in this study are as follows:

Stenocephalum apiculatum (Martius in DC.) Schultz-Bip.

Figs. 1–4

Vernonia apiculata Martius in DC., Prodr. 5:51. 1836. *Vernonia monticola* Martius in DC., Prodr. 5:18. 1836. *Stenocephalum monticola* (Martius in DC.) Schultz-Bip., Pollichia 20/21:386. 1863. *Stenocephalum apiculatum* (Martius in DC.) Schultz-Bip., Pollichia 20/21:387. 1863.

The species is almost completely restricted to Brazil, but one specimen seen in this study from Venezuela seems to be this species [Bolivar: Rio Villacda (Rio Auyacda). Jan 6, 1956. *Wurdack & Monachino 41144,* US].

Stenocephalum hystrix
(Chodat) H. Robinson, comb. nov.

Vernonia hystrix Chodat, Bull. Herb. Boiss. ser. 11. 2:298. 1902.

Stenocephalum jucundum (Gleason)
H. Robinson, comb. nov.

Vernonia jucunda Gleason, Bull Torrey Bot. Club 46:248. 1919. *Vernonia spinulosa* Gleason, Bull. Torrey Bot. Club 52:188. 1925. *Vernonia llanorum* Badillo, Bol. Soc. Venez. Cienc. Nat. 10:218. 1946.

Gleason (1925) distinguished his Venezuelan species from the Central American entity by the narrower branch leaves, but his description indicated that the type had lost most of its leaves. The slight tendency that has been seen for the distal leaves to be narrower does not seem to justify separate specific rank. The picture has been complicated by the presence in southeastern Venezuela of the specimen mentioned above that has been determined here as the Brazilian *S. apiculatum.*

Stenocephalum megapotamicum
(Spreng.) Schultz-Bip.

Vernonia megapotamica Spreng., Syst. Veg. 3:437. 1826. *Vernonia megapotamica* var. *brevifolia* DC., Prodr. 5:51. 1836. *Vernonia megapotamica* var. *melanotrichia* DC., Prodr. 5:51. 1836. *Stenocephalum brevifolium* (DC.) Schultz-Bip., Pollichia 20/21:387. 1863. *Stenocephalum megapotamicum* (Spreng.) Schultz-Bip., Pollichia 20/21:388.1863. *Stenocephalum melanotrichium* (DC.) Schultz-Bip., Pollichia 20/21:388. 1863. *Stenocephalum penicillatum* Schultz-Bip., Pollichia 20/21:389. 1863. *Stenocephalum hexanthum* Schultz-Bip., Pollichia 20/21:390. 1863. *Vernonia hexantha* (Schultz-Bip.) Baker in Mart., Fl. Bras. 6(2):27. 1873.

Stenocephalum tragiaefolium
(DC.) Schultz-Bip.

Vernonia tragiaefolia DC., Prodr. 5:60. 1836. *Stenocephalum tragiaefolium* (DC.) Schultz-Bip., Pollichia 20/21:389. 1863. *Vernonia interjecta* Baker in Mart.?, Fl. Bras. 6(2):28. 1973.

Acknowledgments

The pollen specimens were prepared by Mary Sangrey using the facilities of the Botany Department Palynological Laboratory. The photographs were prepared by Suzanne Braden of the Smithsonian Museum of Natural History SEM Laboratory using a Hitachi 570 scanning electron microscope.

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STUDIES IN THE *LEPIDAPLOA* COMPLEX (VERNONIEAE: ASTERACEAE). II. A NEW GENUS, *ECHINOCORYNE*

Harold Robinson

Abstract.—The genus *Echinocoryne* is established for a group of Brazilian species related to the genus *Lepidaploa* in the "rhizomatous" form of the columellae in its lophate pollen. The new genus is characterized by its large number of slender involucral bracts and its pedunculate heads. The genus is also notable for its densely sericeous pubescence and poorly differentiated style base.

The present paper is one of a series of five devoted to the particular problem of refining generic limits in the neotropical *Lepidaploa* relationship of the Vernonieae. *Echinocoryne* is one of three genera in the complex showing a specialized pollen that is unique to the group. The first of the genera treated, *Stenocephalum,* a small genus of Central of South America south to Argentina, is distinguished by heads with few flowers and by pollen with some extra areoles (Robinson, 1987). The present genus, *Echinocoryne* is also small, but is restricted to Brazil. Another paper will deal with the small *V. brachiata* and *V. scorpioides* groups. The two remaining papers in the series will deal with the two larger elements of the complex, one being on *Lepidaploa* itself with a fuller discussion of the basic pollen form of the complex.

The species of *Echinocoryne* have been placed together in some previous treatments. Baker (1873) placed them in his *Vernonia* catagory Lepidaploae Paniculatae I. Oxylepidae, while Jones (1979) placed them in *Vernonia* as a new series *Subulatae* under his subsection Nudiflorae. The Baker treatment included two additional species in the group. The first, *V. foliosa* Gardn. with its strikingly different Lychnophorine habit and *Proteopsis*-like heads, seems from photographs to have no close relationship. The second, *V. virgulata,* was also retained by Jones in his series *Subulatae.* The latter species has some resemblance to *Echinocoryne* in its sericeous indument and variably short-pedunculate heads, but differs in the aspect of the short-tipped multiseriate involucral bracts. The number of bracts is approximately 40 in head compared to ca. 10 flowers, a ratio approaching but not equalling that in *Echinocoryne.* In addition, the stems are distinctively grooved, receptacles setiferous, corollas have more hairs on their lobe tips, carpopodium has a different shape, while the upper achene and corolla have larger short-stalked capitate glands of a form not seen in *Echinocoryne.* The pollen differences are cited below. The overall impression is one of a remote relationship elsewhere in the *Lepidaploa* complex.

The only species included here that was not covered in the previously mentioned works is *V. echinocephala* H. Robinson which has been described since those works (Robinson 1980).

Significant Characters

Pubescence.—The vegetative parts of *Echinocoryne* are notable for their sericeous pubescence. Such hairs occur to the exclusion of evident glandular punctations. The density of the hairs varies from the sparse form seen in the more herbaceous *E. subulata* to the usually dense, sometimes silvery sericeousness of parts of the other species. The pubescence is most dense on the undersides of the leaves, but is often nearly as thick on the upper side without obscuring the darker color of the leaf surface. The hairs are shorter but often very dense on the involucral bracts. In contrast, the corollas have less hairs than those of many other species in the Vernonieae. The corollas are nearly glabrous, except at the tips of the lobes, in all the species. In *E. subulata* even the tips of the lobes have no hairs, just the few characteristic minute glands found in all the species.

Pedunculate heads.—The heads of *Echinocoryne,* with rare exceptions, are all pedunculate; however, the length of the peduncles varies. The peduncles are longest in the herbaceous *E. subulata* and subshrub *E. echinocephala,* but are short in typical *E. holosericea* and *E. schwenckiaefolia.* The length seems consistent in the first two species, but in the latter two seems to be variable. The longest peduncles in the genus seem to be generally associated with larger heads, but the correlation breaks down in forms with shorter peduncles.

Involucre.—The graduated bracts of the involucre in *Echinocoryne* are all similar in their general form and show no differentiation of the type seen in many *Lepidaploa.* They have minimal differentiation of the largest inner bracts. All the bracts are linear-lanceolate with narrowly pungent almost setiform tips. The appearance of the involucre is characteristically echinate.

The most significant aspect of the involucre compared to *Lepidaploa* is the ratio of the bracts to the flowers. The example with the largest numbers, *E. echinocephala,* has 400–500 bracts with ca. 50 flowers in a head. The number of bracts may be as great as any in the tribe, and the ratio of bracts to flowers is larger than any in the tribe except those with three or less flowers in a head. The stability of the usually 2:1 or 3:1 ratio in the large genus *Lepidaploa* seems significant, and the striking exception to that ratio in *Echinocoryne* is therefore also considered significant.

Style base.—In all of the species the base of the style has a few rows of sclerified cells on the part that is immersed in the top of the nectary, but no enlargement of the type seen in *Lepidaploa* has been seen in any of the species of *Echinocoryne.*

Achene.—The achene is densely and sericeously setuliferous without any intervening glands or uniseriate hairs. The five weak ribs of the surface are completely obscured by the setulae. The carpopodium is somewhat unusual in its turbinate form which is constricted above. The incurved upper surface is further distinct for the number of setulae borne as low as the broadest part of the carpopodium, well below the level of the uppermost margin of the structure. Although the differentiated carpopodial cells do not occur directly above such setulae, but only between them, the impression is nevertheless that the upper incurved third of the carpopodium is setuliferous.

Pollen.—*Echinocoryne* has lophate pollen grains with a "rhizomatous" columellar structure under the crests (Figs. 1–6). The pollen in the group was classified as type B by Jones (1979), which it is in the broad sense of having colpi continuous to the poles. That classification has proven much too broad, however, because it includes phyletically significant variations. The type B of Jones is approximately the same as that called the *Vernonia argyrophylla* type by Stix (1960). The type, as represented by the latter species, was erroneously regarded by Stix under her general *Vernonia* category which she showed in a drawing with the structure here called "rhizomatous." The type B based on *V. argyrophylla* is not rhizomatous, and it tends to be larger in size with three areoles equatorially across the intercolpar region. The *Echinocoryne* pollen has only two intercolpar rows of areoles (Figs. 1–3) and has rhizomatous structure (Figs. 5, 6). It is a type more often seen in the genus *Lepidaploa.* The grains seem distinct from similar forms in *Lepidaploa* in only one possible way, the manner in which the rhizomatous columellae peel away from the foot-layer leaving slightly raised ridges but no clear scars (Fig. 4).

Vernonia virgulata which was placed with species of *Echinocoryne* by both Baker (1873) and Jones (1979) actually does not have the type B pollen designated for it by Jones. The type is technically C with polar areoles, but the grains are distinct from any other type C grains by the non-rhizomatous columellar structure of the crests and the frequent extra areole in the middle of the intercolpar region. The pollen is regarded here as closest phyletically to the type B as seen in *V. argyrophylla* although it has a different areolation. The pollen structure tends to reinforce the impression gained from other characters that *V. virgulata* is only remotely related to *Echinocoryne.*

Relationships

A phyletic position of *Echinocoryne* can be proposed if one accepts certain conclusions regarding the characters analyzed above. The specialized rhizomatous crests of the pollen place the genus in the immediate relationship of *Lepidaploa* in which such complex pollen is unique. Since the bract/flower ratio of *Lepidaploa* extends more widely than the rhizomatous pollen character, then the departure from that ratio in the small genus *Echinocoryne* seems derived in the more immediate ancestry of that genus. The pedunculate condition of the heads is not found in *Lepidaploa* but is found in what appears to be its nearest outgroup. Consequently, a position for *Echinocoryne* from near the basal stock of *Lepidaploa* might be possible. It is also possible that the pedunculate condition is a reversion and that the genus is a more recent derivative of *Lepidaploa.* However, no species in the latter genus seems a likely candidate for close relationship.

As indicated, the genus dealt with here is well-marked in its habit, and the characters violate the character limits by which all the most closely related genera are most effectively defined. Furthermore, a phyletic position outside of the immediate *Lepidaploa* generic clade seems possible. The name *Echinocoryne,* meaning hedgehog or prickly club, is particularly suitable for the pedunculate heads of the plants with their many spiny involucral bracts.

Echinocoryne H. Robinson, gen. nov.

Plantae herbaceae perennes erectae ad 2 m altae vegetative laxe ramosae, in caulibus foliis et bracteis involucri dense albo-sericeae. Folia alterna sessilia vel subsessilia linearia vel oblonga margine integra anguste reflexa apice acuta et minute apiculata subtus pallidioria non glandulifera. Inflorscentiae diffusae in pedunculis leniter vel arcte elongatae. Capitula late campanulata; bracteae involucri super-abundentes dense subimbricatae graduatae ca. 110–500 et 6–9 seriatae patentes vel erecto-patentes lineares apice longe punguntes. Flores 15–60 in capitulo; corollae lavandulae in partibus majoribus glabrae in lobis subapice pauce spiculiferae et minute glanduliferae; cellulae endotheciales in scutis scleroideis radiatae vel curvatae, nodis multifidis; appendices antherarum non glanduliferae; basi stylorum noduliferi. Achaenia longe setulifera, costis 5 indistinctis in setulis dense obsitis, setulis perdensis strictis sericeis, cellulis intercostalis raphides elongates continentibus; carpopodia turbinata in partibus superioribus setulifera; setae pappi interiores capillares persistentes ca. 30, squamae pappi exteriores lineares. Grana pollinis in diametro ca. 50 μm valde lophata *Lepidaploa*-forma (subtypus E).

Type species.—Vernonia holosericea Mart. ex DC.

A number of names have been proposed

for various entities in the genus *Echinocoryne,* but the name *V. subulata* has represented the only obviously distinct species besides the type. The other members of the genus have seemed comparatively alike, and the name *V. holosericea* has been applied widely to them by myself and others. Contrary to the superficial appearances, the present study has shown that all the available names in the genus correlate with distinguishable species having distinctive geographical distributions.

Key to the Recognized Species of *Echinocoryne*

1. Plants laxly herbaceous with pale green membranaceous leaves and yellowish-green stems, leaf blades broad, plane or with scarcely recurved margins, with sparse flexuose hairs; peduncles long and flexuous .... *E. subulata*
– Plants more stiffy herbaceous to suffrutescent with darker leaves and stems, leaf blades narrow or broad with distinctly recurved margins, with dense hairs on at least under surface; peduncles strict and often short 2
2. Heads few or solitary on peduncles 7 cm long or longer; leaves lanceolate with densely whitish sericeous undersurface .... *E. echinocephala*
– Heads usually numerous in complex inflorescences; peduncles usually 4 cm or less long; leaves linear to oblong with sordid or grayish pubescense on undersurfaces 3
3. Leaves mostly broadly elliptical to oblong ¼ to ½ as wide as long, often velvety pubescent beneath .... *E. schwenkiaefolia*
– Leaves narrowly lanceolate to linear, less than ¼ as wide as long, with pubescence beneath variable but not velvety 4
4. Heads with 30–60 flowers, 12 mm or more high at maturity .... *E. holosericea*
– Heads with 15–21 flowers, 8–10 mm high at maturity 5
5. Involucres pale yellowish; upper leaves abruptly terminating in narrowly obtuse apices .... *E. stricta*
– Involucres tinged with red; upper leaves tapering to narrowly acute apices .... *E. pungens*

The species recognized in the genus are as follows:

Echinocoryne echinocephala
(H. Robinson) H. Robinson, comb. nov.

Vernonia echinocephala H. Robinson, Phytologia 45:173. 1980. Southern Goias.

Echinocoryne holosericea
(Mart. in DC.) H. Robinson, comb. nov.
Figs. 1–6

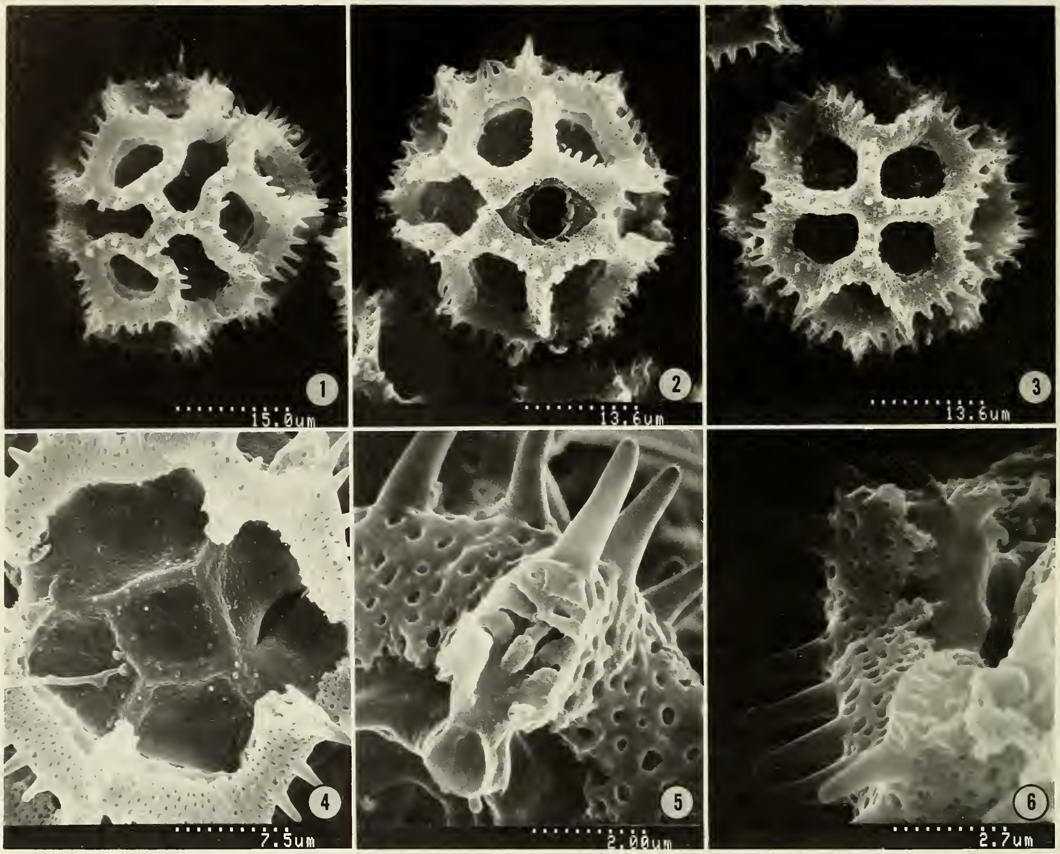
Vernonia holosericea Mart. in DC., Prodr. 5:43. 1836. Bahia, southern Maranhao, northern Minas Gerais.

Echinocoryne pungens
(Gardn.) H. Robinson, comb. nov.

Vernonia pungens Gardn., London J. Bot. 6:418. 1847. Southern Goias, western Bahia, western Minas Gerais, Distrito Federal. Examination of an isotype (US) shows that neither the odd statement of 4–5 flowers by Gardner (1847) nor the 30–40 flowers in the head claimed by Baker (1873) is correct. The number seems to be ca. 20, essentially the same as that in *E. stricta* which has heads of about the same size. The involucral bracts are generally less longly attentuate than in the other species.

Echinocoryne schwenkiaefolia
(Mart. in DC.) H. Robinson, comb. nov.

Vernonia schwenkiaefolia Mart. in DC., Prodr. 5:44. 1836. Minas Gerais, south-



Figs. 1–6. Pollen of *Echinocoryne holosericea* (Martius in DC.) H. Robinson, dotted lines of 1. = 15 μm, 2, 3. = 13.6 μm, 4. = 7.5 μm, 5. = 2 μm, 6. = 2.7 μm. 1, Polar view showing convergence of colpi; 2, View of colpus (transverse); 3, View of intercolpar region showing characteristic two rows of areoles; 4-6. Broken grains. 4, View showing nearly unscarred foot-layer with crest removed; 5, Crest in section showing "rhizome" and structure of perforated tectum; 6, Lateral view of crest showing weak basal attachment of "rhizome."

ern Goias, southern Bahia. The species is rather consistent in its broad short leaves but is more variable in its heads. The latter range from nearly as pale as *E. stricta* to as dark as *E. holosericea,* but the mature heads are mostly in the size range of the latter species with 25–45 flowers.

Echinocoryne stricta
(Gardn.) H. Robinson, comb. nov.

Vernonia stricta Gardn., London J. Bot. 5: 219. 1846. Southern Minas Gerais, São Paulo. The small pale involucres are very noticeable, especially in contrast to the rufus pappus and the reddish corollas.

Echinocoryne subulata
(Baker) H. Robinson, comb. nov.

Vernonia subulata Baker, Fl. Bras. 6(2):108. 1973. Southern Goias, central Minas Gerais.

Acknowledgments

The pollen specimens were prepared by Mary Sangrey using facilities of the Botany Department Palynological Laboratory. The photographs were prepared by Suzanne Braden of the Smithsonian Museum of Natural History SEM Laboratory using a Hitachi 570 scanning electrom microscope.

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UPOGEBIA SYNAGELAS, NEW SPECIES, A COMMENSAL MUD SHRIMP FROM SPONGES IN THE WESTERN CENTRAL ATLANTIC (DECAPODA: UPOGEBIIDAE)

Austin B. Williams

Abstract.—*Upogebia synagelas,* a new species of mud shrimp from the western central Atlantic, lives commensally as adult male-female pairs in species of the agelasid sponge, *Agelas,* in the eastern Gulf of Mexico and West Indian region. Both adults and zoea I are described. The species is similar to *U. ramphula* of the eastern Pacific.

Specimens of an undescribed species of *Upogebia* were brought to my attention recently by Drs. Paula J. B. Scott of McMaster University, Hamilton, Ontario, Canada, and Elizabeth Sides, Dublin, Ireland. Both of these investigators have found the species living commensally in the agelasid sponge, *Agelas sceptrum* (Lamarck), and both Scott, Reiswig, and Marcotte (in press) and E. Sides have observed that the adults live as male-female pairs in the sponge whereas juveniles may occur singly. Michael Dardeau and associates of the Marine Environmental Sciences Consortium, Dauphin Island, Alabama, have found the shrimp in *A. dispar* Duchassaing and Michelotti on the Florida Middle Grounds in the Eastern Gulf of Mexico and the Bahama Islands. The purpose of this paper is to describe the adult shrimp as well as selected features of the zoea stage I, with comparative remarks on similar species.

Type specimens and larval material have been placed in the crustacean collection of the United States National Museum of Natural History (USNM) and in the research collection of the Marine Environmental Sciences Consortium (MESC), Dauphin Island Sea Lab, Dauphin Island, Alabama 36528.

Upogebia synagelas, new species
Figs. 1–3

Material examined.—Jamaica: USNM 233572, ♂ Holotype; USNM 233573, ♀ Allotype; USNM 233574, 1 ♂, 1 ♀, Paratypes; Discovery Bay, 18°28′N, 77°24′W, spur and groove reefs on Fore Reef, Long Term Survey site, 27.4–35 m (90–115 ft.), P. J. B. Scott, SCUBA, 3 Oct 1985, host sponge *Agelas sceptrum.*—USNM 233575, 2 ♂, 2 ♀ (ovig., 1 with eyed eggs, 1 with variably hatched zoeae) Paratypes; Pear Tree Bottom, 22 m, J. Woodley, 25 Nov 1985, occurring as pairs in *A. sceptrum.*

Barbados: USNM 233576, 2 ♂, 1 ♀; 233577, 1 ♂, 3 ♀ ovig., Paratypes; "Nurse's Jetty, on Bank Reef," 1 km W Holetown, St. James, 13°10.7′N, 59°38.9′W, 18.3 m (60 ft.), H. M. Reiswig collection No. 76-8-9.1, SCUBA, 9 Aug 1976, host sponge *A. sceptrum* (specimens in collection of Redpath Museum, McGill University Cat. No. RMI 2727).

MESC, Paratypes.

Florida Middle Grounds, coral reef, Gulf of Mexico: Sta 151, 28°32′20″N, 84°18′36″W: MESC 6183-4563, 1 juv., diver collected, 27.4 m, 5 Oct 1978; MESC 6183-

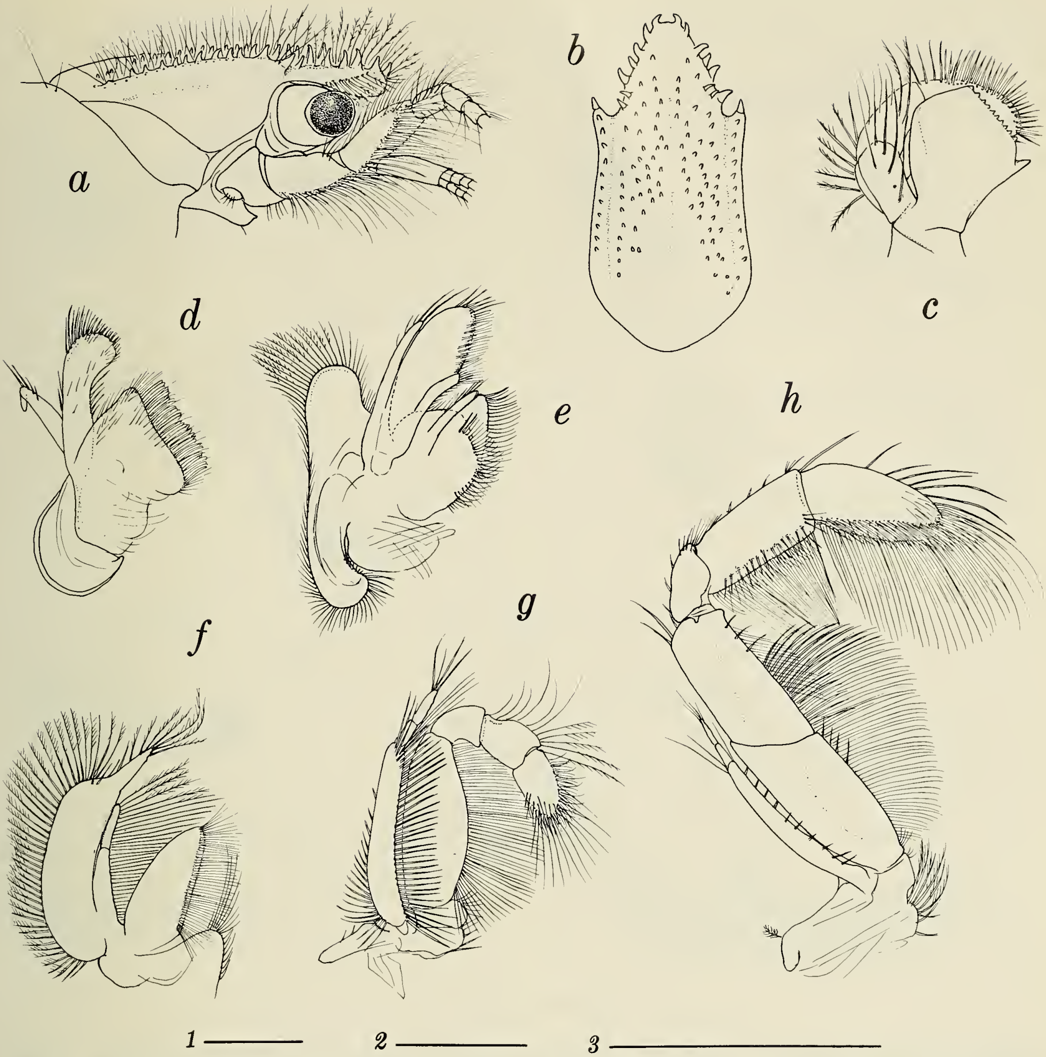

Fig. 1. *Upogebia synagelas,* ♂ holotype: a, Cephalic region, lateral; b, Anterior carapace, dorsal; c, Mandible; d, e, Maxilla 1, 2; f, g, h, Maxilliped 1, 2, 3. Scales all 1 mm: 1 = a–b; 2 = c; 3 = d–h.

4558, 1 juv., diver collected, 31.3–33 m, 17 Jan 1979; MESC 6183-4574, 5 juv., diver collected, 27.4 m, 18 Jan 1979.—Sta 481, 28°30′52″N, 84°18′59″W: MESC 6183-4589. 1 ♂, diver collected, 29 m, 6 Oct 1978; MESC 6183-4556, 2 juv., diver collected 29 m, 8 Oct 1978; MESC 6183-4580, 2 ♂ (juv.), diver collected, 29 m, 8 Oct 1978; MESC 6183-4587, 1 juv., diver collected, 29 m, 8 Oct 1978; MESC 6183-4552, 1 juv. (tiny), submersible, 37.5 m, 8 Nov 1978.—Sta 491, 28°27′18″N, 84°17′02″W: MESC 6183-4575, 1 ♂, diver collected, 29 m, 16 Oct 1978.—Sta 482, 28°31′06″N, 84°18′55″W: MESC 6183-4578, 1 ♀ (juv.), diver collected, 33.5 m, 8 Jul 1979.—Sta 2315, 28°34′05″N, 84°14′11″W: MESC 6183-10523, 1 juv., Capetown dredge, 38 m, 30 Aug 1977.

Bahamas: Freeport, Grand Bahama Island: MESC 6183-10524, 1 juv., diver collected, 21–23 m, Nov 1975; MESC 6183-10525, 1 ♂, 2 ♀ (1 ovig.), 1 frag., diver collected, 21–23 m, Nov 1975.

Diagnosis.—Projections to either side of

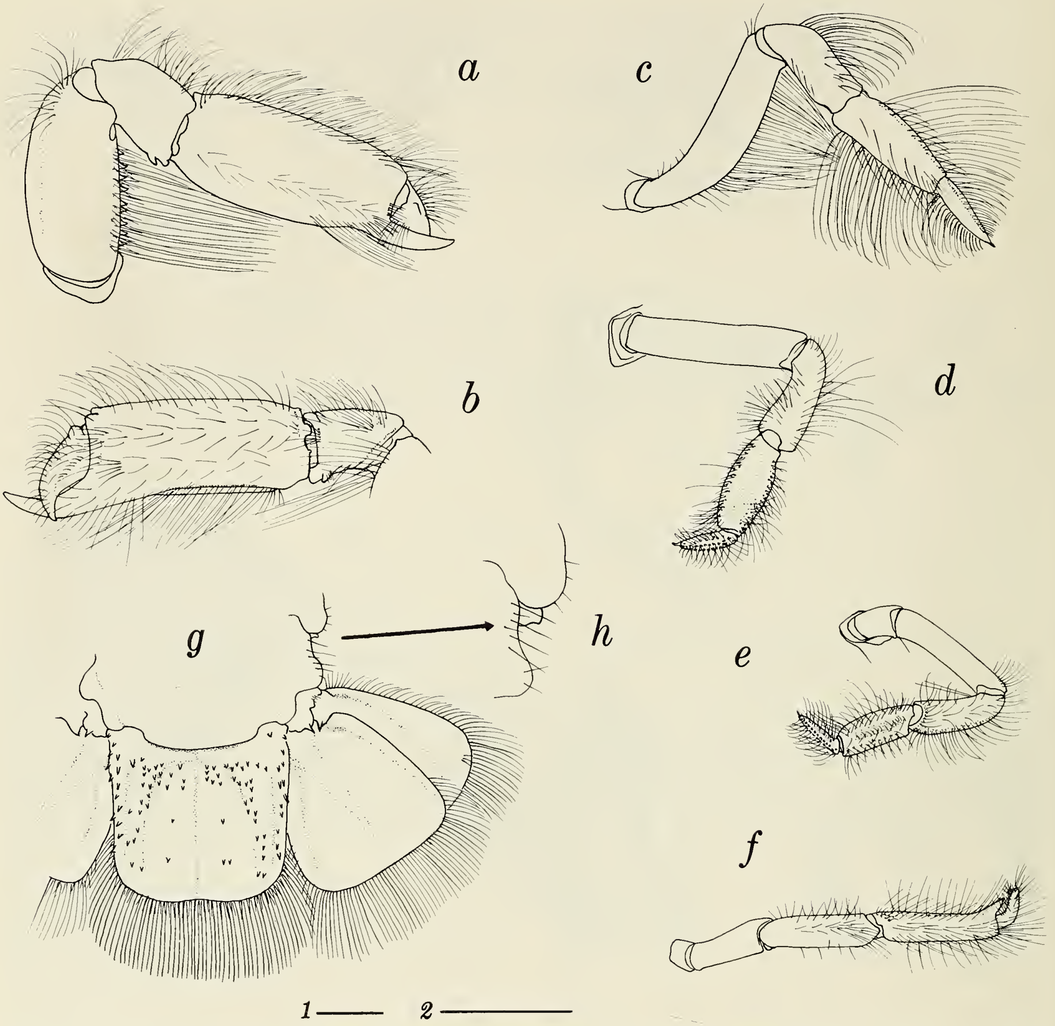

Fig. 2. *Upogebia synagelas,* ♂ holotype: a, Cheliped, lateral; b, Cheliped, mesial; c, d, e, f, Legs 2–5; g, Parts of abdominal segment 6, telson and uropods; h, Parts of lateral margin, segments 5–6. Scales all 1 mm: 1 = a–g; 2 = h.

rostrum ending in acute spine. Postocular spine absent. First and second abdominal segments lacking ventral spines; sixth segment bearing anterolateral process; telson longer than wide, slightly narrowed posteriorly. Chelipeds with fully developed fixed finger equal to dactyl in length, merus with ventral row of low spines; remaining legs spineless.

Description.—Rostrum truncate, triangular in dorsal view, slightly broader than long, downturned tip exceeding eyestalks; 4–6 strong acute spines along each lateral margin; dorsal surface bearing anterior mat of long silky setae followed by field of scattered spines angling toward sides posteriorly, gastric region smooth; ornamented part separated from, and flanked on each side by, slightly sinuous ridge bearing crest of about 11 spines grading from slender anteriorly on lateral rostral process to sharp tubercles posteriorly. Postorbital spine absent. Shoulder lateral to cervical groove prominent; thalassinidean line faint but extending to posterior margin of carapace.

Abdomen weakly sclerotized; first 2 seg-

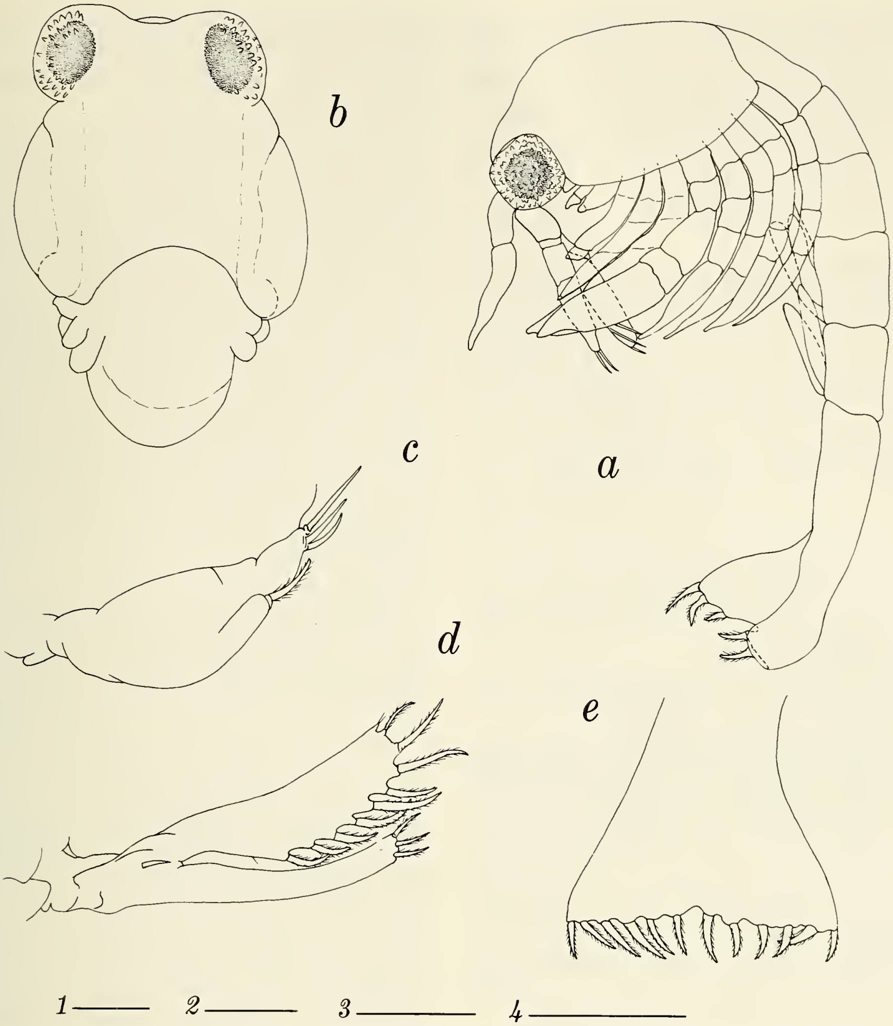

Fig. 3. *Upogebia synagelas,* Zoea I, just hatched or in process of hatching but still partly encapsulated in egg membrane. a, Lateral view, semidiagrammatic; b, Dorsal view, cephalothorax and proximal part of abdomen; c, Antennule; d, Antenna; e, Telson, composite of 2 specimens. Scales all 0.5 mm: 1 = a–b; 2 = c; 3 = d; 4 = e.

ments lacking spines or spinules on sterna, pleura and bases of pleopods; pleura of segment 1 very poorly developed, of 2–5 rather well developed and bearing plumose setae on margins from middle of 2 to middle of 5, pilose tract extending dorsally to some extent near anterior and posterior margin of tergum on segment 3, scattered setae elsewhere dorsally; segment 6 broader than long, bearing slightly hooked process on anterolateral margin and behind it an irregularly rounded lobe, marked dorsally on each side with an obsolescent, irregularly lunate furrow.

Telson as long as uropods, slightly wider than long, somewhat narrowed and rounded posteriorly; median longitudinal furrow and broader submarginal furrow at each side; small acute spines irregularly placed along lateral margins as well as submarginally and irregularly on raised tracts, some spines clustered in twos and threes.

Eyestalks rather stout, clearly exceeded by rostrum; cornea large but narrower than base of eyestalk in lateral view and directed anterolaterally.

Antennular and antennal peduncles with articles unspined; scale on latter minute.

Mouthparts as figured; epipod of maxilliped 1 minute, maxilliped 3 lacking epipod.

Extension of epistome spineless in lateral view.

Chelipeds subequal, moderately robust, depth of palm less than ½ length; fingers elongate, gently curved toward each other and tapering to tip, opposed edges entire; carpus often with small distolateral, ventral spine; merus bearing row of about 4–9 spines on ventral margin. All walking legs with smooth, spineless articles; they and chelipeds bearing usual tracts of long, silky setae.

Two arthrobranchs arranged in biserial rows of undivided (entire) lamellae on maxilliped 3 and legs 1–4.

Pleopods densely setose, exopod far longer and broader than endopod.

Uropodal exopod with convex distal margin, that of endopod less so, distal spine on protopod lateral to articulation of endopod; comparable acute spine proximally on prominent rib of exopod; central rib of endopod bearing irregular row of about 4–12 or more small spines in distal half and sometimes scattered spines elsewhere on blade, exopod usually bearing sparse obsolescent spines on distolateral margin.

Measurements (mm).—Holotype ♂, length anterior carapace 3.84, length carapace 6.34, length right chela including fixed finger 4.8, height 1.66. Allotype ovigerous ♀, same, 4.22, 6.49; 4.67, 1.34; 4.48, 1.34; eggs of one individual approximately 0.9 × 1.04 in diameter.

Known range.—Confined to the material studied.

Color.—Chelipeds with distal parts of palm colored shades of orange, fingers similar but light at tips.

Remarks.—There is considerable variation in the amount of spination on the tail fan and in ornamentation elsewhere; for example, the cheliped merus of the holotype lacks a dorsal subdistal tubercle whereas such a tubercle is present on this member in some individuals.

Chelae of selected juveniles are noticeably stouter than those of adults. For example, in one juvenile with a carapace length of 2.56 mm the right chela has a palm length of 1.79 and a mid-palm height of 0.77; mid-palm height of the right chela in the holotype is 0.35 the palm length, whereas in the abovementioned juvenile the relationship is 0.43. In still another juvenile the relationship is 0.53. The rostrum and eyes show obvious ontogenetic changes from juveniles of this size to the full adult phase; the eyes are relatively large in juveniles, overshadowing the short narrow rostrum, though its marginal spines are evident.

Upobegia synagelas most closely resembles *U. ramphula* Williams (1986) in structure of the rostrum, abdomen, eyes, mouthparts, and walking legs. There are differences in shape of the fingers (toothless in *U. synagelas*) and in shape of elements of the tailfan which are spineless in *U. ramphula.* Nevertheless, the similarity is striking, as in many species pairs found on both sides of Central America, and, though the exact habitat of *U. ramphula* is presently unknown, it may prove to be some species of sponge.

Most members of the genus *Upogebia* are burrowers in subtidal substrates (Williams 1986). Some are highly specialized for burrowing in stony corals (Kleemann 1984), and still others are adapted for living in the cavities of sponges (Barnard 1950).

Etymology.—A noun in apposition from the Greek *syn,* with, and *Agelas,* the generic name of the host sponge.

Notes on Zoea I
Fig. 3

Jamaican females studied (see above) are ovigerous, and one of them bears both hatching and recently hatched zoeae I among setae on the pleopods. Interesting comparisons can be made between these zoeae and the zoea I of *U. affinis* (Say, 1818) described and figured by Sandifer (1973). The larvae figured here agree in general structure with the latter but differ from them in lack of a rostrum, in possession of developed pleopods, in lack of incipient uropods which are indicated in Sandifer's Fig. 1A but not in 1B, and in pattern of spination on the tail fan. Some of these differences may result from a premature hatch due to handling. Zoea I of *U. affinis* has 5 terminal spines on each side of the telson and 2 or more smaller lateral setae which may represent the distal edge of the developing uropods. In contrast, the telson of *U. synagelas* has 6 terminal spines to either side of the midline. Differences in the admittedly variable abovementioned features may be additional evidence of the clustered relationships among upogebian species in the western hemisphere (Williams 1986).

Acknowledgments

I am indebted to both P. J. B. Scott and E. Sides for bringing this interesting species to my attention, to P.J.B.S. for giving specimens to the USNM, to M. R. Dardeau, Dauphin Island Sea Lab, Dauphin Island, Alabama, for loan of study specimens from the MESC research collection, and to P.J.B.S., M.R.D., and B. B. Collette for critical reading of the manuscript. Klaus Rützler gave information on the host. Keiko Hiratsuka Moore carefully drew the adults and inked drawings of the larvae.

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RANGE EXTENSION OF THE GENUS *ASYMPHORODES MEYRICK* *(LEPIDOPTERA: COSMOPTERIGIDAE)*

J. F. G. Clarke

Abstract.—*Asymphorodes aporema* is described from Guam. The new species is distantly removed from the Marquesas Islands, the center of distribution of the genus *Asymphorodes. Asymphorodes aporema* is closely related to *A. poliopterus* but is distinguished from it by the strongly spined posterolateral margin of the sixth sternum and the annulated antenna. The lectotype of *Stathopoda monoxesta* (Meyrick), new combination, is designated.

The genus *Asymphorodes* (Meyrick, 1929: 498–501) originally contained 13 species from the Marquesas Islands, one from the Paumotus (Tuamotus), one from Tahiti (*monoxesta*) and one from Rapa (*perfuga*) which Meyrick transferred from the genus *Ulochora.*

Currently, the genus contains 75 species from the Marquesas Islands (Clarke 1986: 180–283), two from Hawaii (Zimmerman 1978:1055–1067), one from Easter Island (Clarke 1986:161), one from the Solomon Islands, (Bradley 1957:100), and one from the Tuamotus (Meyrick 1929:500).

Asymphorodes monoxesta Meyrick from Tahiti is misplaced and is treated elsewhere in this paper. *Asymphorodes perfuga* (Meyrick) from Rapa, was transferred to *Stathmopoda* (Clarke 1971:176).

Recently, while sorting species of Cosmopterigidae from Micronesia, an obvious species of *Asymphorodes* from Guam was encountered. Guam is ca. 3750 miles (6039 km.) from Hawaii and ca. 5250 miles (8454 km.) from the Marquesas Islands. These are the nearest areas from which any species of *Asymphorodes* has been reported.

The specimen was collected on an airplane in 1939, the "Philippine Clipper," and it is not clear whether the moth was a stowaway or whether it boarded the airplane in Guam. The only place where the Pan American Clipper Ships stopped on their way to or from the Orient, and where any species of *Asymphorodes* are known to occur, is Hawaii. The two species of this genus that occur in Hawaii are not closesly related to the Guam species, so it is not likely that the Guam specimen originated there. The microlepidopterous fauna of Guam is very poorly known and it is quite possible that extensive collecting on that island will reveal the presence of other species of *Asymphorodes*, as well as additional specimens of *A. aporema.*

In the meantime we must consider this apparent great extension of range of the genus with some scepticism.

Asymphorodes aporema, new species
Figs. 1, 2

Description.—Alar expanse 6 mm. Labial palpus shining white; second segment shaded with fuscous on outer side; third segment fuscous anteriorly and on outer side. Antenna, scape white; flagellum white annulated fuscous. Head white. Thorax white; thornlike processes of metascutum well developed. Forewing ground color white; from base to apex a broad median, longitudinal fuscous streak, edges of which not clearly defined; cilia mixed white and grayish. Hindwing sordid white; cilia grayish. Fore-

Fig. 1. *Asymphorodes aporema*, new species, right wings.

leg white; femur, tibia and tarsal segments fuscous on outer side; midleg white; tarsal segments slightly infuscated; hindleg white; tibia slightly infuscated dorsally; tarsal segments slightly infuscated. Abdomen fuscous above, whitish ventrally; segments 6, 7 and 8 strongly modified (see figures).

Male genitalia slide USNM 26411. Harpe broad basally; neck moderately narrow; cucullus moderately dilated distally. Brachia unequal, right brachium longer than left, distally hooked. Tegumen shorter than broad. Aedeagus slightly S-shaped, slender. Manica thickened distally.

Holotype.—USNM. Unique male holotype, 15 Mar 1939, Guam No. 1912, R. G. Oakley.

Type locality.—Guam (no specific locality).

Distribution.—Guam.

Food plant.—Unknown.

Remarks.—The nearest relative to *A. aporema* is *A. poliopterus* Clarke (1986:241) from the Marquesas Islands. In the male of *poliopterus* the antenna is cream white but the antenna of *aporema* is white, annulated with fuscous; also, the fuscous marking of the forewing of *aporema* is confined to a median longitudinal streak but in *poliopterus* the fuscous marking covers all of the wing except the dorsal white edge. The modifications of the abdominal segments are similar, but distinct. Compare figures of *aporema* with those of *poliopterus* (Clarke 1986: fig. 168 c–e).

Stathmopoda monoxesta (Meyrick), new combination

Asymphorodes monoxesta Meyrick, 1929: 501. "♂♀. 11–13 mm. . . . Society Is. Tahiti, 500–2500 feet, March to May (*Miss Cheesman, Collenette*); 9 ex."

Lectotype.—♂, 12mm. "Fautaua, Tahiti, at light 2500 ft. 13.3.25. St. George Expedn. C.L. Collenette." Slide JFGC No. 11519. Lectotype hereby designated. This specimen is marked "Type ♀" in the British Museum. A small white label bears the number "P607."

Type.—British Museum (Natural History).

Type locality.—Tahiti, Fautaua.

Distribution.—Tahiti.

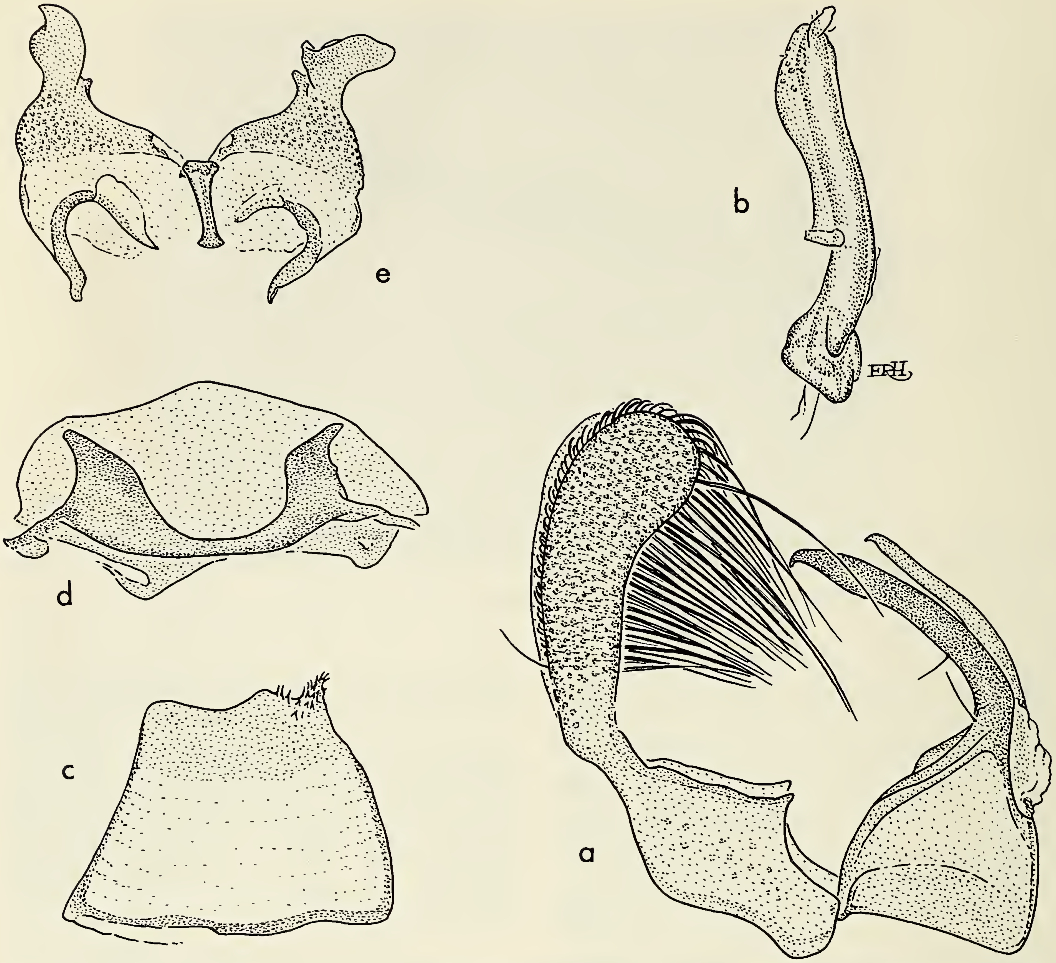

Fig. 2. *Asymphorodes aporema*, new species: a, Lateral aspect of male genitalia with aedeagus removed; b, Aedeagus; c, 6th tergum; d, 7th tergum and sternum; e, 8th sternum.

Remarks.—The fact that the lectotype was marked "Type ♀" presents no problem because the gender of many "types" from the Meyrick collection was mislabelled.

Acknowledgments

I wish to thank Miss Ann Whyte, Manager, Pan American World Airways, New York, for providing information on the routes of the "Clipper Ships" during the years 1939–40. I am indebted to Mrs. Nancy McIntyre for calculating the distances indicated. Also, I wish to express my appreciation to Victor Krantz for the photograph of the moth wings, to Elaine R. S. Hodges for the drawings and to Silver West for typing the manuscript, all members of the Smithsonian staff.

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REIDENTIFICATION OF DAVID CAUSEY'S *CALIGUS* COLLECTIONS (CRUSTACEA: COPEPODA)

Roger Cressey and Patricia Nutter

Abstract.—The David Causey collections of *Caligus* from the Gulf of Mexico and Caribbean Sea housed at the University of Arkansas are reidentified and names are changed for about half of the samples.

During Causey's tenure at the University of Arkansas he authored four papers reporting on parasitic copepods from the Gulf of Mexico, Caribbean Sea and the west coast of Mexico (Causey 1953a, b, 1955, 1960). The reidentifications reported here are only of those from the Gulf and Caribbean. The identifications of the west coast of Mexico material will follow a study by the first author of all species of *Caligus* from the eastern Pacific Ocean.

Our report on the collection is arranged chronologically by Causey publication date. There are six previously unreported collections included herein. Also, some collections reported by Causey are not present in the collection.

We thank Dr. Nancy Glover McCartney, Curator of Zoology at the University of Arkansas Museum for bringing this collection to our attention and for loaning us the material for study. Other parasitic copepod material of Causey's is also present in U.A.M. collections and available for study.

All University of Arkansas Museum numbers in the table should be prefaced by 78-93-.

Parasitic Copepoda from Grande Isle, Louisiana

UAM no.	Causey identification	new identification	host
78-93-183	*C. bennetti*	*Scianophilus tenuis*	*Lobotes surinamensis*
184	*C. bennetti*	*Scianophilus tenuis*	*Lobotes surinamensis*
194	*C. haemulonis*	*Lepeophthirus* sp.	*Scianops ocellatus*
227	*C. pelamydis*	*Scianophilus tenuis*	*Pogonias cromis*
235	*C. productus*	*Caligus bonito*	*Coryphaena hippurus*
236	*C. productus*	*Caligus bonito*	*Coryphaena hippurus*
239	*C. productus*	*Caligus bonito*	*Coryphaena hippurus*
	Additional records not in the collection		

Parasitic Copepoda of Texas coastal fishes

UAM no.	Causey identification	new identification	host
179	*C. aliuncus*	*Tuxophorus caligoides*	*Rachycentron canadum*
195	*C. haemulonis*	*Caligus haemulonis*	*Galeichthys felis*
196	*C. haemulonis*	*Lepeophthirus* sp.	*Galeichthys felis*
196		*Caligus haemulonis*	
214	*C. pelamydis*	caligid, not *Caligus*	*Pogonias cromis*
215	*C. pelamydis*	*Scianophilus tenuis*	*Pogonias cromis*
216	*C. pelamydis*	*Tuxophorus collettei*	*Sarda sarda*
217	*C. pelamydis*	*Tuxophorus collettei*	*Scomberomorus cavalla*

218	*C. pelamydis*	*Tuxophorus collettei*	*Scomberomorus cavalla*
219	*C. pelamydis*	*Scianophilus tenuis*	*Pogonias cromis*
229	*C. praetextus*	*Caligus praetextus*	*Galeichthys felis*
254	*C. rapax*	*Caligus* n. sp.	*Scomberomorus maculatus*
257	*C. robustus*	*Caligus robustus*	*Caranx hippos*
258	*C. robustus*	*Caligus robustus*	*Caranx hippos*

Additional records not in the collection

Parasitic Copepoda from Gulf of Mexico fish

UAM no.	Causey identification	new identification	host
185	*C. bennetti*	*Scianophilus tenuis*	*Lobotes surinamensis*
197	*C. haemulonis*	*Caligus haemulonis*	*Galeichthys felis*
198	*C. haemulonis*	*Caligus haemulonis*	*Galeichthys felis*
199	*C. haemulonis*	*Caligus haemulonis*	*Galeichthys felis*
200	*C. haemulonis*	*Caligus haemulonis*	*Bagre marinus*
203	*C. haemulonis*	*Caligus haemulonis*	*Pogonias cromis*
207	*C. mutabilis*	*Caligus mutabilis*	*Trachinotus carolinensis*
220	*C. pelamydis*	*Scianophilus tenuis*	*Pogonias cromis*
221	*C. pelamydis*	*Scianophilus tenuis*	*Pogonias cromis*
224	*C. pelamydis*	*Caligus mutabilis*	*Scomberomorus maculatus*
225	*C. pelamydis*	*Scianophilus tenuis*	*Pogonias cromis*
226	*C. pelamydis*	*Caligus mutabilis*	*Scomberomorus maculatus*
228	*C. pelamydis*	*Scianophilus tenuis*	*Pogonias cromis*
230	*C. praetextus*	caligid—not *Caligus*	*Bagre marinus*
231	*C. praetextus*	*Caligus* sp. male	*Bagre marinus*
232	*C. praetextus*	caligid—not *Caligus*	*Bagre marinus*
233	*C. praetextus*	caligid—not *Caligus*	*Bagre marinus*
240	*C. productus*	*Caligus bonito*	*Coryphaena hippurus*
241	*C. productus*	*Scianophilus tenuis*	*Pogonias cromis*
262	*C. setosus*	*Caligus haemulonis*	*Galeichthys felis*

Additional records not in collection

Parasitic Copepoda from Mexican coastal fishes

UAM no.	Causey identification	new identification	host
192	*C. bennetti*	*Scianophilus tenuis*	*Kyphosus sectatrix*
204	*C. haemulonis*	*Caligus haemulonis*	"bandara-a cat"

All other material in the collection reported in this paper is from the Pacific coast of Mexico.

Unreported collections of interest

UAM no.	Causey identification	new identification	host
181	*C. balistae*	*Caligus balistae*	*Canthidermis sabaco*
186	*C. bonito*	*Caligus chelifer*	*Brevoortia tyrannus*
206	*C. latifrons*	*Caligus praetextus*	*Scianops ocellatus*
234	*C. praetextus*	*Caligus atromaculatus*	*Lutianus griseus*
237	*C. productus*	*Caligus bonito*	"cutlass fish"
261	*C. setosus*	*Caligus haemulonis*	*Bagre marinus*

Collection 181 is from Grande Isle, Louisiana. Collection 234 is from Alligator Harbor, Florida. Collections 186, 206, 237, and 261 are from Port Aransas-Laguna Madre, Texas.

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TWO NEW SPECIES OF CURIMATID FISHES (OSTARIOPHYSI: CHARACIFORMES) FROM RIO GRANDE DO SUL, BRAZIL

Richard P. Vari

Abstract.—*Curimata spilota* is described from two localities in the Rio Uruguay basin in southeastern Brazil. The species is unique in the family in its higher number of branched dorsal-fin rays (10 or 11). *Curimata stigmosa* is described from the coastal rivers of southeastern Brazil and Uruguay and from one locality in the Rio Uruguay basin, and is the first member of its phyletic lineage known from that region. The possession of lobulate fleshy processes on the roof of the oral cavity, the distinctive pigmentation pattern, and meristic values distinguish the species within the family.

Recent collecting efforts by Carlos A. S. Lucena, Luiz R. Malabarba, and Roberto E. Reis of the Museu de Ciências of the Pontificia Universidade Catolica do Rio Grande do Sul, Rio Grande do Sul, Brazil have produced a number of interesting species. Included in those collections are two undescribed species belonging to separate lineages within the characiform family Curimatidae. The family is the subject of ongoing phylogenetic and revisionary studies (Vari 1982, 1983, 1984), but the species in question are members of genera that will not be published on for some time. In order to make the names of these species available for ongoing ecological and faunal studies, those taxa are described separately in this paper.

Counts and measurements in the species descriptions follow the methods outlined in Vari (1982, 1984). Ranges of counts and measurements include values of all specimens. Values in square brackets are those of the holotype. Specimens examined for this study are deposited in the following institutions: Museu de Ciências da Universidade Catolica do Rio Grande do Sul, Porto Alegre, Rio Grande do Sul, Brazil, MCP; Museu de Zoologia da Universidade do São Paulo, São Paulo, Brazil, MZUSP; and National Museum of Natural History, Smithsonian Institution, Washington, D.C., USNM.

A variety of very different classifications have been utilized by authors publishing on the Curimatidae. Under these classifications, the number of genera recognized in the family has ranged from seven (Eigenmann 1910) to 29 (Fernández-Yépez 1948). Research completed (Vari 1982, 1984) or in progress, attempts to redefine subunits of the family along natural lines, and has or will result in the synonymization of numerous genera and the redefinition of those taxa that will be recognized. Pending completion of those studies, the species described herein are retained in the broadly encompassing genus *Curimata* which has included the bulk of the species of the family in the more widely used classificatory schemes.

Curimata spilota, new species
Figs. 1, 2

Holotype.—Brazil, Rio Grande do Sul, Rio Santa Maria, at bridge on highway Br 293, between Dom Pedrito and Livramento

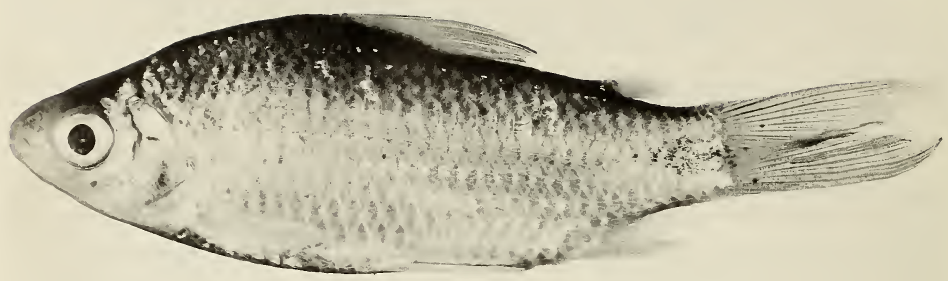

Fig. 1. *Curimata spilota*, holotype, MZUSP 37133, 56.9 mm SL; Brazil, Rio Grande do Sul, Rio Santa Maria, at bridge on highway Br 293, between Dom Pedrito and Livramento.

(listed as Santana do Livramento on some maps), C. Lucena and L. Malabarba, 22 Jan 1982, MZUSP 37133, 56.3 mm.

Paratypes.—Brazil, Rio Grande do Sul, taken with holotype, MZUSP 37134, 7, 34.7–43.4 mm; USNM 285194, 12, 36.9–59.7 mm (2 specimens cleared and counterstained for cartilage and bone).—Brazil, Rio Grande do Sul, headwaters of Rio Negro, at Bagé, C. Lucena and L. Malabarba, 25 Oct 1983, MCP 9613, 4, 43.4–62.8 mm.

Diagnosis.—The possession of 10 or 11 (typically 10) branched dorsal-fin rays distinguishes *Curimata spilota* from all other members of the family Curimatidae which have 8 or 9, rarely 10, branched dorsal-fin rays. The few species of curimatids reported as having 10 branched dorsal-fin rays in occasional individuals are members of the genus *Potamorhina* (Vari, 1984), all of which have 75 or more lateral line scales, contrary to the 30 to 33 scales in that series in *Curimata spilota*. The low lateral line count (30 to 33) of *C. spilota* also distinguishes the species from the vast majority of curimatids. The *Curimatopsis* species with such low lateral line counts (*evelynae*, *macrolepis*, *crypticus*, *myersi*) all have an anteriorly convex ventral portion of the maxilla that is lacking in *Curimata spilota*, along with pronounced sexual dimorphism that is also absent in the latter species (see Vari 1983: 4–11).

Within the LaPlata drainage system, three species are phenetically similar to *C. spilota* and have comparable scale counts. The first of these, *C. gillii*, described by Eigenmann and Kennedy (1903:510) from the Río Paraguay in Paraguay, differs in having fewer branched dorsal-fin rays (8 or 9) than *C. spilota* (10 or 11). The second similar species in that basin is *Curimata saladensis*, described by Meinken (1933) in *Curimatopsis*. That species, which is not closely related phylogenetically to *Curimatopsis* (see Vari 1983:10–12), can be readily distinguished from *C. stigmosa* in having 8 or 9 branched dorsal-fin rays, and having the pores of the laterosensory canal system of the body developed only on the anterior 7 to 9 scales, contrary to the completely developed series of such pores in *C. spilota*. *Curimata stigmosa*, a partially sympatric species described in this paper, has very similar lateral line counts to *C. spilota*, but is distinguished by the presence of fleshy lobulate processes on the roof of the mouth.

Description.—Body moderately elongate, somewhat compressed, more so in juveniles. Dorsal profile of head convex anteriorly, straight from above nostrils to rear of head. Dorsal profile of body slightly convex from rear of head to origin of rayed dorsal fin; straight and slightly posteroventrally slanted at base of dorsal fin, gently convex from base of last dorsal-fin ray to caudal peduncle. Dorsal surface of body transversely rounded anteriorly, with indistinct median keel immediately anterior to rayed dorsal fin, smoothly rounded transversely posterior to fin. Ventral profile of body gently curved from tip of lower jaw to caudal peduncle. Prepelvic region obtusely flattened, with median series of scales proximate to pelvic fin origin. An obtuse median keel posterior to pelvic fin insertion.

Greatest body depth at origin of rayed dorsal fin, depth 0.33–0.41 [0.39]; snout tip to origin of rayed dorsal fin 0.50–0.53 [0.52]; snout tip to origin of anal fin 0.82–0.86 [0.84]; snout tip to insertion of pelvic fin 0.55–0.58 [0.58]; snout tip to anus 0.79–0.82 [0.81]; origin of rayed dorsal fin to hypural joint 0.53–0.59 [0.53]. Rayed dorsal-fin margin rounded; anteriormost rays three to three and one-half times length of ultimate ray. Pectoral fin pointed; length of pectoral fin 0.18–0.21 [0.21], extending two-thirds to three-quarters distance to vertical through insertion of pelvic fin. Pelvic fin pointed, length of pelvic fin 0.22–0.26 [0.25], reaching approximately two-thirds distance to origin of anal fin. Caudal fin deeply forked. Adipose dorsal fin well developed. Anal fin emarginate, anteriormost branched rays about two and one-half times length of ultimate ray. Caudal peduncle depth 0.14–0.15 [0.15].

Head obtusely pointed, head length 0.28–0.32 [0.31]; upper jaw slighty longer, mouth subterminal; snout length 0.26–0.31 [0.31]; nostrils very close, anterior circular, posterior crescent shaped with aperture closed by thin flap of skin separating nares; orbital diameter 0.30–0.36 [0.30]; adipose eyelid present, more developed anteriorly, with broad vertically ovoid opening over center of eye; length of postorbital portion of head 0.40–0.45 [0.45]; gape width 0.20–0.25 [0.22]; interorbital width 0.40–0.46 [0.42].

Fig. 2. Map of major drainages in southeastern Brazil, Uruguay, and proximate portions of Argentina showing collecting localities of specimens reported on in this paper (all localities in Brazil, state of Rio Grande do Sul unless otherwise noted): 1, Rio Santa Maria (holotype and paratypes of *Curimata spilota*); 2, upper Rio Negro, at Bagé (paratypes of *C. spilota*); 3, Rio Jacui (holotype and paratypes of *Curimata stigmosa*); 4, Rio Forqueta (paratypes of *C. stigmosa*); 5, Arroio Sarandi and Arroio Chasqueiro (paratypes of *C. stigmosa*); 6, Brazil, state of Santa Catarina, Rio Uruguai near Concórdia (*C. stigmosa*); and 7, Uruguay, Florida, Arroio Chamizo (*C. stigmosa*).

Pored lateral line scales from supracleithrum to hypural joint 30 to 33 [31]; all scales of lateral line pored, canals in scales straight; 2 to 4 series of scales extending beyond hypural joint onto caudal fin base; 6½ [6½] scales in transverse series from origin of rayed dorsal fin to lateral line; 4½ or 5 (5 rare) [4½] scales in transverse series from lateral line to origin of anal fin.

Dorsal-fin rays ii,10 or 11, or iii,10 or 11 (ii,11 and iii,11 less common; when three unbranched rays present, first ray very short) [iii,10]; anal-fin rays ii,7 or iii,7 (when three unbranched rays present, first ray very short)[iii,7]; pectoral-fin rays 13 to 15 [14]; pelvic fin rays i,8 [i,8].

Total vertebrae 30 (4), 31 (20), 32 (3).

Color in alcohol.—Specimens retain some guanine on scales; silvery overall, purplish dorsally and whitish ventrally. Head darker

Fig. 3. *Curimata stigmosa*, holotype, MZUSP 37135, 73.4 mm SL; Brazil, Rio Grande do Sul, Rio Jacui, at bridge on the road between Santa Maria and Veracruz.

dorsally. Iris, opercle and ventral portions of head silvery. Obscure midlateral dusky band extending from supracleithrum to caudal peduncle. Horizontally elongate midlateral spot on caudal peduncle. Spot somewhat diffuse, more apparent in individuals in which guanine is largely lacking. Median fins with small chromatophores scattered over membranes; dusky overall. Adipose dorsal fin dusky. Paired fins hyaline.

Distribution.—Rio Uruguay basin (Fig. 2). The two localities from which this species is known (localities 1 and 2, Fig. 2) although relatively close, lie within the basins of two different tributaries of the Rio Uruguay whose mouths are distant from each other. This occurrence of the species in the headwaters of those two rivers may indicate that the species is widely distributed through the Rio Uruguay basin.

Etymology.—The specific name, *spilota*, from the Greek for spotted or stained, refers to the midlateral spot on the caudal peduncle.

Curimata stigmosa, new species
Figs. 2, 3

Holotype.—Brazil, Rio Grande do Sul, Rio Jacui, at bridge on the road between Santa Maria and Veracruz (approx. 29°41′S, 53°19′W), C. Lucena, L. Malabarba, and R. Reis, 16 Sep 1983, MZUSP 37135, 73.4 mm SL.

Paratypes.—(All specimens collected in Brazil, Rio Grande do Sul, unless noted otherwise), taken with holotype, USNM 285193, 3, 65.5–73.6 mm (one specimen cleared and counterstained for cartilage and bone); MCP 9224, 3, 58.1–70.4 mm; MZUSP 37136, 3, 52.5–74.3 mm.—Rio Forqueta, and Marquês de Souza, Municipio de Lajeado, MZUSP/USNM expedition, 7 Nov 1979, USNM 285191, 1, 53.7 mm; MZUSP 21721, 1, 53.4 mm.—Arroio Sarandi, along highway (Br 116) between Pelotas and Jaguarão, MZUSP/USNM expedition, 14 Dec 1978, MZUSP 21728, 1, 43.0 mm.—Arroio Chasqueiro (empties into Lagoa Mirim north of Arroio Grande), along highway (Br 116) between Pelotas and Jaguarão, MZUSP/USNM expedition, 14 Dec 1978, USNM 285190, 2, 43.5–56.5 mm.

The following non-typic specimens were also examined: Brazil, Santa Catarina, pools along Rio Uruguai, near Concórdia, MZUSP 28252, 4, 71.5–72.3 mm.—Uruguay, Florida, Arroio Chamizo, USNM 285192, 2, 64.2–70.4 mm.

Diagnosis.—The presence of a series of lobulate fleshy processes in the roof of the mouth of *Curimata stigmosa* distinguishes the species from the majority of curimatids with the exception of those species phyletically aligned with *Curimata elegans* Steindachner (1874). The wide deep-lying stripe of dark pigmentation is distinctive for *C. stigmosa* in that assemblage. Only three other species with lobulate processes on the roof of the oral cavity inhabit river systems proximate to the known distribution of *C. stigmosa*. These are *C. elegans* Steindachner of the coastal drainages of Brazil north of São Paulo state, *C. insculpta* (Fernández-Yépez, 1948) an inhabitant of the Rio Paraná above Sete Quedas rapids, and *C. nitens* Holmberg (1891) of the Paraguay, lower Paraná and Uruguay rivers. *Curimata insculpta* is readily distinguished from *C. stigmosa* by differences in lateral line scale counts (37 to 42 versus 30 to 33). *Curimata nitens*, which is sympatric with *C. stigmosa* in the Uruguay basin, differs from the latter species in having an intense black stripe along the entire extent of the lateral line, and in lacking the wide deep-lying band of pigmentation on the caudal peduncle characteristic of the latter species. *Curimata elegans* similarly lacks the pronounced deep-lying wide band on the caudal peduncle.

Description.—Body moderately deep, more so in larger specimens, somewhat compressed. Dorsal profile of head convex anteriorly, straight from over nostrils to rear of head. Dorsal profile of body gently convex from rear of head to origin of rayed dorsal fin; straight and slightly posteroventrally slanted at base of dorsal fin, straight or gently convex from base of last dorsal-fin ray to caudal peduncle. Dorsal surface of body transversely rounded anteriorly, with indistinct median keel immediately anterior to rayed dorsal fin, smoothly rounded transversely posterior to fin. Ventral profile of body gently curved from tip of lower jaw to caudal peduncle. Prepelvic region obtusely flattened proximate to pelvic fin origin. Obtuse median keel posterior to pelvic fin insertion. Secondary obtuse keel on each side of postventral portion of body one scale dorsal of ventral midline.

Greatest body depth at origin of rayed dorsal fin, depth 0.35–0.40 [0.40]; snout tip to origin of rayed dorsal fin 0.48–0.53 [0.49]; snout tip to origin of anal fin 0.80–0.84 [0.82]; snout tip to insertion of pelvic fin 0.53–0.57 [0.56]; snout tip to anus 0.76–0.79 [0.78]; origin of rayed dorsal fin to hypural joint 0.52–0.57 [0.55]. Rayed dorsal-fin margin rounded; anteriormost rays three to three and one-half times length of ultimate ray. Pectoral fin pointed; length of pectoral fin 0.17–0.21 [0.19], extending about two-thirds distance to vertical through insertion of pelvic fin. Pelvic fin pointed, length of pelvic fin 0.19–0.22 [0.22], reaching about two-thirds distance to origin of anal fin. Caudal fin forked. Adipose dorsal fin well developed. Anal fin emarginate, anteriormost branched rays about two and one-third to two and two-thirds times length of ultimate ray. Caudal peduncle depth 0.12–0.14 [0.12].

Head obtusely pointed, head length 0.25–0.29 [0.26]; upper jaw slightly longer, mouth subterminal; snout length 0.29–0.33 [0.30]; nostrils very close, anterior circular, posterior crescent shaped with aperture closed by thin flap of skin separating nares; orbital diameter 0.30–0.36 [0.31]; adipose eyelid present, more developed anteriorly, with vertically ovoid opening over center of eye; length of postorbital portion of head 0.39–0.44 [0.39]; gape width 0.25–0.29 [0.28]; interorbital width 0.44–0.50 [0.44].

Pored lateral line scales from supracleithrum to hypural joint 31 to 34 [32]; all scales of lateral line pored, canals in scales straight; 2 to 4 series of scales extending beyond hypural joint onto caudal fin base; 5½ to 6 [5½] scales in transverse series from origin of rayed dorsal fin to lateral line; 4½ [4½] scales in transverse series from lateral line to origin of anal fin.

Dorsal-fin rays ii,9 or iii,9 (iii,9 rare) [ii,9]; anal-fin rays ii,7 [ii,7]; pectoral-fin rays 13 to 15 [14]; pelvic-fin rays i,8 or 9 [i,8].

Total vertebrae 33 (21), 34 (1).

Color in alcohol.—Overall ground coloration of specimens lacking guanine on scales tan to tannish-brown, darker on dorsal portions of head and body. Obscure middorsal band from rear of head to origin of rayed dorsal fin, and between rayed and adipose dorsal fins. Scales of dorsal portion of body with field of dark chromatophores on exposed surface; field more extensive on dorsal scales. Lateral line scales with pores surrounded by patches of dark pigmentation. Deep-lying dark band extends from vertical through origin of dorsal fin posteriorly to somewhat beyond hypural joint; both deep-lying stripe and surface chromatophores forming dark, anteriorly pointed slightly elongate spot on lateral surface of caudal peduncle. Field of small chromatophores continuing posteriorly on body surface to base of middle caudal-fin rays. Median fins somewhat dusky; other fins hyaline.

Distribution.—Atlantic coastal drainages of Rio Grande do Sul in Brazil, Uruguay, and Rio Uruguai in Santa Catarina, Brazil (Fig. 2).

Etymology.—The specific name, *stigmosa*, from the Latin for full of marks, refers to the series of dark spots surrounding the pores of the lateral line scales.

Relationships.—*Curimata stigmosa* is the first member of the *Curimata elegans* Steindachner (1874) lineage that has been collected in the coastal drainages of far southeastern Brazil and Uruguay. The lineage, characterized by the presence of fleshy lobulate processes on the roof of the oral cavity, is widely distributed through the freshwaters of South America. Three members of the lineage occur in regions close to that inhabited by *C. stigmosa* (see "Diagnosis" for that species); however, the exact phylogenetic relationships of *C. stigmosa* to these and other members of the lineage are unknown.

Resumo

Duas novas espécies de Characiformes da família Curimatidae (Pisces: Ostariophysi) do Estado do Rio Grande do Sul, no sudeste do Brasil, são descritas. *Curimata spilota* é descrita dos rios Santa Maria e Negro, tributários do rio Uruguai. A espécie é única na família pelo número mais elevado de raios ramificados na nadadeira dorsal (10 ou 11). *Curimata stigmosa* é descrita dos rios da região costeira atlântica do Uruguai e sudeste do Brasil; e de uma localidade na bacia do rio Uruguai. A espécie é caracterizada por processos lobulares carnosos no teto da cavidade oral e um padrão de pigmentação distinto. Estas características e valores merísticos distinguem a espécie dentro da família. A posse dos processos na cavidade oral é característica única do complexo *Curimata elegans*. Nenhum membro deste grupo foi anteriormente assinalado para a área habitada por *C. stigmosa*.

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DEEVEYA BRANSONI, A NEW SPECIES OF TROGLOBITIC HALOCYPRID OSTRACODE FROM ANCHIALINE CAVES ON SOUTH ANDROS ISLAND, BAHAMAS (CRUSTACEA: OSTRACODA)

Louis S. Kornicker and R. J. Palmer

Abstract.—*Deeveya bransoni,* a new species of troglobitic halocyprid ostracode in the subfamily Deeveyinae, from anchialine caves on South Andros Island, Bahamas, is described and illustrated. A supplementary description is presented of the type species of the genus, *Deeveya spiralis* Kornicker and Iliffe, 1985, based on type specimens from the Turks and Caicos Islands.

The new species described herein increases to five the known number of trogolobitic ostracodes in the Halocypridoidea: 1, *Danielopolina orghidani* (Danielopol, 1972) from Cuba; 2, a species of *Spelaeoecia* from Bermuda described by Angel and Iliffe (1987) and mentioned by Angel (1983:531); 3, *Deeveya spiralis* Kornicker and Iliffe, 1985, from the Turks and Caicos Islands; 4, *Danielopolina wilkensi* Hartmann, 1985, from the Canary Islands; and 5, *Deeveya bransoni,* new species, from the Bahamas. A supplementary description is presented of *Deeveya spiralis* Kornicker and Iliffe, 1985.

Superfamily Halocypridoidea Dana, 1853

Composition.—The superfamily comprises the families Halocyprididae Dana, 1853, and Thaumatocyprididae Müller, 1906.

Family Halocyprididae Dana, 1853

Composition.—The family comprises the subfamilies Halocypridinae Dana, 1852, Conchoecinae Claus, 1891, Archiconchoecinae Poulsen, 1969, Euconchoecinae Poulsen, 1969, and Deeveyinae Kornicker and Iliffe, 1985.

Subfamily Deeveyinae Kornicker and Iliffe, 1985

Composition.—The subfamily comprises the genera *Deeveya* Kornicker and Iliffe, 1985, and *Spelaeoecia* Angel and Iliffe, 1987.

Deeveya Kornicker and Iliffe, 1985

Type species.—*Deeveya spiralis* Kornicker and Iliffe, 1985.

Composition.—The genus comprises two species from marine caves: *D. spiralis* from the Turks and Caicos Islands, and *D. bransoni,* a new species from South Andros Island, Bahamas.

Terminology.—The distribution of bristles on joints 7 and 8 of the 1st antenna of *Deeveya* appears quite similar to those of members of the Myodocopina; therefore, the lettering system proposed by Skogsberg (1920:188) for bristles of the Cypridiniformes is used herein for *Deeveya* (Fig. 6e): "The one situated anteriorly = "the a-bristle"; the one placed distally-medially and somewhat anteriorly = "the b-bristle"; the posterior-distal one = "the c-bristle." The four bristles on the original 8th joint: The anterior of the two simple sensory filaments which are situated laterally, close to each other, is called "the d-bristle," the posterior one of them is called "the e-bristle"; of the two distal-medial bristles, the anterior one is called "the f-bristle," the posterior one = "the g-bristle." On *Deeveya* the e-bristle is longer and stouter than other bristles of the 8th joint and is generally named the "principal bristle" in the Halocyprididae. The terminology used for *Deeveya* herein differs from the terminology proposed by Skogsberg (1920:583) for the bristles of the end joints of the 1st antenna of members of the genus *Halocypris,* but coincidentally the e-bristle is the principal bristle in both terminologies.

The terminology proposed by Skogsberg (1920:575) for bristles of the endopodite of the 2nd antenna of the Halocyprididae is applied herein to *Deeveya* (Figs. 1e, f; 4d; 6f, g): a- and b-bristles refer to the 2 dorsal bristles of the 1st joint; f-bristle (lateral) and g-bristle (medial) refer to the 2 long distal bristles of the 2nd joint; and h-, -i, and j-bristles refer to the 3 long terminal bristles of the 3rd joint. The c-, d-, and e-bristles of the 2nd joint, which are not present on all species of the Halocyprididae, and are mostly found only on males, were not present on the juveniles of known species of *Deeveya,* but a small proximal peg on the 2nd joint of the A-1 females of *D. spiralis* (Fig. 6g) and *D. bransoni* (Fig. 1f) may represent one of those bristles. An additional short unlettered bristle is present on the 3rd joint of *D. spiralis* (Fig. 6g).

Deeveya bransoni, new species
Figs. 1–5

Etymology.—The species is named for Mr. Richard Branson of Virgin Ltd, one of the main sponsors of the field work in which the junior author participated.

Material.—Bahama Islands, The Bluff, South Andros Island (map reference: Bahamas 1: 25000 O.S. series): Evelyn Green's Blue Hole (type locality) (grid reference TB 410648); 4 Jul 1986; collected from just beyond limit of daylight at depth of 22 m in saline water; holotype, USNM 193301, A-1 female on slide and in alcohol (Palmer specimen SA/3/86).—Stargate Blue Hole (grid reference TB 403681); 3 Jul 1986; collected in saline water at depth of 30 m, 80 m from cave entrance; paratype, USNM 193302, juvenile female (A-2) on slide and in alcohol (Palmer specimen SA/2/86).

Distribution.—Known only from Evelyn Green's Blue Hole and Stargate Blue Hole, South Andros, Bahamas.

Habitat.—Specimens from both caves were from clear water with salinities in excess of 18‰ and a stable temperature of 25°C. They were collected just below the mixing zone between brackish and saline waters. The mixing zones in both caves have an associated growth of colonial bacterial plate, which may be providing a reducing environment and provides a primary food source (Cunliffe 1985). The two caves lie on a major fracture line which has its southern end extending offshore, and its northern end over 1 kilometer onshore. The fracture parallels the tongue of the Ocean, a 2000 m deep oceanic trough to the east of Andros. Current flow has been monitored along the line of the fracture (Smart, Whittaker, and Palmer, in prep.), and the fracture can be regarded as a subterranean tidal creek, which partially drains the fresh water lenses of South Andros. In Stargate Cave the A-2 female was free-swimming in clear water and appeared to be from a good population.

Description of A-1 female (Figs. 1–3).—Carapace oval in lateral view except for straight dorsal margin and slightly concave anterior margin (Fig. 1a). Right valve with small tubercle on dorsal margin near posterior end.

Ornamentation (Fig. 1c): Carapace when viewed with transmitted light appearing reticulate (reticulations appearing bright); minute rounded processes present on outer surface of walls of reticulations (processes generally appearing darker than walls and may extend above surface of valve).

Bristles (Fig. 1a): Valve margins with few

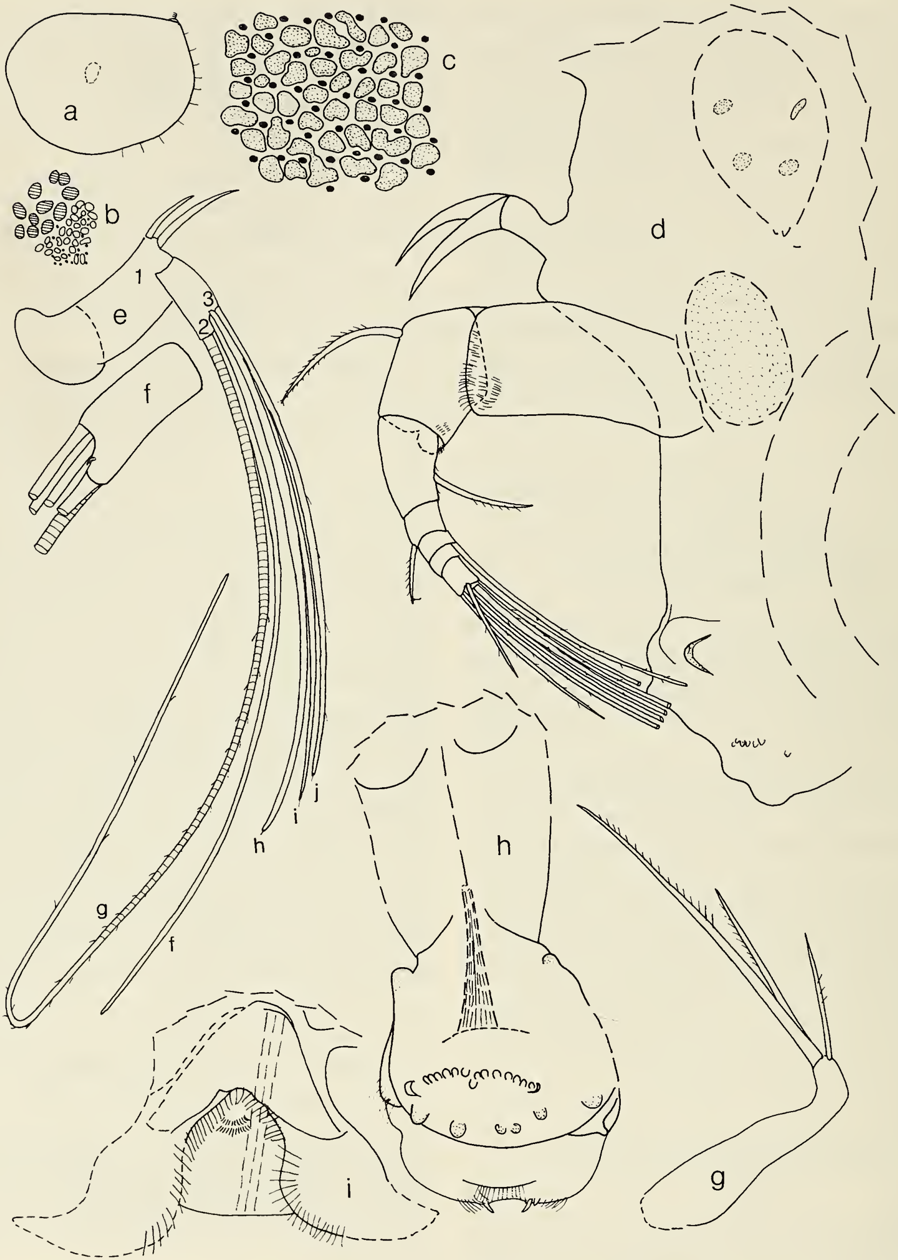


Fig. 1. *Deeveya bransoni,* A-1 female, holotype: a, Complete specimen from left side (dashed oval represents location of central adductor muscle attachment scars), length 1.68 mm; b, Detail of adductor muscle attachments (striate) and some reticulations as viewed through shell; c, Reticulations and bosses (small filled-in circles) viewed with transmitted light (stippled areas appear dark); d, Anterior of body showing divided Bellonci organ, left hepatic organ (upper dashed ovoid), left 1st antenna, and upper lip; e, Endopodite of left 2nd antenna, medial view; f, Fused joints 2 and 3 of left endopodite, lateral view; g, Left 7th limb, lateral view; h, Anterior of body from anterior showing upper lip (arcs at top represent sockets of 1st antennae); i, Anterior view of lower lip.

widely spaced bristles. Setal bristle at tip of posterodorsal tubercle of right valve just posterior to glandular opening.

Glands: Glandular opening on tip of posterodorsal tubercle of right valve.

Central adductor muscle attachments (Fig. 1b): Indistinct attachment scars forming cluster near valve midlength.

Shell size: USNM 193301, length 1.68 mm, height 1.27 mm.

First antenna (Fig. 1d): Elongate with 8 joints. 1st joint with distal lateral spines becoming longer near ventral margin; distal end of 1st joint overlapping proximal end of 2nd joint, especially near ventral margin. 2nd joint with distal medial spines and dorsal midbristle with short marginal spines; distal end of 2nd joint overlapping proximal end of 3rd joint. 3rd joint elongate, with spinous ventral bristle distal to midlength, few minute spines along dorsal margin, and longer medial spines near ventral margin. 4th joint short with small, slender, dorsal, terminal bristle reaching past 6th joint. 5th joint shorter than 4th, with long, terminal, filament-like ventral bristle bearing few, short, widely spaced, spines. 6th joint slightly shorter than 5th, bare. 7th joint about same length as 4th joint, with 1 short, distal, lateral a-bristle, and 2 long b- and c-bristles on small terminal pedistal (both bristles longer than bristle of 5th joint and with widely separated marginal spines and terminal papilla; medial b-bristle filament-like; lateral c-bristle with well-defined proximal rings and about ⅓ longer than b-bristle). 8th joint small, with very long principal e-bristle and 3 shorter filament-like d-, f-, and g-bristles (all bristles with widely spaced marginal spines and terminal papilla; principal bristle about same length as c-bristle of 7th joint; g-bristle slightly longer than b-bristle of 7th joint, and longer than d- and f-bristles).

Second antenna (Fig. 1e, f): Protopodite with lateral spines forming cluster distal to middle. Endopodite 3-jointed. 1st joint with 2 distal dorsal a- and b-bristles on small protuberance (proximal a-bristle about half length of distal b-bristle); 2nd joint forming right angle with 1st joint, with filament-like f-bristle slightly longer than half length of g-bristle (with widely separated marginal spines and terminal papilla) and medial g-bristle about twice length of protopodite, stouter than f-bristle and with fairly strong rings in proximal half (both f- and g-bristles longer than bristle of 5th joint and with widely separated marginal spines and terminal papilla); minute proximal lateral peg present near 3rd joint (Fig. 1f). 3rd joint fused to second, with filament-like h-, i-, and j-bristles, each less than half length of g-bristle (with widely spaced marginal spines and terminal papilla). Exopodite 9-jointed: 1st joint weakly divided into long proximal and short distal parts; proximal part with minute faint spines near dorsal (concave) margin; distal part with short ringed bristle reaching middle of 5th joint; 2nd joint with long bristle with small spines along middle part and distal natatory hairs; joints 3–8 each with long bristle with natatory hairs; 9th joint with 4 bristles (2 short and 1 medium length, all with distal ventral spines and no natatory hairs; 1 long with distal natatory hairs and ventral spines).

Mandible (Fig. 2): Coxale endite with teeth forming 3 rows (proximal (=dorsal), middle, distal (=ventral)) (Fig. 2b–d, f). Proximal row consisting of 4 broad teeth (Fig. 2b, f); densely packed spines between teeth and at each end; medial and lateral spines and hairs proximal to teeth; single bifurcate pointed or rounded tooth present between proximal and middle rows (about midway between posterior tooth of proximal row and anterior tooth of middle row), and adjacent to 2 stout spinous pointed bristles; 2 spinous bristles (posterior stouter) with bases just proximal and dorsal to bases of teeth forming middle row. Middle row with 5 teeth (posterior tooth longer than others) (Fig. 2c). Distal row forming ventral edge of endite with 6–7 teeth (middle tooth larger than others) (Fig. 2d). Basale with 3 proximal

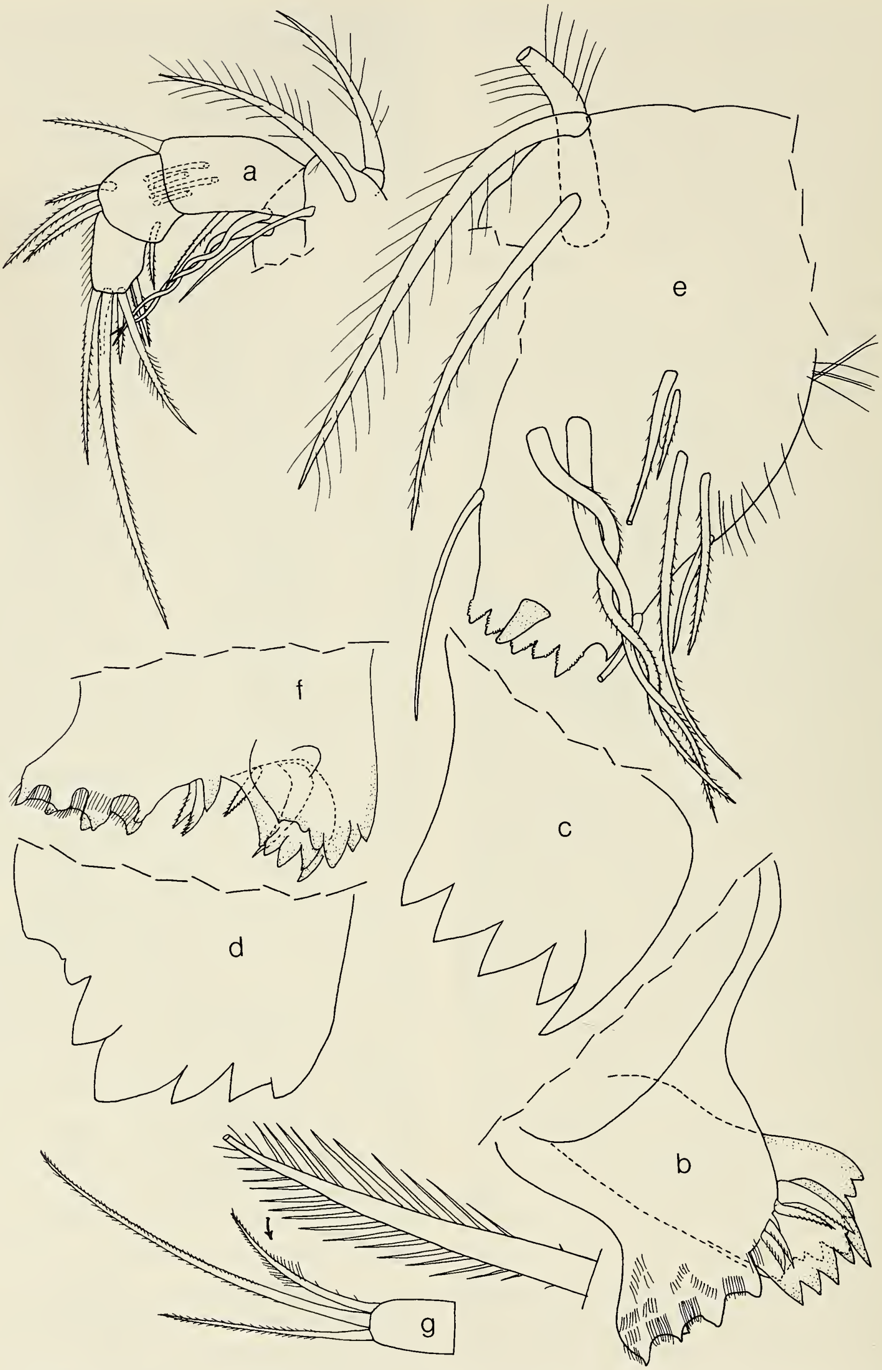


Fig. 2. *Deeveya bransoni,* A-1 female, holotype, mandible: a, Proximal part of basale and endopodite of left limb, lateral view; b, Coxale endite of left limb, anterior view; c, d, Detail from b showing middle and distal teeth; e, Basale of left limb, lateral view; f, Coxale endite of right limb, posterior view; g, 3 terminal bristles of 3rd endopodial joint of left limb, lateral view.

bristles (2 stout and plumose, 1 slender with short marginal hairs) (Fig. 2a, e). Basale endite (Fig. 2e): anterior margin with single ringed bristle; posterior margin with proximal hairs, 1 short proximal bristle and 1 short distal tube-formed bristle; lateral side with few long hairs, 6 slender distal bristles (2 longer than others and entwined), and 1 short, stout, tooth just proximal to distal edge of endite; medial side with few long hairs; ventral edge with 6 terminal cusps (5 anterior serrate proximally, 1 posterior cusp bare, smaller than others and separated from them by space). Endopodite 3-jointed (Fig. 2a): 1st joint with 1 spinous, terminal, dorsal bristle, 1 spinous, distal, ventral bristle, and 4 spinous, distal, medial bristles; 2nd joint with 3 spinous, terminal, dorsal bristles, and 1 spinous, terminal, ventral bristle; 3rd joint hirsute medially and along dorsal margin, with 4 medial bristles forming row, and 3 stout, spinous, terminal bristles (ventral of these with long spines at midlength and shorter thinner spines distally; middle bristle longest, with smooth sharp tip, closely spaced posterior spines forming medial and lateral row and more widely spaced anterior spines) (Fig. 2g).

Maxilla (Fig. 3a): 3 well developed endites (bristles of endites not shown in illustration): endite I with 2 proximal bristles with long proximal hairs and about 8 terminal bristles; endite II with 2 proximal bristles with short marginal spines and about 7 terminal bristles; endite III with 1 proximal bristle with short marginal spines and about 5 terminal bristles. Coxale with 1 stout, hirsute, terminal, dorsal bristle. Basale with 1 slender ventral bristle with short marginal spines and 1 slender terminal bristle at midwidth. Endopodite: 1st joint with 4–5 spinous bristles on or near anterior margin, 5–6 bristles at distal posterior corner, and sparse surface hairs; 2nd joint with 2 stout claws, 5 slender bristles, and long hairs on anterior surface.

Fifth limb (Fig. 3b): Epipodite with hirsute bristles forming 3 groups: dorsal group with 1 short and 4 long bristles; middle group with 6 long bristles; ventral group with 4 long and 1 short bristles. Protopodite and endopodite with 27 bristles including 2 pectinate claw-like bristles at ventral corner. Exopodite 3-jointed: 1st joint with total of 12 bristles: 2 distal dorsal bristles (longest bare, other with long marginal hairs), 2 lateral bristles (distal of these plumose), 1 medial bristle near middle, 3 proximal ventral bristles, and 4 bristles on distal ventral corner. 2nd joint elongate with 4 bristles (1 dorsal, 3 ventral). 3rd joint short with 2 long claw-like bristles and 2 slender ringed bristles (smallest bristle medial).

Sixth limb (Fig. 3c): Epipodite with hirsute bristles forming 3 groups: dorsal group with 1 short and 6 long bristles; middle group with 6 long bristles; ventral group with 5 long bristles. Protopodite with 2 joints: proximal joint with 4 bristles on or near ventral margin (2 plumose, 2 with short marginal spines); distal joint with 4 bristles on or near ventral margin (2 plumose, 2 with short marginal spines). Exopodite 4-jointed: 1st joint with plumose lateral bristle, 5–6 plumose bristles on or near ventral margin, and process with 4 bristles (1 long bristle bare, others plumose) on distal dorsal corner; 2nd joint with 4 bristles (bare or with short marginal spines) on or near ventral margin; 3rd joint separated from 2nd joint by suture, elongate with 3 bristles (2 ventral, 1 dorsal, either bare or with short marginal spines); 4th joint short, with 2 stout claw-like pectinate bristles and 2 slender bristles (1 long, ventral, 1 short, medial).

Seventh limb (Fig. 1g): Limb unjointed, with 3 terminal bristles (1 long, 2 shorter) with indistinct marginal hairs.

Furca (Fig. 3d): Each lamella with total of 7 claws followed by unpaired dorsal bristle; claws decreasing in width posteriorly along lamella; claw 4 slightly shorter than claw 5, and claw 5 about same length as claw 6; claws 1–4 with spines along posterior margin; claw 5 with longer spines along anterior margin than along posterior mar-

Fig. 3. *Deeveya bransoni,* A-1 female, holotype: a, Maxilla, endite bristles not shown; b, Left 5th limb, lateral view; c, Left 6th limb, lateral view; d, Left lamella of furca and apron; e, Ventral view of posterior end of hinged valves showing attached protistans.

gin; claw 6 with spines along anterior margin, claw 7 with few spines along anterior margin; stout triangular protuberance on each lamella following last claw, and small process laterally between claws 1 and 2. Unpaired dorsal bristle with marginal spines.

Bellonci organ (Fig. 1d): Well developed, bifurcate distally, with branches tapering to pointed tip.

Lips (Fig. 1d, h, i): Anterior face of upper lip with 14 small tooth-like processes forming upper horizontal row, and 6 larger processes forming lower horizontal row (Fig. 1h); crescent-like low process at each end of upper row (Fig. 1d, h); posteroventral edge with slight concavity at midwidth (when viewed anteriorly (Fig. 1h) or posteriorly) having stout spine at each end of concavity (Fig. 1h); hair-like spines forming rows near concavity (Fig. 1h). Lower lip with triangular process at each side of mouth (Fig. 1i).

Posterior of body: Evenly rounded, unsegmented.

Apron (Fig. 3d): Curving shield anterior to both anus and proximal leading edge of furca.

Gut: Narrow in vicinity of mouth (Fig. 1d), broadening dorsal to central adductor muscle, then becoming narrower in short segment proximal to a second broad area (not as broad as anterior broad area), then narrowing at anus. Anterior and posterior broad areas containing brown unrecognizable organic particles.

Epizoa (Fig. 3e): Holotype with attached protistans on posterodorsal edges of valves.

Description of A-2 female (Figs. 4, 5).—Carapace differs from that of A-1 female in having slightly convex dorsal margin (Fig. 4a).

Shell size: USNM 193302, length 1.21 mm, height 0.94 mm.

First antenna (Fig. 1b, c): Similar to that of A-1 female.

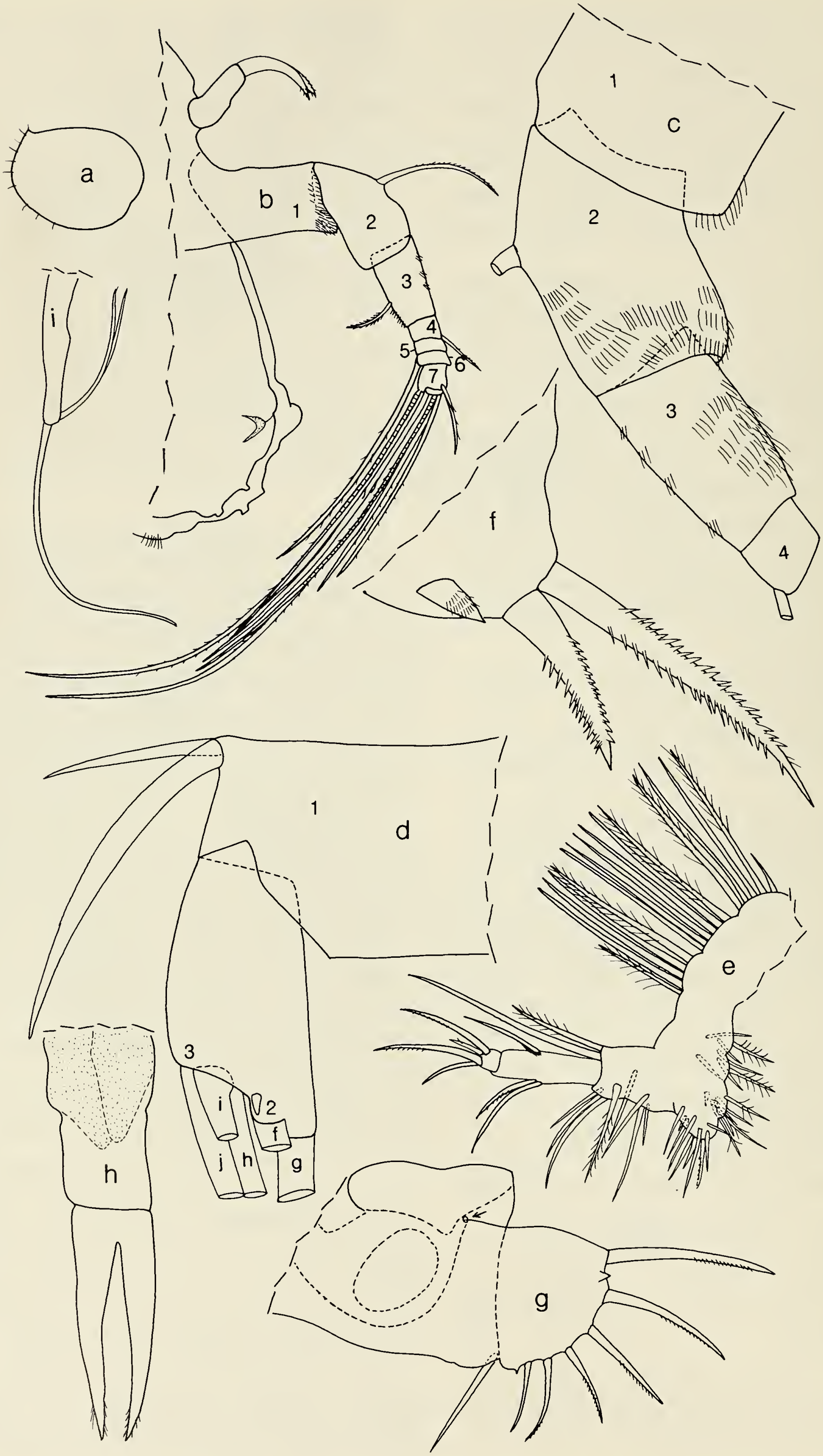
Second antenna (Fig. 4d): Longest of 4 bristles of 9th exopodial joint without natatory hairs or spines. Limb otherwise similar to that of A-1 female.

Mandible (Fig. 5a–g): Coxale similar to that of A-1 female (Fig. 5b, d, g). Basale with 4 proximal bristles (3 stout and plumose, 1 slender, bare) (Fig. 5e). Basale endite (Fig. 5b–e) similar to that of adult female except entwined bristles cross in 2 or 3 places rather than 4 or 5 (Fig. 5e). Endopodite 3-jointed (Fig. 5a): 1st joint with 1 spinous terminal dorsal bristle, 1 spinous distal ventral bristle, and 2 spinous distal medial bristles; 2nd joint with 3 terminal dorsal bristles, and 1 terminal ventral bristle; 3rd joint hirsute medially and along dorsal margin, with 4 spinous medial bristles forming row, and 3 stout spinous terminal bristles similar to those of A-1 female (Fig. 5a, f).

Maxilla: 3 well developed endites: endite I with 2 proximal bristles (1 with long proximal hairs) and 9 terminal bristles; endite II with 2 proximal bristles and about 7 terminal bristles; endite III with 1 proximal bristle and about 6 terminal bristles. Coxale with 1 stout, hirsute, terminal, dorsal bristle. Basale with 1 slender ventral bristle and 1 shorter, slender terminal bristle at midwidth. Endopodite: 1st joint with 3 bristles on or near anterior margin, 3–4 bristles at distal posterior corner, and sparse surface hairs; 2nd joint with 2 stout claws, 4 slender bristles, and long hairs on anterior surface.

Fifth limb (Fig. 4e, f): Epipodite similar to that of A-1 female. Protopodite and endopodite with 24 bristles including 2 claw-like bristles and 1 small spinous medial bristle (Fig. 4f). Exopodite 3-jointed: 1st joint with total of 10 bristles: 2 distal dorsal bristles (longest bare, other with long marginal hairs); 2 lateral bristles (distal of these plumose), 1 medial bristle near middle, 2 proximal ventral bristles, and 3 bristles on distal ventral corner. 2nd joint elongate with 3 bristles (1 dorsal, 2 ventral). 3rd joint short with 2 long claw-like bristles and 2 slender ringed bristles (smallest bristle medial).

Sixth limb (Fig. 5h): Epipodite similar to that of A-1 female. Protopodite with 2 joints: proximal joint with 3 bristles on or near ventral margin (1 plumose, 2 with short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marginal spines); distal joint with 3 bristles on or near ventral margin (1 plumose, 2 with short marginal spines). Exopodite 4-jointed: 1st joint with plumose lateral bristle, 4 plumose bristles on or near ventral margin, and process with 4 bristles (1 long bristle bare, others plumose); 2nd joint with 2 ventral bristles; 3rd joint separated from 4th by weakly defined suture, elongate with 2 bristles (1 ventral, 1 dorsal); 4th joint short, with 2 claw-like pectinate bristles and 2 slender bristles (shortest of these medial).

Seventh limb (Fig. 4i): Limb unjointed, with 3 bare bristles (1 long, 2 short equilength).

Furca (Fig. 4g): Each lamella with total of 6 claws followed by unpaired dorsal bristle; claws decreasing in width posteriorly along lamella, claw 4 slightly shorter than claw 5 and claw 6 slightly shorter than claw 5; claws 1–4 with spines along posterior margin; claw 5 with few distal hair-like spines along anterior margin; stout triangular protuberance on each lamella following last claw, and small process laterally between claws 1 and 2.

Bellonci organ (Fig. 4b): Well developed, bifurcate distally with branches tapering to pointed tip. Marginal hairs visible at high magnification (×100 objective).

Lips (Figs. 4b, 5i, j), posterior of body (Fig. 4g), apron (Fig. 4g), gut: Similar to those of A-1 female.

Comparisons.—The carapace of *D. bransoni* has bosses on walls of reticulations larger than those of *D. spiralis* (compare Figs. 1c and 6b). The A-1 female *bransoni* has a much smaller shell than that of the A-1 female of *spiralis*: 1.68 mm compared to 2.67–2.87 mm. The end joints of the exopodites of the 5th and 6th limbs of the A-1 female *bransoni* bear four bristles whereas those of *spiralis* bear five. The ventral bristle on the end joint of the mandible of the A-1 female *bransoni* bears near midlength long stout marginal spines (Fig. 2g); these are less well developed and closer to the tip on *spiralis* (Fig. 6i).

Ontogenetic development.—The collection comprised an A-1 and A-2 female. Their carapaces are similar in shape and ornamentation except the dorsal margin of the shell is slightly convex on the A-2 instar and straight on the A-1. The 1st and 2nd antennae have the same number of bristles in both stages. The coxale and basale of the mandible are similarly developed, except the A-2 instar has four proximal bristles on the basale and only three on the A-1 (possibly a bristle broke off during dissection of the A-1 female), and the two entwined bristles of the basale cross each other two to three times on the A-2 instar and four to five times on the A-1. The endopodites of the mandible and maxilla and the exopodites of the 5th and 6th limbs of the A-2 instar have in total a smaller number of bristles, but fewer bristles are added on distal joints (Table 1). The 7th limb and Bellonci organ are similar for both stages. The furca of the A-2 instar has six claws, compared to seven for the A-1.

Deeveya spiralis
Kornicker and Iliffe, 1985
Fig. 6

Material.—Holotype, USNM 193117; paratype, USNM 193118.

Distribution.—The Hole, a marine cave on Providenciales Island, Caicos Islands, Turks and Caicos Islands.

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Fig. 4. *Deeveya bransoni,* A-2 female, paratype: a, Complete specimen from right side, length 1.21 mm; b, Anterior of body showing divided Bellonci organ, right 1st antenna, and upper lip; c, Medial view of joints 1–4 of right 1st antenna showing spinosity; d, Endopodite of left 2nd antenna, lateral view; e, Right 5th limb, lateral view; f, Claw-like bristles and short stout medial bristle of endite of left 5th limb, medial view; g, Right lamella of furca (arrow indicates anus); h, Ventral or dorsal view of Bellonci organ under cover slip; i, Right 7th limb, lateral view.

Fig. 5. *Deeveya bransoni,* A-2 female, paratype: a–g, Mandible: a, Posterior view of proximal parts of coxale and basale, and lateral view of endopodite of right limb; b, Medial view of coxale endite of right limb, not under

Remarks.—Because both the holotype and paratype of *D. spiralis* had unextruded eggs in their ovaries, Kornicker and Iliffe (1985) interpreted the specimens to be adult females; however, they could be A-1 females, and they are so interpreted herein. A reason for this is that a species from a cave in Bermuda referred to *Spelaeoecia* by Angel and Iliffe (1987) has almost identical appendages to those of *Deeveya,* and the adult female of that species has eight claws on the furca, one more than on the known specimens of *D. spiralis.* It seems probable that the adult *Deeveya* will also have eight furcal claws, and the A-1 instar only seven.

Supplementary description of A-1 female (Fig. 6).—Kornicker and Iliffe (1985:fig. 2) illustrated a fragment of shell having convex pillow structures forming surfaces of areas within reticulate walls; further examination suggests that convex structures probably occur only on a decalcified shell, and that the outer surface of calcified specimens are essentially flat (Fig. 6c). Reticulations visible in transmitted light are structures within the shell wall and not surface structures. Minute bosses on the shell surface occur lateral to the walls forming reticulations, generally where walls intersect (Fig. 6b, c). Small round structures appearing lighter (when viewed with transmitted light) than surrounding area occur on the surface of some areas bounded by reticulate walls, but whether these are raised or depressed could not be ascertained (Fig. 6b), but they are shown raised in Fig. 6c.

Table 1.—Number of bristles on mandible, maxilla, and 5th and 6th limbs of A-2 and A-1 females of *Deeveya bransoni.*

	Growth stages	
	A-2	A-1
Mandible, endopodite		
1st joint	4	6
2nd joint	4	4
3rd joint	7	7
Maxilla, endopodite		
1st joint	6–7	9–11
2nd joint	6	7
5th limb, exopodite		
1st joint	10	12
2nd joint	3	4
3rd joint	4	4
6th limb, exopodite		
1st joint	9	10–11
2nd joint	2	4
3rd joint	2	3
4th joint	4	4

First antenna (Fig. 6d, e): 5th joint with filament-like bristle with widely spaced minute marginal spines and terminal papilla. 6th joint bare. 7th joint with short ringed spinous lateral a-bristle near distal dorsal corner and 2 bristles on terminal ventral pedistal (medial b-bristle about ⅔ length of lateral, filament-like, with minute widely spaced marginal spines and terminal papilla; lateral c-bristle about 1½ times length of stem, ringed in proximal ⅔ and with widely spaced marginal spines and terminal papilla (spines stouter than those on bristle of 5th joint)). 8th joint with 4 terminal bristles: d-bristle filament-like, short, with small widely spaced marginal spines and terminal papilla (tip of e-bristle of illustrated right limb aberrant; dashed line indicates length of e-bristle of left limb); e-bristle (principal bristle) about twice length of stem and distinctly ringed in proximal half, with small widely spaced marginal spines and terminal papilla; f-bristle about ⅓ length of principal bristle; g-bristle more than half length of principal bristle, both f- and g-bristles filament-like, with small widely spaced marginal spines and small terminal papilla.

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cover slip; c, Medial view of distal teeth of basale of right limb, not under cover slip; d, Anterior view of coxale endite of right limb, under cover slip; e, Lateral view of basale of right limb; f, Ventral terminal bristle of 3rd endopodial joint of right limb, lateral view; g, Posterior view of coxale endite of left limb, under cover slip; h, Right 6th limb, lateral view; i, Outline of upper lip from right side, anterior to right; j, Lower lip, ventral view.

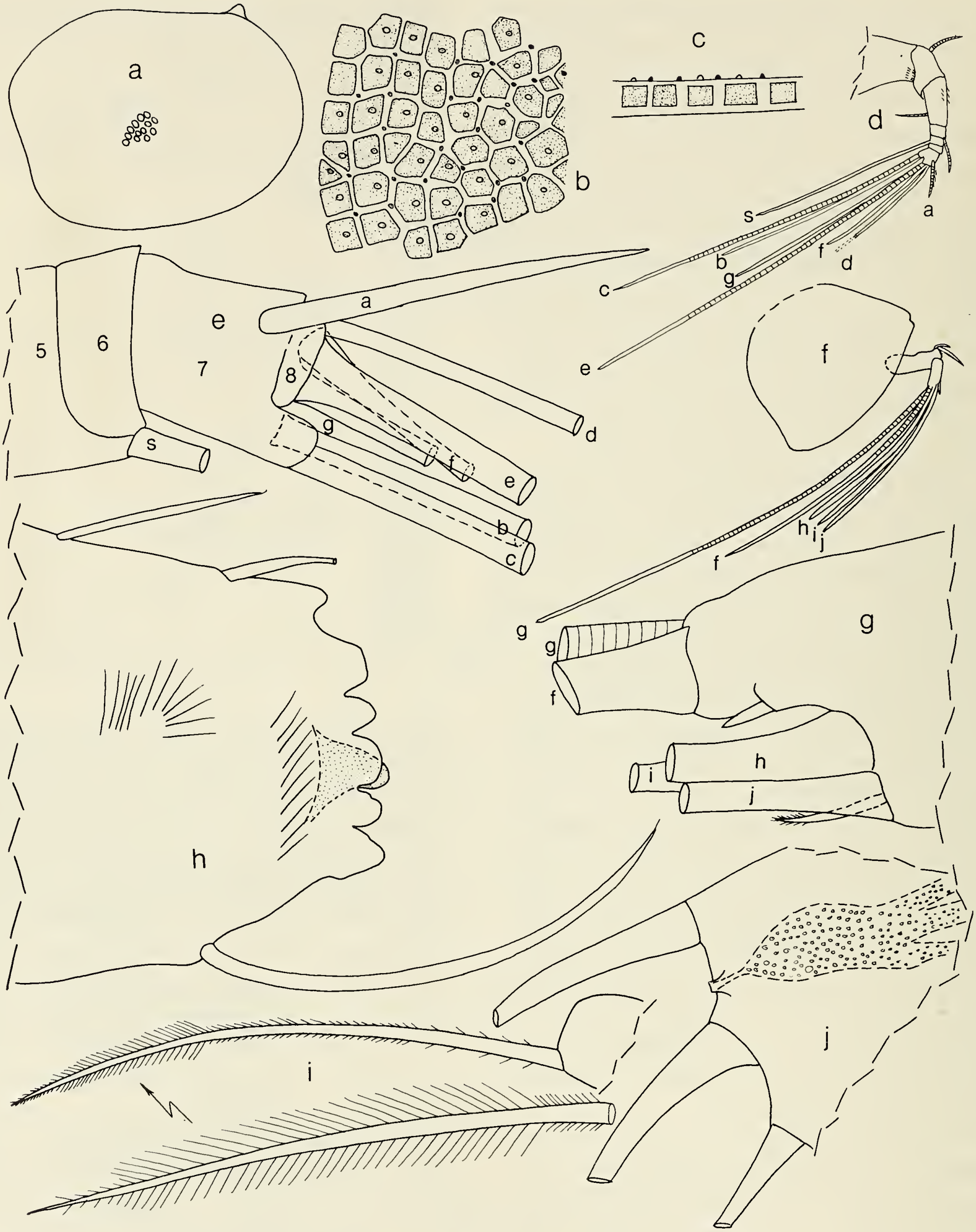

Fig. 6. *Deeveya spiralis,* A-1 female, paratype: a, Complete specimen from left side, length 2.67 mm; b, Lateral view using transmitted light of part of right valve just ventral to central adductor muscle attachments showing shell structure (stippled areas appear darker when viewed through microscope); c, Sketch of theoretical cross-section of shell shown in b (outside of shell at top). Holotype: d, Right 1st antenna, lateral view; e, Detail of tip of limb in d; f, Protopodite and endopodite of right 2nd antenna, lateral view; g, Detail of tip of endopodite in f; h, Distal part of basale of right mandible, medial view; i, Ventral bristle of end joint endopodite of right mandible, medial view; j, Left lamella of furca showing gland between claws 1 and 2, lateral view.

Second antenna: Endopodite (Fig. 6f, g): 1st joint: dorsal margin with stout prominence bearing spinous a-bristle less than half length of spinous b-bristle, both bristles directed anteriorly. 2nd joint forming right angle with 1st joint, with 2 distal bristles: f-bristle filament-like, slightly more than half length of g-bristle, with widely spaced minute spines (smaller than marginal spines of g-bristle), and terminal papilla; g-bristle more than twice length of protopodite, with distinct rings in proximal half, with widely spaced minute marginal spines, and terminal papilla; minute, unringed, pointed peg present proximally on dorsal margin of joint. 3rd joint with 3 similar filament-like h-, i-, and j-bristles, each less than half length of g-bristle, with widely spaced minute marginal spines (spines about same size as those of f-bristle), and with terminal papilla; small, unringed, medial, terminal bristle with marginal spines along distal quarter present near dorsal corner of joint (length of bristle about half width of joint).

Mandible: Distal end of basale with stout lateral tooth (Fig. 6h); ventral (=posterior) bristle of 3rd endopodial joint with long hairs (Fig. 6i). (Figure 10 in Kornicker and Iliffe (1985:488) was incorrectly labelled and should be as follows: "b" is an illustration of the coxa, and "c" the basis and endopodite.)

Maxilla: Hirsute dorsal bristle on coxale (not on basale as stated by Kornicker and Iliffe 1985:490).

Furca (Fig. 6j): Small lateral process between claws 1 and 2 of each lamella representing glandular outlet (this process was overlooked by Kornicker and Iliffe 1985: 491).

Acknowledgments

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TWO NEW TURTLES FROM SOUTHEAST ASIA

Carl H. Ernst and William P. McCord

Abstract.—*Cuora chriskarannarum* (Emydidae: Batagurinae), new species, from Yunnan Province, China, and *Platysternon megacephalum shiui* (Platysternidae), new subspecies, from northern Vietnam are described and compared with other members of their genera.

The recent relaxation of regulations regarding scientific exploration and the collection and export of reptiles from China and Vietnam have introduced many uncommon and unusual animals into the pet trade. Dr. William P. McCord, a turtle fancier, obtained a number of turtles and recognized that some of these animals represented new taxa. Two of these are described below.

Methods and Materials

Straight-line measurements of each specimen were taken with dial calipers accurate to 0.1 mm, of the greatest carapace length, carapace width and depth at the level of the seam between vertebrals 2 and 3, marginal width (the difference between the carapacial width and the width across the pleurals taken between the points of juncture of the marginals and pleurals at the level of the seam between vertebrals 2 and 3), greatest plastron length, greatest width and length of both plastral lobes, greatest bridge length, greatest width and length of vertebrals 1 and 2 and pleural 2, and the medial seam length and greatest width of all plastral scutes. Notes and drawings were made of head, neck, limb, carapacial, plastral, and bridge patterns. Colors were recorded from living turtles and color transparencies. Shell proportions are expressed as ratios of one measurement to another. Sixteen ratios proved useful (abbreviations used in the text are given in parentheses): width/length of cervical scute (W/L CS), width/length of first vertebral (W/L 1st V), width/length of second vertebral (W/L 2nd V), width/length of second pleural (W/L 2nd Pl), marginal width/carapacial width (MW/CW), marginal width/carapacial length (MW/CL), carapacial width/carapacial length (CW/CL), carapacial depth/carapacial length (D/CL), carapacial depth/carapacial width (D/CW), plastral length/carapacial length (PL/CL), bridge length/plastral length (B/PL), bridge length/carapacial length (B/CL), length of anterior plastral lobe/plastral length (APL/PL), width of anterior plastral lobe/plastral length (APW/PL), length of posterior plastral lobe/plastral length (PPL/PL), and width of posterior plasteral lobe/plastral length (PPW/PL). The number of rows of large scales at the lateral edge of the antibrachium between the claw of digit V and the first horizontal skin fold proximal to the elbow (presented in text as foreleg scale rows) was recorded.

Specimens from the following collections were examined (abbreviations used in the text are given in parentheses): William P. McCord personal collection of living turtles (WPM), National Museum of Natural History, Smithsonian Institution (USNM).

Cuora chriskarannarum, new species
Fig. 1

Holotype.—USNM 266162, adult male; Ta Lau Shan, Yunnan Province, China (23°30'N, 102°25'E); Oscar Shiu, Sep 1986.

Paratype.—USNM 266163, adult female; Chinsha (=Chin ´ Ping), Yunnan

Province, China (22°46′N, 103°15′E); Oscar Shiu, Sep 1986.

Diagnosis.—Flattened, green species of *Cuora* with yellowish-green, black-bordered postorbital stripe, oblique yellowish-green stripe extending from upper jaw to below tympanum to neck, medial carapacial keel most pronounced on vertebrals 1–3, vertebral 1 usually extending laterally to seam separating marginals 1–2 or beyond, broad black seam-following plastral pattern, plastron with wide anal notch, and interanal seam complete.

Description (from all specimens examined).—Carapace length to 160 mm (males 113, females 160), elliptical, flattened (D/CL 0.29–0.42, $\bar{x} = 0.346$; D/CW 0.40–0.60, $\bar{x} = 0.498$; CW/CL 0.67–0.73, $\bar{x} = 0.694$); widest at marginals 8, highest at posterior of vertebral 2. Carapace sides straight, posterior rim slightly serrated and with a very small medial notch. All marginals flared, those over bridge slightly downturned (MW 11.8–17.3 mm, $\bar{x} = 14.1$; MW/CW 0.13–0.18, $\bar{x} = 0.157$; MW/CL 0.09–0.14, $\bar{x} = 0.109$). Marginal 1 widest, marginals 3–6 smallest. Scute texture rough with growth annuli. Cervical rectangular, longer than wide (W/L CS 0.70–0.72, $\bar{x} = 0.713$). Vertebrals wider than long; vertebral 1 largest and very flared anteriorly, reaching seam separating marginals 1–2 or marginal 2 in 15 (88%) specimens; vertebral 5 posteriorly flared. Low medial keel most pronounced on vertebrals 3–5. Olive-brown, rim yellow, seams outlined with dark brown or black, keel black. Undersides of marginals yellow with black, posteriorly-directed wedge at each seam, some with narrow, radiating black lines.

Plastron length to 159 mm (males 111, females 159), longer than carapace in 7 (41%) specimens (PL/CL 0.96–1.02, $\bar{x} = 0.995$), slightly upturned anteriorly, movable hinge between pectoral and abdominal scutes. Posterior lobe longer and wider than anterior lobe (APL/PL 0.39–0.44, $\bar{x} = 0.414$; PPL/PL 0.55–0.60, $\bar{x} = 0.578$; APW/PL 0.45–0.50, $\bar{x} = 0.474$; PPW/PL 0.51–0.57, $\bar{x} = 0.536$; APW/CW 0.62–0.70; $\bar{x} = 0.682$; PPW/CW 0.74–0.81, $\bar{x} = 0.769$). Anterior lobe truncated, posterior lobe with shallow anal notch. Anal scutes laterally tapering toward midline. Bridge moderate (B/CL 0.22–0.32, $\bar{x} = 0.273$; B/PL 0.23–0.31, $\bar{x} = 0.274$); 0–1 axillaries; 1 inguinal. Average plastral formula An. > Abd. > Pect. > Gul. > Fem. > Hum.; 10 (59%) had this formula, but 5 other formulae occurred; An., Abd., Pect. always longer than Gul., Fem., Hum. Interanal seam present and complete. Yellow with wide black seam-following pattern becoming more extensive with age (size); bridge with black bar.

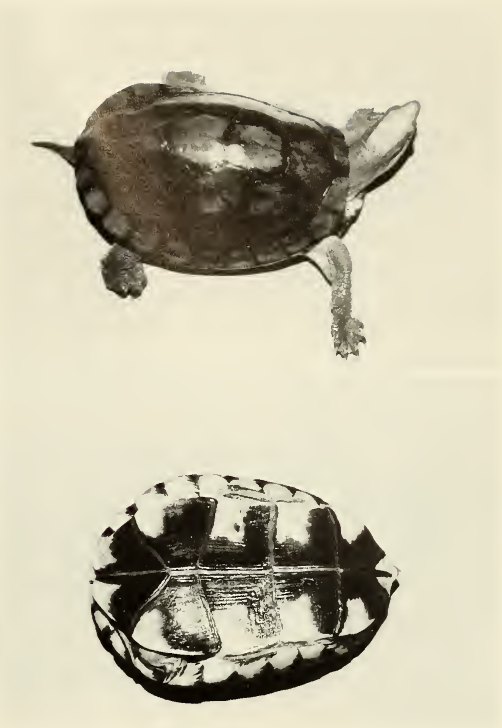

Fig. 1. *Cuora chriskarannarum,* new species.

Head narrow; snout slightly projecting; upper jaw slightly hooked. Olive (lighter dorsally, darker laterally) with yellowish-green postorbital stripe and second yellowish-green stripe extending obliquely downward from upper jaw to below tympanum;

both stripes with narrow black borders. Faint thin black line may circle tympanum. Iris green; unmarked yellow jaws and chin. Neck olive dorsally and laterally, yellowish-green ventrally, several faint, narrow yellow lateral stripes present.

Digits webbed. Forelimbs with large scales (10–15 rows, $\bar{x} = 14.0$); outer surface olive, inner surface and sockets cream to whitish-green. Hindlimbs with smaller scales, colored as forelimbs. Holotype with amputated right hindlimb. Tail olive dorsally with two dark-bordered longitudinal stripes, venter yellow with olive tip.

Smaller, flatter males having concave plastra, longer thicker tails with anal vent beyond carapacial rim, and pointed snouts; larger, more vaulted females having flat plastra, shorter tails with anal vent beneath carapacial rim, and rounded snouts.

Other material.—WPM 1–15 (live; 2 males, 13 females); from localities of type specimens.

Etymology.—The name *chriskarannarum* is in honor of Dr. McCord's daughters Christine and Karen, and his wife Anne.

Remarks.—The new species is most closely related to *Cuora pani* Song, 1984, *C. trifasciatus* (Bell, 1825), and *C. yunnanensis* (Boulenger, 1906), and at least one additional undescribed species. These taxa form a distinct subgroup within *Cuora* characterized by relatively flattened carapaces, plastrons with wide anal notches, and complete interanal seams. *Cuora pani* is from Shaanxi Province, China. It has a lemon-yellow head with a broad yellow longitudinal stripe, a brown carapace with reddish vertebrals and a keel extending over vertebrals 1–5, a yellow plastron with a pattern of black wedges that are often separated along the seams, and a broad vertebral 1 that may extend to marginals 2. *Cuora trifasciatus* ranges from Kwangsi and Kwangtung provinces and Hainan in China through northern Vietnam and possibly to Burma. Its head is olive dorsally, brown to black laterally, and with a lateral longitudinal stripe; an olive to brown tricarinate carapace bears three longitudinal black stripes; the black plastron has a yellow border; vertebral 1 usually does not extend to the seam separating marginals 1–2. *Cuora yunnanensis* is known only from the highlands of Yunnan Province, China. It has a brown head with a narrow yellow stripe extending from the nostril through the eye to the neck, a unique mottled chin pattern, a brown carapace with dark seams and a keel extending over all five vertebrals, a yellow to light brown plastron with narrow dark seams, and a vertebral 1 that does not extend to the seam separating marginals 1–2.

Platysternon megacephalum shiui,
new subspecies
Fig. 2

Holotype.—USNM 266160, adult male; vicinity of Langson, Langson Province, Vietnam (26°50′N, 106°45′E); Oscar Shiu, Aug 1986.

Paratype.—USNM 266161, adult male; same collection data as holotype.

Diagnosis.—Head, shell, limbs, sockets, ventral surface of tail heavily speckled with yellow, orange or pink spots; cephalic shield moderately developed, not entering orbit; upper jaw strongly hooked; carapacial surface smooth, posterior rim unserrated; no postorbital stripe, dark plastral figure, or small additional scales at medial juncture of gular and humeral scutes.

Description.—(From all specimens examined.) Carapace length to 151 mm (males 151, females 107), flat (D/CL 0.26–0.31, $\bar{x} = 0.280$; D/CW 0.38–0.47, $\bar{x} = 0.438$; CW/CL 0.60–0.68, $\bar{x} = 0.640$), widest at marginals 9, highest at vertebral 1. Carapace sides straight, or slightly indented at bridge; anterior rim medially indented; posterior rim smooth, but with small medial notch. Anterior and posterior marginals flared, especially over hindlimbs, those at bridge downturned (MW 3.6–7.9 mm, $\bar{x} = 5.53$; MW/CW 0.42–0.81, $\bar{x} = 0.65$; MW/CL

0.025–0.045, $\bar{x} = 0.041$); marginals 1 widest, those over bridge smallest. Scute surfaces smooth. Cervical very small, wider than long (absent in two specimens). Vertebrals wider than long, 5th largest. Medial keel low, blunt; most prominent on vertebrals 3–5. Brown with mottled pattern of small yellow, orange, or orangish-red spots throughout, but most prominent on pleurals and dorsal surface of marginals. Ventral surface of marginals yellowish-brown or olive with yellow, orange or pink speckles.

Plastral length to 112 mm (males 112, females 94); PL/CL 0.75–0.80, $\bar{x} = 0.776$. Anterior lobe slightly longer than posterior lobe, which wider (APL/PL 0.36–0.47, $\bar{x} = 0.433$; PPL/PL 0.40–0.44, $\bar{x} = 0.423$; APW/PL 0.36–0.48, $\bar{x} = 0.443$; PPW/PL 0.46–0.52, $\bar{x} = 0.493$; APW/CW 0.46–0.61, $\bar{x} = 0.537$; PPW/CW 0.55–0.67, $\bar{x} = 0.598$). Anterior lobe truncated; posterior lobe with anal notch. Femorals and anals laterally tapering toward midline. Bridge narrow; B/CL 0.15–0.20; $\bar{x} = 0.173$; B/PL 0.19–0.24, $\bar{x} = 0.223$; 1–2 axillaries, 1–2 inguinals. Plastron connected to carapace by ligaments at bridge. Average plastral formula An. > Hum. > Fem. > Pect. > Abd. > Gul.; 8 formulae present in 11 specimens examined (3 with average formula); variation occurring in Hum., Pect., Fem., and An.; Abd. and Gul. consistently shortest. Yellowish-brown or olive with many small yellow to orangish-red spots throughout, and yellow seams.

Head large, cannot be withdrawn into shell. Snout pointed, projecting; upper jaw strongly hooked. Dorsal cephalic shield only moderately developed, not covering posterior portion of orbit. Upper jaw sheath not as well developed as in other subspecies. Brown with numerous orange to red spots on dorsal and lateral surfaces. Eyes bulging; iris brown. Jaws, chin, throat brown with yellow, orange or red mottling.

Digits webbed. Forelimb with large scales (7–10 rows, $\bar{x} = 8$). Thighs with tubercle-like scales; skin of outer surface of limbs and dorsal surfaces of neck and tail brown; limb sockets and ventral surface of neck yellowish-brown. Limbs, sockets, underside of tail with yellow, orange or red spots. Tail long, covered dorsally with large annular scales.

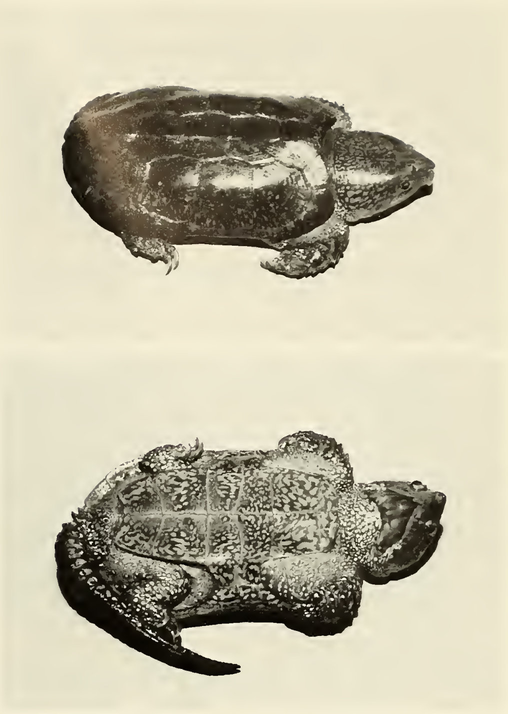

Fig. 2. *Platysternon megacephalum shiui,* new subspecies.

Males having concave plastra and anal vent beyond carapacial marginals; females flat plastra and vent beneath carapace.

Other material.—WPM 1–9 (live, 7 males, 2 females) from type locality.

Etymology.—The name *shiui* is in honor of the collector Oscar Shiu.

Remarks.—Four other subspecies of *Platysternon megacephalum* have been described. *Platysternon megacephalum megacephalum* Gray, 1831, which occurs in southern China, has an unpatterned yellow plastron, a slightly keeled carapace with poorly developed growth annuli, and a slightly serrated posterior rim, the marginals above the bridge flared, a well developed cephalic shield that often covers the rear of the orbit, a strongly hooked upper jaw, yellow mottling on the jaws, and a pattern of radiating narrow lines on the dorsal surface of the head. *Platysternon megacephalum peguense* Gray, 1870 is found from western Vietnam west to southern Burma. It has a dark seam-following plastral pattern, the carapacial keel pronounced and sometimes indications of lateral keels, well developed growth annuli, the posterior carapacial rim serrated, unpatterned yellow jaws, a strongly hooked upper jaw, and a black-bordered postorbital stripe. *Platysternon megacephalum vogeli* Wermuth, 1969 occurs in northwestern Thailand. It is similar to *P. m. peguense* in having a dark plastral figure, but differs in having a short, narrow, less hooked upper jaw, and a smooth, unserrated carapace. *Platysternon megacephalum tristernalis* Schleich and Gruber, 1984 is from Yunnan Province, China, and similar to *P. m. megacephalum* except it has three additional small scales at the medial junction of the gular and humeral scutes. It is likely that further study will prove *P. m. vogeli* and *P. m. tristernalis* invalid. Ernst is currently studying the variation within *Platysternon.*

Acknowledgments

George R. Zug critically commented on the manuscript, and Evelyn M. Ernst typed it.

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THE CAPRELLIDS (AMPHIPODA: CAPRELLIDA) OF BERMUDA: A SURVEY OF SPECIMENS COLLECTED FROM 1876–1987, INCLUDING CAVE INHABITANTS, AND THE DESCRIPTION OF *DEUTELLA ASPIDUCHA,* NEW SPECIES

Michael F. Gable and Eric A. Lazo-Wasem

Abstract.—An examination of all available specimens of Bermuda caprellids, including recently collected cave caprellids, permits a contemporary survey of the group for Bermuda waters. A new species, *Deutella aspiducha,* is described. Its transitional characters suggest the reabsorption of *Luconacia incerta* into the genus *Deutella.* Four other Bermuda caprellids (*Caprella danilevskii, C. equilibra, Hemiaegina minuta,* and *Fallotritella biscaynensis*) are reviewed, and keys are provided for all six species. Zoogeographical and evolutionary theories using cave and shallow-water specimens are not possible because of the paucity of material from the latter habitat.

Kunkel's 1910 monograph on the amphipods of Bermuda included four species of caprellids. In 1968 McCain mentioned two more species for Bermuda and summarized the small amount of information known for the six Bermuda species on habitat preferences, morphological variation, etc. Several recent factors predicate an updated treatment of the Bermuda caprellids: the discovery at the Yale Peabody Museum (YPM) of many of Kunkel's specimens (Lazo-Wasem and Gable 1987), a collection of Bermuda amphipods made in 1985, and the examination of all Bermuda caprellids housed at the United States National Museum (USNM), including specimens collected by G. Brown Goode in 1876–1877, and the cave specimens collected this decade by T. M. Iliffe of the Bermuda Biological Station. In addition, the discovery of a possibly endemic species, *Deutella aspiducha,* adds to the desirability of a reconsideration of the Bermuda caprellids.

Systematics

Full synonymies for the Bermuda caprellids are in McCain (1968); taxonomic changes since his publication are noted in this paper. Our synonymies apply only to publications that mention a species as it occurs in Bermuda. The classification schemes of McCain (1970), Bowman and Abele (1982), and Schram (1986) are used throughout this paper. Legend: major body parts are marked by abbreviations beginning with uppercase letters. Abbreviations are as follows: A, antenna; Ab, abdomen; C, cephalon; Gn, gnathopod; Md, mandible; Mx, maxilla; Mxpd, maxilliped; P, pereopod; Pn, pereonite.

Family Aeginellidae Vassilenko, 1968
Deutella Mayer, 1890, emend.

Diagnosis.—Flagellum of antenna 2 biarticulate (rarely triarticulate?), swimming setae absent; mandibular palp 3-segmented, setal formula for terminal article 1-x-1, 1, or 2, knob on terminal article present or absent, molar present; outer lobe of maxilliped larger than inner lobe; gills on pereonites 3 and 4; pereopods 3 and 4, 2-segmented, pereopod 5, 6-segmented; abdomen of male with pair of appendages and pair of setose lobes, female with or without a pair of lobes.

Deutella aspiducha, new species
Figs. 1–3

Diagnosis.—Cephalon and pereonite 2 each with 1 dorsal, anteriorly directed spine. Males with anterior spatulate processes on pereonite 2; pereonites 3 and 4 with outwardly projecting, crenulate side plates. Insertion of pereopod 5 in both sexes, ¼ from posterior edge of pereonite 5.

Etymology of specific modifier.—From the Greek *aspiduchos* meaning "shield-bearer," in reference to the distinct and crenulate side plates on pereonites 3 and 4 of the male.

Description.—Male holotype, 4.8 mm. Cephalon with 1 dorsal, anteriorly directed spine, followed posteriorly by 2 smooth, rounded dorsal humps; posterolateral margins with small, anteriorly projecting triangular processes. Pereonite 2 with 1 middorsal, anteriorly directed spine; anterolateral margins with distinct, large, anteriorly projecting spatulate processes. Pereonites 3–7 dorsally smooth, except pereonites 3 and 4 with middorsal hump; side plates of pereonites 3 and 4 projecting ventrolaterally with margins distinctly crenulate. Eyes present, round.

Antenna 1, 46% of body length. Peduncular segment 1 broader than segment 2; peduncular ratios 1:1.3:0.7. Peduncular segments heavily circumsetose with fine setae. Flagellum 0.6 length of peduncle, of 6 or 7 articles, first article conjointed. Antenna 2, 16% of body length, swimming setae absent, flagellum 2-articulate.

Mandible with 3-segmented palp, setal formula for terminal article 1-x-1, terminal article with knob, penultimate segment with single distal seta. Left mandible with 6-toothed incisor, serrate lacinia, spine row of 3 broad and short spines, molar strong. Right mandible identical. Palp of maxilla 1 with 3 apical spines, 1 medial spine and 1 facial seta; outer lobe with 4 apical spines and 1 shorter subapical spine. Outer lobe of maxilla 2 with 4 apical setae; inner lobe with 3. Outer lobe of maxilliped narrow, long, reaching ⅓ length of palp segment 2, with 2 apical setae, 2 medial setae, and 1 facial seta; inner lobe oval, small, ⅙ length of outer, with 2 apical setae; terminal article of palp with 1 distal seta, penultimate article with no triangular projection.

Article 6 of gnathopod 1 triangular, with grasping spine, palm with few setae, a small distal notch, and a facial spine row on inner surface; dactyl extending length of palm, with straight inner margin. Gnathopod 2 strongly inserted in expanded anteroventral corner of pereonite 2; article 2 with small, proximal, medially projecting triangular process; article 6, proximal end of palm demarcated by a grasping spine, palm with a strong poison tooth proximal to a deep notch followed distally by a small notch, and more distally armed with small teeth; article 7, curved and smooth.

Pereopods 3 and 4 inserted at base of gills, 2-segmented with tiny, distal, setose segments. Pereopod 5 of 6 segments, much smaller than pereopods 6 and 7, inserted ¼ from posterior margin of pereonite 5, propodus without palm, terminal article small and setose. Pereopods 6 and 7 normal, articles 6 with grasping spines.

Abdomen with medium-sized penes, a pair of appendages with recurved spines, and a pair of setose lobes.

Female allotype, 4.2 mm. Ovigerous. All features same as those for male except as noted. Posterolateral margins of pereonite 1 without small, anteriorly projecting processes. Anteriorly projecting processes on anterolateral margins of pereonite 2, small, tooth-like. Side plates of pereonites 3 and 4 not developed.

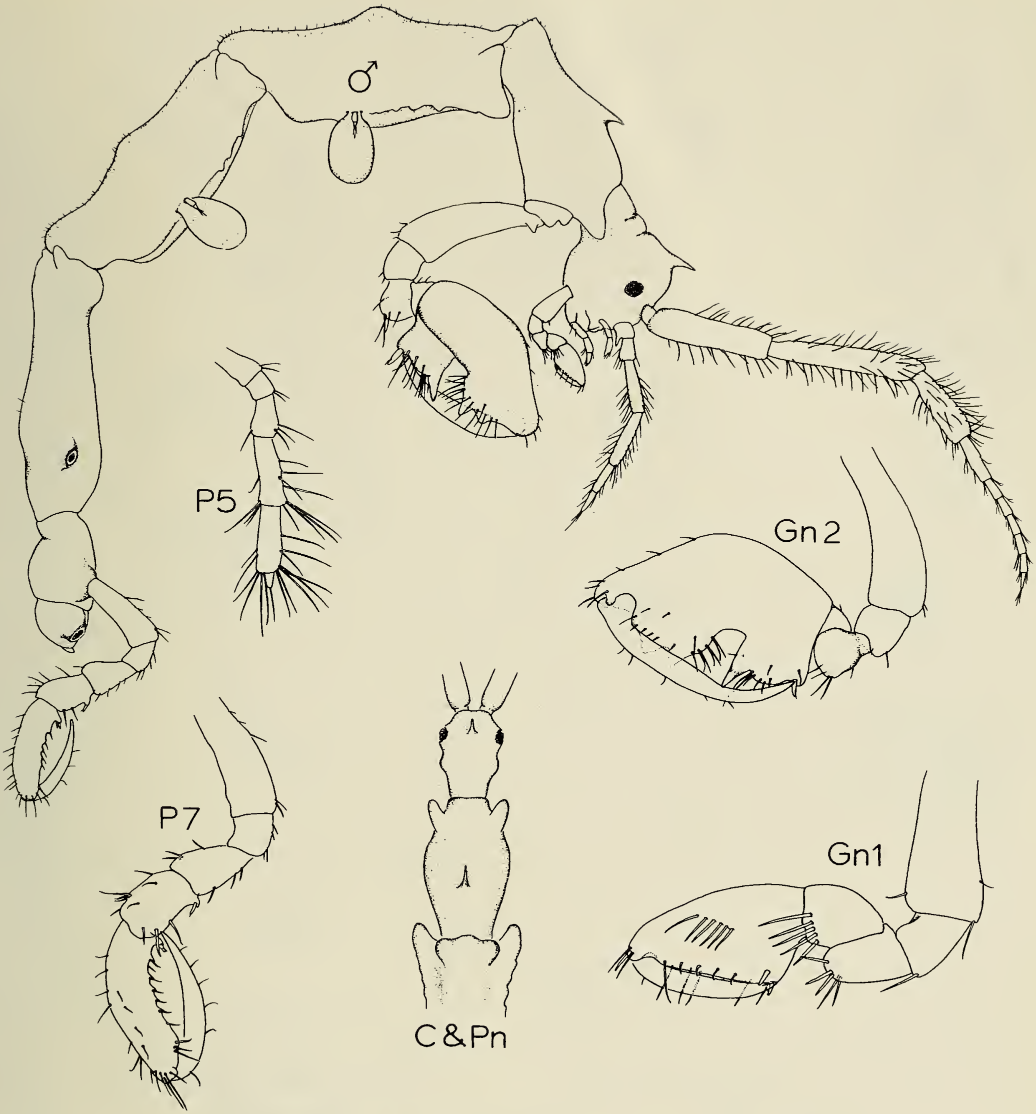

Fig. 1. *Deutella aspiducha,* male holotype. USNM 195178.

Antenna 1, 35% of body length, flagellum of 4 articles, ratio to peduncle, 0.3:1. Right antenna 2, flagellum of 2 articles, first conjointed; left flagellum of 3 articles.

Maxilliped, terminal article with 2 setae, 1 short and 1 curved.

Gnathopod 2, article 6 subquadrate, palmar margin with 2 small teeth on distal half, unnotched. Pereopods 3 and 4 inserted next to gills, both larger than those of males, both segments setose. Pereopod 5, anterior margin with tubercles. Abdomen with 2 lobes, weakly setose.

Remarks.—Even the smallest individuals of *D. aspiducha* show the beginnings of the dorsal spines on the cephalon and pereonite 2. The spatulate processes of pereonite 2 and the middorsal humps and side plate extensions of pereonites 3 and 4 in males definitely exhibit allometry, being barely visible in juveniles. The crenulations on the margins of the side plates of pereonites 3

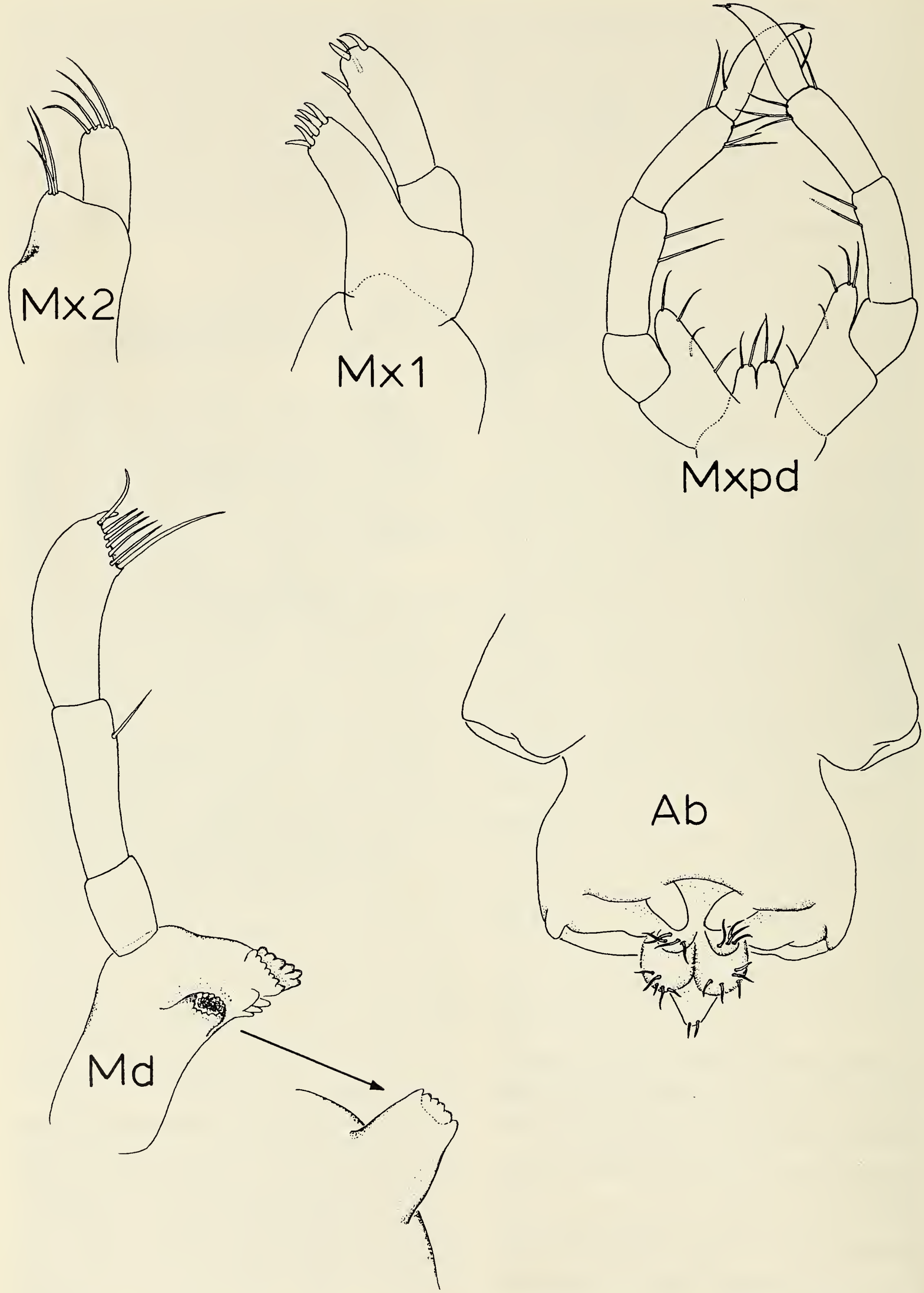

Fig. 2. *Deutella aspiducha,* male paratypes. USNM 195179: Mx1, Mx2, Md, Ab. YPM 8261: Mxpd.

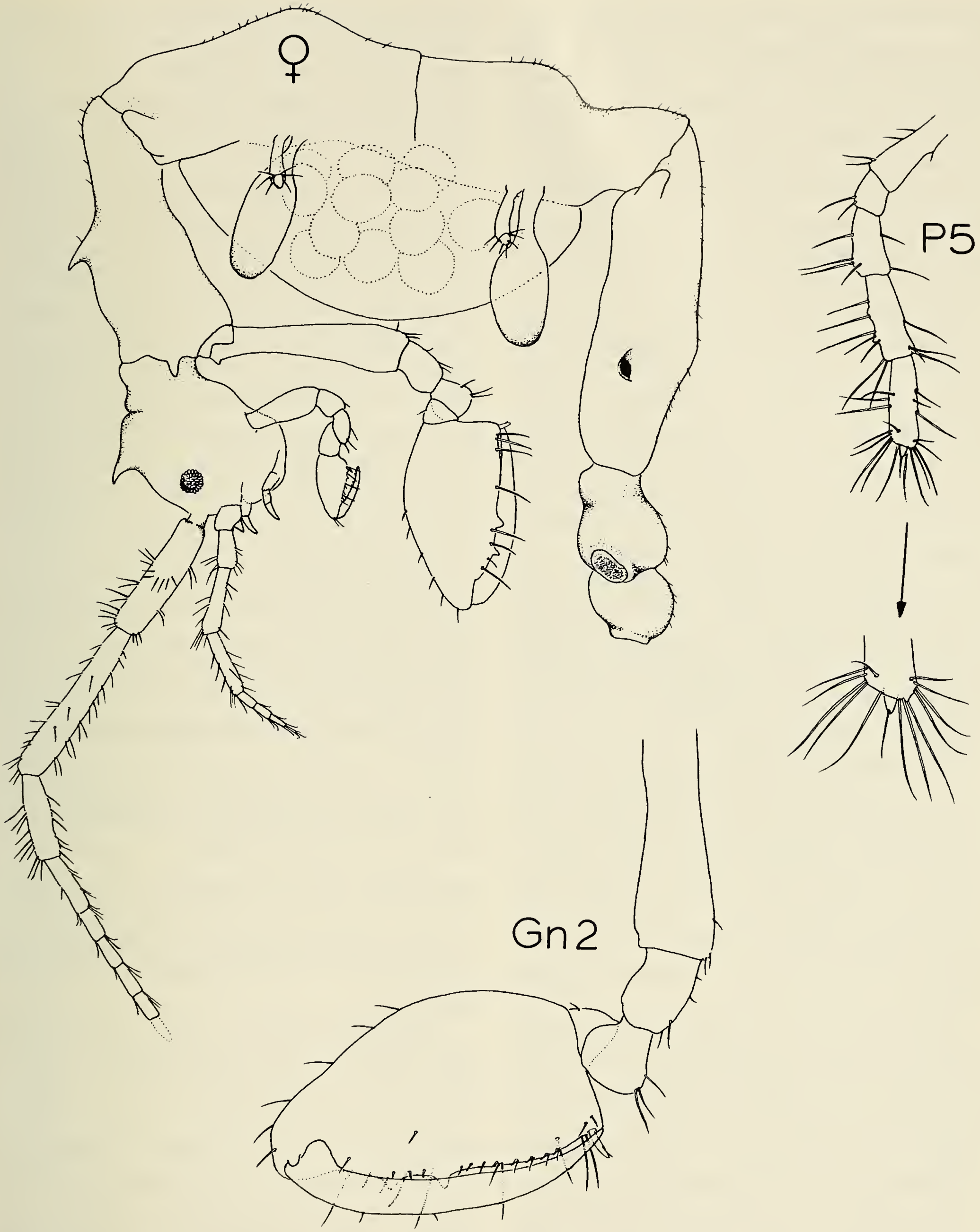

Fig. 3. *Deutella aspiducha,* female allotype. USNM 195177.

and 4 in males also become more distinct with increasing size. Females do not possess the small, projecting process on pereonite 2 until ovigerous. The possession or lack of pereonite processes, their shapes when present, and the 6th article of gnathopod 2 make this species notably sexually dimorphic.

The bodies of many of the animals, when

preserved, are bent into an inverted "U" at the junctions of pereonites 2 and 3 and pereonites 4 and 5; in some males, an additional flexion at the junction of pereonites 3 and 4 forms the animals into virtual squares. All ovigerous females exhibit a tight, inverted U-shape. Many individuals are covered thickly with flocculent detritus and morphological details can be obscured unless ultrasonically cleaned.

The female allotype, with one antenna 2 triarticulate and the other biarticulate (but with its first article conjointed) is an enigma. Most caprellid genera, other than some in the Phtisicidae, have a biarticulate flagellum on antenna 2 (McCain 1968). Of 44 other specimens of *D. aspiducha* examined, a few do appear to have a conjointed first article on antenna 2 and one male does appear to have a triarticulate flagellum. Perhaps triarticulation and conjointed articles are mere exceptions to a generally conservative feature or perhaps the occasional occurrence of these features has been overlooked in other genera.

The number of small setae in the formula for the terminal mandibular palp article varies from 4 to 5. The distal setation of the terminal maxillipedal palp varies from 1 short, to 1 short and 1 long, to 1 long. Distal setation of the palp of the maxilliped is normally characteristic of only one genus (*Paracaprella*) other than *Deutella* (McCain 1968).

Deutella aspiducha differs from all other *Deutella* species (sensu McCain 1968) by the lack of a triangular projection on the penultimate article of the palp of the maxilliped, by the shape of the last two articles of pereopod 5, and by the point of insertion of pereopod 5. The genus *Deutella,* however, exhibits a rather wide range of variation. *Deutella schieckei* Cavedini 1981 (possibly the *Deutella* sp. of Mayer (1890)), and *D. mayeri* Stebbing, 1895, are both dorsally smooth; *D. californica* Mayer, 1890 and *D. venenosa* Mayer, 1890, the only other two species in the genus, possess dorsal spines, as does *D. aspiducha.* Body spination is indeed often a variable character but even conservative characters such as the mouthparts, which McCain (1968) and Laubitz (1970) believe offer some of the best taxonomic characters, show significant variability. The same latter three species, for example, have a terminal article mandibular palp formula of 1-x-1; *D. schieckei* (Cavedini, 1981) and *D. mayeri* (McCain, 1968), however, have only one or two setae in toto on the palp. Pereopod 5 offers another example of extreme variability. Pereopod 5 of *D. venenosa* is described by Mayer (1890) as being "shortly rendered" and pereopod 5 of *D. aspiducha* is distinctly shorter than pereopods 6 and 7; the size of pereopod 5 in the other three species does not differ distinctly from that of pereopods 6 and 7.

Based on the above examples, a case for a strict generic diagnosis could be made in such a way as to eliminate any one of the *Deutella* species and allow the others to remain united. We believe that the structure and proportions of the antennae of *D. aspiducha,* most of its mouthpart morphology, the various pereonite projections, the delineation of the palm of gnathopod 2 in males, the strong anterior insertion of gnathopod 2 on pereonite 2, the shape, length, and insertion patterns of pereopods 3 and 4, and the structure of the male abdomen all link this new species to the genus *Deutella.*

Deutella aspiducha was first discovered at the YPM in a vial of specimens examined by Kunkel and labelled *Protellopsis stebbingii* Pearse, Bermuda, with no precise habitat description. That the species is indeed an inshore species was ascertained by the collection of a small male from hydroids at a 1 meter depth in 1985. Subsequent examination of Iliffe's material from Little River Cave, collected in 1982, revealed many *D. aspiducha* of both sexes at all growth stages. Because the inshore amphipod fauna of Bermuda has been so poorly surveyed and studied, however, at this time no suggestion of a stygophilic nature should be ascribed to this species. At present, its occurrence in caves and in shallow inshore waters can be said only to support the statement of several authors (e.g., Stock 1986, Maddocks and Iliffe 1986) that species found in the marine waters of certain types of island sea caves often also occur in shallow inshore waters.

Material examined. —Male holotype, USNM 195178, Little River Cave, Bermuda, T. M. Iliffe, 8 May 1982, 4.8 mm.—Female allotype, USNM 195177, Little River Cave, Bermuda, T. M. Iliffe, 8 May 1982, 4.2 mm.—19 paratypes, USNM 195179, Little River Cave, Bermuda, T. M. Iliffe, 8 May 1982.—USNM Acc. No. 359182, Little River Cave, Bermuda, T. M. Iliffe, 8 May 1982, 152 specimens.—1 male paratype, YPM 8261, Bermuda, Dr. J. L. Cole, 15 Jul 1903.—3 male paratypes, YPM 8263, Bermuda, Dr. J. L. Cole, 15 Jul 1903.—1 male paratype, YPM 8262, Shelly Bay, Hamilton Parish, Bermuda, off promontory NNW of Bay, M. F. Gable, 3 Jun 1985, among hydroids, shallow subtidal.

Deutella incerta (Mayer) 1903
Fig. 4

Protellopsis stebbingii: Kunkel, 1910:111–113, fig. 43.
Deutella incerta: Steinberg and Dougherty, 1957:281, 285–286.
Luconacia incerta: McCain, 1968:53–54, 68–72, figs. 33–35.—McCain and Steinberg, 1970:53.—Johnson, 1986:381, fig. 125.

Remarks. —Steinberg and Dougherty (1957) synonymized the monotypic *Luconacia* of Mayer (1903) with *Deutella*. Their argument for combining the genera rested on differences between the genera that they deemed trivial, the most important of which is the form of the distal segments of pereopod 5. Steinberg and Dougherty (1957) also claimed that swimming setae were mentioned in the diagnosis of *Luconacia* (*Deutella* lacks them), but that illustrations in various papers never showed them.

Interestingly, McCain (1968) himself questioned the use of pereopods 3, 4, and 5 as generic characters, because of their various degrees of reduction. Nonetheless, he re-established *Luconacia* and claimed several important differences between the genera (yet he eliminated the presence of swimming setae from his diagnosis of *Luconacia*): apical setae are present on the terminal article of the maxillipedal palp and a projection is present on the penultimate article in *Deutella* and both are lacking in *Luconacia*; the terminal article of the mandibular palp in *Deutella* has no knobs and a setal formula of 1-x-1 or "1 or 2," and in *Luconacia* there is a knob with a formula of 1-x-1; in *Deutella* the tip of the male abdominal appendage is without papillae and fringed or not fringed, and in *Luconacia* both papillae and fringes are present; the female abdomen in *Deutella* is lobed and in *Luconacia* it is not; in *Deutella,* pereopod 5 is inserted posteriorly and in *Luconacia,* midlength; finally, the right lacinia is 5-toothed or serrate in *Deutella* and serrate in *Luconacia.*

The discovery of *D. aspiducha* provides us with a transitional form that makes a case for uniting *Deutella* and *Luconacia* once again, increasing the number of known *Deutella* species to six. *D. aspiducha* possesses apical setae on the terminal article of the maxillipedal palp yet lacks the projection on the penultimate article. The terminal article of the mandibular palp bears a knob as in *Luconacia* (sensu McCain). The tip of the male abdominal appendage of *D. aspiducha* is without papillae and is not fringed; the female abdomen is lobed. The insertion of pereopod 5 is neither midlength nor posterior in *D. aspiducha* but almost precisely halfway in between. In addition, the propodus of pereopod 5 lacks a palmar margin as does that of McCain's *Luconacia.* The right lacinia of *D. aspiducha* is serrate.

Finally, McCain's (1968) suggestion that the removal of *D. mayeri* from the genus

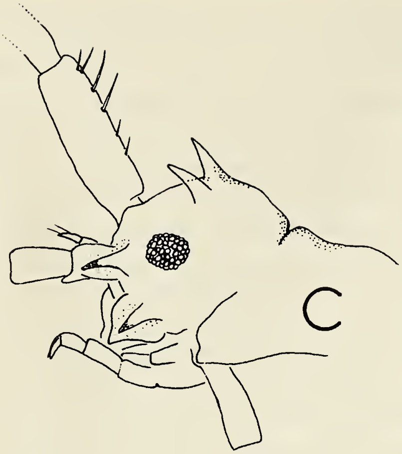

Fig. 4. *Deutella incerta.* Cephalon of female. USNM Acc. No. 359182.

would make it an exclusive Pacific Ocean genus and *Luconacia,* then, an exclusive Atlantic Ocean genus, loses a foundation for further consideration with Cavedini's (1981) discovery of the Mediterranean *D. schieckei.* Until these rather obscure, geographically widely separated and poorly studied species are much better known, we believe that the overlapping characters among them, punctuated in particular by the definitely *Deutella*-like (and *Luconacia*-similar) *D. aspiducha,* argue strongly for absorbing *Luconacia* into *Deutella.*

Many of the specimens of *D. incerta* from Bermuda of moderate to large size, both male and female, have gnathopod 2 palmar margins much more heavily setose than those figured by McCain (1968). In addition, these same specimens possess two large spines on the cephalon, one pre-ocular and one sub-ocular (Fig. 4), not figured by McCain (1968). Body spination at the species level is often of questionable taxonomic value (McCain 1968), but the invariable possession of these cephalic spines in moderate to large sized Bermuda specimens is a distinctive population character worth noting.

Deutella incerta seems to be one of the most commonly encountered caprellids in Bermuda. It has been found associated with hydroids in shallow inshore waters and in several caves. Johnson (1968) stated that it is also common on mangrove roots, *Sargassum, Thalassia,* sponges, and ascidians. The many specimens at Kunkel's disposal were presumably from non-cave waters.

Material examined.—YPM 8212, Bermuda, Dr. J. L. Cole, 15 Jul 1903, 186 specimens.—YPM 8264, Shelly Bay, Hamilton Parish, Bermuda, off promontory NNW of Bay, M. F. Gable, 3 Jun 1985, among hydroids, shallow subtidal, 1 specimen.—USNM Acc. No. 359182, Palm Cave, Bermuda, T. M. Iliffe, 13 Mar 1982, 87 specimens; Palm Cave, Bermuda, T. M. Iliffe, 13 Mar 1982, from hydroids, 4 specimens; Little River Cave, Bermuda, T. M. Iliffe, 8 May 1982, 37 specimens; Cripplegate Cave, Bermuda, T. M. Iliffe, 22 Jul 1982, 1 specimen.

Family Caprellidae White, 1847

Caprella danilevskii Czerniavski, 1868

Caprella danilevskii: Kunkel, 1910:110–111.—McCain, 1968:22–25, fig. 10.—McCain and Steinberg, 1970:16–17.—Johnson, 1986:381, fig. 125.

Remarks.—According to McCain (1968), this species is easily distinguished from all other species of *Caprella* in the western North Atlantic by its elongate gills whose axes lie parallel to the body, by its distinctive abdomen, and by the short dactyl on male gnathopod 2. Kunkel saw no specimens of this species but relied on accounts of it for Bermuda in the Challenger Report (Stebbing 1888). Johnson (1986) claimed it is common in turtle grass in Bermuda. Despite such reports in the literature, no specimens from Bermuda were found in the available museum collections, nor were any collected recently. Because of its distinctive appearance, one can only assume that reports of its occurrence in Bermuda are accurate.

Caprella equilibra Say, 1818

Caprella equilibra: Kunkel, 1910:106–108, fig. 41.—McCain, 1968:25–30, figs. 12–13.—McCain and Steinberg, 1970:19–21.—Johnson, 1986:381, fig. 125.—Lazo-Wasem and Gable, 1987:335–336, fig. 10.
Caprella bermudia: Kunkel, 1910:108–110, fig. 42.—Lazo-Wasem and Gable, 1987: 335–336, fig. 10.

Remarks.—Every specimen examined, even the smallest, possesses the ventral tooth between the insertions of the second gnathopods. This species in Bermuda has a wide size range. *Caprella equilibra* in Bermuda is found, as is *D. incerta,* in near-shore waters and in caves. It has been collected from hydroids, and Johnson (1986) stated it is also common on bryozoans, ascidians, *Thalassia,* and algae.

Material examined.—YPM 8223, Bermuda, Dr. J. L. Cole, 15 Jul 1903, lectotype male of *C. bermudia* Kunkel (6.3 mm).—YPM 8208, Flatts Village, Bermuda, collector unknown, 4 Jul 1898, 2 males, 1 female.—YPM 8265, Shelly Bay, Hamilton Parish, Bermuda, off promontory NNW of Bay, M. F. Gable, 3 Jun 1985, among hydroids, shallow subtidal, 1 male.—USNM collection, Bermuda, G. Brown Goode, 1876–1877, 1 ovigerous female.—USNM Acc. No. 359182, Cripplegate Cave, Bermuda, T. M. Iliffe, 22 Jul 1982, 9 specimens.

Hemiaegina minuta Mayer, 1890

Hemiaegina minuta: McCain, 1968:61–64, figs. 29–30.—McCain and Steinberg, 1970:51.

Remarks.—McCain (1968) stated that *H. minuta* was found "in several localities near Bermuda," and in 1970 McCain and Steinberg gave its distribution as "off Bermuda." They also mentioned that the species had been collected in plankton tows and from *Sargassum.* Two specimens, presumably from near-shore waters, were discovered in the vial of *Protellopsis stebbingii* used by Kunkel. Two other specimens were taken intertidally from hydroids under rocks in May 1985, a time when no *Sargassum* was in evidence. Very likely, therefore, *H. minuta* is a permanent inshore inhabitant of Bermuda waters, even if new populations arrive with each wash of *Sargassum.*

Specimens collected from such an inshore *Sargassum* wash in January 1987 by T. M. Iliffe greatly exceeded the maximum sizes given by McCain (1968). Iliffe collected a male of 4.8 mm length (McCain's largest male = 4.0 mm) and an ovigerous female of 5.4 mm length (McCain's largest female = 3.2 mm). Personal observation of thousands of specimens of *H. minuta* from New England waters always attested to the specific epithet chosen by Mayer; perhaps if he had seen some of the Bermuda specimens the epithet chosen would have been different.

Material examined.—YPM 8240, Bermuda, Dr. J. L. Cole, 15 Jul 1903, 2 specimens.—YPM 8266, Whalebone Bay, St. George's, Bermuda, A. J. Baldinger, 22 May 1985, hydroids under rock, 2 specimens. Non-catalogued: St. George's, Bermuda, T. M. Iliffe, 10 Jan 1987, *Sargassum,* 8 specimens.

Family Dodecadidae Vassilenko, 1968

Fallotritella biscaynensis McCain, 1968

Fallotritella biscaynensis McCain, 1968:57–61, figs. 27–28.—McCain and Steinberg, 1970:51.

Remarks.—McCain (1968) stated that this species is difficult to detect because of its small size and its usual covering of detritus. The five specimens we examined were indeed all detritus-covered; special care by one not familiar with caprellids would be necessary in dealing with this species so as not to confuse it with *D. aspiducha.* The only habitat records for the species are from red algae (McCain 1968); one of our specimens was taken from *Avrainvillea,* a green alga, and two other specimens were collected from *Thalassia.*

Material examined. —YPM 8267, Ferry Reach, St. George's, Bermuda, cove W of BBS, M. F. Gable, 28 May 1985, from *Avrainvillea,* 1 female.—YPM 8268, Shelly Bay, Hamilton Parish, Bermuda, off promontory NNW of Bay, M. F. Gable, 3 Jun 1985, from mixed subtidal algae, 1 female.—USNM Acc. No. 346847, Ferry Reach, Bermuda, adjacent to W side of dock at BBS, M. L. Jones, 2 Sep 1983, Cohen net through *Thalassia,* 1 juvenile female.—USNM Acc. No. 359182, Castle Harbour, Bermuda, T. M. Iliffe, 24 Aug 1984, 1 male. Non-catalogued: Ely's Harbour, Bermuda, T. M. Iliffe, 21 Nov 1986, from *Thalassia,* 1 male.

Key to the Caprellids of Bermuda (Pereopods 5, 6, and 7 present)

1. Pereopod 5 much smaller than 6 and 7, not inserted posteriorly on pereonite, terminal segment not claw-like 2

– Pereopod 5 similar to 6 and 7 in size or, if shorter and thinner, with a claw-like terminal segment 3

2. Insertion of pereopod 5 at mid-segment; peduncular segments of antenna 1 with few setae .... *Deutella incerta*

– Insertion of pereopod 5 75% back from front edge of segment; peduncular segments of antenna 1 heavily setose ...... *Deutella aspiducha* n. sp.

3. Pereopods 3 and 4 present, of only 1 segment, animal seldom longer than 6 mm 4

– Pereopods 3 and 4 absent, no mandibular palp, animal can be much larger than 6 mm 5

4. Dorsal surface of body with spines, at least on head .... *Fallotritella biscaynensis*

– Animal usually with all appendages splayed out in same plane as body, dorsal body with no spines; 2 teeth between insertions of 2nd gnathopods .... *Hemiaegina minuta*

5. Gills with long axis parallel to body, dactyl (last segment) of male 2nd gnathopod less than half as long as article 6 .... *Caprella danilevskii*

– Gills normal, long axis perpendicular to body; ventral tooth prominent between insertions of 2nd gnathopods .... *C. equilibra*

Key to the Caprellids of Bermuda (Pereopods 5, 6, and 7 missing)

1. Pereopods 3 and 4 present, small, of only 1 or 2 segments 2

– Pereopods 3 and 4 absent 5

2. Pereopods 3 and 4 of 1 segment .. 3

– Pereopods 3 and 4 of 2 segments, mandibular palp present 4

3. Dorsal surface of body with spines, at least on head .... *Fallotritella biscaynensis*

– Animal usually with all appendages splayed out in same plane as body, no dorsal body spines; 2 teeth between insertions of 2nd gnathopods .... *Hemiaegina minuta*

4. Insertion of pereopod 5 (even if missing) 75% back from front edge of segment; peduncular segments of antenna 1 heavily setose .... *Deutella aspiducha* n. sp.

– Insertion of pereopod 5 (even if missing) at mid-segment; peduncular segments of antenna 1 with few setae .... *Deutella incerta*

5. Gills with long axis parallel to body, dactyl (last segment) of male 2nd gnathopod less than half as long as article 6 .... *Caprella danilevskii*

– Gills normal, long axis perpendicular to body; ventral tooth prominent between insertions of 2nd gnathopod .... *C. equilibra*

Summary

The caprellid fauna of Bermuda has been poorly and only incidentally collected and studied. Although not rich in numbers of species, some of the species so far discovered raise interesting taxonomic questions, as indicated in this paper. The Bermuda caprellids also raise several interesting ecological questions. As the collections of T. M. Iliffe demonstrate, for example, significant populations exist in many of the island caves, yet no evolutionary conclusions can be drawn because the inshore fauna has been virtually neglected.

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TWO NEW SPECIES AND A NEW GENUS OF MINIATURE CHARACID FISHES (TELEOSTEI: CHARACIFORMES) FROM NORTHERN SOUTH AMERICA

Stanley H. Weitzman and Richard P. Vari

Abstract.—The first known miniature characid fishes apparently aligned with the Characinae and Cynopotaminae are described as new from the Río Negro and Río Orinoco drainages of Venezuela and tributaries of the Río Amazonas in Colombia. Although the suggested relationships of the new genus (*Priocharax*) and species (*P. ariel* and *P. pygmaeus*) to those subfamilies appear reasonable, their exact phylogenetic relationships within the Characinae and Cynopotaminae remain obscure. The new species are distinguished from others in these subfamilies primarily by a higher number of jaw teeth, a lower number of pelvic- and anal-fin rays, retention of larval pectoral fins in adults, and a minute adult body size of a maximum of about 17 mm in standard length.

The early explorer-naturalists who sampled the South American freshwater fish fauna focused nearly exclusively on species of moderate to large body size, evidently under the mistaken belief that all smaller fishes were juveniles, or if distinct the species were unimportant. Agassiz, during the Thayer Expedition to Brazil in 1865, was the first collector who fully endeavored to collect even the smallest fishes, recognizing that such specimens often represented interesting species of small adult size. During the twelve decades that have passed since that trip numerous species of relatively small adult body sizes have been described from the freshwaters of South America. Recent collecting efforts in Venezuela have yielded miniature species of the family Lebiasinidae (Fernandez and Weitzman 1987) and the subfamily Characidiinae of the Characidae (Weitzman 1986). Those collections also revealed the existence of a miniature species evidently aligned phyletically with the characid subfamilies Characiinae and Cynopotaminae. A second, very similar species, originally collected in the Colombian Amazon, was subsequently found in the collection of the Naturhistoriska Riksmuseet, Stockholm. These two species, assigned herein to a new genus, are described as new and the possible phylogenetic relationships of these taxa are discussed.

Methods and Materials

The counts and measurements are those described by Fink and Weitzman (1974:1–2). All measurements other than standard length (SL) are expressed as a percentage of SL except subunits of the head which are expressed as a percentage of head length or as otherwise noted.

Specimens examined for this study are deposited in the American Museum of Natural History, New York (AMNH); Academy of Natural Sciences of Philadelphia (ANSP); British Museum (Natural History), London (BMNH); California Academy of Sciences, San Francisco (CAS); Field Museum of Natural History, Chicago (FMNH); Museo de Biología, Universidad Central de Venezuela, Caracas (MBUCV); Museu de Ciências, Pontificia Universidade Católica do Rio Grande do Sul, Porto Alegre (MCP);

Museum of Comparative Zoology, Harvard University, Cambridge (MCZ); Muséum d'Histoire Naturelle, Génève (MHNG); Muséum National d'Histoire Naturelle, Paris (MNHN); Museu de Zoologia da Universidade de São Paulo (MZUSP); Naturhistoriska Riksmuseet, Stockholm (NRM); Naturhistorisches Museum Wien, Vienna (NMW); University of Michigan, Museum of Zoology, Ann Arbor (UMMZ); National Museum of Natural History, Smithsonian Institution, Washington, D.C. (USNM); and Institute of Taxonomic Zoology (Zoölogisch Museum), Amsterdam (ZMA).

Priocharax, new genus

Diagnosis.—New World characid fish group distinguished from all other characids by retaining larval rayless pectoral fin in adults. Distinguished from all other New World characids except some members of Characinae and Cynopotaminae by having lower jaw (dentary bone) with approximately 30 to 50 conical teeth in somewhat irregular single row, and upper jaw (premaxilla and maxilla) with approximately 45 to 90 conical teeth in somewhat irregular single row. Adult body size ranges from about 11 to 17 mm standard length; such diminutive adult body size otherwise unknown in Characinae and Cynopotaminae.

Within the tribe Characini of the Characinae (sensu Géry 1977:302–306) and the Cynopotaminae (Menezes 1976) 16 to 22 branched anal-fin rays of *Priocharax* further distinguish its species from *Acanthocharax* Eigenmann, *Acestrocephalus* Eigenmann, *Asiphonichthys* Cope, *Charax* Scopoli, *Cynopotamus* Valenciennes, *Eucynopotamus* Fowler, *Galeocharax* Fowler, *Gilbertolus* Eigenmann, *Gnathocharax* Fowler, *Heterocharax* Eigenmann, *Hoplocharax* Géry, *Lonchogenys* Myers, *Moralesia* Fowler, *Roestes* Günther, and *Roeboides* Günther all with 26 or more branched anal-fin rays. *Priocharax* posesses i,5 pelvic-fin rays, discriminating it from all other members of Characinae and Cynopotaminae, all with i,7 pelvic-fin rays.

Type species.—*Priocharax ariel,* new species.

Etymology.—*Prio* from the Greek for saw, and *charax* from the Greek characo meaning pointed stake, here used in reference to the characid genus *Charax,* hence a characid fish. *Priocharax* means a saw-bearing characid fish in reference to its numerous small jaw teeth.

Key to the Species of *Priocharax*

1. Caudal peduncle depth about 32 to 46 percent of caudal peduncle length; dentary teeth about 38 to 55; lower limb gill-rakers 11 to 13 . . . . *Priocharax ariel,* new species
– Caudal peduncle depth about 52 to 65 percent of caudal peduncle length; dentary teeth about 28 to 36; lower limb gill-rakers 8 to 10 . . . . *Priocharax pygmaeus,* new species

Priocharax ariel, new species
Figs. 1–5, Table 1

Holotype.—MBUCV V-15340, male, SL 14.5 mm, Venezuela, Territorio Federal Amazonas, Departamento Río Negro, Caño Manu, tributary of Río Casiquiare approximately 250 m upstream from Solano, 02°00'N, 66°57'W; R. P. Vari, C. J. Ferraris, Jr., O. Castillo, and J. M. Fernandez, 7 Dec 1984.

Paratypes.—Following 16 lots collected with holotype and deposited in cited institutions; all museums received 25 specimens unless otherwise noted; extremes of SL are given only for USNM specimens, lengths of other series fall within that range: USNM 272619, SL 8.8–17.1 mm, 1229 specimens, 41 cleared and counterstained for cartilage and bone; AMNH 57007; ANSP 158006; BMNH 1986.2.4:1-25; CAS 57944; FMNH 96689; MBUCV V-15341, 100 specimens; MCP 9953; MCZ 63031; MHNG 2239.48; MNHN 1986-303; MZUSP 3647, 50 spec-

Table 1.—Morphometrics of *Priocharax ariel* and *P. pygmaeus*. Males of *P. ariel* all with anal-fin hooks. Specimens of *P. ariel* and *P. pygmaeus* of undetermined sex lack anal-fin hooks. Standard length is expressed in mm. First group of measurements are presented as percentages of standard length; second group as percentages of head length.

	Priocharax ariel males				*Priocharax ariel* sex undetermined			*Priocharax pygmaeus* sex undetermined			
	Holotype	n	Range	$\bar{x}$	n	Range	$\bar{x}$	Holotype	n	Range	$\bar{x}$
Standard length	14.5	27	11.8–15.1	14.0	27	11.8–17.1	14.2	16.4	7	10.8–16.4	12.0
Depth at dorsal-fin origin	24.8	27	21.8–24.8	23.4	27	22.0–25.4	23.9	24.4	7	23.2–24.6	23.9
Snout to dorsal-fin origin	55.9	27	53.2–55.9	54.6	27	52.5–55.8	54.3	54.9	7	50.9–56.3	53.7
Snout to pelvic-fin origin	42.4	27	39.5–42.5	40.9	27	39.1–42.4	40.7	42.1	7	42.1–44.6	43.6
Snout to anal-fin origin	53.8	27	53.0–56.6	54.7	27	52.8–56.1	54.3	55.5	7	53.6–56.6	55.6
Peduncle depth	7.6	26	7.2–8.3	7.8	27	7.2–9.0	8.2	7.9	7	7.9–8.4	8.2
Peduncle length	21.4	27	19.2–23.2	20.8	27	18.1–23.7	22.2	12.2	7	12.2–15.8	14.8
Pelvic-fin length	11.0	27	10.2–13.0	11.3	27	9.8–13.7	11.1	11.6	7	9.1–11.6	10.4
Dorsal-fin height	23.4	25	22.0–26.4	23.7	26	21.1–25.2	23.7	24.4	7	24.1–25.7	24.9
Anal-fin anterior lobe length	20.7	27	19.7–22.5	21.2	25	20.0–22.9	21.7	26.2	7	21.1–26.2	23.6
Bony head length	23.4	27	23.0–26.4	24.4	27	22.8–25.3	24.1	25.6	7	25.6–27.9	27.2
Horizontal eye diameter	31.8	27	27.7–33.8	31.5	27	29.7–34.4	32.3	30.0	7	30.0–35.2	33.1
Snout length	23.5	27	20.0–24.7	22.6	27	19.7–24.4	22.6	21.4	7	19.4–24.7	22.1
Interorbital width	35.3	22	32.1–37.2	34.2	26	32.7–38.9	35.3	33.3	7	32.3–36.4	35.1
Upper jaw length	55.9	27	49.9–60.0	55.8	27	50.0–60.0	56.1	48.3	7	43.3–50.9	47.2
Caudal peduncle depth as percent of caudal peduncle length	35.5	26	33.3–42.4	36.8	27	32.1–46.0	39.2	65.0	7	52.6–65.0	56.1

imens; NRM A86/1984495.3603, 50 specimens; NMW 81788; UMMZ 213500, 35 specimens, 10 cleared and counterstained for cartilage and bone; and ZMA 119.456. All following paratypes collected in Venezuela, Territorio Federal Amazonas, R. P. Vari and party unless otherwise noted: USNM 272613, SL 13.9 mm, 1, Departamento Río Negro, lagoon northeast of airport at San Carlos de Río Negro, 01°55′N, 67°02′W, 4 Dec 1984. USNM 272614, SL 14.0 mm, 1, Departamento Río Negro, Caño Chola, where crossed by road from San Carlos de Río Negro to Solano, 01°58′N, 67°00′W, 5 Dec 1984. USNM 272615, SL 11.4–13.6 mm, 10, Departamento Río Negro, small caño off Caño Urami, just upriver of Santa Lucia, 01°17′N, 66°51′W, 6 Dec 1984. AMNH 57008, SL 13.1 mm, 1, Departamento Río Negro, Río Negro at Santa Lucia, 01°17′N, 66°52′W, 4 Feb 1984, C. J. Ferraris and party. USNM 272618, SL 13.7–14.9 mm, 3, Departamento Río Negro, Caño Loro, where crossed by road from San Carlos de Río Negro to Solano, 01°59′N, 66°58′W, 7 Dec 1984. USNM 272616, SL 11.9 mm, 1, Departamento Ature, small caño crossed by road from Puerto Ayacucho to Samariapo, 2 km south of Mirabel, 05°25′N, 67°46′W, 12 Dec 1984. USNM 272617, SL 12.2–12.9 mm, 2, Departamento Ature, Río Platanillal, where crossed by road from Puerto Ayacucho to Samariapo, 05°37′N, 67°35′W, 2 Dec 1984.

Diagnosis.—Two species of *Priocharax* diagnosable on basis of complete separation in one morphometric and two meristic characters. In both sexes of *Priocharax ariel* caudal peduncle depth about 32 to 46 percent of caudal depth, contrasted to about 52 to 65 percent in *P. pygmaeus*. *Priocharax ariel* with greater number of lower limb gill rakers on anterior gill-arch, 11 to 13, than *P. pygmaeus*, 8 to 10. Large individuals of

Fig. 1. A, *Priocharax ariel,* new species, holotype, MBUCV V-15340, male SL 14.5; Venezuela, Departamento Río Negro, Caño Manu; B, *Priocharax ariel,* new species, paratype, USNM 272619, female, SL 15.3 mm; same locality as holotype.

both species with greater number of dentary teeth, but counts do not overlap between species. Specimens of *P. ariel* with 38 to 55 dentary teeth ($\bar{x}$ = 44, n = 41), those of *P. pygmaeus* with 28 to 36 teeth ($\bar{x}$ = 32.5, n = 10). Other meristic characters probably will show significant differences, but specimens of *P. pygmaeus* too poorly preserved to allow definitive analysis without clearing and staining many specimens. Some overlap occurs in all following characters, but covariance analysis of larger numbers of *P. pygmaeus* probably would show distinct differences between these species. Branched anal-fin rays 16 to 21 in *P. ariel* ($\bar{x}$ = 18.5, n = 96) and 20 to 22 in *P. pygmaeus* ($\bar{x}$ = 21.0, n = 16); upper limb rakers 3 to 5 in *P. ariel* ($\bar{x}$ = 3.9, n = 41) and 2 or 3 in *P. pygmaeus* ($\bar{x}$ = 2.2, n = 10); premaxillary teeth 22 to 34 in *P. ariel* ($\bar{x}$ = 27.7, n = 41) and 19 to 24 in *P. pygmaeus* ($\bar{x}$ = 21.7, n = 10); maxillary teeth 38 to 58 in *P. ariel* ($\bar{x}$ = 47.7, n = 41) and 27 to 41 in *P. pygmaeus* ($\bar{x}$ = 31.4, n = 10).

Description.—Table 1 presents morphometrics of holotype and measured paratypes. See Fig. 1A, B for body form. Body slender, sides compressed. Greatest body depth at dorsal-fin origin. Dorsal-fin origin somewhat closer to caudal-fin base (at posterior of hypural fan and anterior of caudal-fin rays) than to tip of snout. Dorsal-fin origin approximately intersected by vertical line through anal-fin origin. Pelvic-fin ori-

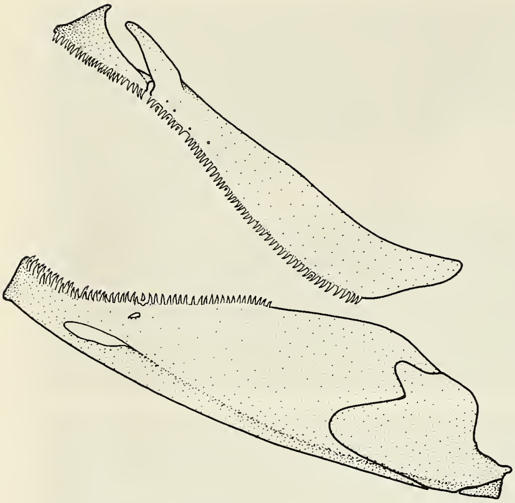

Fig. 2. Anterolateral view of jaws of *Priocharax ariel,* new species, paratype, UMMZ 213500, male, SL 16.7 mm, same locality as holotype.

gin nearly midway between anal-fin origin and vertical line through most posterior point of opercle. Snout bluntly rounded. Dorsal profile of head and body gently convex from snout tip to dorsal-fin origin. Dorsal profile of body along dorsal-fin base nearly straight, gently sloping posteroventrally. Dorsal body and caudal peduncle profile very slightly concave from dorsal-fin insertion to base of procurrent rays. Caudal peduncle slender, elongate, with sides compressed. Ventral body profile gently convex from symphysis of lower jaw to ventral to pectoral-fin origin. Belly profile from that point to vent and anal-fin origin may be slightly convex, more often straight, or sometimes slightly concave. Body profile along anal-fin base and caudal peduncle to anterior ventral procurrent rays gently concave. Base of anal fin posterodorsally oriented.

Head length approximately one-quarter of standard length. Snout rounded in profile. Jaws about equal, mouth terminal or lower jaw slightly included. Mouth elongate, somewhat posteroventrally inclined. Maxilla elongate; upper jaw long, posterior border reaching to or posterior to vertical line through posterior border of pupil of eye, length half to nearly two-thirds of head length. Eye about one-third of head length. Fleshy interorbital width often over one-third of bony head length, gently convex transversely.

Maxilla with 38 to 58 teeth ($\bar{x} = 47.4$, n = 41; teeth of holotype not counted); teeth conical, small and slender, in single series along ventral border of bone. Number of teeth increasing with body length. Accessory cusps absent. Premaxilla with 22 to 34 teeth ($\bar{x} = 27.7$, n = 41) in a single series. Premaxilla teeth similar in form to those of maxilla. Dentary with 38 to 55 teeth ($\bar{x} = 44.6$, n = 41). Dentary teeth in a single row posteriorly; larger specimens with irregular row of closely placed teeth anteriorly, but two distinct anterior rows never present. Anterior dentary teeth larger than those posterior. All jaw teeth lingually curved to a moderate extent (see Fig. 2).

Infraorbital series incomplete, with antorbital bone only element ossified, apparent only in cleared and stained specimens over 13.5 mm SL. Fronto-parietal fontanel large, extending from ethmoid to supraoccipital, completely separating parietals; frontals only in contact at strong epiphyseal bar. Frontal about of same width along entire length; similar in form to that of small juvenile characids. Supraoccipital spine poorly developed (Fig. 3).

Dorsal-fin rays ii,9 in holotype; other examined specimens with 2 unbranched rays followed by 8 to 10 mostly divided rays ($\bar{x} = 8.9$, n = 96); usually with posterior ray or more rarely posterior two rays not divided to their base. Dorsal-fin height moderate, 20 to 25% of SL. Pectoral fin larval in form (Fig. 4). Radials of two incompletely separated hyaline cartilaginous flat plates articulating anteriorly with vertically elongate cartilaginous coracoscapular plate and posteriorly with striated actinotrich tissue around which rays form in developing larvae of other characids. In specimens about 14 to 15 mm SL coracoscapular plate par-

Fig. 3. Lateral view of posterior portion of neurocranium and Weberian apparatus of *Priocharax ariel,* new species, paratype, UMMZ 213500, male, SL 16.7 mm, same locality as holotype.

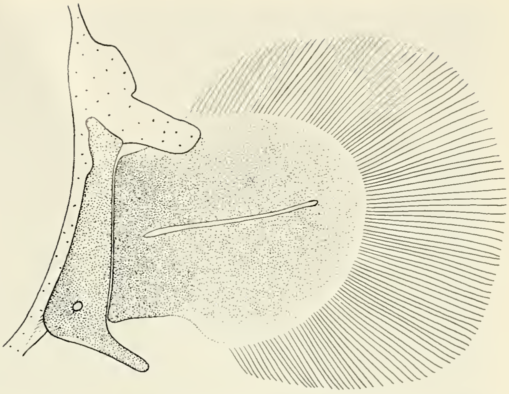

Fig. 4. Lateral view of pectoral girdle of *Priocharax ariel,* new species, paratype, UMMZ 213500, male, SL 16.7 mm, same locality as holotype. Densely stippled structures are cartilage.

tially ossified dorsally. Cleithrum ossified, slender, attached dorsally to slender supracleithrum by relatively loose ligamentous tissue. No notch or spine on cleithrum. Coracoid and other pectoral girdle elements often not ossified, but slight ossification present along ventral border in example drawn. Posttemporal weakly ossified, not shown in Fig. 4. Pelvic-fin rays i,5 in all counted specimens, n = 97. Posterior tip of pelvic fin extending about to region of vent. No hooks present on pelvic, dorsal or pectoral-fin rays. Anal fin iii,20 in holotype; other examined specimens with three unbranched rays followed by 16 to 21 branched rays ($\bar{x} = 18.5$, n = 96), posterior ray divided to its base. Anal-fin hooks present in 35 specimens from Caño Manu, all other specimens (1319) from that locality without hooks. Hooks occur on posterior margin of three anterior undivided rays and anterior 4 or 5 divided rays (Fig. 5). Usually 6 to 8 hooks per ray, with one short hook per ray segment. Anal-fin margin concave, with anterior elongate lobe and posterior section of short rays. Fin shape similar in specimens with and without hooks. Caudal fin forked, of moderate length; principal rays 10/9 in 91 specimens. Adipose fin absent.

Squamation almost completely absent in most specimens, apparently lost in handling during capture; following counts thus tentative. Scales in lateral series on body about 31 or 32; with no indication of perforated lateral line scales, but scales typically lacking on anterior of body just posterior to cleithrum and supracleithrum. Scale rows between dorsal-fin origin and pelvic-fin origin apparently 7. About 12 or 13 scale rows around narrowest portion of caudal peduncle. Predorsal scales perhaps 11 or 12; scales often present immediately anterior to dorsal fin but always absent or lost just posterior to supraoccipital spine.

Vertebrae 32 to 34 ($\bar{x} = 33.1$, n = 41).

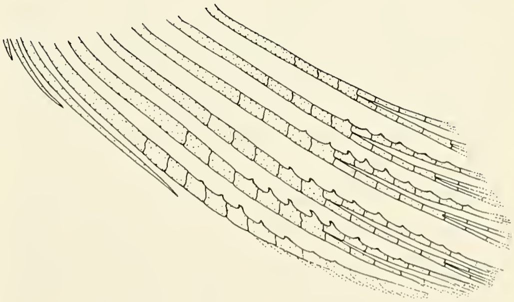

Fig. 5. Lateral view of anterior nine anal-fin rays of *Priocharax ariel,* new species, paratype, UMMZ 213500, male, SL 16.7 mm, same locality as holotype.

Upper limb gill-rakers 3 to 5 ($\bar{x}$ = 3.9, n = 41) and lower limb gill-rakers 11 to 13 ($\bar{x}$ = 12.5, n = 41). Branchiostegal rays 4 (n = 31), 3 rays on anterior and 1 ray on posterior ceratohyal.

Weberian apparatus (Fig. 3) well developed, all components except claustrum well ossified. Os suspensorium exceptionally large and projecting forward to anterior end of third centrum. Neural spine of fourth vertebra moderately developed. Neural prezygopophyses of fifth centrum undeveloped. Lack of buttressing flanges on base of fifth pleural rib, short neural spine of fourth vertebra and little developed posterior crest of enlarged supraneural all characteristic of juvenile Weberian apparatus in characids.

Color in life.—Translucent without any bright colors; some guanine pigmentation overlying gasbladder; dark chromatophore pattern distributed as discussed below for color in alcohol.

Color in alcohol.—Body-color of holotype pale brown to white (Fig. 1). Dark chromatophores limited, distributed as shown in Figs. 1A, B. Proportionally large chromatophores on head covering brain tissue. Few scattered dark chromatophores on opercle and along base of dorsal, anal and pelvic fins. Dorsal and lateral region of caudal peduncle with few scattered dark chromatophores, and base of caudal fin with dark spot usually consisting of about 10 to 20 contracted chromatophores. Sometimes one or two chromatophores at region of triangular muscular hiatus in body wall posterior to dorsal end of free opercular border. Dorsal, anal and caudal fins with scattered small elongate dark chromatophores along borders of fin rays. A few dark chromatophores present in region of vent.

Sexual dimorphism.—Males with anal-fin hooks described above for anal fin. Anal-fin hooks absent in females and juveniles. Examined specimens apparently not fully sexually mature. Females apparently with developing eggs but no mature eggs found. Males, even those with anal-fin hooks, with only developing testes. Using anal-fin hooks as a criterion, large population sample from type locality with only 35 identifiable males among 1740 specimens; remainder immature or females. Members of this population perhaps approaching sexual maturity at time of capture and many males not matured sufficiently to develop anal-fin hooks.

Etymology.—*Ariel* from the Greek for an airy spirit, in reference to the tiny and translucent nature of this fish in its natural habitat.

Habitat.—The species is an inhabitant of black acidic waters of the upper Río Negro and Río Orinoco drainage systems. The majority of specimens were captured in still waters of shaded rain forest streams. Individuals from the extensive series captured at the type locality were most common in emergent vegetation, along the shore line and around terrestrial plants that were hanging into the water.

Priocharax pygmaeus, new species
Fig. 6, Table 1

Holotype.—NRM THO/1976303.1445, 6, SL 16.4 mm, Colombia, Departamento Amazonas, in Quebrada Pajarito, tributary of Quebrada Bacada, tributary of Quebrada Matamata, a tributary of Río Amazonas, northwest of Leticia, about 04°41′S, 69°57′W; T. Hongslo, 21 Jul 1976.

Paratypes.—Collected with holotype, 87 specimens: NRM THO/1976303.1446, SL 8.0–11.4 mm, 41 specimens, 4 cleared and counterstained for cartilage and bone; USNM 278479, SL 8.1–12.2 mm, 36 specimens, 6 cleared and counterstained for cartilage and bone; MBUCV V-15340, SL 10.0–10.9 mm, 5 specimens; MZUSP 36498, 10.2–10.7 mm, 5 specimens.

Diagnosis.—See diagnosis of *P. ariel.*

Description.—Table 1 presents morphometrics of holotype and measured paratypes. See Fig. 6A, B for body form. Body slender, sides compressed. Greatest body depth at dorsal-fin origin. Dorsal-fin origin

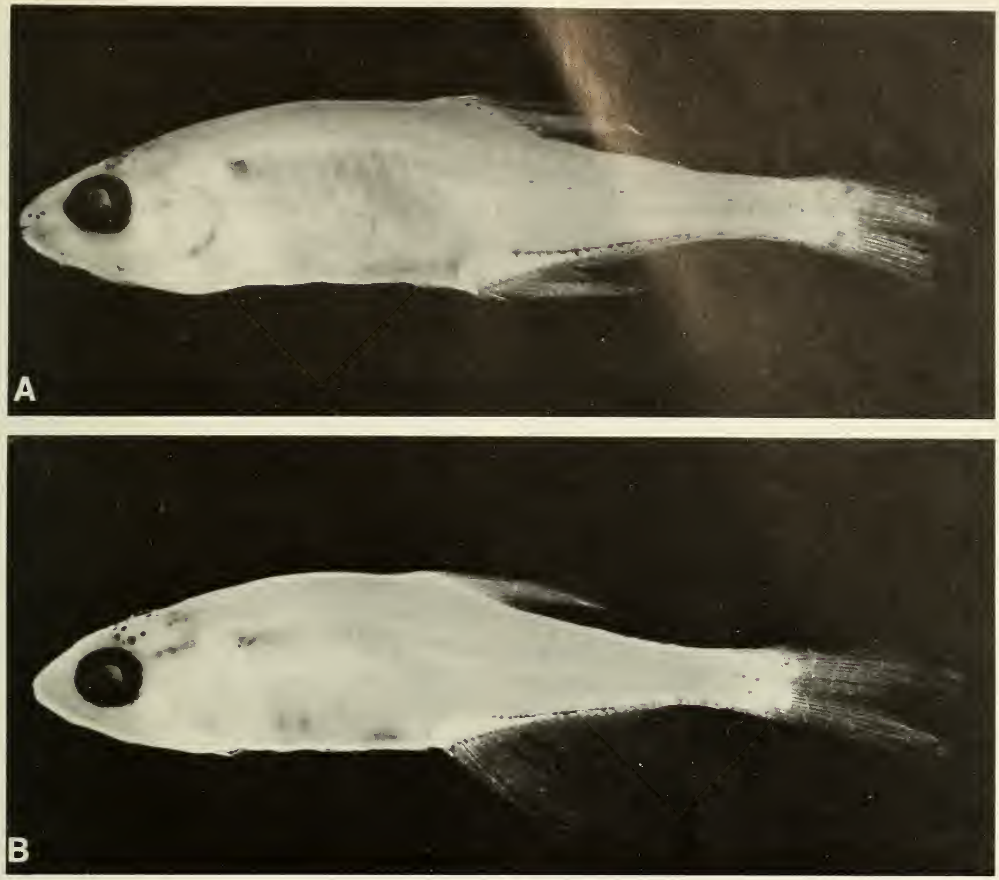

Fig. 6. A, *Priocharax pygmaeus,* new species, holotype, NRM THO/1976303.1445, SL 16.4 mm, Quebrada Pajarito, Río Amazonas system, northeast of Leticia, Colombia; B, *Priocharax pygmaeus,* new species, paratype, USNM 278479, SL 10.8 mm, same locality as holotype.

somewhat closer to caudal-fin base (hypural joint) than to tip of snout. Dorsal-fin origin approximately intersected by vertical line through anal-fin origin, or slightly in advance of that line. Pelvic-fin origin nearly midway between anal-fin origin and vertical through most posterior point of opercle. Snout bluntly rounded. Dorsal profile of head and body gently convex from snout tip to dorsal-fin origin. Dorsal profile of body along dorsal-fin base nearly straight, gently sloping posteroventrally. Dorsal body and caudal peduncle profile very slightly concave from dorsal-fin insertion to base of procurrent rays. Caudal peduncle slender, elongate, with sides compressed. Ventral body profile gently convex from symphysis of lower jaw to ventral to pectoral-fin origin. Belly profile from that point to vent and anal-fin origin may be slightly convex, more often straight, or sometimes slightly concave. Body profile along anal-fin base and caudal peduncle to anterior ventral procurrent rays gently concave. Base of anal fin posterodorsally oriented.

Head length moderate, approximately one-quarter of standard length. Snout rounded in profile, of moderate length. Jaws about equal, mouth terminal or lower jaw slightly included. Mouth elongate, somewhat posteroventrally inclined. Maxilla elongate; upper jaw long, posterior border reaching approximately to or posterior to vertical line through center of pupil of eye, length half or somewhat less than half of head length. Eye large, about one-third of head length. Fleshy interorbital width wide, often somewhat over one-third of bony head length, gently convex transversely.

Maxilla with 27 to 41 teeth ($\bar{x}$ = 31.6, n = 10; holotype with 41); teeth conical, small and slender, in single series along ventral border of bone. Larger specimens with greater number of teeth. Accessory cusps absent. Premaxilla with 19 to 24 teeth ($\bar{x}$ = 22.7, n = 10, holotype with 24) in a single series. Premaxilla teeth similar in form to those of maxilla. Dentary with 28 to 36 teeth ($\bar{x}$ = 32.5, n = 10, holotype with 36). Dentary teeth in single row posteriorly; larger specimens with irregular row of closely placed teeth anteriorly, but two distinct anterior rows never present. Anterior dentary teeth larger than posterior. All jaw teeth lingually curved to a moderate extent.

Infraorbital series incomplete, with antorbital bone only element ossified, apparent only in cleared and stained specimen of 12.2 mm SL. Fronto-parietal fontanel large, extending from ethmoid to supraoccipital, completely separating parietals; frontals only in contact at strong epiphyseal bar. Frontal about of same width along entire length; similar in form to that of small juvenile characids. Supraoccipital spine poorly developed.

Dorsal-fin rays ii,9 in 15 counted specimens including holotype. Usually with posterior ray or more rarely posterior two rays not divided to their base. Dorsal-fin height moderate, about 25% of SL. Pectoral fin larval in form. Radials as described above for *P. ariel.* Cleithrum ossified, slender, attached dorsally to slender supracleithrum by relatively loose ligamentous tissue. Coracoid and other pectoral girdle elements apparently not ossified or chondrified. Posttemporal weakly ossified. Pelvic-fin rays i,5 in all counted specimens, n = 15. Fin of moderate length, posterior tip extending about to region of vent. No hooks present on pelvic, dorsal or pectoral-fin rays. Anal fin v,21 in holotype; all examined specimens with four or five unbranched rays ($\bar{x}$ = 4.1, n = 15) followed by 20 to 22 branched rays ($\bar{x}$ = 21.7, n = 15), posterior ray divided to its base. Anal-fin hooks not present in any specimens. Anal-fin margin concave, with anterior elongate lobe and posterior section of short rays. Caudal fin forked, of moderate length; principal rays 10/9 in 91 specimens. Adipose fin absent.

Squamation completely absent in all specimens. Although some scale pockets visible, their distribution not consistent enough for counts.

Vertebrae 32 or 33 ($\bar{x}$ = 32.9, n = 9, holotype with 33). Upper limb gill-rakers 2 or 3 ($\bar{x}$ = 2.2 n = 10, holotype with 3) and lower limb gill-rakers 9 in all specimens. Branchiostegal rays 4 (n = 15), 3 rays on anterior and 1 ray on posterior ceratohyal.

Weberian apparatus well developed, similar to that of *P. ariel.*

Color in life.—Report as "transparent, faint pink" by T. Hongslo.

Color in alcohol.—Holotype pigmentation very similar to that of *P. ariel* (Fig. 6). Fewer dark chromatophores present in specimens of *P. pygmaeus*; however, those specimens may have faded more in preservative since they were collected eight years earlier.

Etymology.—*Pygmaeus* from the Greek for dwarf, in reference to the tiny size of this fish.

Habitat.—The species was collected from a shaded or partially shaded rainforest stream about two meters wide in water to about one meter deep. The bottom was "clay" with much leaf litter and no submerged plants. The water temperature was 25.2°C, the pH about 5.5 and the water was somewhat turbid. Water type was not noted.

Relationships

Priocharax is an example of the problems inherent in studies of the phylogenetic relationships of miniature, paedomorphic species. The species of *Priocharax* have or appear to have plesiomorphic character states relative to the conditions described below in various characines and cynopotamines. Plesiomorphic features can be distinguished from paedomorphic characters only when phylogenetic hypotheses and developmental information for characters in ingroup and outgroup taxa are available. Unfortunately the state of our understanding of relationships among likely close relatives of *Priocharax* is unsatisfactory (see discussion below). As a consequence of that situation it is beyond the scope of this study to advance a detailed corroborated hypothesis of phylogenetic relationships based on shared derived characters. This lack of a corroborated hypothesis of phylogenetic relationships also means that we cannot presently discriminate the pattern of plesiomorphy versus paedomorphosis in *Priocharax* and its putative relatives. Polarity statements and hypotheses of the paedomorphic nature of some features are instead advanced within the context of broader outgroup comparisons. Fink (1982), Weitzman and Fink (1983:345–346, 390), and Weitzman and Fink (1985:9–10) discussed the issues raised by paedomorphic, possibly progenetic, characters, especially where outgroup information may be inadequate.

The phylogenetic relationships of *Priocharax* within the Characidae are difficult to resolve satisfactorily. The apparent derived and non-paedomorphic characters of numerous conic teeth and elongate maxillae in the genus suggest that its relationships lie in the putative subfamily Characinae of Géry (1977:302), in particular with the genera *Acanthocharax, Acestrocephalus, Charax, Cynopotamus, Galeocharax, Gnathocharax, Heterocharax, Lonchogenys,* and *Roeboides.* A hypothesis of a phyletic association of *Priocharax* to and within the Characinae is complicated by the lack of any proposed derived characters that support the concept of the monophyly of the subfamily. Géry (1977:295) attempted to delimit the Characinae in his admittedly artificial key to the subfamilies of his Characidae. Although his key has some limited use in a typological sense, no evidence was presented that his Characinae was monophyletic.

According to Géry the subfamily consisted of three tribes: the Characini, the Bramocharacini, and the Acestrorhynchini. Weitzman and Fink (1983:342, 344), based on Rosen (1972:12), questioned the recognition of a separate tribe for *Bramocharax* Gill and Bransford, and the assignment of that genus to the Characinae. They agreed with Rosen (1972) that *Bramocharax* is most likely a derivative of *Astyanax* Baird and Girard, a member of the large characid subfamily Tetragonopterinae. Menezes and Géry (1983:587, 588) recognized the Acestrorhynchini as a subfamily rather than as a tribe and noted that at present "there is not enough information available to study the relationships of *Oligosarcus* Günther and *Acestrorhynchus* Eigenmann [the genera of the Acestrorhynchinae] with [other] characiform genera." Furthermore those authors also noted that the "Acestrorhynchinae may not be a monophyletic group." The remaining tribe, the Characini, is also of questionable monophyly. Menezes (1976) considered the genera *Cynopotamus, Galeocharax* and *Acestrocephalus* to be a separate monophyletic subfamily, the Cynopotaminae, but now Menezes (pers. commun.) informs us that this separation may no longer be tenable in light of a more detailed phylogenetic analysis.

On the basis of preliminary observations, Menezes (in Sazima 1983:88) suggested that some of the remaining Characinae and Characini of Géry are polyphyletic, with *Exodon* Müller and Troschel being more closely related to members of the Tetragonopterinae than to the remaining genera of the Characini. Sazima (1983:88) noted that his behavioral evidence appeared to confirm Menezes' concepts. Vari (1986:332, 333) discussed the tentative relationships of his new genus and species, *Serrabrycon magoi* Vari. He noted that although he placed

Table 2.—Number of teeth on jaw bones and number of branched anal-fin rays in *Priocharax ariel, P. pygmaeus,* and genera of the Characinae discussed in text. Dentary tooth information for *Lonchogenys* and dentary and premaxillary tooth counts for *Acanthocharax* presented as range of outer tooth row counts followed by range of inner tooth row counts. Tooth data for *Lonchogenys* based on two cleared and stained specimens, 40.1–45.2 mm SL (USNM 270232) and anal-fin ray counts on 12 specimens (USNM 270230, 270231, 270232). Tooth data and anal-fin ray counts for *Heterocharax* based on 7 cleared and stained specimens, 21.7–34.0 mm SL (USNM 278994) and for *Acanthocharax* on 1 paratype (USNM 66109).

	Priocharax				
	ariel	*pygmaeus*	*Lonchogenys*	*Heterocharax*	*Acanthocharax*
Teeth					
Premaxillary	22–34	19–24	12–16	8–11	6/10
Maxillary	38–58	27–41	42–50	20–24	60
Dentary	38–55	28–36	16–18/11–14	33–38	4/33
Branched anal-fin rays	16–22	20–22	34–38	31–35	28

it in the Tetragonopterinae, its possession of a mosaic of characters left open the possibility that the phylogenetic relationships of *Serrabrycon* Vari could be with the Characinae. *Serrabrycon magoi,* if a characine, is one with a short based anal-fin (15 or 16 rays posterior to the anterior undivided rays) similar to that of *Priocharax* species. The number of teeth on the maxilla, premaxilla and dentaries of *Serrabrycon* are less than those in *Priocharax* and the genera also differ in tooth forms. These differences do not, of course, refute a hypothesis of a close phylogenetic relationship between the taxa. The various uncertainties associated with taxa such as *Exodon* and *Serrabrycon* together with the lack of proposed synapomorphies for possible members of Géry's Characinae complicate a consideration of the relationships of *Priocharax* among *Charax* and putatively associated genera.

The numerous conic jaw teeth and elongate maxilla of *Priocharax* suggest a possible relationship with genera of the Characinae and Cynopotaminae. Among the genera listed at the beginning of this section, *Acanthocharax, Acestrocephalus, Cynopotamus, Galeocharax, Lonchogenys* and *Priocharax,* particularly *P. ariel,* have very high maxillary and total dentary tooth counts (Tables 2, 3). *Heterocharax* and those genera with the exception of *Acestrocephalus* have high total dentary tooth counts (above 28) compared to other Characinae. These high tooth counts might be synapomorphies relating these genera, but we prefer not to advance a hypothesis of relationships based solely on that one system.

One possible synapomorphy common to at least *Priocharax, Roeboides* and *Cynopotamus* is the retention of a larval pectoral fin anatomy at relatively large body sizes. Many characids convert from the larval pectoral fin anatomy to an essentially adult form at about 6 to 9 mm SL (pers. obs.). *Priocharax,* in contrast, retains the larval fin to at least 17 mm SL and at least one undetermined species of *Roeboides* (USNM 279251) retains that fin form up to 26 mm SL. *Cynopotamus atratoensis* (Eigenmann) has a larval pectoral fin in specimens as large as 41 mm SL (CAS-IUM 15033, paratypes). The distribution of this feature in most genera of the Characinae and Cynopotaminae is unknown. Thus it would be inappropriate to use it as a synapomorphy for putative subgroups in those subfamilies until its phyletic distribution has been thoroughly analyzed.

The possession of a larval pectoral fin has also been reported within the Characidae by Durbin (1909:55) for the tetragonopterid *Dermatocheir catablepta* Durbin. That species, since moved to *Hyphessobrycon* by

Table 3.—Number of teeth on jaw bones and number of branched anal-fin rays in *Priocharax ariel, P. pygmaeus,* and genera of the Cynopotaminae discussed in text. Dentary tooth information for genera of the Cynopotaminae presented as range of outer tooth row counts followed by range of inner tooth row counts.

	Priocharax				
	ariel	*pygmaeus*	*Acestrocephalus*	*Cynopotamus*	*Galeocharax*
Teeth					
Premaxilla	22–34	19–24	9–13	8–12	8–12
Maxilla	38–58	27–41	30–44	42–60	36–54
Dentary	38–55	28–36	3/9–13	2–4/22–35	3–4/7–11
Branched anal-fin rays	16–22	20–22	29–36	36–53	36–45

Géry (1977:462), is known only from an 18 mm holotype described as having the "Pectoral short and paddle-shaped with a fringe of soft rays" (Durbin 1909:56). Although sharing an evidently very similar form of pectoral fin with the species of *Priocharax, H. catableptus* differs from *Priocharax* and the species of the Characinae and Cynopotaminae in the form and distribution of the oral teeth. Although Géry's alignment of *H. catableptus* with other *Hyphessobrycon* species appears reasonable, the question of the phylogenetic relationships of the species, and the significance of the retention of the larval form of pectoral fin, requires further study once additional material of the species becomes available.

A variety of apparently derived characters listed in "keys" by Géry (1977:302–330) such as a notch and spine along the ventral margin of the cleithrum, a sharp ventral preopercular angle or spine, enlarged coracoid bones forming a keel along the ventral border of the cleithrum, ctenoid body scales, outwardly projecting mammilliform teeth (discussed by Sazima and Machado 1982), and certain body shape configurations (e.g., a dorsal hump in the body profile anterior to the dorsal-fin origin) occur in various subunits of the Characinae or Cynopotaminae, or both. Although these characters have been used in part to diagnose genera and species groups, the current lack of cladistic phylogenetic analyses of these subfamilies prevents an evaluation of the usefulness of these features in diagnosing monophyletic groups at this time.

Acknowledgments

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HETEROMYSIS KENSLEYI AND *H. CORALINA*, NEW SPECIES FROM THE SHALLOW WATERS OFF LOOE KEY, FLORIDA (MYSIDACEA: HETEROMYSINI)

Richard F. Modlin

Abstract.—Descriptions of *Heteromysis kensleyi* and *H. coralina*, new species from coral reef habitats off Looe Key, Florida, are presented.

Species in the genus *Heteromysis* appear to show considerable adaptive radiation in shallow waters of the Caribbean Sea and Gulf of Mexico (Modlin 1983). About 22 of these species are known to inhabit these waters. Eight occur in the waters off Florida. Brattegard (1969, 1970) reported collecting specimens of *H. formosa* in the vicinity of Ft. Pierce, *H. floridensis* in Biscayne Bay, and *H. nouveli* and *H. dispar* in the Florida Keys. *Heteromysis beetoni, H. guitarti, H. filitelsona,* and *H. hopkinsi* inhabit the Florida Middle Ground coral reef system northwest of Tampa, Florida, in the Gulf of Mexico (Modlin 1984). This paper describes two new species of *Heteromysis* from the waters off Looe Key, Florida.

Heteromysis kensleyi, new species
Fig. 1A–K

Material examined.—Male, 8.1 mm, holotype (USNM 229527); 2 males (6.0, 7.9 mm), 2 females (6.5, 7.7 mm), 3 ovigerous (6.4–8.5 mm), paratypes (USNM 229528) collected 27 Jan 1983, from upper spur and groove, vertical buttress wall with hard and soft corals, depth 6.1 m, sta FLK-24.—Male, 6.1 mm, collected 27 Jan 1983, from coral rubble at base of upper spur and groove buttress, depth 6.1 m, sta FLK-25.—Ovigerous female, collected 28 Sep 1982, from buttress wall region of spur and groove, depth 6.1 m, sta FLK-12, specimen dissected. Specimens were hand-collected by B. Kensley and M. Schotte at collecting sites previously poisoned.

Description.—Body large, robust. Carapace with anterior margin produced into triangular rostrum, posterior margin emarginate, exposing thoracic segments 7 and 8, postero- and anterolateral lobes rounded. Eyes large, oval, stalked; cornea rounded, dorsal margin scalloped, with prominent ocular tooth on anterosuperior edge.

Antennular peduncle 3-segmented; segment 1 about 1.1 times longer than segment 3; segment 2 compressed, with short spine and plumose seta distomedially; segment 3 with 3 short simple setae on medial edge, robust spine, inconspicuously flagellated, about 0.7 times length of medial margin of segment 3 (flagellum visible only with aid of very high magnification) and three small setae distomedially, midventral male lobe prominent with less than 10 hair-like setae.

Antennal peduncle 3-segmented, about 1.7 times longer than scale; segment 1 inconspicuous; segment 2 about 1.6 times longer than segment 3, one long and one short naked seta, and one long plumose seta distomedially; segment 3 with 3 naked setae distomedially. Antennal scale blade-like, medial margin strongly convex, lateral margin slightly convex, setose all around, apical tip about 0.06 times scale length.

Right and left mandibles with blade-like incisors, right lacinia mobilis saddle-like with 4 tall cusps, left pedestal-like with 4 low cusps; each mandible with 3 robust se-

Fig. 1. *Heteromysis kensleyi,* new species: A, Carapace; B, Antennular peduncle; C, Antennal peduncle and scale; D, Mandibular palp; E, Left mandible; F, Right mandible; G, Thoracic endopod 3; H, Pleopod 3; I, Pleopod 4; J, Uropod; K, Telson. A = male, 8.1 mm; B, H, I = male, 7.9 mm; C–G, J, K = female, 6.5 mm.

tose accessory blades; right molar surface rugose distally, left plate-like along entire length. Mandibular palp 3-segmented; segment 1 inconspicuous; segment 2 expanded, medial margin with 7 setae proximally, lateral margin with 17–19 setae along entire length; segment 3 about 0.4 times length of segment 2, medial margin slightly sinuous, proximal half with 7 naked setae, lateral margin with 8 short spined setae and 6–7 tubercles distally, distal tip with long plumose seta and robust spined claw.

Labium, maxillule, maxilla, and paragnaths typical of genus.

Thoracic endopod 1 and 2 typical of genus. Thoracic endopod 3-merus, about 1.2 times longer than carpopropodus, medial margin with 2 short simple setae proximally, one long and 3 short simple setae in group distally; medial margin of carpopropodus with 8 robust, subequal flagellated spines arranged in pairs, anterior edges of center 2 pairs serrate, one long simple seta submarginal to each anterior pair of spines, 3 short simple setae anterior to spinal group, lateral margin with 2 simple setae in proximal half, 2 groups of 3 short simple setae distally; dactylus conspicuous with 2 simple setae proximally. Carpopropodus of thoracic endopod 4 with 3 segments; carpopropodus of thoracic endopods 5–8 with 8 segments. Thoracic exopods 2–8 with 10 segments.

Pleopods unsegmented; male pleopods 1, 2, and 5 not differentiated. Pleopod 3 with 13 long naked setae on anterior surface, 7 flagellated spines on distal margin, one long plumose seta distolaterally, 2 short plumose setae on lateral margin proximally, 2 short naked setae on medial margin, pseudobranchial lobe with one short and 4 long plumose setae. Pleopod 4 with 11–13 long naked setae on anterior surface, 7–8 flagellated spines on distal margin, one long plumose seta distomedially, 2 short plumose setae on lateral margin proximally, 1–2 short simple setae on medial margin, pseudobranchial lobe with one short and 4 long plumose setae. Female pleopods rudimentary.

Uropod exopod about 1.1 times longer than endopod, lateral margin straight, medial margin slightly convex, setose all around. Endopod linguiform with 5 robust spines on medial margin in region of statocyst, entire margin setose.

Telson about 0.8 times as long as exopod of uropod, lateral margins slightly concave, completely spined with 19–20 marginal spines (apical spines included), outer apical spine about 1.7 times longer than inner, cleft 0.15 times the length of the telson, completely spined with 11 spines.

Remarks.—Characteristics of *H. kensleyi* place it near *H. bredini* (Brattegard, 1970) and *H. tuberculospina* (Modlin, 1987). It differs from both by having a very long inconspicuously flagellated spine on the distomedial edge of segment 3 of the antennule peduncle. On *H. bredini* and *H. tuberculospina* this spine is less than 0.2 times the length of the medial margin of antennule peduncle segment 3 rather than 0.7 times. Carpopropodus of thoracic endopod 3 of *H. kensleyi* has eight flagellated spines arranged in four pairs, while that of *H. bredini* and *H. tuberculospina* has, respectively, ten and seven. Spines in the telsonal cleft of *H. kensleyi, H. tuberculospina,* and *H. bredini* number, respectively, 11, 20 and 31. Mandibular structure of *H. kensleyi* varies distinctly from that of *H. tuberculospina.* Distal margins of male *H. kensleyi* pleopods 3 and 4 each have seven distal spines, while those of *H. tuberculospina* have ten each. Mandibles and male pleopods of *H. bredini* have not been described.

Ecological Notes.—Ovigerous females carried 2–4 eggs or larvae. Specimens of *H. dispar* Brattegard and *H. coralina,* new species, were collected with *H. kensleyi.*

Etymology.—Named for Dr. Brian Kensley, U.S. National Museum of Natural History, who kindly provided me with his Looe Key mysid collection and who has done

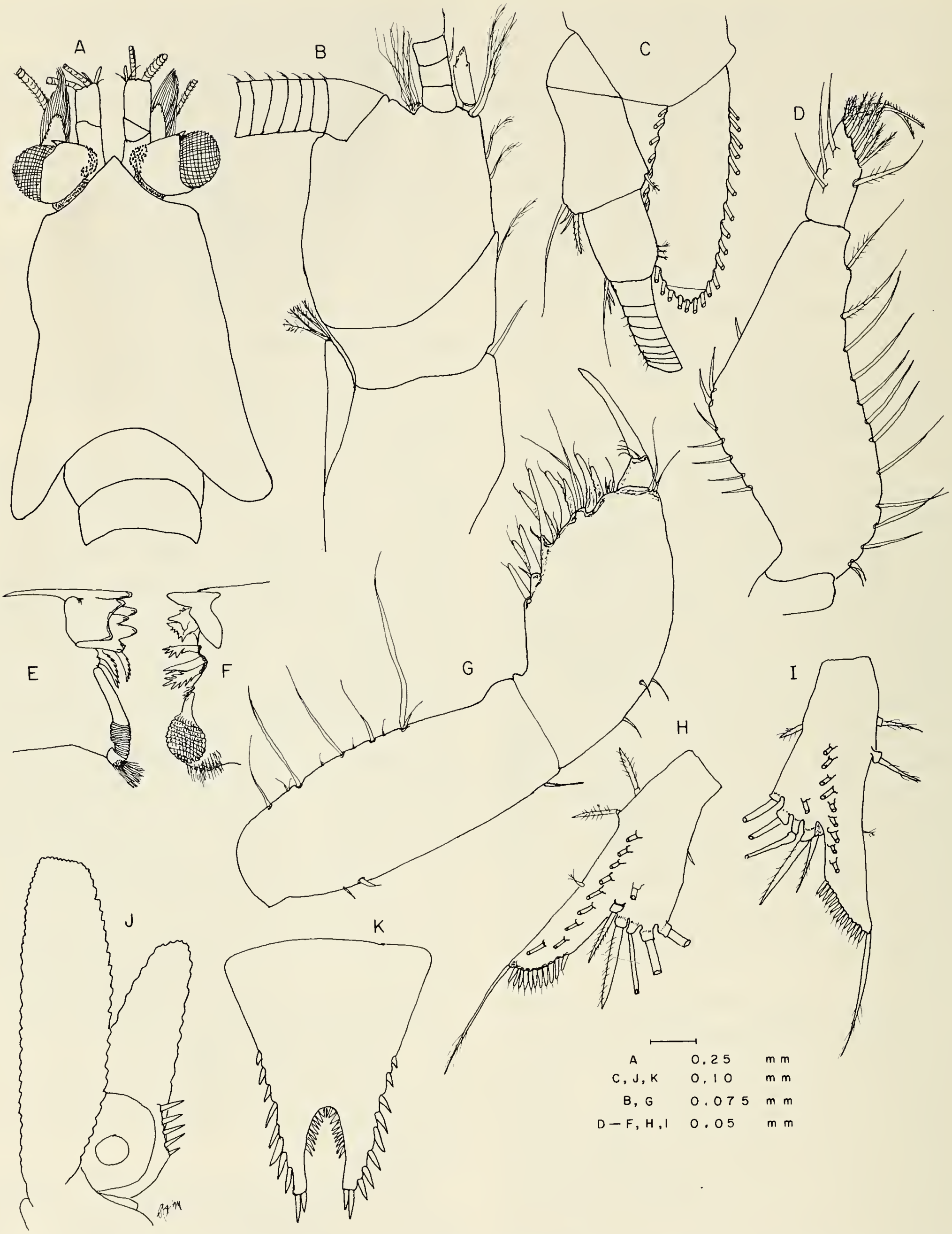

Fig. 2. *Heteromysis coralina,* new species: A, Carapace; B, Antennular peduncle; C, Antennal peduncle and scale; D, Mandibular palp, E, Left mandible; F, Right mandible; G, Thoracic endopod 3; H, Pleopod 3; I, Pleopod 4; J, Uropod; K, Telson. A–K = male, 4.9 mm.

much to forward systematical and ecological knowledge of the Caribbean Sea Isopoda.

Heteromysis coralina, new species
Fig. 2A–K

Material examined.—Female, 5.2 mm, holotype (USNM 229529); 4.9 mm male (dissected on 6 microscope slides), 4.3 mm female, 3.1 mm juvenile, paratypes (USNM 229530); and 5.0 mm male (badly damaged) collected 27 Jan 1983 from upper spur and groove, vertical buttress wall with hard and soft corals, depth 6.1 m, hand collected at station FLK-24 in area previously poisoned.

Description.—Body small, robust. Carapace with anterior margin produced into triangular rostrum, posterior margin emarginate exposing thoracic segments 7 and 8, anterolateral lobes rounded, posterolateral lobes angular. Eyes large, stalked, oval with posteromedial region produced and covered with regularly arranged minute denticles; cornea small, oval, prominent ocular tooth on anteromedial edge.

Antennular peduncle 3-segmented; segment 1 as large as segment 3 with distinct lateral process having 4 plumose setae on apex, simple seta distomedially; segment 2 compressed; segment 3 with 2 plumose setae on medial margin; anterior margin with 2 long plumose setae and a strong blade-like spine medially with inconspicuous flagellum (flagellum visible only with aid of very high magnification), male lobe with few hair-like setae ventrally.

Antennal scale blade-like, apical segment about 0.05 times length of scale, setose all around. Antennal peduncle 3-segmented, 1.1 times length of scale, segment 1 small, inconspicuous; segment 2 with one long and 2 small simple setae, and one robust spined seta distomedially, one minute plumose seta distolaterally; segment 3 about 0.7 times length of segment 2, one long and 2 short simple setae distomedially, 3 minute plumose setae on lateral margin distally.

Mandibles and palp: right and left mandibles with blade-like incisors, right incisor with prominent anterior cusp, left incisor with 2 anterior cusps; right lacinia mobilis, small, with serrate edges and 2 prominent spike-like cusps, left with 4 cusps; each mandible with 3 strong setose accessory blades; right molar surface strongly rugose posteriorly with setose clumps at anterior and posterior edges; left molar surface, anterior half plate-like, posterior half with minute rugae, setose clump at posterior edge. Mandibular palp 3-segmented; segment 1 small, inconspicuous; segment 2 expanded, anterior margin with 8 simple setae, lateral margin with 11–12 simple setae and 2 distal spined setae; segment 3 with 3 long simple setae near anterior margin, posterior margin sinuous, proximal half with one spined seta, distal half with 12–14 spined setae and 2 long spined claws on apex.

Labium, maxillule, maxilla and paragnaths typical of genus.

Thoracic endopods 1 and 2 typical of genus. Thoracic endopod 3 lateral margin of merus with 2 small simple setae proximally and 1 simple seta distally, medial margin with 5 long simple setae interspersed with 1–2 small simple setae; medial margin of carpopropodus with 9 robust flagellated spines, 8 arranged in pairs with single spine proximally, 3 small and 2 long setae distally, lateral margin with 3 short simple setae proximally and 3 longer simple setae distally; dactylus with 4 minute setae distally and prominent claw. Thoracic endopod 4 with 3-segmented carpopropodus. Thoracic endopods 5–8 with 6-segmented carpopropodus. Exopod 1 and 2 with 8 segments; exopods 3–8 with 9 segments.

Pleopods unsegmented. Male pleopods 1, 2 and 5 not differentiated. Pleopod 3 with 10 long plumose setae on anterior surface, distal margin with 8–11 flagellated spines and one long plumose seta distolaterally, lateral margin with 2 spined setae proximally and one minute flagellated seta distally, medial margin with one minute seta proximally, pseudobranchial lobe with 3 long and 2 short plumose setae. Pleopod 4 with 10 long plumose setae on anterior surface, distal margin with 14–15 flagellated spines and one long plumose seta distolaterally, lateral margin with 2 spined setae proximally and one minute plumose seta distally, lateral margin with one spined seta, pseudobranchial lobe with 3 long and 2 short plumose setae. Female pleopods rudimentary.

Uropods: exopod about 1.2 times longer than endopod, lateral margin straight, medial margin convex, setose all around; endopod, linguiform, with 5 prominent spines medially in region of statocyst, setose all around.

Telson about 0.8 times length of exopod of uropod, distal ⅔ of lateral margins each with 10 spines (apical spines included) that increase in length distally, outer apical spine 1.5 times longer than inner; telsonal cleft with 19–20 small spines concentrated in proximal half, 0.3 times length of telson.

Remarks.—*Heteromysis coralina* appears closely related to *H. beetoni,* but it differs by having five rather than nine spines in the region of the statocyst on the endopod of the uropod; 19–20 spinules in the proximal half of the telsonal cleft rather than 15–17; nine flagellated spines on the carpopropodus of the thoracic endopod 3 rather than eight; 9–11 and 14–15 flagellated spines, respectively, on the distal margins of male pleopods 3 and 4. Male pleopods 3 and 4 of *H. beetoni* have seven and 20, respectively. Additionally, the design of the mandibular surfaces of the two species differ radically.

Ecological notes.—Specimens of *H. dispar* Brattegard and *H. kensleyi* occurred in the same sample as *H. coralina.*

Etymology.—Named for the habitat from which this species was collected.

Acknowledgments

I would like to extend my appreciation to Dr. Brian Kensley for providing the Looe Key mysid collection and to Dr. Thomas E. Bowman for assisting in the publication of this manuscript. Financial support for a trip to the U.S. National Museum of Natural History was provided in part by the Marine Environmental Sciences Consortium, Dauphin Island, Alabama. This is MESC contribution No. 134.

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BAHALANA MAYANA, A NEW TROGLOBITIC CIROLANID ISOPOD FROM COZUMEL ISLAND AND THE YUCATAN PENINSULA, MEXICO

Thomas E. Bowman

Abstract.—*Bahalana mayana* is described from two anchialine caves, Cueva Quebrada on the island of Cozumel, and Temple of Doom Cave on the adjacent Yucatan Peninsula near Tulum. It differs from the two known species, both from the Bahamas, *B. geracei* Carpenter from San Salvador Island, and *B. cardiopus* Notenboom from Mayaguana Island, in the ventrally projecting clypeus, pereopods 1–3 lacking the long processes on the merus and carpus, the armament of pleopods 3–5, and the narrow exopod of the uropod.

The genus *Bahalana* was proposed by Carpenter (1981) for an unusual troglobitic cirolanid isopod, *Bahalana geracei,* from the anchialine Lighthouse Cave on San Salvador Island, Bahamas. About 50 pages later in the same journal, a second very similar species, *B. cardiopus,* was described by Notenboom (1981) from Mount Misery Cave, Mayaguana Island, Bahamas. San Salvador and Mayaguana, both in the Bahama archipelago, are separated by about 250 km. Some 1300–1400 km to the southwest, a third species of *Bahalana,* described below, has now been discovered in anchialine caves on the island of Cozumel and the adjacent mainland of the Yucatan Peninsula near Tulum, Quintana Roo, Mexico.

Bahalana mayana, new species
Figs. 1–2

Material.—Mexico, Quintana Roo, Cozumel Island, Cueva Quebrada, leg. Dennis Williams and Jeffrey Bozanic, 19 Sep 1985, 1 ♀ 7.9 mm, USNM 233292; 1 ♂ 4.5 mm, USNM 233300.—Leg. Dennis Williams, 13 Jun 1986, 3 ♂ 5.9, 8.0, 8.2 mm, 1 ♀ 8.5 mm, 1 juv. 3.7 mm; 14 Jun 1986, 1 ♂ 10.0 mm (holotype), USNM 233298; 16 Jun 1986, 1 ♂ ca. 9.4 mm (head detached), USNM 233293; 17 Jun 1986, 1 ♂ 9.6 mm, 4 ♀ 8.2, 8.3, 8.4, not measured (dissected, larger than others), USNM 233295.—Tulum area, Temple of Doom Cave, leg. Dennis Williams, 20 Jun 1986, 1 ♂ 6.6 mm, USNM 233296.—Leg. Thomas M. Iliffe, 10 Nov 1986, 1 ♂ 6.4 mm, USNM 233299. All specimens except the holotype are paratypes.

Etymology.—Named for the Maya, native people of the Yucatan region.

Diagnosis.—*Bahalana mayana* is distinguished from its two congeners by the acutely produced clypeus, the long segment 2 of antenna 1, the fewer flagellar segments in antenna 1 and 2, the long subapical seta on the mandibular palp segment 2, the short segment 4 of the maxillipedal palp, the morphology of pereopods 1–3, and the narrow exopod of the uropod. The principal differences between the three species are set forth in Table 1.

Habitats.—For the following information on the caves inhabited by *Bahalana mayana* I thank Dr. Thomas M. Iliffe and Ms. Jill Yager.

Both Temple of Doom Cave and Cueva Quebrada, as well as numerous other caves in the region, were formed by the mixing of fresh ground water with subterranean Caribbean seawater in a highly reactive geochemical zone that produced enhanced carbonate dissolution (Back et al. 1986). Thus

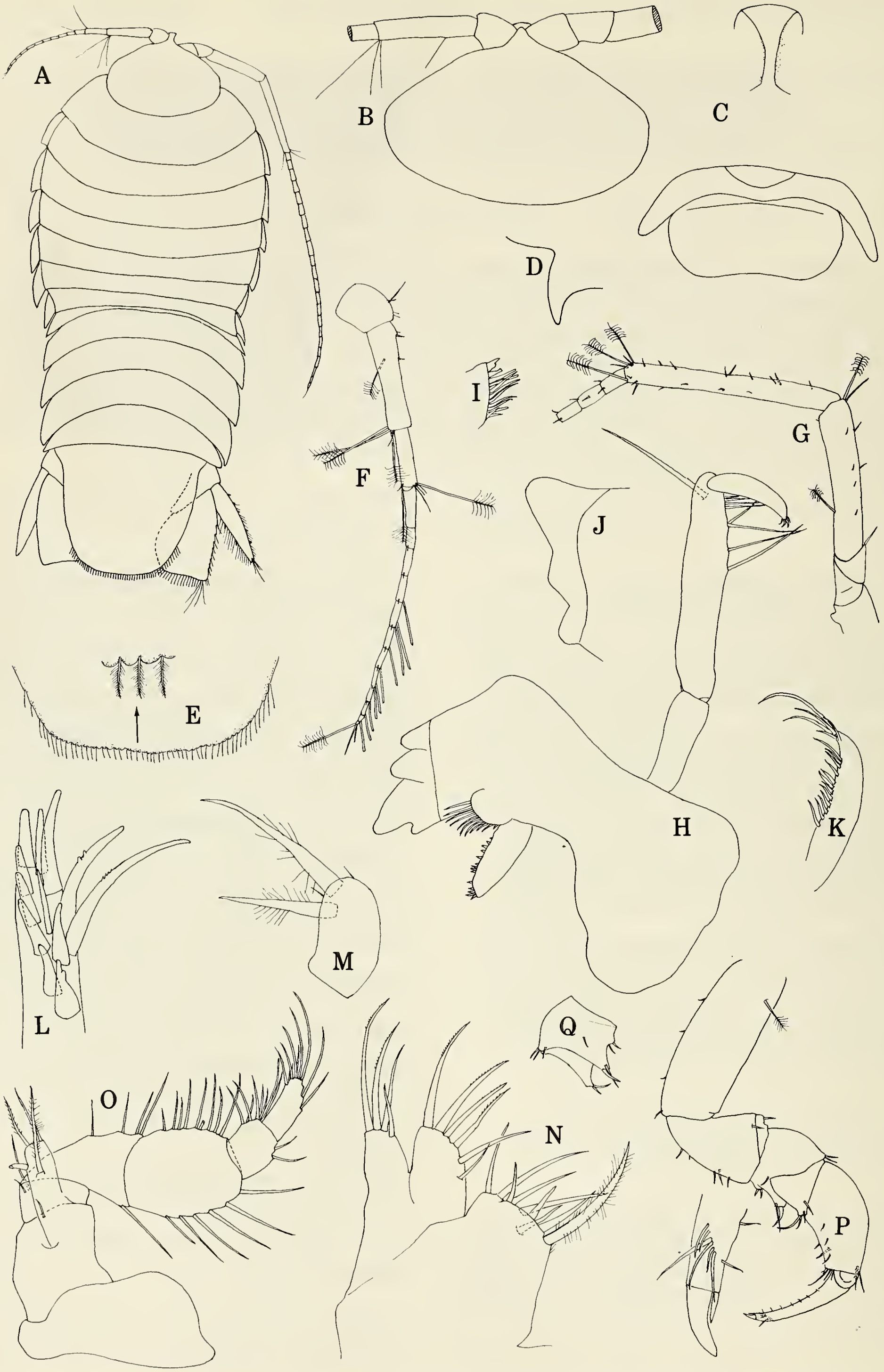

Fig. 1. *Bahalana mayana*: A, Habitus, dorsal; B, Head, dorsal; C, Frontal lamina, clypeus, and labrum; D, Clypeus, lateral; E, Posterior margin of telson; F, Antenna 1; G, Antenna 2, proximal segments; H, Right mandible; I, Lacinia of left mandible; J, Incisor of left mandible; K, 3rd segment of mandibular palp; L, Maxilla 1, apex of exopod; M, Maxilla 1, endopod; N, Maxilla 2; O, Maxilliped; P, Pereopod 1, lateral; Q, Pereopod 1, merus and carpus, medial.

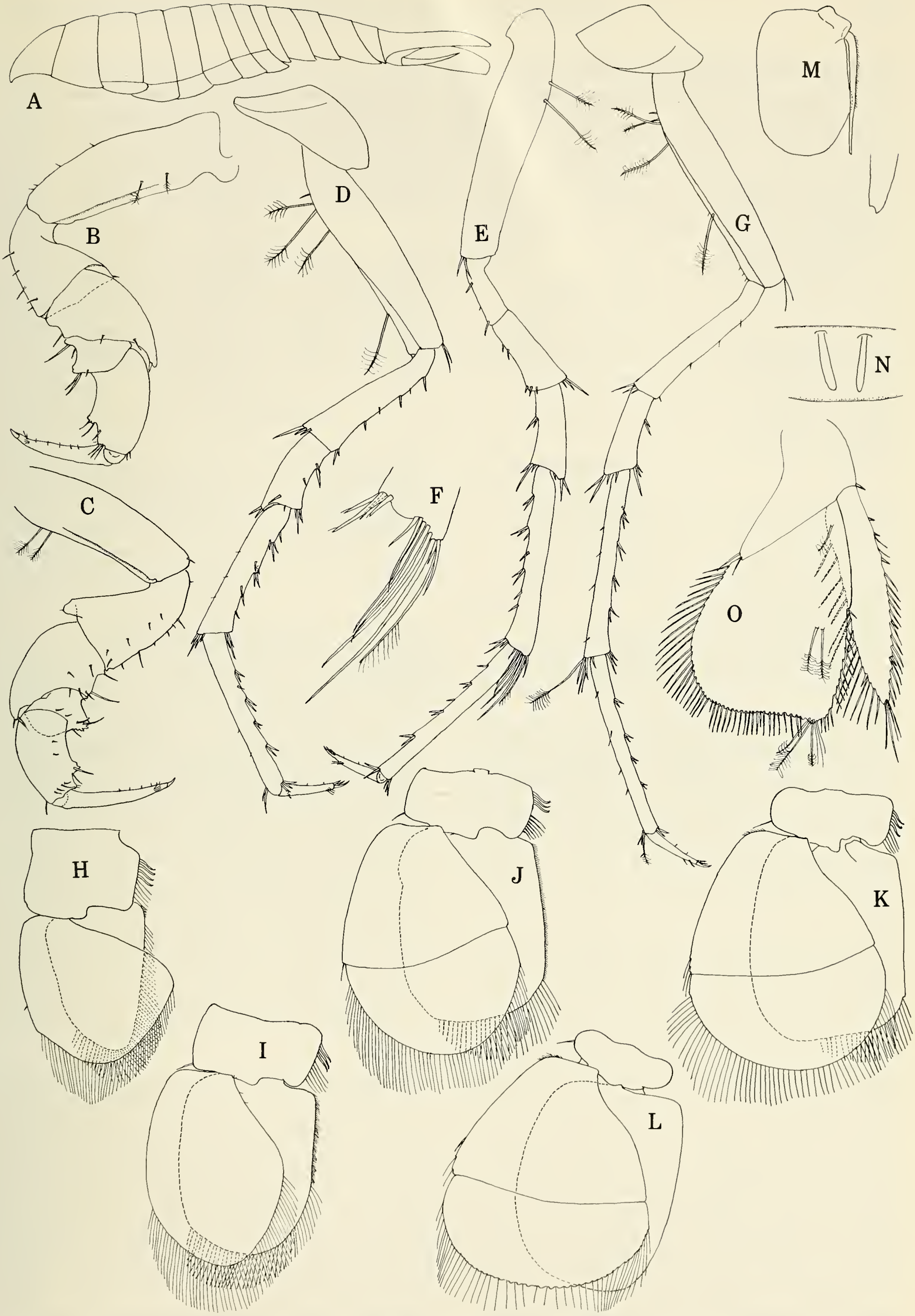

Fig. 2. *Bahalana mayana*: A, Habitus, lateral; B, Pereopod 2; C, Pereopod 3; D, Pereopod 5; E, Pereopod 6; F, Pereopod 6, distal end of carpus; G, Pereopod 7; H–L, Pleopods 1–5, ♀; M, Endopod of pleopod 2, ♂, setae omitted; N, Penes; O, Uropod, dorsal.

Table 1.—Characteristics of the species of *Bahalana.*

Character	*P. geracei*	*P. cardiopus*	*P. mayana*
Greatest length	15 mm	10 mm	10 mm
Clypeus	Not produced	Not produced	Acutely produced
A-1 peduncle, longest segment	Segment 3	Segment 3	Segment 2
A-1 flagellum segments	23	19–22	12
A-2 flagellum segments	40–45	ca. 32	ca. 22
Md palp segment 2	Without long subapical seta	Without long subapical seta	With long subapical seta
Mx-1 exopod apex	11 spine + 1 seta	10 spines + 1 seta	11 spines + 1 seta
Mx-1 endopod apex	4 spines + 1 setule	4 spines + 1 setule	2 spines + 2 setules
Mx-2 exopod apex	8 setae	8 setae	6 setae
Mxp retinacula	2	1	1
Mxp palp, length of segment 4/segment 3	0.7	0.8	0.4
P-1 merus	With long postero-distal process	With long postero-distal process	With rudimentary posterodistal process
P-2-3 merus	With long antero-distal process	With long antero-distal process	With rudimentary anterodistal process
P-4-7 unguis	Pectinate	Pectinate	Entire, with 2 basal spines
P1-3-5, distal margins of endopods	With a few setae	Unarmed	With setae in P1-3-4, unarmed in P1-5
Up endopod distal margin	Convex	Convex	Slightly concave
Up exopod width	½ width of endopod	½ width of endopod	⅓ width of endopod
Up rami lateral margins	Without setae	Without setae	With setae

most caves in the region have their primary development at depths corresponding to the halocline or mixing zone. The depth of the halocline, and correspondingly the depth of the caves, tends to increase with increasing distance inland as the freshwater lens thickens.

Cueva Quebrada, Chankanaab National Park, Isla Cozumel, Quintana Roo, Mexico: This cave is located on the east coast of the island of Cozumel. It has five surface openings and 2759 m of surveyed passage possibly making it Mexico's longest completely submerged cave. The deepest point in the cave is only −12 m. Brackish water is discharged in the form of reversing tidal currents from entrances along the coast. The cirolanid was collected about 800 meters from the opening, at a depth of about 5 meters. Salinity was 21‰; dissolved oxygen 3.0 ppm. Associated fauna include the amphipod *Bahadzia* sp., undetermined thermosbaenaceans, and *Procaris* sp.

As reported by Bozanic (1984:14), "Marine life was fairly abundant . . . observed were encrusting sponges and hydroids, lobsters, grunts, parrotfish, big eye, tarpon, shrimp, and many species of small (less than ¼ inch long) animals. As in the marine caves of Grand Bahama Island, the sponges extended from the opening as far as I penetrated, the fish were seen primarily near the entrances, and the smaller shrimp and creatures in the naturally lightless zones of the caves."

Temple of Doom Cave, Tulum, Quintana Roo, Mexico: This cenote is located about 15 km inland from the Caribbean Sea on the east coast of the Yucatan Peninsula. The entrance consists of an undercut circular hole about 6 m in diameter with a 3 m drop to the water. Underwater the cave radiates down and outward on all sides from a central collapse mound. From the base of the mound, a white-walled passage extends to a huge submerged chamber approximately

90 m long by 40 m wide and 10 m high. Maximum water depth was 18 m, with primary passage development occurring in the region of the halocline at −15 m. Salinities at the surface and at −18 m were 3 and 14‰, respectively. Water temperature was 25°C in November 1986.

Most animals were observed just above the halocline in oligohaline waters. Troglobitic species were only found in more remote areas of the cave, away from the numerous and voracious small fish present near the entrance. Collecting was done with a plankton net and suction bottle from the water column in 12 to 8 m depths using scuba. In addition to *Bahalana mayana,* specimens of the cirolanid *Creaseriella anops* (Creaser), the mysid *Antromysis* (*Antromysis*) *cenotensis* Creaser, amphipods, and shrimp were collected.

Acknowledgments

Once again I am indebted to skilful and resolute cave divers for the collection of remarkable isopods. For their successful efforts my sincere thanks go to Jeffrey Bozanic, Thomas M. Iliffe, and Dennis Williams. Collecting by Dr. Iliffe was supported by National Science Foundation grant BSR-8417494, and he was assisted by Dinah Drago, Juan José Fucat, Michael Madden, and James Coke; logistical and collecting aid was provided by Dr. John Markham. This is Contribution No. 1119 of the Bermuda Biological Station for Research.

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FRESHWATER TRICLADS (TURBELLARIA) OF NORTH AMERICA. XVI. MORE ON SUBTERRANEAN SPECIES OF *PHAGOCATA* OF THE EASTERN UNITED STATES

Roman Kenk

Abstract.—Three new species of *Phagocata* are described, *P. pygmaea* and *P. spuria* from caves in North Carolina, and *P. notorchis* from a seep in eastern Tennessee. Additional distributional records are given for *P. carolinensis* and *P. procera.*

The species discussed in this paper were collected by several investigators, mainly speleologists, in the course of several years. In order to obtain an accurate picture of the shape of living planarians, which can hardly be maintained by any known method of preservation, I had asked my collaborators to send me live specimens. Another good reason to insist on living specimens is the fact that many flatworms are collected in the immature state, lacking their reproductive systems which form the basis of their taxonomic standing. They may be either juveniles that have not yet achieved sexual maturity, or specimens that have been subjected to prolonged starvation for the lack of proper food. It is known that planarians may sustain starvation for several months without detriment. They gradually reduce some parts of their anatomy, decrease in size, and cannot be distinguished from juveniles. It is highly probable that many of the immature planarians collected in the field, particularly those inhabiting subterranean waters, are not true juveniles but specimens that have been kept from full development or have reduced in size and structure on account of deficient nutritive conditions. These immature specimens may be raised to maturity in the laboratory by being kept in aquaria under proper temperature conditions and being fed once or twice a week. Species of *Phagocata* accept beef liver as food and mature after several months in the culture.

Methods

Mature specimens were preserved by killing well extended worms with a hot aqueous solution of mercuric chloride ($HgCl_2$), acidulated with acetic acid after the killing. Serial sections of 6–8 μm thickness were stained with Ehrlich's acid hematoxylin and counterstained with Eosin-Phloxine B.

The type specimens of the new species have been deposited in the National Museum of Natural History (formerly United States National Museum, USNM), Smithsonian Institution, Washington, D.C.

Phagocata notorchis, new species
Figs. 1A, B, 2, 3

Type material.—Holotype: posterior part of worm, sagittal sections on 4 slides (USNM 102760). Paratypes: sagittal sections of entire animal, 7 slides (USNM 102761); sagittal sections of posterior part, 4 slides (USNM 102762); transverse sections of posterior part, 7 slides (USNM 102763).

External features. (Fig. 1A, B).—This white, blind, very slender species reaches a considerable size, up to a length of 27 mm and a width of 2 mm when quietly gliding. The anterior end is truncate, with a slightly convex frontal margin and a pair of slender,

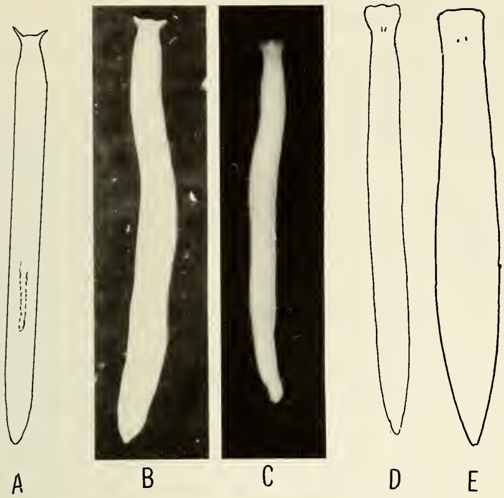

Fig. 1. Drawings and photographs of living specimens. A and B, *Phagocata notorchis*; C and D, *P. pygmaea*; E, *P. morgani.*

pointed auricles projecting anterolaterally and held elevated when in gliding motion. Behind the auricles the body margins widen, then run parallel for the greater part of the body length, to narrow again near the bluntly pointed posterior end. The pharynx is situated in the posterior third of the body. Thus the species externally resembles two other white *Phagocata* species of the Appalachian region that have prominent auricles, *P. bursaperforata* Darlington and *P. procera* Kenk, from which it is clearly separated by its anatomical characters.

Anatomy.—The branching of the intestine could not be analyzed in the living specimens. There are very many, certainly over 20, lateral branches on either side of the anterior intestinal trunk, and perhaps an equal number on each posterior trunk.

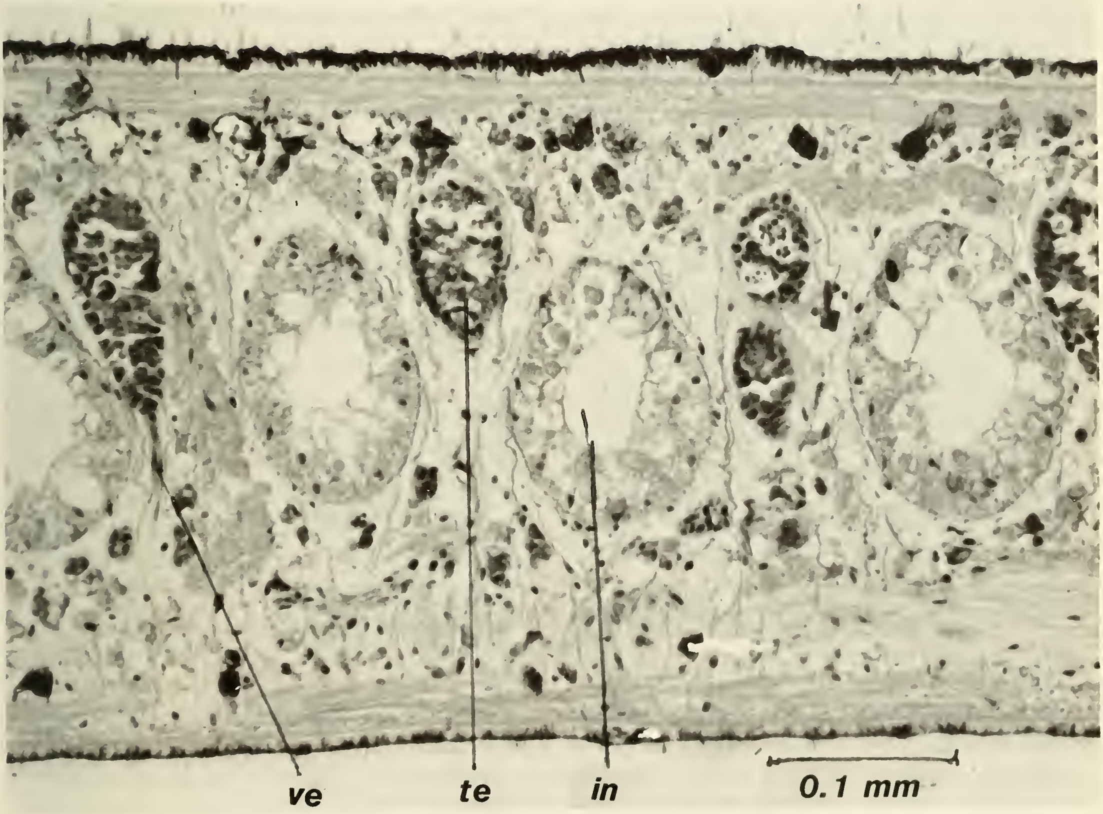

Fig. 2. *Phagocata notorchis,* sagittal section through anterior region. *in,* intestine; *te,* testis; *ve,* vas efferens.

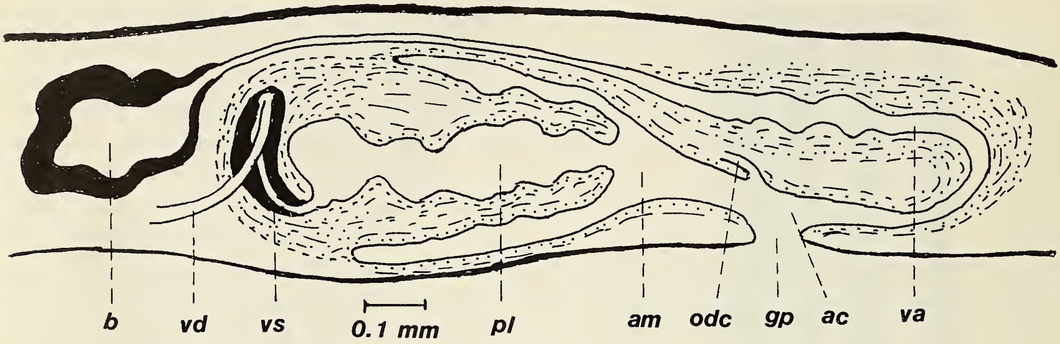

Fig. 3. *Phagocata notorchis,* semidiagrammatic view of copulatory apparatus in sagittal section. *ac,* common atrium; *am,* male atrium; *b,* copulatory bursa; *gp,* gonopore; *odc,* common oviduct; *pl,* penis lumen; *va,* vagina; *vd,* vas deferens; *vs,* seminal vesicle.

In the reproductive system, the ovaries are located behind the third to fifth pair of intestinal branches. The testes (Fig. 2) are predominantly subdorsal, situated above and between the intestinal branches. The follicles are not directly attached to the thin anterior vas deferens, as they are in many other species of the genus, but connect with it by individual efferent ductules (*ve*). The testicular zone on either side begins at a considerable distance posterior to the ovaries and extends to about the level of the pharynx root.

In the copulatory apparatus (Fig. 3), the gonopore leads into a small common atrium that connects anteriorly with the male atrium and posteriorly with the outlet of the copulatory bursa. The penis consists of a small bulb and a plug-shaped papilla. Its lumen is divided into an anterior seminal vesicle (*vs*) situated in the bulb and a large cavity (*pl*) that would correspond to an ejaculatory duct. The vesicle is lined by a thick epithelium of tall, apparently secretory, cells. In sagittal sections it appears as a dorsoventrally oriented duct, but extends also laterally in the bulb, so as to represent an anteroposteriorly compressed cavity. Ventrally it opens into the large cavity in the penis papilla, which is lined by a cuboidal epithelium and surrounded by a strong muscular layer. The walls of this cavity are variously folded and the cavity opens into the male atrium in a place dependent on the state of contraction of the muscular systems of the cavity and the external wall of the papilla. The two vasa deferentia, after expanding into the usual spermiductal vesicles, enter the penis bulb laterally and open separately into the dorsal portion of the seminal vesicle.

The two oviducts or ovovitelloducts unite in the space above the atrium and the short common oviduct (*odc*), equipped with eosinophilic shell glands, opens into the common atrium (*ac*) from the dorsal side. The copulatory bursa (*b*), a cavity with irregular outline, is located a short distance posterior to the pharyngeal pouch. Its outlet, the bursal duct, runs posteriorly somewhat to the left of the midline, and is divided into two different section. The anterior section is a narrow canal proceeding along the male atrium, surrounded by a moderate muscle layer. The posterior section or vagina (*va*), however, is greatly expanded and curves ventrally to open into the common atrium. It has a very thick muscular layer composed of intermingled fibers. There is no communication between the bursa and the intestine.

Distribution and ecology.—The species was collected by J. J. Lewis and T. Everitt on 7 May 1977 in Great Smoky Mountains National Park, in a seep near the trail to Alum Cave Bluffs, Sevier County, Tennessee, at an altitude of about 4900 feet (circa 1500 meters). About 20 specimens were sent to me alive, the majority of them immature. From its blindness and occurrence in a seep we may consider the species to be a groundwater inhabitant.

Taxonomic position.—The species belongs to a group of *Phagocata* widely distributed in the Appalachian region and apparently related to the subgenus *Atrioplanaria.* Its most outstanding characteristic is the presence of a large vagina with an extraordinarily developed muscle coat. A large vagina, but without excessive musculature, is seen also in *P. procera.* The dorsal position of the testes is also a good character, that is approached also in *P. bursaperforata.*

Etymology.—The species name, *notorchis* (Greek *noton,* dorsum; *orchis,* testis) refers to the subdorsal position of the testicular follicles.

Phagocata procera Kenk

Phagocata procera was described by Kenk (1984) from Cat Den Cave in Jackson County, North Carolina, but is more widely distributed in caves and springs in that state. The characteristic features of the species, apart from the presence of elongated pointed auricles and ventral prepharyngeal testicles, are in the differentiation of the copulatory apparatus. The penis lumen consists of two sections with histologically different linings, an anterior "seminal vesicle" with a tall, glandular epithelium and a posterior "ejaculatory duct" lined by a nonglandular cuboidal epithelium. Both sections may vary considerably in their appearance in preserved specimens, due to muscular contractions and distortions. The anterior section receives many faintly cyanophilic gland ducts and may appear as a cavity or a convoluted duct. The posterior section may have the aspect of a canal or of a wide cavity of irregular outline, opening on the dorsal side or at the tip of the penis papilla. The bursal duct widens gradually as it proceeds posteriorly and acquires a strong muscle coat to form a vagina, without altering the histological appearance of its epithelial lining.

Additional distributional records, all in North Carolina:

Burke County: Flatworm Fissure, located in Linville Gorge Wilderness Area, 13 May 1984, six immature specimens collected in two small pools by Cato O. Holler, Jr. and Christopher Holler and shipped to me alive; they matured in a laboratory culture.—Fifty/Fifty Fissure, in Linville Gorge Wilderness Area, near Linville Falls, 23 Sep 1984, 5 specimens collected by Cato O. Holler and his family and Lee James in a small seep; shipped to me alive.

McDowell County: Lake Tahoma Cave, located on the road up Little Buck Creek near Lake Tahoma, just outside of Marion, 4 Jan 1985, 4 specimens collected by Cato O. Holler, Jr. and Christopher Holler in a small seep and shipped alive.

Mitchell County: Buckshot Cave, 9 Sep 1979, in a seep in the cave 5 specimens collected by Cato O. Holler, Jr. and shipped to me alive.

Yancey County: Seep on State Road 128, 1.5 miles north of Blue Ridge Parkway, at about 6000 feet (circa 1830 m) altitude, 5 Jun 1972, 13 specimens collected by Leslie Hubricht and shipped preserved.—Seep on State Road 128, 10 Nov 1979, 3 specimens collected by Cato O. Holler, Jr. and Cathy Topping and sent alive.—Mt. Mitchell, Sep 1975, many specimens collected by Nicole Gourbault and Ian R. Ball and brought to me alive.

Phagocata pygmaea, new species

Figs. 1C, D, 4, 5

Type material.—Holotype: set of sagittal sections on 4 slides (USNM 102764). Paratype: sagittal sections on 3 slides (USNM 102765).

External features (Fig. 1C, D).—This is a small and slender white species, externally

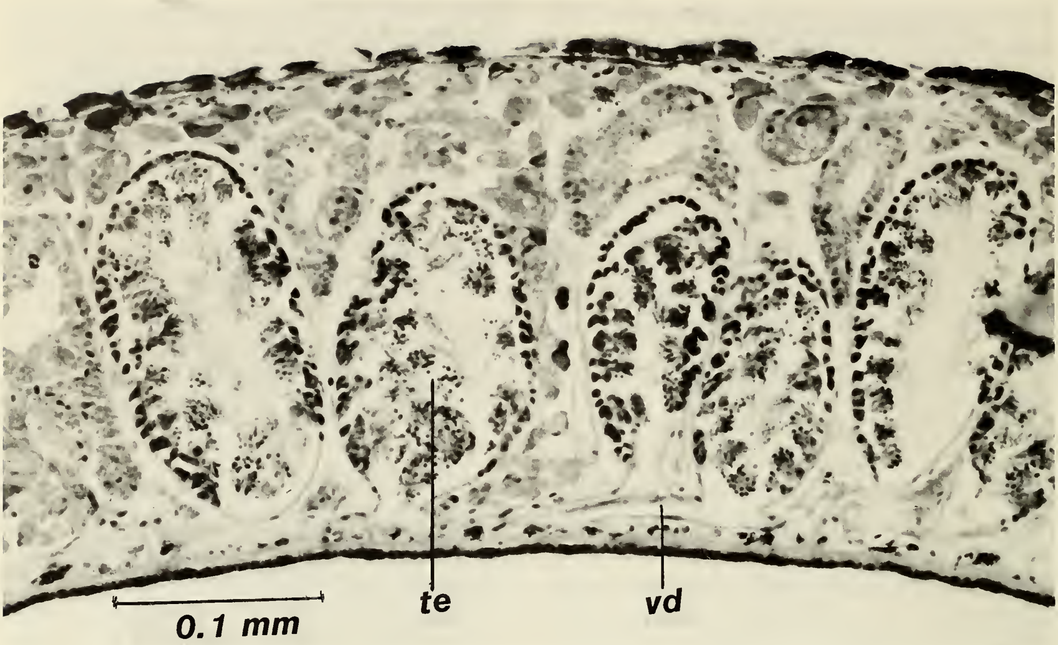

Fig. 4. *Phagocata pygmaea,* sagittal section through anterior region. *te,* testis; *vd,* vas deferens.

resembling several other species of the genus in the same general area. Mature specimens are about 10.5 mm long and 0.8 mm wide. The anterior end is truncate, with a slightly convex central part of the frontal margin and rounded lateral edges somewhat protruding laterally, lacking pointed auricles. There is an insignificant neck-like constriction, posterior to which the body widens again, the lateral margins remaining parallel for the greater part of the body length, to narrow again behind the level of the copulatory complex and to meet at the rather rounded posterior end. There are two small eyes (diameter of the pigment cups about 23 μm), situated very close together at a level rather far removed from the frontal margin of the head. The pharynx is inserted behind the middle of the body and measures about ⅕ the body length. The number of branches on the intestinal trunks could not be counted, but is certainly very large.

Anatomy.—The ovaries, equipped with parovaria, are situated behind the second or third lateral branches of the intestinal trunk. The numerous testes (Fig. 4) are prepharyngeal and are attached directly to the ventral sperm ducts or vasa deferentia. They must be considered to be essentially ventral, although many of the large follicles may extend between the intestinal branches far dorsally, occupying almost the entire dorsoventral diameter of the body.

In the copulatory apparatus (Fig. 5), that is located some distance behind the pharyngeal pouch, the gonopore leads into a small common atrium that connects anteriorly with the male atrium (*am*) and dorsally with the outlet of the bursal duct. The penis consists of a small, but highly muscular, bulb and a finger-shaped papilla. The penis lumen (*pl*) is a uniform, rather wide cavity, not divided into a seminal vesicle and an ejaculatory duct. It is confined mainly to the penis papilla and opens at the tip of the papilla. Its wall forms a number of villus-like projections. The vasa deferentia, that in their posterior parts form the enlarged and convoluted spermiductal vesicles filled with sperm, ascend dorsally at the level of the penis bulb, enter the bulb lat-

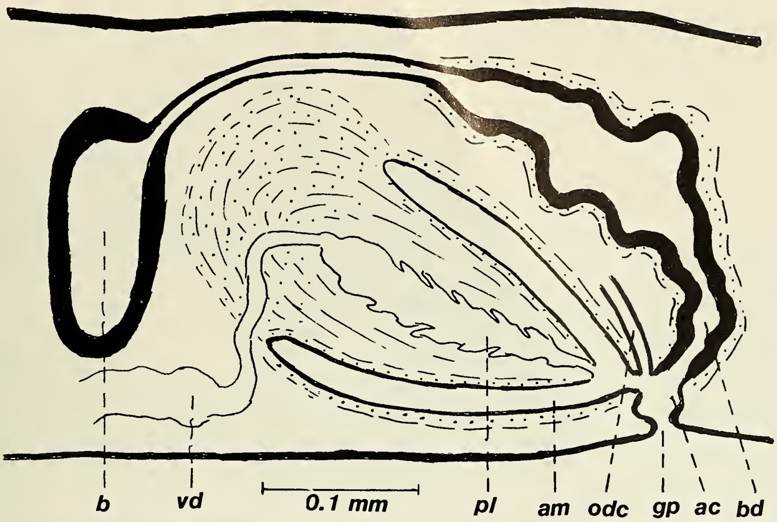

Fig. 5. *Phagocata pygmaea,* copulatory apparatus in sagittal section. *ac,* common atrium; *am,* male atrium; *b,* copulatory bursa; *bd,* bursal duct; *gp,* gonopore; *odc,* common oviduct; *pl,* penis lumen; *vd,* vas deferens.

erally, then curve posteriorly to open separately into the anterior end of the penis lumen. The two oviducts unite in the space between the male atrium and the bursal duct. The common oviduct thus formed opens from the dorsal side into the atrial cavity at the border between the male atrium (*am*) and the common atrium. The copulatory bursa is a rounded cavity without any special modifications. Its outlet, the bursal duct, is divided histologically into two sections. The anterior section is a straight narrow duct lined with a ciliated cuboidal epithelium. The posterior section is widened and somewhat convoluted and bends ventrally to reach the common atrium. Its lining epithelium consists of apparently secretory (apocrine) cells without cilia. Both sections are surrounded by moderate layers of muscular fibers.

Distribution and ecology.—*Phagocata pygmaea* was collected in Turtle Shell Cave, Stokes County, North Carolina, located at the base of Moore's Wall near Hanging Rock State Park, between Danbury and Moore's Springs. Seven immature specimens were taken by Cato O. Holler and Christopher Holler on 20 Nov 1983 and shipped to me alive. Some matured in the laboratory in a culture kept at 14°C and fed beef liver at weekly intervals.

Taxonomic position.—The species is closely related to the other subterranean species of *Phagocata* of the Appalachian area. Its outstanding characteristics are in the anatomy of the copulatory apparatus, mainly the structure of the penis and the differentiation of the bursal duct.

Etymology.—The name *pygmaea* (Latin, dwarfish) refers to the small size of the species.

Phagocata spuria, new species

Figs. 6, 7

Type material.—Holotype: set of sagittal sections on 4 slides (USNM 102766). Paratypes: sagittal sections of two specimens on 10 slides (USNM 102767, 102768).

External features.—This is a small, white, two-eyed species resembling the common sympatric *Phagocata morgani morgani* (Stevens and Boring) to such an extent that it was at first considered to be that species. No sketches or photos were prepared of living specimens (see Fig. 1E of *P. morgani*). The anterior end is truncate, with a more or less straight frontal margin and rounded

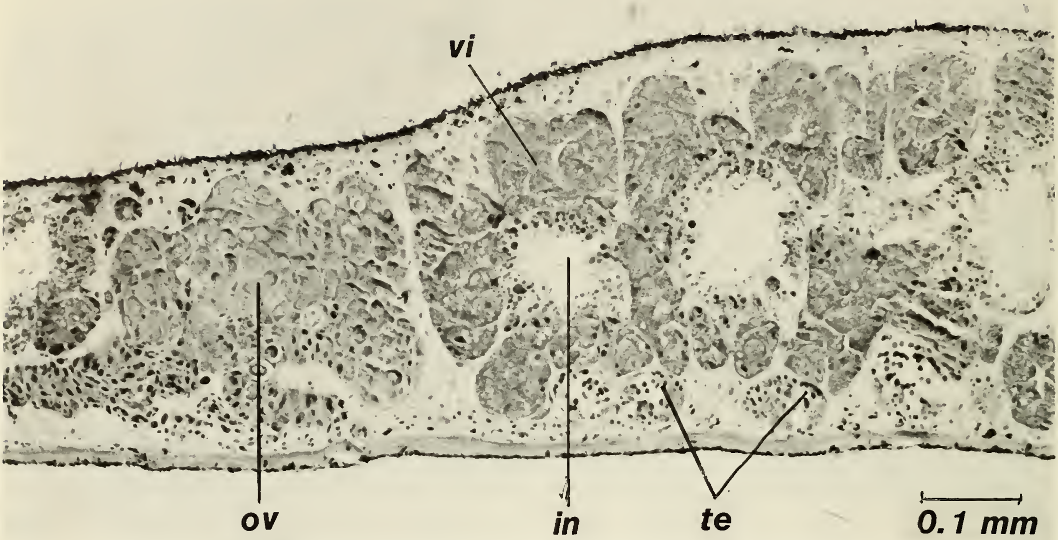

Fig. 6. *Phagocata spuria,* sagittal section through anterior part of body. *in,* intestine; *ov,* ovary; *te,* testis; *vi,* vitellarium or yolk gland.

lateral edges. Eyes are two, of regular size, placed close together and removed from the frontal margin. The specimens were immature when collected and were placed in a laboratory culture where they matured after several months. The length of the preserved mature worms is 6 mm, which would correspond to about 8–10 mm in life.

Anatomy.—Apart from the reproductive system, the general anatomy shows no peculiarities. The eyes are of normal size (diameter of the pigment cup 57 μm). The ovaries (Fig. 6) are hyperplastic, of enormous size, and consist of amply lobed and branched masses of darkly staining (cyanophilic) cells. Histologically, not all these cells are oocytes, but some, particularly in the peripheral portions, are comparable to those of parovaria. The yolk glands or vitellaria are very abundant and fully developed, occupying all spaces of the mesenchyme, beginning somewhat anterior to the ovaries and extending to the posterior end. The numerous testicular follicles are small, round, and located strictly ventrally, below the intestinal branches. The testicular zone on either side begins a short distance behind the ovary and reaches posteriorly to about the level of the mouth. In all three specimens examined, the follicles contain no ripe sperm cells, only immature spermatogonia.

The copulatory apparatus (Fig. 7) is rather small and not very clearly differentiated. The atrial cavity is undivided. The penis has a small weakly muscular bulb and a finger-shaped papilla. Its lumen consists of a bulbar cavity (seminal vesicle) lined with a tall glandular epithelium, and a narrow duct (ejaculatory duct) with cuboidal or flattened cellular lining, that runs through the center of the papilla and opens slightly dorsally to its tip. The vasa deferentia, which in other planarians appear widened, convoluted, and filled with sperm before entering the penis, forming the spermiductal for false seminal vesicles, are here empty and only slightly widened. They enter the penis bulb laterally and open separately into the seminal vesicle. The outlet of the rounded copulatory bursa takes an arch-shaped course, gradually widening in its posterior section, without forming a histologically dif-

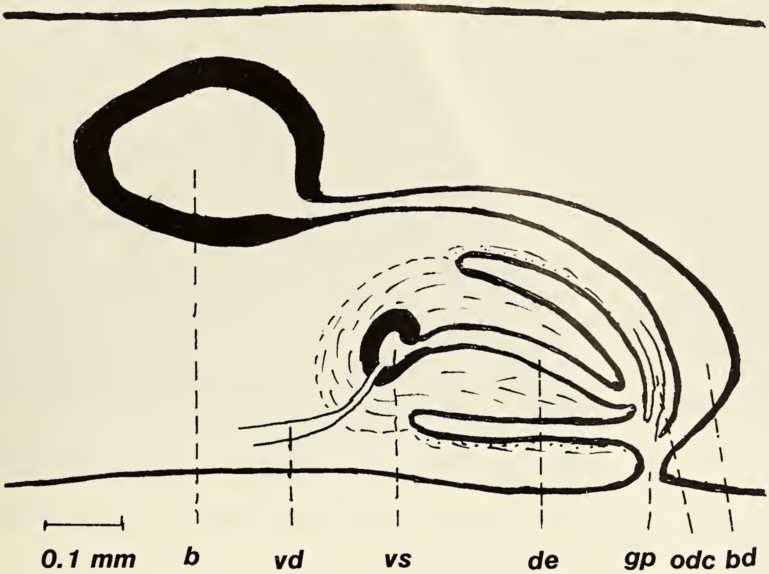

Fig. 7. *Phagocata spuria,* copulatory apparatus in sagittal section. *b,* copulatory bursa; *bd,* bursal duct; *de,* ejaculatory duct; *gp,* gonopore; *odc,* common oviduct; *vd,* vas deferens; *vs,* seminal vesicle.

ferent vagina. It opens into the atrial cavity near the gonopore.

Distribution and ecology.—The species is known only from Bennett's Mill Cave in McDowell County, North Carolina, located just outside the town of Marion. Cato O. Holler, Jr. collected 3 immature specimens on 12 Jun 1977 and sent them to me alive. They matured in the laboratory. No signs of reproduction, either by fission or by cocoons, were observed. Two specimens were preserved in Dec 1977 and the third in Sep 1978.

Taxonomic position.—While the general anatomical plan of the species places it clearly in the genus *Phagocata,* the specimens exhibit some characters rarely observed in planarians. The full development of the ovaries and yolk glands, together with the incomplete appearance of the testes, may seem to indicate that the female gonads mature at a time different from that of the male gonads. This would not, however, explain the remarkable hyperplasia of the ovaries which are generally rather small rounded organs adjoining the ventral nerve cords. This hyperplastic condition is occasionally observed in fissiparous races, such as has been reported for *Phagocata morgani* in Canada (Benazzi and Ball 1972) and for the European *Dugesia subtentaculata* (Draparnaud) and some related species (Benazzi 1968, 1974; Gremigni and Banchetti 1972; Benazzi and Deri 1980; de Vries 1986). Nonetheless, the anatomy of the penis and of the bursal duct separates *P. spuria* from other species of the genus.

Etymology.—The name *spuria* (Latin, spurious, false) alludes to the striking external similarity of the species to *P. morgani.*

Phagocata carolinensis Kenk
Fig. 8

This species was established and described by Kenk (1979) from One Bat Cave, Burke County, North Carolina. It is characterized by having a truncate anterior end with some lateral widening, but lacking prominent pointed auricles; it also has a pair of very small eyes. The most conspicuous anatomical feature is the presence of an exceptionally large posterior section of the

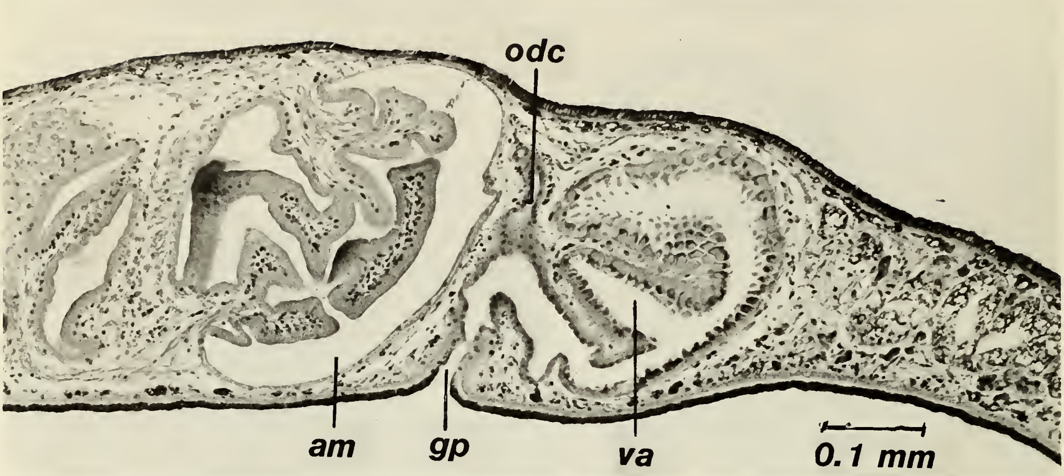

Fig. 8. *Phagocata carolinensis,* sagittal section through copulatory apparatus. *am,* male atrium; *gp,* gonopore; *odc,* common oviduct; *va,* vagina.

bursal duct, or vagina (Fig. 8, *va*), which may extend far posteriorly and is lined by a glandular epithelium differing from that of the anterior section of the duct. The vagina lacks any excessive muscular coating and may appear variously folded in the preserved specimens. The penis, which in its retracted state has a serpentine-like lumen shown in the original description of the species, may extend and assume an irregularly convoluted shape of the penis papilla (Fig. 8).

Additional material of the species was obtained from Wind Cave, McDowell County, North Carolina, located near Marion. It was collected by Cato O. Holler, Jr. on two visits to the cave; 4 specimens, some mature, taken from a small seep, 15 Apr 1984; and 5 specimens, all immature, collected beneath rocks lying on moist clay in an abandoned water course, 15 Feb 1985 (they were raised to maturity in the laboratory).

Acknowledgments

Thanks are due to all collaborators who furnished the materials discussed in the paper. First of all, to Dr. Cato O. Holler, Jr., member of the North Carolina Cave Survey, an indefatigable collector of cave animals. Individual species were given to me by Dr. Nicole Gourbault (Muséum National d'Histoire Naturelle, Paris), Dr. Ian R. Ball (now at Memorial University of Newfoundland), Leslie Hubricht (Meridian, Mississippi), J. J. Lewis, and all their coworkers mentioned under the individual species. Photomicrographs were prepared in Dr. John C. Harshbarger's laboratory and in part processed by Abbie J. Yorkoff (Smithsonian Institution). Dr. Marian H. Pettibone kindly reviewed the paper for stylistic and topical errors.

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100(3), 1987, pp. 674–679

MYSIDIUM RICKETTSI, A NEW SPECIES OF MYSID FROM THE GULF OF CALIFORNIA (CRUSTACEA: MYSIDACEA: MYSIDAE)

Elizabeth B. Harrison and Thomas E. Bowman

Abstract.—*Mysidium rickettsi,* the sixth species of the genus and the first from the Pacific Ocean, is described from the Gulf of California. It is characterized by the armament and proportions of the telson, the subdivision of the sixth segment of the endopod of the pereopods, and the length of the peduncle of antenna 2 in relation to the scale.

The genus *Mysidium* Dana includes *M. gracile* (Dana, 1852) from Brazil, Florida, Bermuda, Jamaica, Puerto Rico, Curaçao, Venezuela, and the Virgin Islands; *M. colombiae* (Zimmer, 1915) from Colombia (Atlantic side), the Bahamas, the Florida Keys, Jamaica, the Virgin Islands, Cuba, Mexico, Belize, and Venezuela; *M. integrum* W. Tattersall, 1951, from Florida, the Virgin Islands, the Bahamas, the West Indies, Puerto Rico, Belize, and the Gulf of Mexico; and *M. rubroculatum* and *M. cubanensis* Băcescu and Ortiz, 1984 from Cuba. A 6th species, the first from the Pacific is described below.

Mysidium rickettsi, new species
Figs. 1–3

Material.—Male holotype (USNM 233310) female allotype (USNM 233311), and 50+ paratypes (USNM 81113), from Pt. Marcial, Gulf of California 25°31′N, 111°01′W, surface, collected with night light by E. R. Ricketts and J. Steinbeck, 24 Mar 1940; additional material (USNM 81114) was collected with night light by E. R. Ricketts and J. Steinbeck in Bahía de Ohuira (=San Carlos Bay), 25°38′N, 108°58′W, Sonora, Mexico, 4 Apr 1940. Specimens were also found in the stomachs of two species of manta rays collected from four localities in the Gulf of California by Giuseppe Metabartolo di Sciara: From *Mobula thurstoni*: southern Gulf of California, peninsular side, near La Paz, in water 10 m deep or less; near the eastern shore of Isla San Francisco, Punta Arena de la Ventana, 24°04′N,109°52′W, and Bahía de la Ventana, 24°05′N,109°55′W. From *Mobula munkiana*: Estero on southwest side of Isla San José, 24°55′N,110°38′W; and Bahía de la Ventana.

Etymology.—Named for the late Edward F. Ricketts, whose pioneering work on the fauna of the Gulf of California is recorded in Steinbeck and Ricketts (1941).

Description.—Length up to 10 mm. Rostrum round-triangular; posterior margin of carapace emarginate, exposing last pereonite. Eyestalk subquadrate, cornea covering approximately half. Telson entire, rounded apically; about twice as long as wide, tapering posteriorly; posterior half with closely spaced short, blunt, marginal spines (30–37 on each side).

Antenna 1: Segment 1 of peduncle about one-third longer than wide, slightly longer than segment 3; distolateral corner produced into short rounded process. Segment 2 short, trapezoidal, length of longer (medial) margin less than half that of segment 3. Segment 3 nearly as long as wide, with small lobe on distodorsal margin at base of each flagellum, and with pair of long setae at distomedial corner in ♀. Male lobe lan-

Fig. 1. *Mysidium rickettsi*: A, Anterior end, dorsal; B, Appendix masculina, medial; C, Antenna 1 peduncle, dorsal; D, Antenna 2, dorsal; E, Right mandible, with detail of incisor; F, Left mandible; G, Mandibular palp; H,I, Inner and outer lobes of maxilla 1; J, Maxilla 2; K, Maxilliped; L, Labrum; M, Penis.

Fig. 2. *Mysidium rickettsi*: A, Pereopod 1; B–G, Dactyl, "tarsal" segments, and distal part of merus of Pereopods 2–7, setae of merus not shown; H–L, Pleopods 1–5.

Fig. 3. *Mysidium rickettsi*: A, Uropod; B, Telson.

ceolate, 8× as long as wide, proximal ⅔ expanded ventrally, entire ventral surface with long fine setae.

Antenna 2, scale lanceolate, slightly more than 4× longer than greatest width, with suture separating distal segment; lateral margin straight, medial margin slightly convex. Peduncle with 5 segments, 2 broad proximal segments and 3 narrower distal segments; distolateral corner of segment 2 produced into acute tooth. Peduncle and scale subequal in length.

Right mandible: Incisor 3-cuspate; lacinia subcylindrical, apex produced into 2 compound cusps, spine-row with 5–6 spines, anterior spine robust, compound, others denticulate; molar grinding surface striate, medial margin denticulate, tuft of hairs on posterior margin.

Left mandible: Incisor 6-cuspate, lacinia sub-cylindrical, 4-cuspate, spine row with 4 spines, all denticulate. Molar blunt, posterior tuft of hairs shorter than in right mandible. Palp with very short 1st segment, 2nd segment 1.8× length of 3rd; 2nd and 3rd segments setose on medial margin, 3rd segment tapering in distal 3rd with 2 stout apical spines.

Labium: With short, apically rounded paragnaths with fringe of short setae on medial margins.

Maxilla 1: Outer lobe with 1 surface seta and about 9 apical spines, inner lobe with 4 long apical setae and about 7 shorter subapical setae.

Maxilla 2: Endites well developed, heavily setose; distal segment of endopod about 1.8× as long as proximal segment, fingerlike in shape. Exopod not reaching distal margin of proximal segment of endopod, with ca. 13 plumose marginal setae.

Maxilliped (endopod of thoracopod 1): Endite of basis well developed, nearly reaching distal margin of ischium; medial margins of segments densely setose.

Pereopod 1 (endopod of thoracopod 2): Merus with 7 setae on anterior margin, propus with 2 long and 2 shorter setae at anterodistal corner, 4 setae at posterodistal corner and row of setae on posterior margin; dactyl with 7–8 hooked plumose setae and 3 longer, more slender setae. Pereopods 2–5 with 3 tarsal segments, 6 and 7 with 2.

Penis: Oval, with diagonal row of setae near apex.

Pleopods: Pleopods 1–4 successively longer. Pleopod 5 shorter than 2. Pleopods 1–3 and 5, viewed laterally, with straight ventral margin with 5 or more long setae arranged stepwise along length and one at apex; dorsal margin straight along proximal part, then curving inward to posteroventral corner; pseudobranchial lobe with cluster of short, fine, setae with inflated bases; other single or grouped setae of same type on lateral face. Pleopod 4 extending beyond distal end of pleon, with seta of 3rd segment reaching to end of telson. Endopod represented by short simple lobe bearing 7 setae, distal seta 3× as long as others; exopod very long and slender, 4-segmented, relative lengths (%) of segments 1–4 = 58:14:14:14.

Uropod endopod 1.5 as long as exopod, both tapering distally; exopod 5x as long as wide, endopod 7.6× as long as wide.

Comparisons.—*Mysidium rickettsi* is much longer (10 mm) than its Atlantic congeners, whose maximum recorded lengths in mm are *M. columbiae* 7.3, *M. cubanense* 5.2, *M. gracile* 6.5, *M. integrum* 7.0, *M. rubroculatum* 4.5. The telson of *M. rickettsi* is relatively longer than in most other species, having a length/width ratio of slightly more than 2.0. For the other species this ratio is *M. columbiae* 1.5, *M. cubanense* 2.0, *M. gracile* 1.7, *M. integrum* 1.7, *M. rubroculatum* 1.9. The maximum number of marginal spines on the telson of *M. rickettsi,* 74, is the highest in the genus (*M. columbiae* 52, *M. cubanense* 35, *M. gracile* 50, *M. integrum* 70, *M. rubroculatum* 37. The apex of the telson is transversely rounded in *M. rickettsi, M. cubanense, M. integrum,* and *M. rubroculatum,* in contrast to *M. gracile,* where it is shallowly emarginate, and *M. columbiae,* in which it is distinctly excavated.

The relative lengths of the tarsal segments of pereopods 2–6 differs in species of *Mysidium.* The first segment is much longer than the following two in *M. colombiae, M. cubanense, M. gracile,* and *M. rickettsi.* In *M. integrum* and *M. rubroculatum* the three tarsal segments are subequal. In *M. columbiae* there are three segments in the tarsus of pereopod 2, but only two segments in pereopods 3–7; in pereopod 2 the first segment is distinctly longer than the second or third.

The relative lengths of the segments of the exopod of the ♂ pleopod 4 is a useful taxonomic character in *Mysidium* (Brattegard 1969: Table 6). In *M. rickettsi* and *M. gracile* segments 2–4 are subequal in length. In *M. rubroculatum* and *M. integrum* segment 2 is distinctly longer than 3 or 4. In *M. cubanense* and *M. colombiae* the endopod has only three segments.

Ecology.—Steinbeck and Ricketts (1941: 152) reported that the mysids here described as *M. rickettsi* occurred in swarms, perhaps resulting from the light used in night collecting. Small fish were noticed feeding around the edges of these swarms. The presence of large numbers of *M. rickettsi* in ray stomachs suggests that swarming does occur under natural conditions, for seeking individual mysids for food would be an unprofitable expenditure of energy.

Brattegard (1969: 82,86,88) mentions that shoaling in *M. gracile, M. integrum,* and *M. colombiae* has been reported from Bermuda and the Florida keys. Băcescu and Ortiz (1984:21) reported shoaling in *M. rubroculatum.* Steven (1961), studying the shoaling behavior of *M. colombiae* in Jamaica, reported that this species shoals when the number of specimens is above a critical figure. Hahn and Itzkowitz (1986) studied site preference and homing behavior in *M. gracile.*

Acknowledgments

We thank Giuseppe Metabartolo di Sciara, then of Scripps Institution of Oceanography, for providing us with the specimens of *M. rickettsi* from manta ray stomachs.

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ERRATUM

In the article entitled "*Stegophiura ponderosa* (Lyman), new combination, and *Amphiophiura vemae* and *Homophiura nexila* new species (Echinodermata: Ophiuroidea) from the R/V *Vema* collections," by Michael A. Kyte, published in Proceedings of the Biological Society of Washington, volume 100, part 2, pages 249–256, an incorrect Figure 3 was printed. The correct figure and caption are given below.

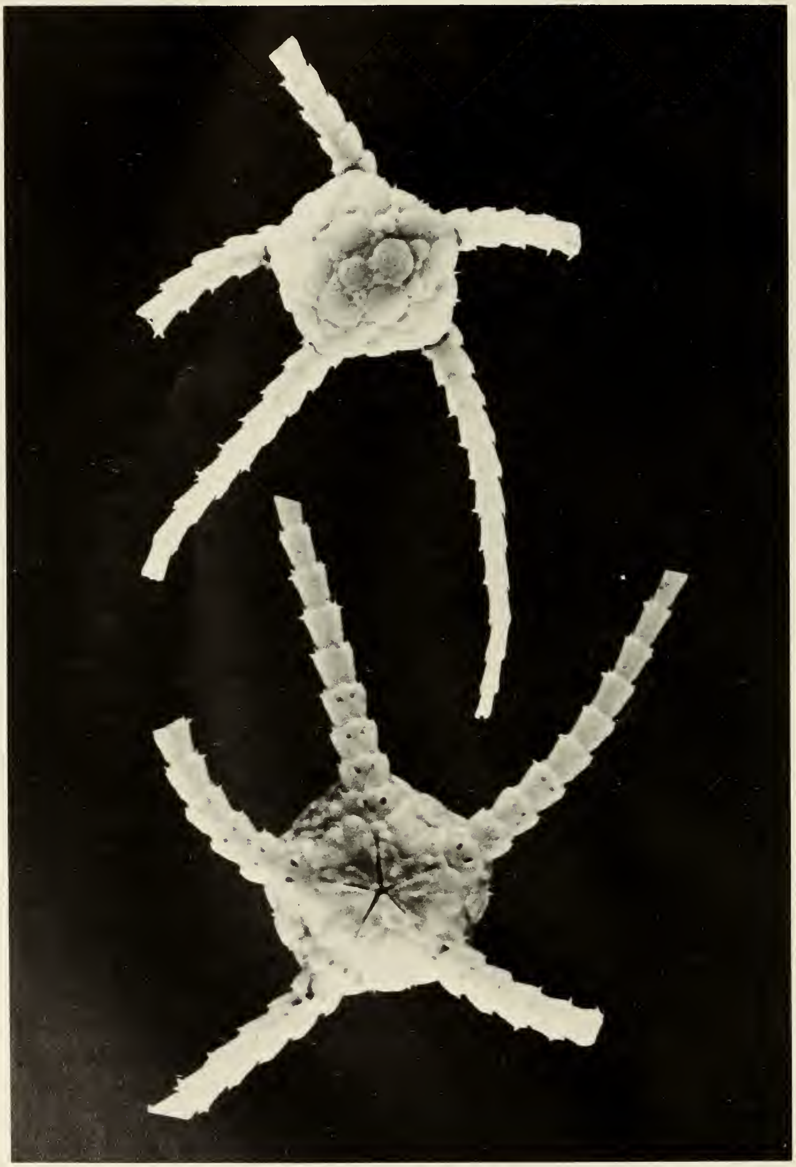

Fig. 3. *Homophiura nexila*. Dorsal view (top) and ventral view (bottom).

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Olson, S. L. 1973. The fossil record of birds. Pp. 79–238 *in* D. Farner, J. King, and K. Parkes, eds., Avian biology, volume 8. Academic Press, New York.

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