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BIOLOGICAL SOCIETY OF WASHINGTON
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1058 Meeting—15 April 1980

The 101st Annual Meeting was called to order by President Ollie Flint at 2:30 p.m. on 15 April, 1980, in the Ecology Theater of the Natural History Museum, Washington, D.C. Eighteen members were present; several others arrived soon thereafter.

The minutes of the 100th annual meeting were read and approved.

Treasurer Dave Pawson reported that the Society is in good financial health. Income exceeded expenses in 1979, leaving nearly $13,000 in operating funds.

There was no report from the absent Secretary. President Fling discussed the substantial increase in membership in 1979, noting that it seemed to be continuing in 1980.

The President reported on the activities of the Council in its three meetings of the past year. The Society had been notified by Allen Press that printing costs would increase from $29 to $35 per page. Dues for 1980 had been raised to $10, and page charges to $35. Flint noted that 1980 is the Centennial year of the Society, and that a dinner forum in celebration would be held on 3 December, the anniversary date of the meeting in which the Constitution had been approved. The publications in the attic are well organized, and the Society is looking for a custodian to send out back issues. Editor Bill Hart has announced his desire to resign at the completion of Volume 93 (1980), and efforts to find a replacement are under way. The extra ballot necessary for the election of a President had been accompanied by a notice of the meeting and information about publications; this resulted in $44 worth of orders and, perhaps, the large attendance at this meeting. On behalf of the absent Editor, the President reported on the status of the current volume of the Proceedings.

As old business, the President read a letter from Assistant Secretary Challinor, thanking the Society for his copies of the Proceedings. A question was raised on the status of efforts to obtain a logo; the matter is still open.

Newly elected officers for 1980 were announced: President, Richard C. Banks; Vice-President, Raymond B. Manning; Secretary, Michael A. Bogan; Treasurer, David L. Pawson; Council Members, Stephen D. Cairns, Anne C. Cohen, Leslie W. Knapp, Storrs L. Olson, and Stanwyn G. Shetler.

After thanking the officers, Council, and members for their cooperation, Flint turned the meeting over to the new President, who called for and received a motion for adjournment.

Respectfully submitted,
Richard C. Banks, for the Secretary

INDEX TO NEW TAXA

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(New taxa indicated in *italics*; new combinations designated n.c.)

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THE BIOLOGICAL SOCIETY OF WASHINGTON

PROCEEDINGS

Membership in the Society is open to anyone who wishes to join. There are no prerequisites. Annual dues of $10.00 include subscription to the *Proceedings of the Biological Society of Washington*. Correspondence concerning membership should be addressed to the Treasurer, Biological Society of Washington, National Museum of Natural History, Smithsonian Institution, Washington, D.C. 20560.

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REVIEW OF SPECIES PREVIOUSLY REFERRED TO *CERATONEREIS MIRABILIS*, AND DESCRIPTIONS OF NEW SPECIES OF *CERATONEREIS*, *NEPHTYS*, AND *GONIADA* (POLYCHAETA)

Thomas H. Perkins

Abstract.—*Ceratonereis tentaculata* Kinberg, *C. excisa* (Grube), and *C. singularis* Treadwell, previously referred to *C. mirabilis* Kinberg, are retained. *Nephtys magellanica* Augener is redescribed. *Ceratonereis longicirrata, Nephtys simoni,* and *Goniada multidentopsis,* n. spp. from Florida and nearby areas are described. A key is provided for species similar to *Ceratonereis mirabilis.*

Introduction

The present paper is one of a series of several reports in progress based primarily on specimens collected between September 1971 and July 1973 in an environmental baseline study of marine biota near the Florida Power and Light nuclear power plant at Hutchinson Island, St. Lucie County, Florida. Additional specimens from nearby areas were examined. The study area and methods and materials were described by Gallagher and Hollinger (1977). Sediments were described by Gallagher (1977), and other aspects of the physical and chemical environment were reported by Worth and Hollinger (1977). Brief descriptions of benthic sampling stations and methods were also given by Perkins (1979).

In addition to specimens deposited in the Invertebrate Reference Collection of the Florida Department of Natural Resources Marine Research Laboratory (FSBC I), additional specimens were borrowed from the following institutions: Allan Hancock Foundation, University of Southern California, through K. Fauchald (AHF); American Museum of Natural History, through H. S. Feinberg (AMNH); Dauphin Island Sea Laboratory, Dauphin Island, Alabama, through T. S. Hopkins (DISL); Harbor Branch Foundation/Smithsonian Institution, Ft. Pierce Bureau, Fort Pierce, Florida, through R. H. Gore and J. E. Miller (SIFP); Museum of Comparative Zoology, Harvard University, through H. W. Levi (MCZ); National Museum of Natural History, Smithsonian Institution, through M. H. Pettibone, M. L. Jones, and K. Fauchald (USNM); Naturhistoriska Riksmuseet, Stockholm, through R. Oleröd (NRS); Zoologisches Museum für Naturkunde der Humboldt-Universität zu Berlin, through G. Hartwich (ZMB); and Zoologisches Museum,

Hamburg, through G. Hartmann-Schröder (ZMH). Additional specimens were donated by R. G. Ernest, Applied Biology, Inc., Jensen Beach, Florida. J. L. Simon, University of South Florida, and K. Fauchald commented on early drafts of the manuscript. M. H. Pettibone provided information and copies of papers not available to me and critically reviewed the manuscript. Many individuals from the Marine Research Laboratory and Applied Biology, Inc., participated in the Hutchinson Island study, for which Florida Power and Light Co., provided partial funding.

Nereididae Johnston

Ceratonereis Kinberg

Type-species.—*Ceratonereis mirabilis* Kinberg, 1866, designated by Hartman (1948:70).

In addition to the generic diagnosis provided by Fauchald (1977a: 88), the type-species and similar species reported herein have an anteriorly cleft prostomium, and all, except possibly one, have soft, cushion-shaped lobes on area VI of the proboscis [see Fauchald (1977a: Fig. 21c, d) for diagram of nereidid pharyngeal areas]. *C. japonica* Imajima (1972: 69–71, Figs. 15o–p) is provisionally included in the group, but differs in having paragnaths on area I of the proboscis and probably does not have soft lobes on area VI. Most other species presently included in the genus have an anteriorly rounded prostomium, with no mention of soft lobes on area VI. Characters noted above for the latter group of species may provide the basis for a new genus or subgenus.

Species redescribed herein have been referred by various authorities to *Ceratonereis mirabilis* Kinberg, 1866. Ehlers (1887:120) suggested the possible synonomy of *C. mirabilis, C. tentaculata* Kinberg, 1866, and *Nereis excisa* Grube, 1874. Augener (1913:168), who examined the type-specimens of *C. mirabilis* and *C. tentalculata,* referred the above three species to *Nereis* (*Ceratonereis*) *tentaculata.* Fauvel (1917:207) placed *C. tentaculata* under *C. mirabilis. Nereis gracilis* Webster, 1884 [HOMONYM, not Hansen, 1882], was referred to *C. mirabilis* by Treadwell (1901:193); however, he later used *N. gracilis* for specimens from Barbados (Treadwell, 1924:13). Hartman (1940:218) referred *C. singularis* Treadwell, 1929, to *C. tentaculata* and later, in her report on Kinberg's types (Hartman, 1948:70), to *C. mirabilis.* Since Hartman's (1948) account, *Ceratonereis mirabilis* has generally been used to include all the above-mentioned species, and the group was considered to be one widely distributed, cosmopolitan species.

Examination of type-specimens of the above taxa indicates that there are distinct differences among them. In the case of *N. gracilis,* differences are considered to be of less importance, and the synonomy of *N. gracilis* Webster and *C. mirabilis* is maintained. The remainder are considered to be distinct species.

Characters of importance in distinguishing atokous members of this group are: 1) body dimensions; 2) development of parapodial lobes along the body; 3) shape and possibly number of falcigers in the three bundles (notopodial, upper and lower neuropodial); 4) stoutness, length, and possibly number of stiff hairs on the blades of compound falcigers; and 5) gross differences in the number, arrangement, and size of paragnaths on the proboscis. Differences in both male and female heteronereidid stages of these animals are also of systematic importance. Such differences occur in differential modification of the prostomium and anterior segments; in the specific segment on which the epitokous parapodia begin; the shape of epitokous parapodia; the shape and number of parapodia of the ''tail'' region, if there is one; and differences in modification of the pygidium [see Pettibone, 1956, for detailed descriptions of heteronereidids]. These characters are consistent on specimens I examined from Florida and the Caribbean area, and should be applicable to specimens from other areas as well.

Many citations to specimens of *C. mirabilis* and *C. tentaculata,* for which I have not examined voucher specimens, include only short descriptions, but a few are sufficiently described to indicate that the specimens do not belong to the species treated in this paper. Further, some specimens from areas other than the western Atlantic and referred to the above-mentioned species were examined and also found to be different. These are not included in the synonymies, but some are discussed in the remarks under certain of the species.

KEY TO ATOKOUS ADULTS OF SPECIES SIMILAR TO *CERATONEREIS MIRABILIS*

1. Blades of upper neuropodial falcigers of middle and posterior segments massive, with very stout, stiff subdistal hairs (Figs. 13e, f) . ... *Ceratonereis* sp.
– Blades of falcigers moderately stout, with moderately stout, stiff hairs (Figs. 1c–f; 10) **2**
2. Upper notopodial ligules absent from posterior parapodia (Figs. 6e, f) **3**
– Upper notopodial ligules present on posterior parapodia but often reduced to small papillae (Figs. 2a, b) **5**
3. Proboscis with paragnaths on area I; separated into 3 groups on area III [not covered in this report; see remarks above] .... *C. japonica*
– Proboscis with paragnaths absent on area I; single group on area III **4**

4. Blades of falcigers of middle and posterior segments unidentate (Figs. 6g–k); dorsal cirri about as long as segmental width or slightly shorter (Figs. 6b–f) .... *C. excisa*
– Blades of falcigers of middle and posterior segments bidentate (Figs. 12a–e); dorsal cirri longer than segmental width (Figs. 11b–e) .... *C. longicirrata,* n. sp.
5. Blades of all falcigers of middle and posterior segments unidentate, distal tips evenly rounded to slightly concave (Fig. 10) .. *C. singularis*
– Blades of notopodial and upper neuropodial falcigers of middle and posterior segments bidentate (Figs. 1c–f); blades of lower neuropodial falcigers bidentate to unidentate, latter with distal tips concave to convex **6**
6. Eyes large; upper and lower notopodial ligules subequal throughout body (Figs. 5a, b); blades of lower neuropodial falcigers with distal tips bidentate above (Fig. 5k) to evenly rounded below .... *C. tentaculata*
– Eyes of average size; upper notopodial ligules about half as long as lower ligules on middle parapodia (Fig. 2a), reduced to papillae and much shorter than lower ligules on posterior parapodia (Fig. 2b); blades of lower neuropodial falcigers with distal tips bidentate above to slightly concave below (Figs. 4c–e) .... *C. mirabilis*

Ceratonereis mirabilis Kinberg
Figs. 1–4

Ceratonereis mirabilis Kinberg, 1866:170.—Ehlers, 1887:117–120 [in part, specimen from *Blake* Sta. 11; description and figures = *C. singularis* Treadwell, 1929].—Hartman, 1948:71, 72 [in part].
Nereis gracilis Webster, 1884:313–314, Pl. 9, Figs. 29–35 [HOMONYM, not Hansen, 1882].—Treadwell, 1924:13 [in part, specimen from Sta. 99].
Nereis (Ceratonereis) tentaculata.—Augener, 1913:168–171 [in part].
Ceratonereis versipedata.—Vittor, 1975:79.—Vittor and Johnson, 1977:167 [in part; not Ehlers, 1887].

Material examined.—BRAZIL: 09°S, 33 m, Werngren, col., 2 syntypes of *C. mirabilis* (NRS 456). BERMUDA: G. B. Goode, col., 1876–77, anterior fragments of 2 syntypes of *Nereis gracilis* (USNM 4787). BAHAMAS: S portion of Bimini Lagoon, 25°43′N, 79°16′W, in plastic sponges submerged behind reef, A. Schoener, col., 1970–71, 5 specimens (USNM 54330); Hydro-Lab, Freeport, 26°30′N, 78°38′W, 16 m, on coral, B. A. Vittor and T. S. Hopkins, cols., 28 Jan. 1974, 1 specimen (DISL); Cherokee Sound, Abaco Island, 26°N, 77°W, in plastic sponges submerged behind reef, A. Schoener, col., 1972, 8 specimens (USNM 51683). FLORIDA, AT-

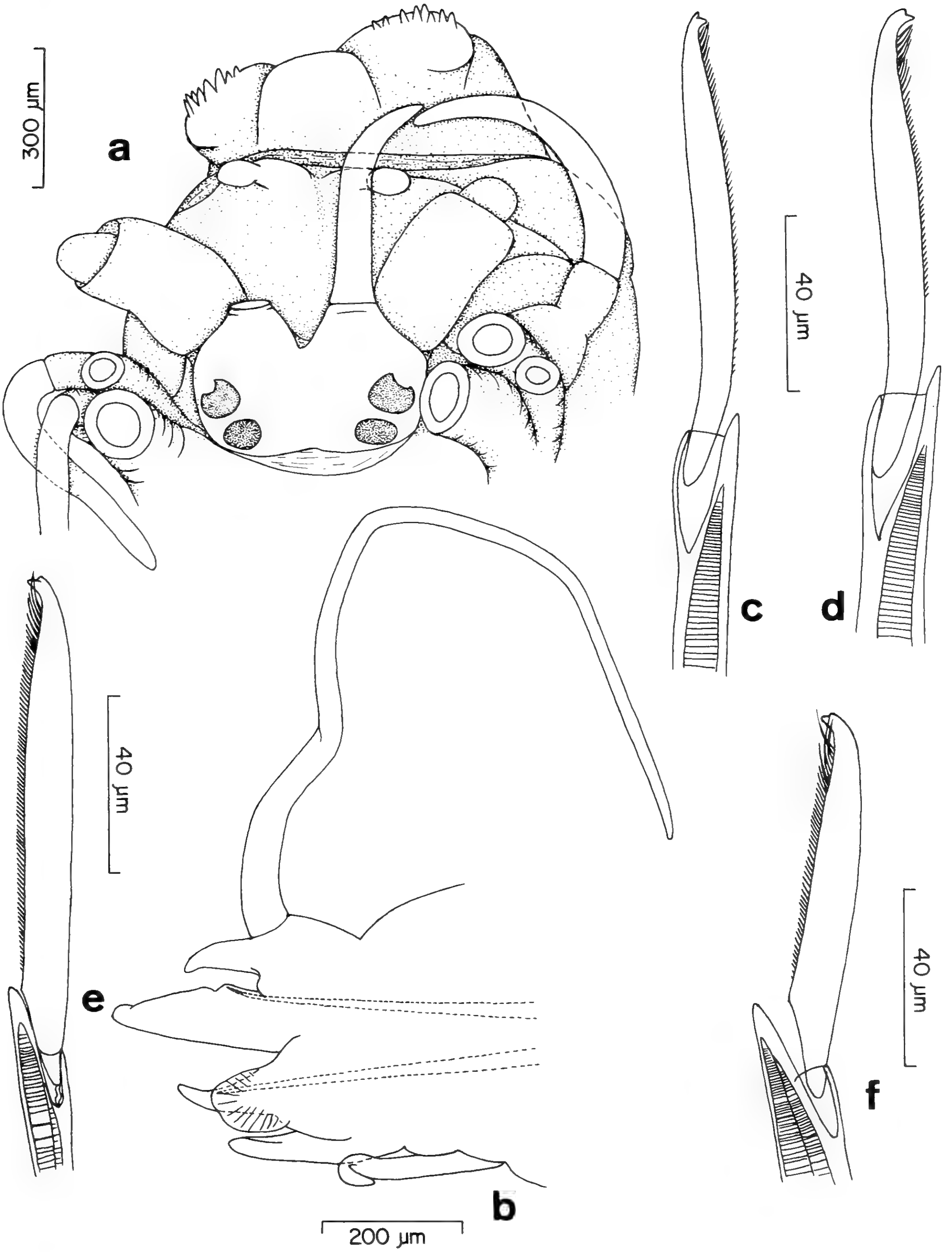


Fig. 1. *Ceratoneris mirabilis,* syntypes: **a,** Anterior end with pharynx extended; **b,** Parapodium from first setiger of middle fragment, posterior view; **c,d,** Notopodial falcigers from same; **e,f,** Upper neuropodial falcigers from posterior segments of middle fragment.

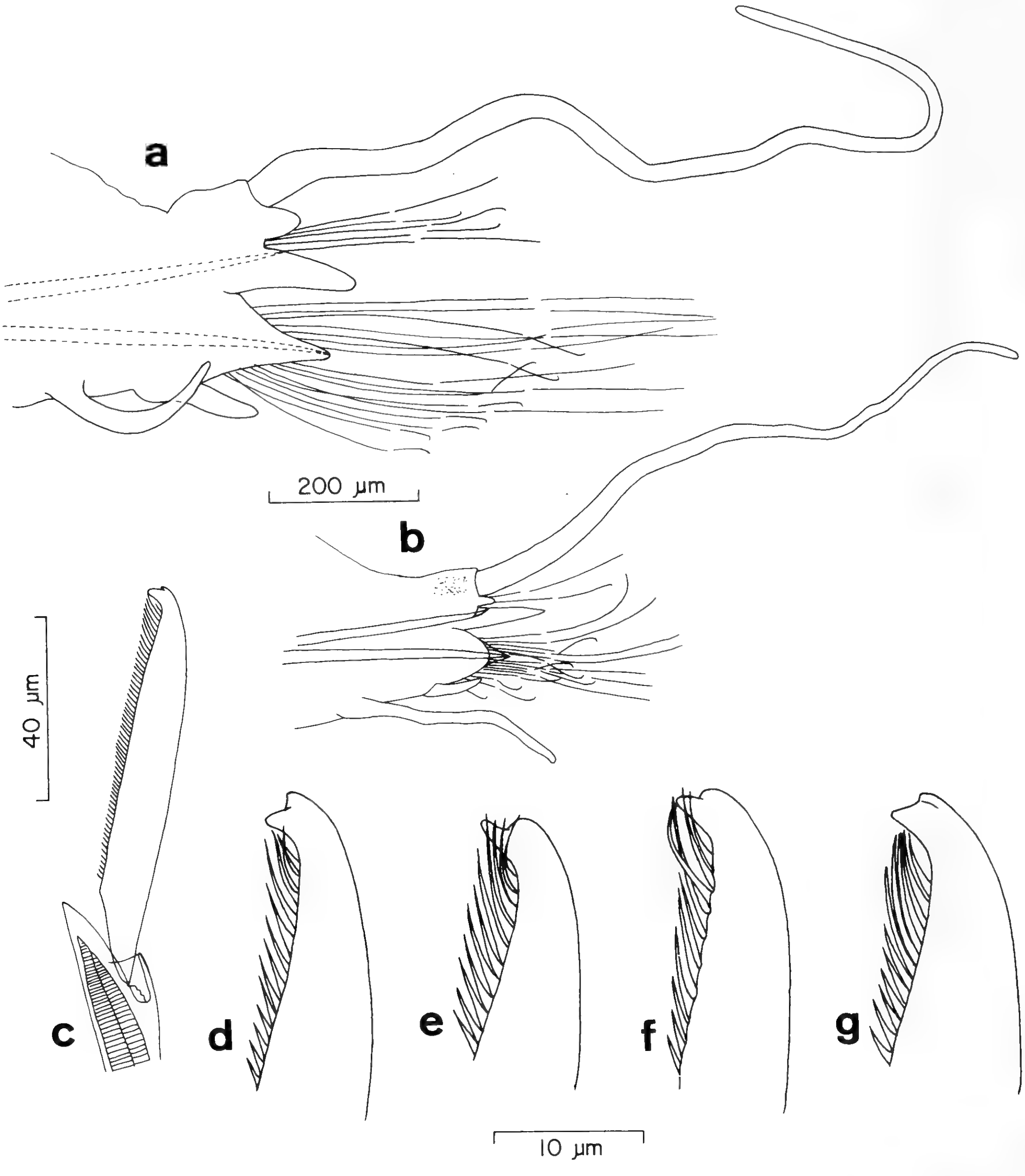


Fig. 2. *Ceratonereis mirabilis,* syntypes: **a,** Parapodium from setiger 25 of anterior fragment, anterior view; **b,** Posterior parapodium, from posterior fragment, posterior view; **c,** Lower neuropodial falciger from same; **d,e,** Tips of notopodial falcigers; **f,** Tip of upper neuropodial falciger; **g,** Tip of lower neuropodial falciger.

LANTIC COAST: Palm Beach, 0.5–0.75 mi off Breakers Hotel, "Breakers Reef," 26°42.8′N, 80°01.2′W, 13.7 m, in carbonate rock, J. W. Smith et al., cols., 3 Mar. 1976, 1 specimen (FSBC I 18980). FLORIDA, GULF OF MEXICO: Florida Middle Ground, 28°35.0′N, 84°14.9′W, 31 m, on coral, R. Matchok, col., 19 May 1977, 1 specimen (FSBC I 18981); 24°43′N, 83°25′W, 68 m; U.S. Coast Survey steamer *Blake* Sta. 11, 1877–78, 1 ato-

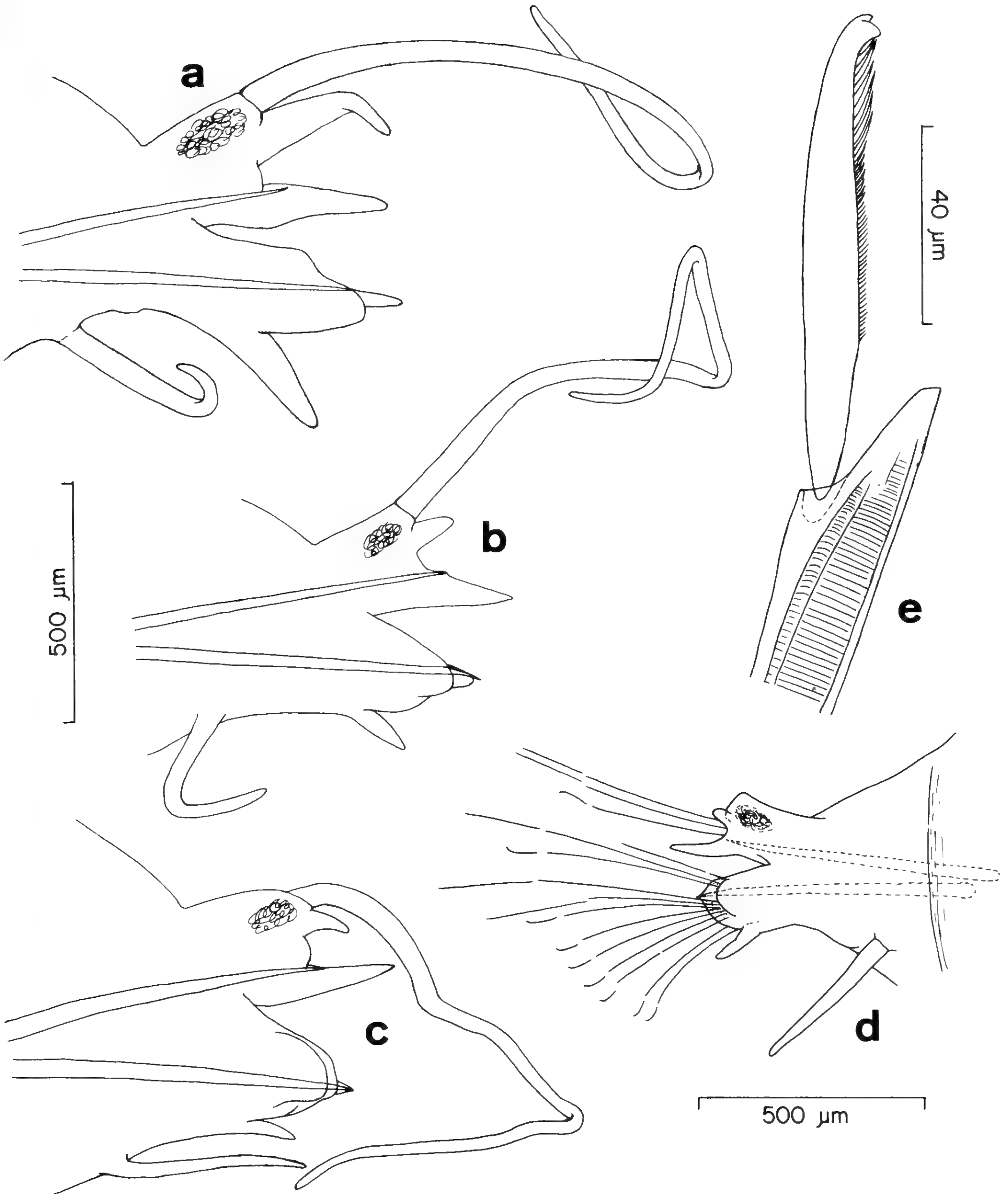


Fig. 3. *Ceratonereis mirabilis*: **a,** Parapodium from setiger 9, posterior view; **b,** Same from setiger 27, posterior view; **c,** Parapodium from setiger 40, posterior view; **d,** 7th parapodium from pygidium, posterior view, style of dorsal cirrus missing; **e,** Upper neuropodial falciger from middle segment (**a,b,** FSBC I 18981; **c,** MCZ 763; **d,** FSBC I 18980; **e,** syntype of *Nereis gracilis,* USNM 4787).

kous male (MCZ 763). PUERTO RICO: Aquadilla, 15 m, N. Hulings and D. Feray, cols., Aug. 1963, 1 juvenile (USNM 42765); Barceloneta, EPA Oceanogr. Study, B. S. Mayo, col., 18°29′57″N, 66°30′50″W, consolidated bottom, Cr. 1, Sta. 6H-1A, 1D, 1E, 1 Aug. 1977, 2 juveniles (USNM 52305);

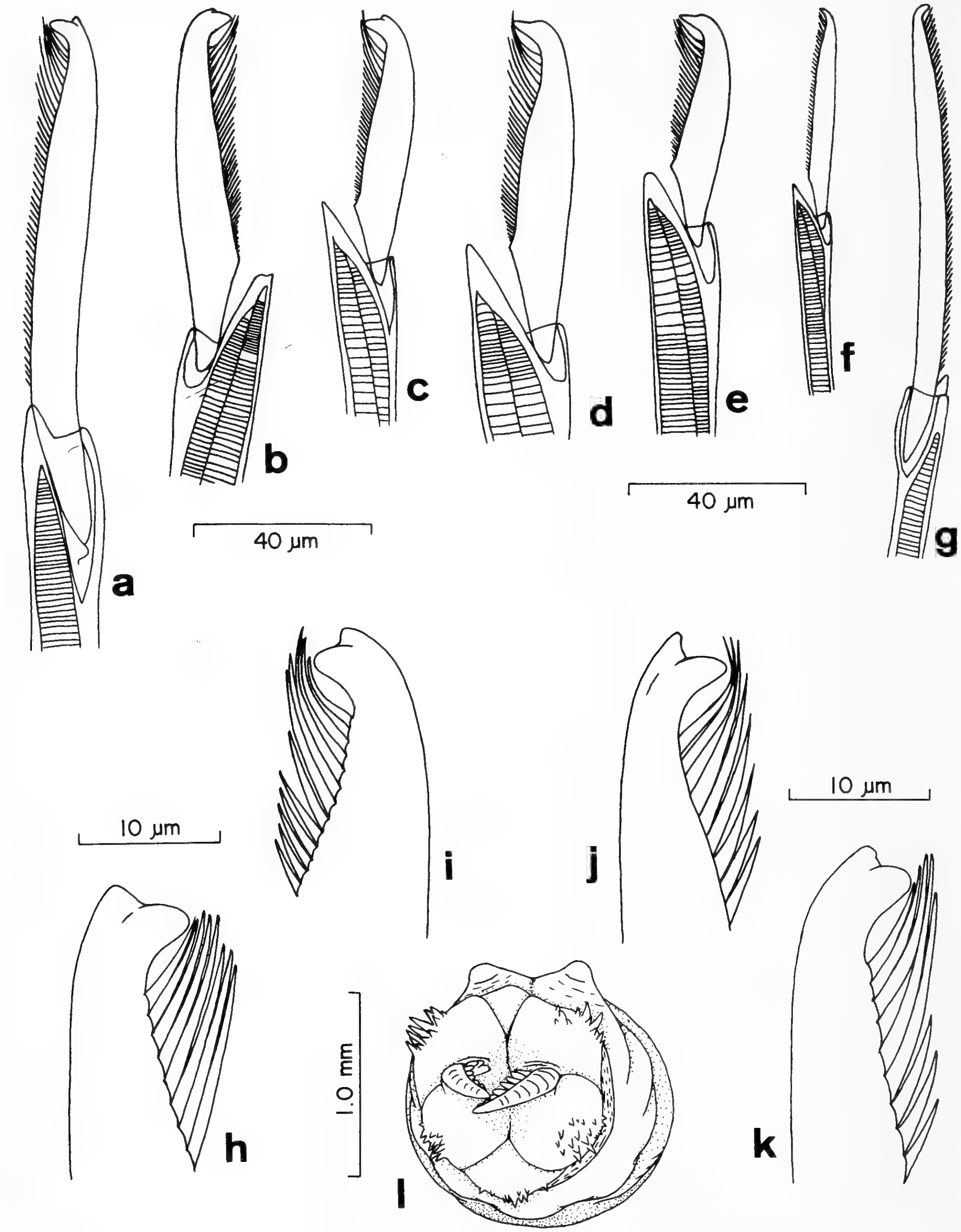


Fig. 4. *Ceratonereis mirabilis*: **a,** Notopodial falciger from setiger 36; **b,** Upper neuropodial falciger from posterior setiger; **c,** Lower neuropodial falciger from setiger 36; **d,** Ventralmost lower neuropodial falciger from same; **e,** Same from posterior setiger; **f,** slender, lower neuropodial falciger from same; **g,** Slender notopodial falciger from same; **h–j,** Notopodial falcigers from middle setigers; **k,** Upper neuropodial falciger from middle steiger; **l,** Proboscis, frontal view (**a–h, j,k,** FSBC I 18980; **i,** USNM 52306; **l,** FSBC I 18981).

same, 18°30′03″N, 66°34′41″W, 12–15 m, hard bottom, Cr. 1, Sta. 6E-1A, 11 Aug. 1974, 1 adult, 2 juveniles (USNM 52306); same, 18°30′03″N, 66°34′41″W, 20 m, hard bottom, Cr. 3, Sta. 6E-3B, 11 Nov. 1974, 1 damaged specimen (USNM 52307). BARBADOS: Barbados-Antigua Expedition, Univ. Iowa, 1918, Sta. 99, 1 specimen (USNM 20313).

Description.—Two syntypes of *C. mirabilis* consisting of anterior fragment of 50 setigers, 13 mm long, 0.9 mm wide without parapodia, 1.7 mm wide including parapodia, gradually decreasing in width after first several segments; middle fragment of 20 setigers (gravid, slightly modified male, not same specimen as anterior fragment) 7 mm long, 2 mm wide including parapodia; pygidial fragment of 25 segments (gravid male, apparently same specimen as middle fragment) 7 mm long. Complete but immature Florida specimen of 75 segments (FSBC I 18980) 40 mm long, 3 mm wide including parapodia. Syntypes colorless; recently collected specimens with reddish-orange to brown pigment on prostomium and tentacular segment, and in 2 transverse bands across dorsum of anterior segments; anterior segmental bands extending in straight line from upper parts of parapodial lobes; posterior bands near segmental grooves; highly colored specimens light orange between segmental bands. Prostomium (Fig. 1a) about twice as wide as long, anteriorly incised to near level of anterior eyes, laterally rounded, slightly incised posteriorly; eyes with lenses, in trapezoidal arrangement open to front, anterior pair slightly larger. Antennae and palps slightly longer than prostomial width; antennae cirriform; palps with cylindrical palpophores and spherical to oblong palpostyles. Tentacular segment similar in length and width to following segment; tentacular cirri very long, longest extending to setiger 10–15. Notopodia of setigers 1 and 2 with dorsal cirri, single ligules and slender acicula; neuropodia similar to those of following segments. Following parapodia biramous (Figs. 1b, 2a, b, 3a–d). Length of dorsal cirri behind first few segments equal to body width without parapodia or more. Upper notopodial ligules of anterior segments longer than all other parapodial lobes, slightly longer than lower notopodial ligules (Fig. 3a), reduced to half length of lower notopodial ligules by setiger 15–25 (Fig. 3b), gradually reduced to small papillae on posterior segments, apparently absent from much of posterior half of juveniles (USNM 52305, 52306). Lower notopodial ligules long on anterior segments, slightly reduced in length on posterior segments proportionately to reduction of parapodial size. Neuropodial presetal lobes [conical ligules below acicula on acicular lobes] relatively long, slender on anterior parapodia, tips extending past tips of acicula on lower side, reduced to acicular lobes by setiger 25–35. Postsetal lobes of anterior segments foliaceous, reduced to obscure, rounded lobes on posterior segments, tips subtriangular to rounded. Neuropodial ligules of anterior segments long, extending to about acicular tips, slightly reduced in length posteriorly proportionate to reduction of parapodial size. Ventral cirri of anterior segments extending about to tips of lower neuropodial ligules, longer than all other parapodial lobes on posterior parapodia of type of *C. mirabilis* (Fig. 2b), relatively long on posterior parapodia of mature specimen from Gulf of Mexico (MCZ 763, Fig. 3c), shorter on immature specimen from Palm Beach (Fig. 3d). Glandular regions in bases of dorsal cirrophores except on Palm Beach specimen, which has them in addition in upper and lower notopodial ligules and lower neuropodial ligules of anterior parapodia. Notopodia with sesquigomph spinigers beginning on setiger 3, joined by long-bladed sesquigomph falcigers (Figs. 1c, d, 4a) beginning on setiger 15–16; blades of falcigers with broadly bifid tips (Figs. 2d, e, 4h, i), stiff hairs on edge short proximally, gradually longer distally, usually not extending past tips; 3 falcigers, 2–6 spinigers on setiger 25; 1 falciger, 1–2 spinigers on posterior setigers; falcigers with shafts similar to spinigers and blades similar to those of anterior neuropodial falcigers on few posterior segments of immature Palm Beach specimen (Fig. 4g; FSBC I 18980) and on much of posterior halves of juveniles (USNM 52305, 52306). Upper neurosetae consisting of posterior row of sesquigomph spinigers and anterior group of long-bladed heterogomph falcigers; blades of falcigers of anterior setigers with evenly rounded, unidentate tips; blades shorter than those of notopodial falcigers on middle and posterior segments (Figs. 1e, f, 2f, 3e, 4b, k) with tips similar but stouter, with stiff hairs similar but usually extending slightly past tips; 2–3 falcigers, 5–6 spinigers on setiger 25; 1–2 falcigers, 3–6 spinigers on posterior segments. Lower neurosetae heterogomph spinigers and falcigers; blades of falcigers of anterior setigers similar to those of upper neuropodial falcigers; blades of falcigers of middle and posterior segments (Figs. 2g, 4c–e) usually shorter than upper neuropodial falcigers, tips broadly bidentate above to unidentate and concave below on outer edges, usually with longer stiff hairs basally; 6–8 falcigers, 5 spinigers on setiger 25; 5–7 falcigers, 1–3 spinigers on posterior parapodia. Lower bundles of posterior few setigers of Palm Beach specimen with few small falcigers having blades similar to those of anterior segments (Fig. 4f). Acicula pale on all type-specimens and some other specimens, brown on tips in anterior and middle parapodia of additional specimens. Transverse rows of obscure ciliary tufts on dorsum of posterior segments of relatively large but immature Palm Beach specimen and some juvenile specimens.

Possible developing heteronereidids: middle and posterior fragments of male syntype of *C. mirabilis* with slightly modified heteronereidid parapodia (Fig. 1b), without natatory setae, with notopodial falcigers in addition to spinigers on anterior parapodia; atokous male anterior fragment from *Blake* Sta. 11 without sexually modified parapodia (Fig. 3c).

Proboscis (Figs. 1a, 4l): area I, 0 paragnaths; II, 8–14; III, 7–11; IV, 8–14; V, reduced; VI, soft, cushion-shaped lobe; VII–VIII, without structures.

Paragnaths on areas II and IV relatively large, covering oval area; cones on area III smaller, covering smaller area. Jaws amber, mostly dark on convex sides near tips, with 5–7 teeth.

Remarks.—The original description of *C. mirabilis* was very brief and lacked most important characters. Type-specimens of both *C. mirabilis* from Brazil and *C. tentaculata* from Hawaii were examined by Augener (1913:168–171), who stated that there were no important differences between them. Both are considered herein to be distinct species and separable as indicated in the key. Hartman (1948:71,72) also examined the types of both species and considered them synonymous. She briefly supplemented Kinberg's description of *C. mirabilis* but incorrectly stated that paragnaths were present on area I of the proboscis and incorrectly reported the number of paragnaths on other areas. The lower numbers of paragnaths in the ranges given above are from a syntype of *C. mirabilis*.

Notopodial falcigers on the anteriormost remaining segments of the syntype, comprised of middle and posterior fragments, indicate that the specimen originally had at least 15 more anterior segments. The missing segments were probably longer and wider than those remaining, suggesting that the specimen was at least 20 mm (but less than 30 mm) long, 2 mm wide, and consisted of at least 60 setigers.

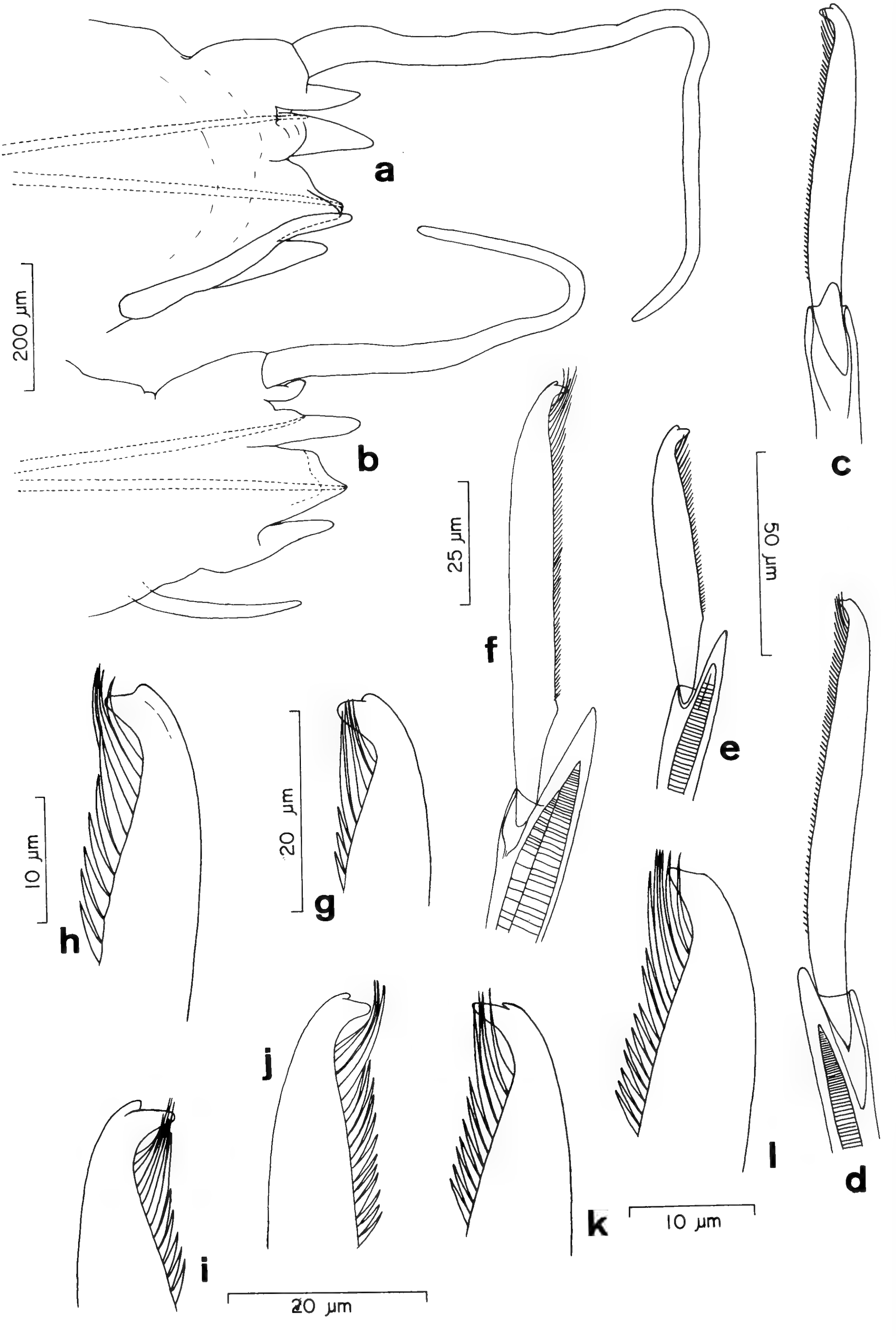
Available syntypes of *Nereis gracilis* consist only of two anterior fragments. (A complete specimen 60 mm long and 4.5 mm wide consisted of 92 segments, according to Webster, 1884). They are about twice as wide as the syntypes of *C. mirabilis,* and there is a corresponding increase in the size of setae and the number of paragnaths on the proboscis. As on *C mirabilis,* ventral cirri of anterior segments extend about to the tips of lower neuropodial ligules and are longer than all the other parapodial lobes on posterior parapodia, as figured by Webster (1884:Pl. 9, Fig. 32). Because other aspects of the parapodia are also similar, *C. mirabilis* and *N. gracilis* are here considered to by synonyms.

Records of *N. gracilis, C. mirabilis,* and *C. tentaculata* from the Gulf of Mexico and the Caribbean area, cited in Perkins and Savage (1975:32–34), may have included specimens of other species. The specimen reported as *C. mirabilis* by Renaud (1956:17, 18) from Key West may be different from any species that I have examined, since it was described and figured as having paragnaths on area I of the proboscis.

Ceratonereis tentaculata Kinberg

Fig. 5

Ceratonereis tentaculata Kinberg, 1866:170; 1910:51, Pl. 20, Fig. 5b–g.
Nereis (Ceratonereis) tentaculata.—Augener, 1913:168–171 [in part].


a
200 µm
b
c
50 µm
25 µm
f
e
d
10 µm
h
20 µm
g
j
i
k
l
10 µm
20 µm

Ceratonereis mirabilis.—Hartman, 1948:71, 72 [in part].—Imajima, 1972:64–66 [in part], Figs. 13a–j, l, n, p–s [not Kinberg, 1866].

Material examined.—HAWAII: Honolulu, Oahu, outside of port, 18 m, among green and brown algae, *Eugenie* Expedition 1851–53, 2 syntypes (NRS 542).

Description.—Anterior fragment of 9 setigers from larger syntype, with proboscis everted, 3 mm long, 2 mm wide including parapodia; middle fragment of 19 setigers from same specimen 5 mm long, 2 mm wide including parapodia; anterior fragment of 30 setigers from smaller syntype 6.5 mm long, 1.8 mm wide including parapodia; posterior fragment of 9 setigers 2.6 mm long, 1.4 mm wide including parapodia. Colorless in alcohol. Prostomium of small syntype, with proboscis withdrawn, about as long as wide, almost twice wider than long on larger syntype with proboscis everted; prostomium anteriorly incised to near level of anterior eyes, laterally rounded, posteriorly straight or slightly concave. Eyes purple, lensed, large, in contact on each side, in trapezoidal arrangement open to front. Antennae cirriform, slightly longer than prostomial width. Palps shorter than antennae, with cylindrical palpophores and sperical to oblong palpostyles. Longest tentacular cirri about as long as anterior 15 setigers, shortest ones about as long as anterior 5 setigers. Notopodia of setigers 1 and 2 subbiramous with dorsal cirri, single ligules and acicula; neuropodia similar to those following segments. Following parapodia biramous (Figs. 5a, b). Dorsal cirri behind first few segments almost as long as body width without parapodia. Upper notopodial ligules as long as lower ones on anterior segments, posteriorly slightly reduced in length but remaining subequal to lower ligules (Fig. 5b; Kinberg, 1866:Pl. 20, Fig. 5f); both upper and lower ligules after about setiger 20 remaining relatively constant to posterior end (Figs. 5a, b). Presetal lobes of anterior segments extending as conical projection slightly past tips of acicula on lower sides, reduced to acicular lobes by setiger 20. Postsetal lobes of anterior segments not extending to tips of acicula, slightly asymmetrical, with tips directed slightly ventrally, gradually reduced in size but continuing to middle part of body or beyond. Neuropodial ligules of anterior setigers about as long as lower notopodial ligules, reduced in length posteriorly, but extending almost as

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Fig. 5. *Ceratonereis tentaculata*, syntypes: **a,** Parapodium from setiger 24, posterior view; **b,** Posterior parapodium, anterior view; **c,** Notopodial falciger; **d,** Same, from setiger 24; **e,** Neuropodial falciger from middle segment; **f,** Upper neuropodial falciger from middle segment; **g,** Notopodial falciger from setiger 30; **h,** Same, from setiger 24; **i,** Upper neuropodial falciger from setiger 30; **j,** Same from middle setiger; **k,** Lower neuropodial falciger from setiger 30; **l,** Same, from setiger 24 (**a,d,f,h,j,l,** large syntype; **c,e,g,i,k,** small syntype; **b,** posterior fragment).

far as neuropodial aciculum on posterior segments. Ventral cirri of anterior and middle segments extending slightly farther laterally than lower neuropodial ligules, slightly shorter than ligules posteriorly (Fig. 5b) or possibly longer (Kinberg, 1910:Pl. 20, Fig. 5f). Notopodia with sesquigomph spinigers beginning on setiger 3, joined by sesquigomph falcigers beginning on setiger 15–20; blades of falcigers long, slender, with broadly bifid to distinctly bidentate tips (Figs. 5c, d, g, h), stiff hairs on edge short proximally, gradually longer distally, extending about to tips; 1–2 falcigers, 3–5 spinigers on setiger 23; 3 falcigers, 1–2 spinigers on posterior parapodia. Upper neurosetae consisting of posterior row of sesquigomph spinigers and anterior group of few heterogomph falcigers; blades of falcigers of anterior segments long, with evenly rounded, unidentate tips (Kinberg, 1910:Pl. 20, Fig. 5g), blades of upper neuropodial falcigers on middle and posterior segments long, slender (Fig. 5f), with tips similar to those of notopodial falcigers, with stiff hairs similar but extending well past tips on large syntype (Figs. 5f, j), slightly past tips on small syntype (Figs. 5e, i); 3 falcigers, 5 spinigers on setiger 23; 2 falcigers, 4 spinigers on posterior parapodia. Lower neurosetae heterogomph spinigers and falcigers; blades of falcigers of anterior segments similar to those of upper neuropodial falcigers; blades of middle and posterior segments similar to those of upper neuropodial falcigers, with shorter blades; tips with distinct, small secondary tooth above, changing to unidentate and concave, then to evenly rounded on outer edges of tips below (Figs. 5k, l); 6 falcigers, 10 spinigers on setiger 23; 5 falcigers, 4 spingers on posterior parapodia. Acicula light amber. No indication of heteronereidid modification of syntypes.

Proboscis: area I, 0 paragnaths; II, long oval group of 8–9; III, triangular group of 6; IV, oval group of 11; V, reduced; VI, soft, cushion-shaped lobe; VII–VIII, without structures. Jaws brown, with about 7 teeth.

Remarks.—*Ceratonereis tentaculata* is similar to *C. mirabilis* in the prostomium, the tentacular segment, and the falcigers, but differs as indicated in the key. Further, stiff hairs on tips of neuropodial falcigers of *C. tentaculata* are slightly longer than those of *C. mirabilis* on the larger, mature syntype. These differences appear more important than generally believed. Because sexual reproductive stages of both *C. mirabilis* and *C. tentaculata* are unknown and may also differ, I am for the present retaining *C. tentaculata*.

In addition to the type-specimens from Hawaii, Imajima's (1972) account of *C. mirabilis* indicates that *C. tentaculata* is also found in Japan; his account certainly referred to at least two species. Augener (1913), who examined the type-specimens, reported this species from Western Australia. Other accounts of *C. mirabilis* and *C. tentaculata* from Indo-Pacific areas may have referred to this species or to other species. Hartman's (1954a) specimens from South Australia (AHF 37651), reported as *C. mirabilis,* were examined and are a different species very similar to *C. singularis;* Horst's account (1924:36) referred in part (Sarassa specimen, *Siboga* Sta. 43) to an undescribed species. A specimen from Bikini (AHF 35912) reported by Hartman (1954b) as *C. mirabilis* and which I examined, appears to be the same as the latter.

Ceratonereis excisa (Grube)

Fig. 6

Nereis excisa Grube, 1874:72, 73.
Nereis (Ceratonereis) tentaculata.—Augener, 1913:168–171 [in part].

Material examined.—BRAZIL: Desterro [Florianópolis, Santa Catarina Is.], F. Müller, col., 2 syntypes (ZMB Q 3504).

Description.—Larger syntype of 88 segments, 22 mm long, 1.2 mm wide without parapodia, 2.1 mm wide with parapodia; smaller syntype of about 95 segments, 16 mm long, 0.7 mm wide without parapodia, 1.5 mm wide with parapodia. Colorless in alcohol. Prostomium (Fig. 6a) about as long as wide, anteriorly incised for short length, laterally rounded, slightly concave posteriorly. Two pairs of relatively small eyes on posterior half in trapezoidal arrangement open to front; prominent, subdermal glandular area between anterior eyes and antennae. Antennae cirriform, longer than prostomium and palpophores by about half. Palps with long, cylindrical palpophores and small, oblong palpostyles (relatively broader on smaller syntype). Upper tentacular cirri equal to about 10 segments in length; lower tentacular cirri to 4 segments in length. Notopodia of setigers 1 and 2 subbiramous with dorsal cirri, single ligules, and acicula; neuropodia similar to those of following segments. Following parapodia biramous (Figs. 5b–f). Dorsal cirri about as long as parapodial length behind anterior few segments, about as long as body width without parapodia by setiger 25, continuing about as long to posterior end, with bases elongating into short cirrophores on middle and posterior segments. Upper notopodial ligules of anterior few segments about as long as neuropodial presetal lobes, reduced to small papillae near lateral borders of dorsal cirrophores by setiger 25 and absent after setiger 32 of large syntype; reduced by about setiger 35 and absent by setiger 55 of small syntype (Figs. 6c–f). Lower notopodial ligules continuing relatively undiminished to posterior end. Neuropodial presetal lobes reduced to acicular lobe by about setiger 20. Neuropodial postsetal lobes foliaceous, extending about as far as acicular lobe on anterior segments, gradually reduced to obscure, rounded lobes on posterior segments. Neuropodial ligules extending farther than acicular lobes on anterior 10–12 setigers, rapidly reduced in length posteriorly and much shorter than acicular lobes, continuing as short lobes to posterior end. Ventral cirri similar in size throughout, extending laterally for much shorter distance than lower neu-

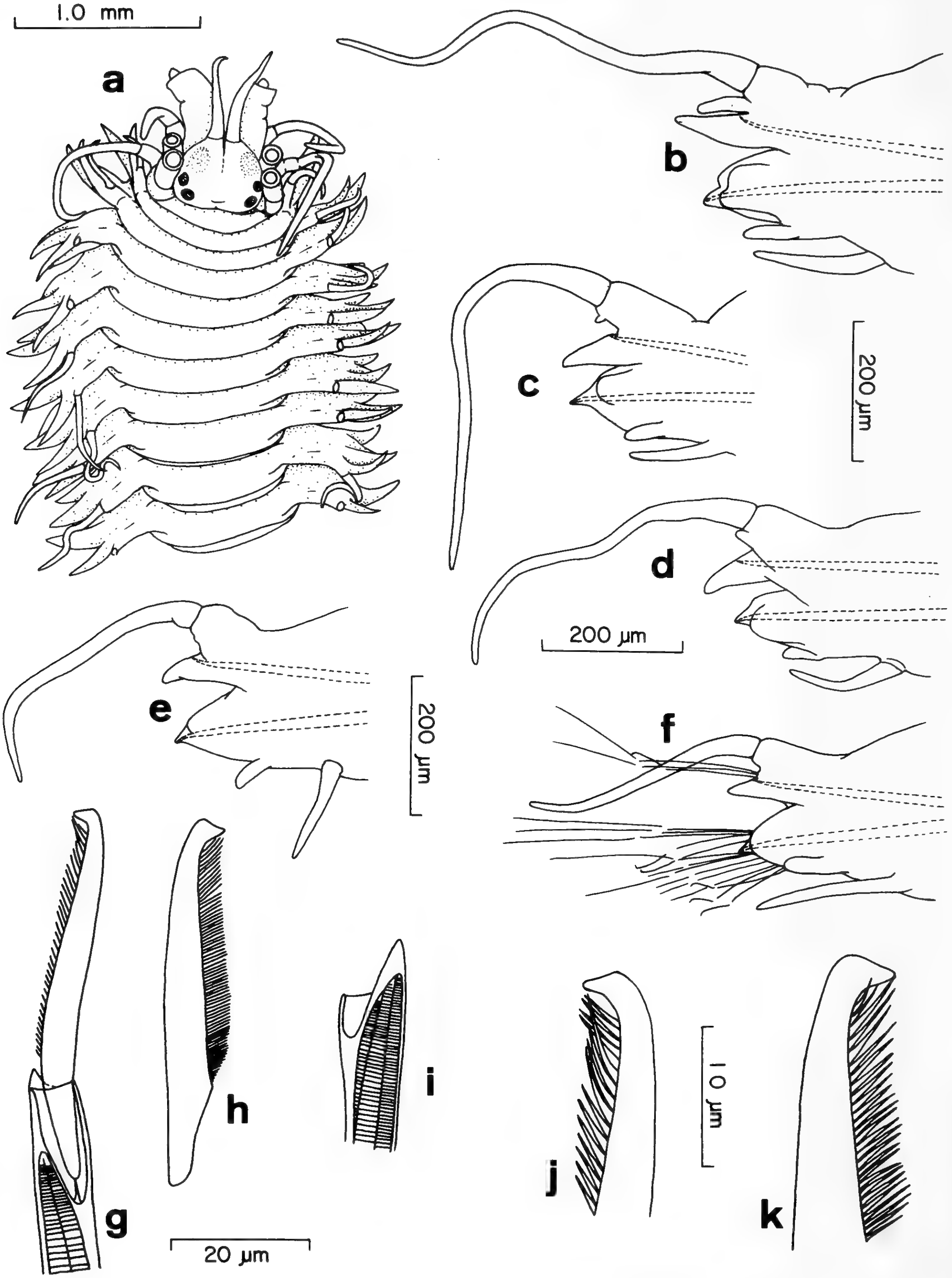

Fig. 6. *Ceratonereis excisa,* syntypes: **a,** Anterior end, dorsal view; **b,** Parapodium from setiger 25, posterior view; **c,** Parapodium from setiger 40, posterior view; **d,** Parapodium from setiger 50, posterior view; **e,** Parapodium from setiger 60, posterior view; **f,** Posterior parapodium, posterior view; **g,** Notopodial falciger from setiger 40; **h,** Blade of upper neuropodial falciger of same; **i,** Shaft of same; **j,** Tip of **g,** magnified; **k,** Tip of **h,** magnified (**a,** large syntype; **b–k,** small syntype).

ropodial ligules on anterior segments, thereafter extending about as far as ligules to posterior end. Notopodia with sesquigomph spinigers beginning on setiger 3, joined by sesquigomph falcigers beginning on setiger 18 on larger, 16 on smaller syntype (Figs. 6g, j). Upper neurosetae consisting of posterior row of sesquigomph spinigers and anterior group of heterogomph falcigers. Lower neurosetae heterogomph spinigers and falcigers. Blades of falcigers small, slender, unidentate, with outer edges of tips evenly rounded on anterior segments, flattened or slightly concave on middle and posterior segments. Stiff hairs on blade edge shorter proximally to longer distally on notopodial falcigers of middle and posterior segments; stiff hairs long, similar in length throughout on blades of neuropodial falcigers (Figs. 6h, k); hairs relatively fine, not extending to tips of blades. Setae of setiger 22 of large syntype: notosetae, 1 falciger, 6 spinigers; upper neurosetae, 2 falcigers, about 10 spinigers; lower neurosetae, 3 falcigers, about 12 spinigers. Parapodium of setiger 40 of small syntype with fewer notopodial and upper neuropodial spinigers. Setae of posterior parapodium: notosetae, 1 falciger, 2 spinigers; upper neurosetae, 2 falicgers, about 10 spinigers; lower neurosetae, 3 falcigers, about 10 spinigers. Acicula clear proximally, light brown distally. Small syntype with single anal cirrus about twice as long as posterior dorsal cirri. No sexually modified specimens.

Proboscis examined on dissected specimen as follows: area I, 0 paragnaths; II, 5; III, 6; IV, 7; V, reduced; VI, cushion-shaped lobe; VII–VIII, without structures (groups II–IV, according to Grube, 1874).

Remarks.—In addition to the distinguishing characters included in the key, *C. excisa* is unique in having prominent subdermal structures, possibly associated with the brain, between the anterior eyes and antennae, and a reduced number of lower neuropodial falcigers.

The species is known only from the original report.

Ceratonereis singularis Treadwell
Figs. 7–10

Ceratonereis mirabilis.—Ehlers, 1887:117–120, Pl. 37, Figs. 1–6 [in part].—Treadwell, 1939:222, Fig. 47 [figure only, taken from Ehlers, 1887].—Hartman, 1956:248; 1968:505–506, Figs. 1–4.—Rioja, 1960:249; 1963:166.—Fauchald, 1973:21 [part from Naos Island, Panama].—Gardiner, 1976:147, Figs. 14f–j [not Kinberg, 1866].

Ceratonereis singularis Treadwell, 1929:1–3, Figs. 1–8.

Ceratonereis tentaculata.—Hartman, 1940:218, Pl. 35, Fig. 47 [in part?].—Rioja, 1941:705, Pl. 8, Fig. 10; 1947:203 [not Kinberg, 1866].

Nereis (Ceratonereis) tentaculata.—Berkeley and Berkeley, 1960:359 [in part; not *Ceratonereis tentaculata* Kinberg, 1866].

Material examined.—MEXICO: San José Island, Gulf of California, 25–26 Mar. 1911, holotype, heteronereidid of unknown sex (AMNH 1986); Cerralvo Island, Gulf of California, 24°08′N, 109°50′W, 1935, Treadwell, det., 1 heteronereidid anterior fragment of unknown sex (AMNH 3159); La Paz harbor, Gulf of California, Klawe, col., 11 Mar. 1959, 2 heteronereidids of unknown sex (fragments of 1 complete and 1 incomplete specimen; as *Nereis (Ceratonereis) tentaculata* by the Berkeleys, USNM 58734); Bahia Falsa, La Paz, Gulf of California, W. Shepherd, col., 14 Nov. 1971, 1 atokous male specimen, prostomium and tentacular segment missing (USNM 48857); Zihuatanejo, Klawe, col., 9 June 1958, 2 specimens (complete atokous female, anterior and middle fragments, USNM 35688). PANAMA: Naos Island, Dexter, col., 30 June 1969, 1 anterior fragment of immature specimen (AHF; as *C. mirabilis* by Fauchald). NORTH CAROLINA: Onslow Bay, 34°20′N, 75°54′W, 24 m, on rock and dead coral, E. Powell, col., 4 Nov. 1974, 2 specimens (USNM 52930; as *C. mirabilis* by Gardiner). FLORIDA, EAST COAST: Just N of Sebastian Inlet on NE side of Indian River, Brevard County, 100 m offshore, Indian River Coastal Zone Study, Sta. 116D, 29 May 1965 (SIFP 50:0785); Hutchinson Island, Sta. IV, 27°20.7′N, 80°12.8′W, about 11 m, coarse calcareous sand, 11 specimens (1 female partially developed heteronereidid; USNM 58735, 58736; FSBC I 22616–22620); Sta. V, 27°22.9′N, 80°13.9′W, about 11 m, coarse calcareous sand, 2 specimens (FSBC I 22621, 22622). FLORIDA, GULF OF MEXICO: Florida Bay, USFC *Fish Hawk*, 29 Jan. 1903, 2 anterior fragments (USNM 28170); Saddlebunch Key, Monroe County, intertidal, sand, S. L. Gardiner, col., Mar. 1972, 1 anterior fragment of partially modified male heteronereidid (USNM 53742); Conch Key, Monroe County, intertidal, sand, H. Wilson, col., 9 Mar. 1975, 1 anterior fragment (USNM 53743); Key West, Monroe County, 2–4 m, U.S. Coast Survey steamer *Blake*, 1877–78, 1 partially modified male heteronereidid, 1 atokous female (as *C. mirabilis* by Ehlers; MCZ); off Shark River, Monroe County, 25°30′N, 81°27′W, 5.4 m, on stone crab trap, R. Sullivan et al., cols., 15 July 1976, 1 atokous male (FSBC I 22623). GULF OF MEXICO: 33 m, E. Powlus, col., 26 Aug. 1961, 1 specimen (USNM 55605). COLOMBIA: Barú Island, Cartagena, over floating wood, P. Ricardo Dueñas, col., Nov. 1978, 1 specimen (USNM 58737).

Description.—Complete eastern Pacific atokous gravid female of about 65 setigers (USNM 35688) 18 mm long, 1.7 mm wide with parapodia (Rioja, 1941, 1963, reported specimens 25–40 mm long and 1.5–2 mm wide; Treadwell, 1929, stated specimens averaged 15 mm length). Western Atlantic specimens mostly larger; complete, immature, atokous specimen of 60 setigers (SUNM 58736), from Hutchinson Island, 20 mm long, 2 mm wide including parapodia; partially metamorphosed female anterior fragment (USNM 58735) slightly wider; Ehlers' specimens (1887; MCZ) including anterior fragment of partially metamorphosed male of 39 setigers, 18 mm long, slightly less than 5 mm wide with parapodia, and nearly complete, atokous female of 56 setigers, 22 mm long, 4 mm wide including parapodia; largest specimen, partially metamorphosed male anterior fragment of 41 setigers (USNM 53742) 42 mm long, 4.7 mm wide with parapodia (apparently relaxed before fixation and preservation). Eyes dark red; reddish-brown pigment on anterior part of body; prostomium pigmented on medial borders of anterior lobes, on lateral and posterior margins, and on large suboval area between posterior pair of eyes; tentacular segment with narrow bands on anterior and posterior margins; dorsum of anterior setigerous segments with 2 transverse bands, anterior ones continuing on dorsal sides of parapodial lobes, posterior bands near posterior margins and continuing on posterior sides of parapodia.

Atokous specimens: prostomium (Fig. 7a; Ehlers:1887, Pl. 37, Fig. 1; Gardiner, 1976:Fig. 14f) about 1.5 times wider than long, incised anteriorly to about level of anterior eyes, rounded laterally and posteriorly. Antennae about as long as prostomial width, cirriform, occasionally with blunt tips; palps with long subcylindrical palpophores and short rounded palpostyles, together about as long as antennae or much shorter when contracted; palps and antennae often widely divergent. Eyes with lenses, in trapezoidal arrangement open to front, subequal on Pacific specimens, with anterior pair up to 1.5 times larger on Atlantic specimens. Longest tentacular cirri about equal to length of first 10–15 setigers. Notopodia of setigers 1 and 2 (Figs. 7b, 8c) subbiramous, with short dorsal cirri, usually shorter single ligules and slender acicula; neuropodia similar to those of following segments but with smaller postsetal lobes. Following parapodia biramous (Figs. 7b, c, 8a, b, 9). Parapodia relatively long throughout body. Dorsal cirri behind first few setigers about ¾ segmental width on some Pacific specimens, about as long as segmental width without parapodia on Atlantic specimens. Upper and lower notopodial ligules subequal on anterior segments, relatively long, ⅓–¼ length of dorsal cirri; upper ligules gradually reduced posteriorly, shorter than lower notopodial ligules, usually about as long as part of lower ligules extending past tips of acicula, shorter on immature specimens; lower ligules relatively prominent throughout, decreasing in length posteriorly proportionate to parapodial size, usually extending farther than other parapodial lobes. Neuropodial presetal lobes behind first few segments shorter than lower notopodial ligules, usually extending farther than neuropodial ligules, reduced to acicular lobes on middle and posterior segments. Neuropodial postsetal lobes prominent on anterior segments, with rounded or slightly papillate tips, extending about to tips of acicula, gradually reduced to obscure, rounded lobes on posterior segments. Neuropodial ligules longer than presetal lobes on first few setigers, gradually reduced posteriorly proportionate to reduction in parapodial size, extending to near tips of presetal or acicular lobes on Pacific specimens, extending about ½ as far and usually

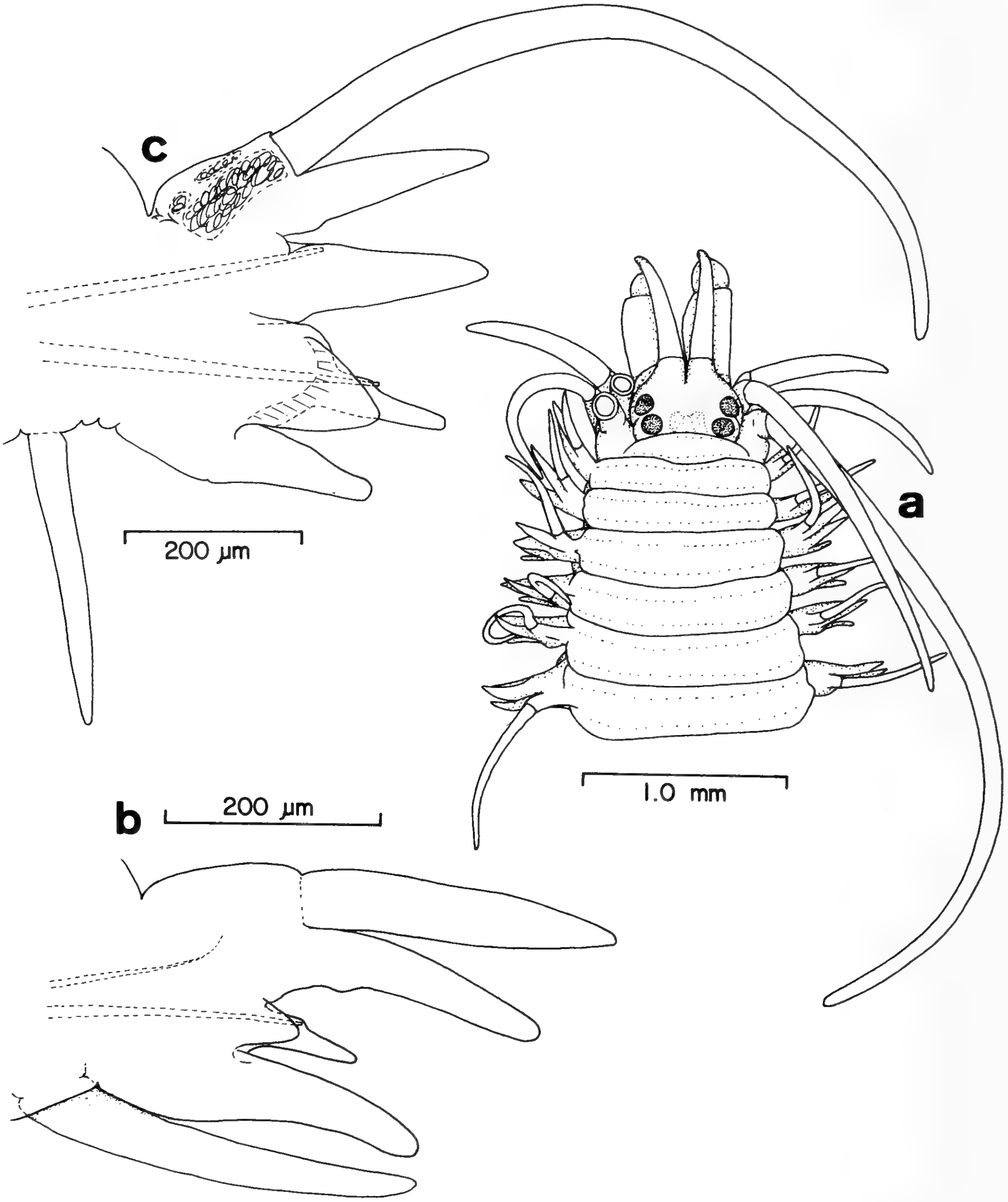

Fig. 7. *Ceratonereis singularis* (gravid, atokous female from Zihuatanejo, western Mexico, USNM 35688): **a,** Anterior end, dorsal view; **b,** Parapodium from setiger 1, posterior view; **c,** Same, from setiger 10, posterior view.

more slender on Atlantic specimens. Ventral cirri slender, similar in relative size throughout, not extending as far as parapodial lobes. Notopodia with sesquigomph spinigers beginning on setiger 3, joined by long-bladed, sesquigomph falcigers beginning on setigers 14–20; blades of spinigers with short, stiff hairs from bases to near tips; blades of falcigers with unidentate tips, evenly rounded to slightly concave distally (Figs. 10a–d, h–k, m); 30–50 stiff hairs on edge, short proximally, gradually increasing in length,

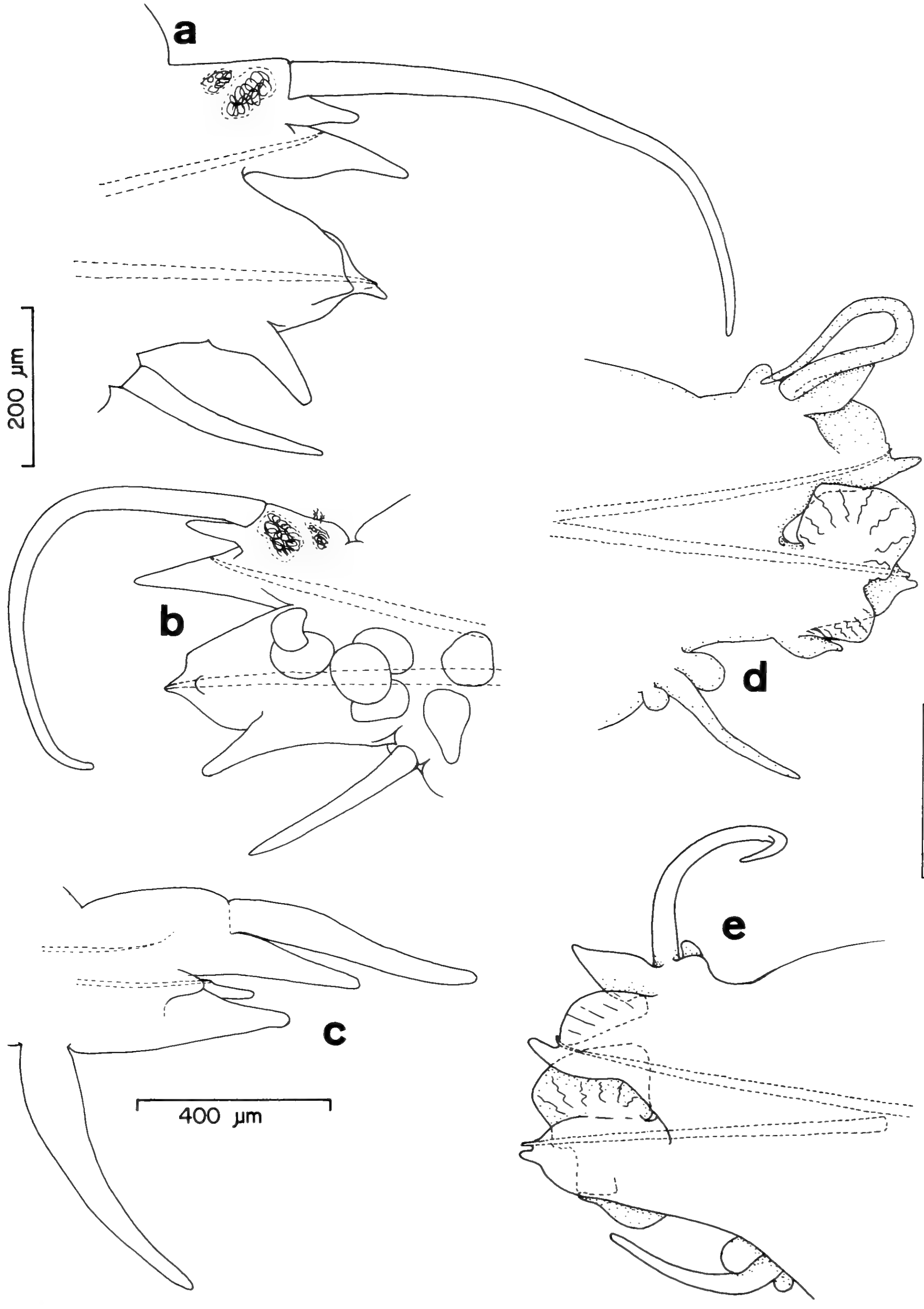

Fig. 8. *Ceratonereis singularis* (eastern Pacific specimens): **a,** Parapodium from setiger 30, posterior view; **b,** Parapodium from posterior setiger, posterior view; **c,** Parapodium from setiger 1 of heteronereidid, posterior view; **d,** Parapodium from setiger 25 of heteronereidid, posterior view; **e,** Parapodium of setiger 24 of same, anterior view (**a,b,** gravid, atokous female, USNM 35688; **c,** USNM 35687; **d,e,** holotype).

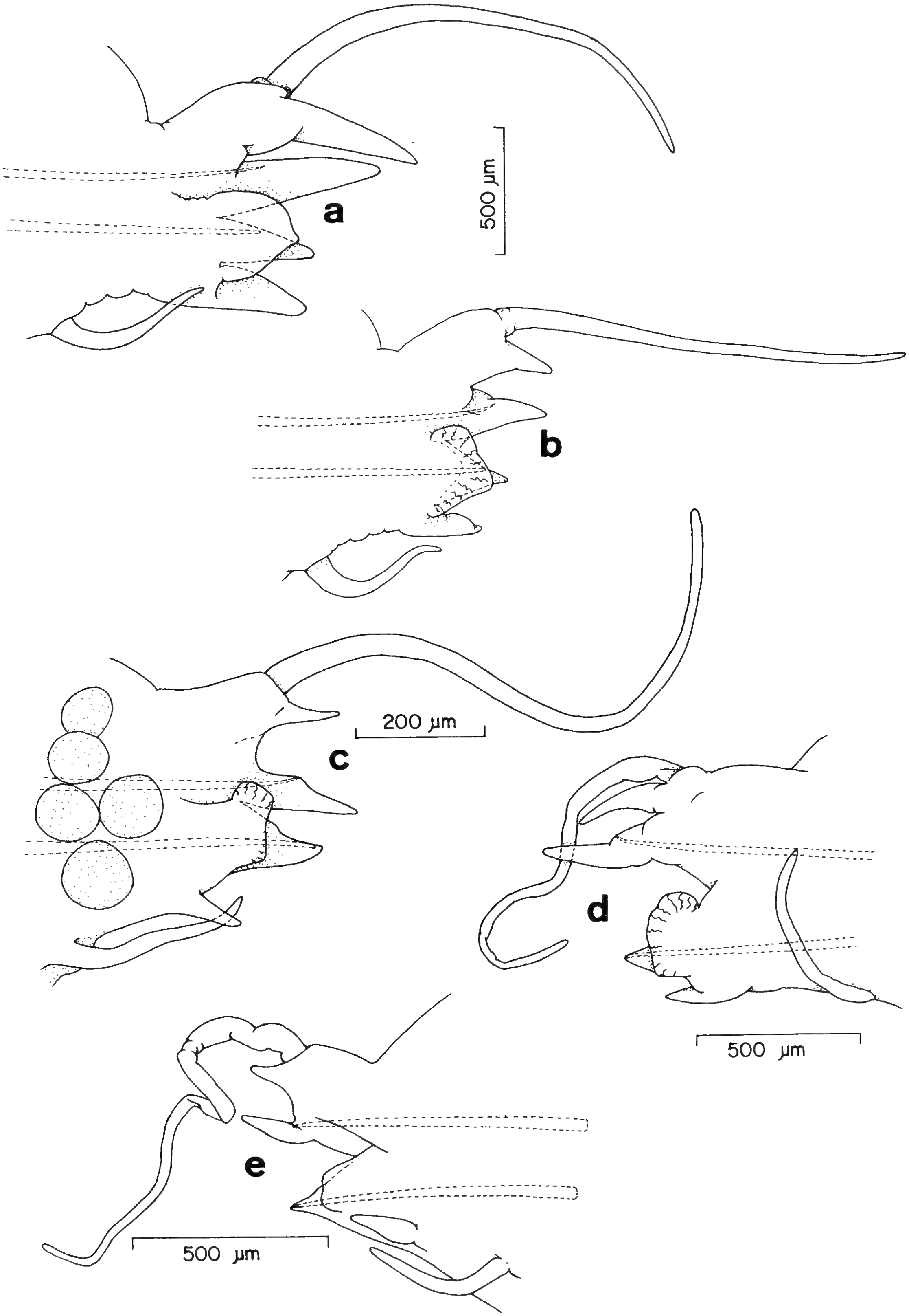

Fig. 9. *Ceratonereis singularis* (western Atlantic specimens): **a,** Parapodium from setiger 15, posterior view; **b,** Parapodium from setiger 30, posterior view; **c,** Parapodium from setiger

abruptly longer distally and extending beyond tips; falcigers smaller on first few segments, thereafter stouter, subequal throughout; 1–2 falcigers on Pacific specimens, 2–5 on Atlantic, 2–4 spinigers on parapodia of about setiger 30; 1–2 falcigers, 2 spinigers on posterior parapodia. Upper neurosetae consisting of posterior row of sesquigomph spinigers and anterior group of long-bladed, heterogomph falcigers; blades of falcigers of anterior segments figured by Treadwell (1929, Fig. 7) and Ehlers (1887, Pl. 37, Fig. 3); blades on middle and posterior setigers shorter than those of notopodial falcigers with similar tips (Figs. 10e, l), with stiff hairs similar but longer proximally; 2–3 falcigers, 8–9 spinigers on about setiger 30; 1–2 falcigers, 4–5 spinigers on posterior parapodia. Lower neurosetae consisting of upper heterogomph spinigers merging with lower heterogomph falcigers; blades of falcigers of anterior segments similar to those of upper neuropodial falcigers; blades of falcigers of middle and posterior segments as long as upper neuropodial falcigers above but lower ones shorter, with similar stiff hairs, with more slender, straighter tips (Figs. 10f,g); 6–9 falcigers, 6–10 spinigers on parapodia of about setiger 30; 5–8 falcigers, 3–5 spinigers on posterior parapodia. Acicula dark brown on distal half in anterior and middle segments of mature specimens. About 3 rows of ciliary tufts on dorsum of setigerous segments, with middle row extending on upper edges of parapodia of some specimens, several rows evident on one specimen (USNM 53742).

Epitokous specimens: prostomium of Pacific specimen with slightly enlarged anterior eyes, with long, enlarged, lanceolate antennae. Unmodified anterior region 16 setigers, with dorsal cirri possibly slightly stouter on anterior few setigers (Fig. 8c); region of swimming parapodia (Figs. 8d, e) of 12–15 segments and "tail" of 25–35 segments; swimming parapodia with atokous setae replaced entirely by swimming setae, with accessory lobes above dorsal cirri and above and below ventral cirri; dorsal cirri shorter than on more anterior and posterior segments, with lamellae between notopodial ligules and bilobed neuropodial postsetal lamellae; tail region of shortened segments, with parapodia similar to those of atokous specimens but without setae. Pygidium of all specimens examined (about 4) without cirri. Atlantic specimens including 3 partially modified heteronereidids: small female from Hutchinson Island, Florida (USNM 58735), with neuropodial lamellae beginning on setiger 19, continuing to setiger 32, with swimming setae partially replacing normal setae; larger males from Key West (MCZ) and Saddlebunch Key, near Key West, Florida (USNM 53742) with

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25, posterior view; **d,** Parapodium from setiger 25, posterior view; **e,** Parapodium from setiger 51, posterior view (**a,b,** metamorphosing male?, USNM 53742; **c,** metamorphosing female, USNM 58735; **d,e,** metamorphosing male, MCZ).

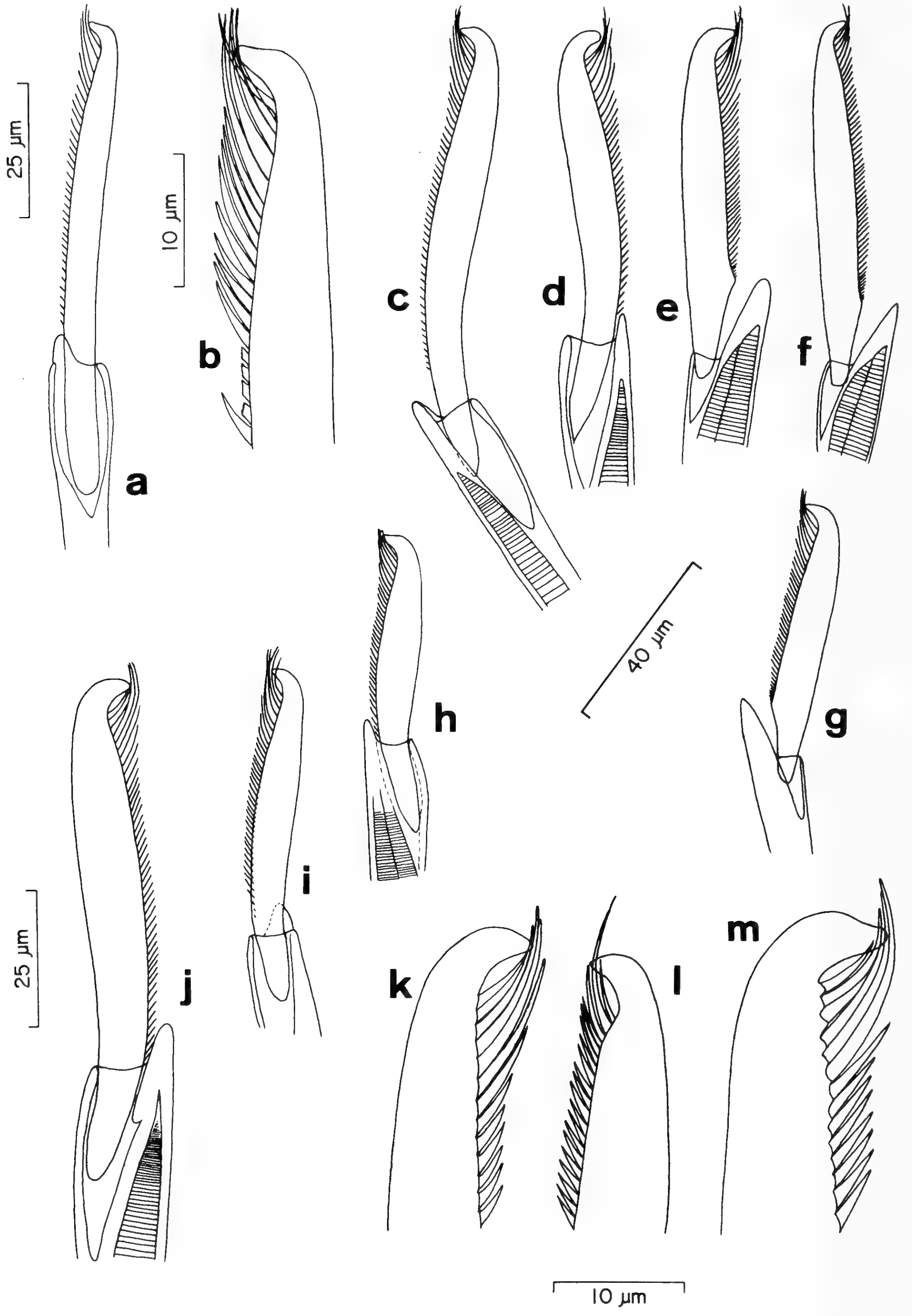

Fig. 10. *Ceratonereis singularis* (falcigers): **a,** Notopodial, from setiger 14; **b,** Tip of **a,** magnified; **c,d,** Notopodial, from posterior parapodium; **e,** Upper neuropodial, from posterior parapodium; **f,g,** Lower neuropodial, from posterior parapodium; **h–j,** Notopodial; **k,** Tip of

neuropodial lamellae beginning on setigers 20 and 22, respectively, without swimming setae on partially modified parapodia; specimens otherwise similar to atokous specimens (Figs. 9b–d).

Proboscis examined by dissection as follows: area I, 0 paragnaths; II, 9–15 in crescent-shaped double row or elongate-oval group; III, 6–10 small cones in small subtriangular to oval group; IV, 10–16, similar in size to those of II, in almost circular group; V, reduced; VI, soft, cushion-shaped lobe; VII–VIII, without structures. Jaws amber to brown with darker margins, with 5–6 teeth.

Remarks.—No diagnostic setae (notopodial falcigers and neuropodial falcigers of middle and posterior segments) remain on the holotype, a heteronereidid, and Treadwell (1929) did not figure one. There are no paratypes deposited in the American Museum of Natural History. A few notopodial falcigers (Figs. 10a, b) were found on setigers 14–16 of a hereonereidid identified by Treadwell as *C. singularis* from near the type-locality (AMNH 3159). The specimen is an anterior fragment of about 25 segments agreeing well with Treadwell's description and the holotype. Similar falcigers were found on another heteronereidid from La Paz, Baja California, Mexico (USNM 58734). Both specimens of the latter lot are missing antennae, but they were apparently enlarged. They otherwise agree well with the holotype. Similar falcigers and parapodia were found on two atokous specimens, including one gravid female, from western Mexico (Figs. 10c, d; USNM 35688) and an atokous male from La Paz identified by the collector as *C. mirabilis* but missing the prostomium and tentacular segment (Fig. 10m; USNM 48857).

Western Atlantic specimens differ slightly from eastern Pacific specimens in average size, in having larger anterior eyes on atokous specimens, slightly longer dorsal cirri, shorter neuropodial ligules on posterior segments and possibly in a more posterior beginning of swimming parapodia on heteronereidids. The setae, however, appear almost identical [specimens from the Gulf of California have falcigers with tips slightly more concave than those of other Atlantic and Pacific specimens (Figs. 10a, b, m vs. 10c, e, h)], and the number and arrangement of paragnaths on the proboscis also appear to be the same. Treadwell's description was apparently incorrect in indicating a larger number of paragnaths on area III than on area IV.

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notopodial, magnified; **l,** Tip of upper neuropodial, magnified; **m,** Tip of notopodial, from setiger 31, magnified (**a,b,** heteronereidid from Cerralvo Is., Gulf of California, AMNH 3159; **c–g,** gravid, atokous female from Zihuatanejo, western Mexico, USNM 35688; **h,i,** gravid metamorphosing male from Key West, Gulf of Mexico, MCZ; **j,** gravid metamorphosing female from Hutchinson Island, USNM 58735; **k,l,** from Hutchinson Island, FSBC I 22619; **m,** gravid, atokous male from La Paz, Baja California, USNM 48857; **h,i,** not scaled).

Hartman (1940:218, Pl. 35, Fig. 37) and Rioja (1941:705, Pl. 8, Fig. 10; 1947:203) under *C. tantaculata,* and Hartman (1956:248) and Rioja (1960:249; 1963:166) under *C. mirabilis* included *C. singularis* in synonymy, and both figured falcigers similar to those of *C. singularis.* However, their records, especially those of Hartman (1940), cover a broad geographic and depth range from southern California to Ecuador, including the Gulf of California and the Galapagos Islands, and may include other species. Specimens reported by Berkeley and Berkeley (1960) from La Paz as *Nereis (Ceratonereis) tentaculata,* which I examined, include *C. singularis* (USNM 58734) and heteronereidids of another *Ceratonereis* species (USNM 35687). The latter species has an incised prostomium, a dark brown bar completely covering the dorsum of the tentacular segment, very long dorsal cirrophores on posterior segments, no upper notopodial ligules on posterior segments, and a single specimen with one bidentate falciger. Another heteronereidid from Sta. Elena Bay, Ecuador (USNM 35686), identified as the same species by the Berkeleys, has 4–7 very large paragnaths on areas II and IV of the proboscis and 2 very small ones on area III. The specimen reported by Fauchald (1973) as *C. mirabilis* from Naos Island, Panama, is *C. singularis*; his specimen from Santa Marta, Colombia, is a juvenile, possibly of the same species.

Ceratonereis singularis includes two specimens from Key West referred to *C. mirabilis* by Ehlers (1887). The tag accompanying the specimens indicates that Ehlers had first intended to report the specimens as *Nereis excisa,* which is a different species. Further, it is apparent that the Key West specimens were used almost completely, if not completely, in the formulation of his description of *C. mirabilis,* and that another specimen from *Blake* Sta. 11 (MCZ 763) 24°34′N, 83°25′W, 68 m, was used only superficially. No parapodia were removed from the latter and the proboscis was not dissected. This specimen proved to be *C. mirabilis.* Material reported by Ehlers from 13 m off Key West is apparently not held by the Museum of Comparative Zoology.

Ceratonereis singularis, as presently defined, ranges from Mexico to Panama in the eastern Pacific Ocean and is reported from North Carolina, eastern and southern Florida, the Gulf of Mexico, and Colombia in the western Atlantic.

Ceratonereis longicirrata, new species

Figs. 11, 12

Nereis gracilis.—Treadwell, 1924:13 [in part, specimens from Pelican Island; not Webster, 1884].

Ceratonereis mirabilis.—Allen, 1957:52.—Vittor, 1975:79.—Vittor and Johnson 1977:167 [not Kinberg, 1866].

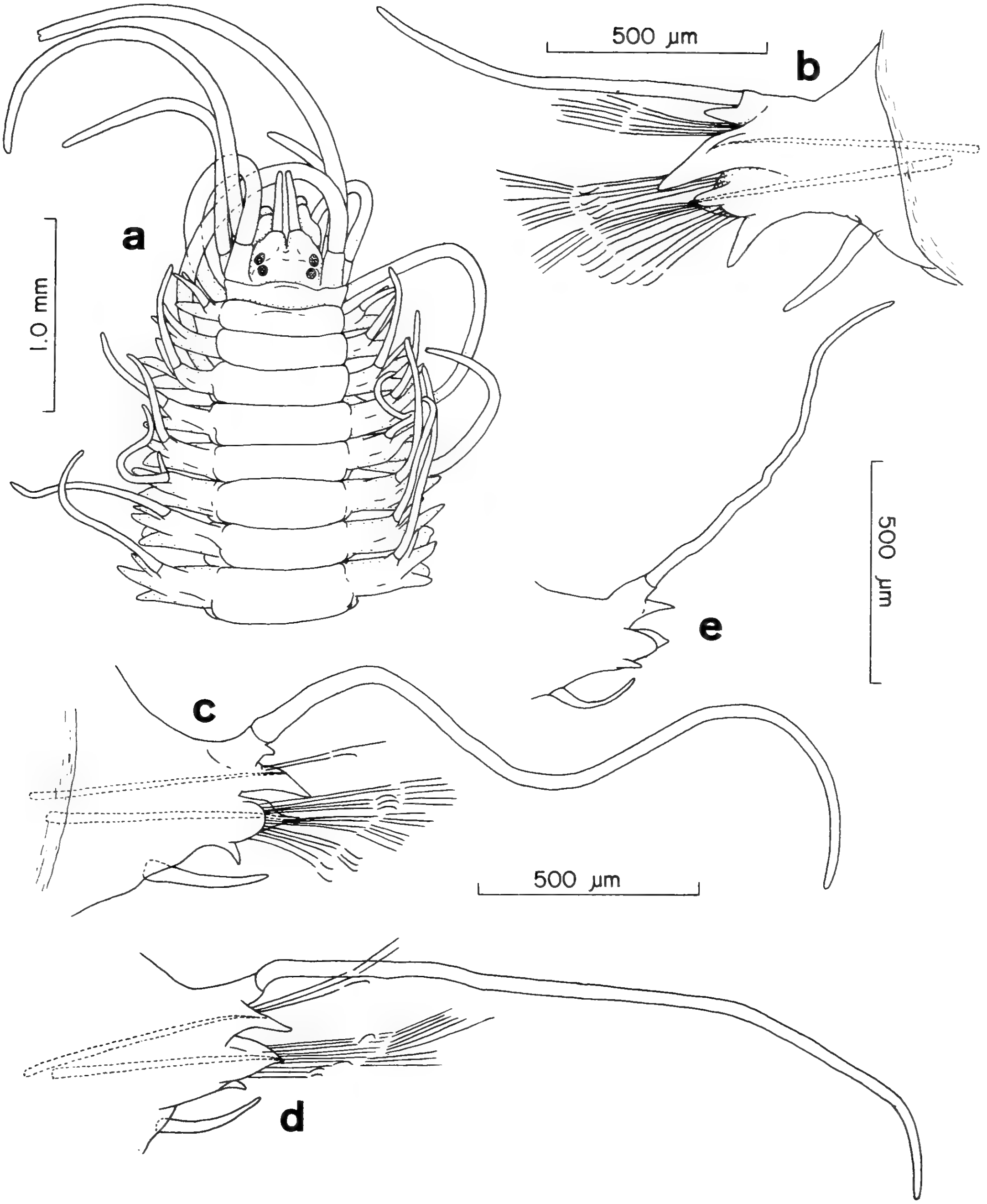

Fig. 11. *Ceratonereis longicirrata,* holotype: **a,** Anterior end, dorsal view; **b,** Parapodium from setiger 10, anterior view; **c,** Parapodium from setiger 25, posterior view; **d,** Parapodium from setiger 34, anterior view; **e,** posterior parapodium, posterior view.

Ceratonereis versipedata.—Vittor, 1975:79.—Vittor and Johnson, 1977:167 [in part; not Ehlers, 1887].

Material examined.—FLORIDA, EAST COAST: Hutchinson Island, 27°19.1′N, 80°13.2′W, 8.2 m, very coarse calcareous sand, Whiting et al., cols., 12 Dec. 1976, holotype (USNM 58740), 5 paratypes (USNM 58741);

Sta. II, 27°21.6′N, 80°13.2′W, about 11 m, coarse calcareous sand, 5 paratypes (FSBC I 22624–22627); Sta. III, 27°22.0′N, 80°12.4′W, about 7 m, medium calcareous sand, 1 paratype (FSBC I 22628); Sta. IV, 27°20.7′N, 80°12.8′W, about 11 m, coarse calcareous sand, 13 paratypes (FSBC I 22629–22631); Sta. V, 27°22.9′N, 80°13.9′W, about 11 m, coarse calcareous sand, 28 paratypes (USNM 54453–54455; FSBC I 22632–22638). FLORIDA KEYS: Grassy Key, 0–3.6 m, among rock and algae, *Thalassia,* E. Joyce et al., cols., Apr. 1966, 1 paratype (FSBC I 22639); Key West, *Albatross,* 15–27 Apr. 1884, 1 paratype (USNM 16745). NORTHEASTERN GULF OF MEXICO (BLM, U.S. Dept. Interior, Miss., Ala., Fla. Study, 1975–76): 29°55.0′N, 86°05.5′W, 37 m, R/V *Columbus Iselin,* 25 Sep. 1975, 1 paratype (USNM 58744); 29°55.0′N, 88°05.0′W, 37 m, R/V *Gyre,* Jan. 1976, 1 paratype (DISL); 29°56.0′N, 86°06.5′W, 38 m, R/V *Gyre,* Jan. 1976, 2 paratypes (DISL); 29°51.0′N, 86°06.5′W, 41 m, R/V *Gyre,* Jan. 1976, 1 paratype (FSBC I 22640); 29°48.0′N, 86°09.5′W, 45 m, R/V *Gyre,* Feb. 1976, 1 paratype (DISL); 29°46.0′N, 86°12.5′W, 52 m, R/V *Gyre,* Jan. 1976, 1 paratype (DISL); 29°40.0′N, 86°17.0′W, 73 m, R/V *Gyre,* Jan. 1976, 1 paratype (USNM 58745); 28°30′00.4″N, 83°29′58.4″W, 22 m, R/V *Columbus Iselin,* Aug. 1977, 2 small paratypes (USNM 55841). BAHAMAS: Hydro-Lab, Freeport, 26°30′N, 78°38′W, 16 m, in coral, B. A. Vittor and T. S. Hopkins, cols., 28 Jan. 1974, 2 paratypes (USNM 58743; DISL); S portion of Bimini Lagoon, 25°43′N, 79°16′W, in plastic sponges submerged behind reef, A. Schoener, col., 1970–71, 1 paratype (USNM 58742), 1 specimen (USNM 58746); Cherokee Sound, Great Abaco, 26°N, 77°W, in plastic sponges submerged behind reef, A. Schoener, col., 1972, 6 specimens (USNM 58747). PUERTO RICO: Parguera, M. J. Allen, col., 22 Apr. 1955, 1 heteronereidid (male *fide* Allen; USNM 28165); Mona Island Reef, Parguera, M. J. Allen, col., 14 Nov. 1955, 1 heteronereidid (female *fide* Allen; USNM 28166); Parguera, M. J. Allen, col., 21 Sep. 1955, 1 heteronereidid (female *fide* Allen; USNM 28167); Parguera, reef in front of Lab, M. J. Allen, col., 23 Mar. 1955, 2 ?male heteronereidids (USNM 33270).—BARBADOS: Pelican Island, Barbados-Antigua Exped., Univ. Iowa, 1918, 3 paratypes (USNM 20299).

Description.—Complete holotype of 59 segments, gravid atokous male, 28 mm long, 1.7 mm wide including parapodia; complete paratype of about 80 segments (USNM 20299) about 20 mm long, 1.5 mm wide including parapodia; few posteriorly incomplete atokous specimens slightly wider. Heteronereidids of 65–80 segments up to 8 mm long, 2 mm wide including swimming parapodia, usually somewhat narrower in anterior and posterior regions. Light brown pigment on dorsum of adults; prostomium with pigment on lateral and posterior margins and extending anteriorly between eyes; tentacular segment with pigment near anterior border and on lateral margins; dorsum of anterior segments with 3 evenly spaced, transverse pigmented bands, becoming obscure at midline; eyes dark purple, lighter on deepwater specimens from northeastern Gulf of Mexico.

Atokous specimens: prostomium (Fig. 11a) anteriorly incised to near level of anterior eyes, dorsally, laterally, and posteriorly rounded, usually partially covered by fold of tentacular segment; eyes subequal, in trapezoidal arrangement open to front, with lenses; anterior pair often appearing reniform in outline due to orientation of lens. Antennae relatively long, cirriform; palps about as long as antennae, often bent ventrally and appearing shorter, with subcylindrical palpophores and hemispherical palpostyles. Tentacular segment slightly shorter than and about as wide as following segment; upper posterior tentacular cirri about as long as anterior 15 segments; lower, anterior cirri about as long as first 4 segments. Notopodia of setigers 1 and 2 subbiramous with dorsal cirri, single ligules and slender acicula; neuropodia similar to those of following segments but with postsetal lobes reduced on setiger 1. Following parapodia biramous. Dorsal cirri relatively short on few anterior segments, rapidly increasing in length to about as long as body width including parapodia on about setiger 15, continuing very long to posterior end. Upper notopodial ligules almost as long as dorsal cirri on first few setigers (Fig. 11a), rapidly shortened posteriorly (Figs. 11b, c), absent after about setiger 30 (Figs. 11d, e). Lower notopodial ligules about as long as upper ones on first few segments, gradually decreasing posteriorly proportionate to reduction in parapodial size. Neuropodial presetal lobes reduced to acicular lobes with acicula extending into tips, rounded on anterior few setigers, pointed after about setiger 10. Neuropodial postsetal lobes subtriangular, as long as acicular lobes on anterior segments, becoming much shorter and rounded on middle and posterior segments. Neuropodial ligules extending about to tips of neuropodial acicular lobes on anterior segments, becoming very short on posterior segments, extending about ⅓ of distance to tips of neuropodial acicular lobes. Ventral cirri relatively long, slender throughout, shorter than neuropodial acicular lobes. Notopodia with sesquigomph spinigers beginning on setiger 3, joined by long-bladed sesquigomph falcigers (Figs. 12a, d) beginning on setiger 17 of holotype, setiger 11 of juvenile; blades of falcigers bidentate, stiff hairs on edge short proximally, gradually longer distally, extending about to tips; blades of spinigers with short, stiff hairs for most of their length; holotype with 9 spinigers on setiger 10; 1 falciger, 1–3 spinigers on parapodia after about setiger 20. Upper neurosetae consisting of posterior row of sesquigomph spinigers and anterior group of long-bladed heterogomph falcigers; blades of falcigers of anterior setigers with evenly rounded, unidentate tips; single bidentate blade beginning on setiger 10 of holotype; all blades bidentate beginning on setiger 16; bidentate blades similar to those of notopodia but with longer stiff hairs proximally (Figs. 12b, e); holotype with 12 falcigers, 6 spinigers on setiger 10; 3–4 falcigers, 8–10 spinigers on setiger 25;

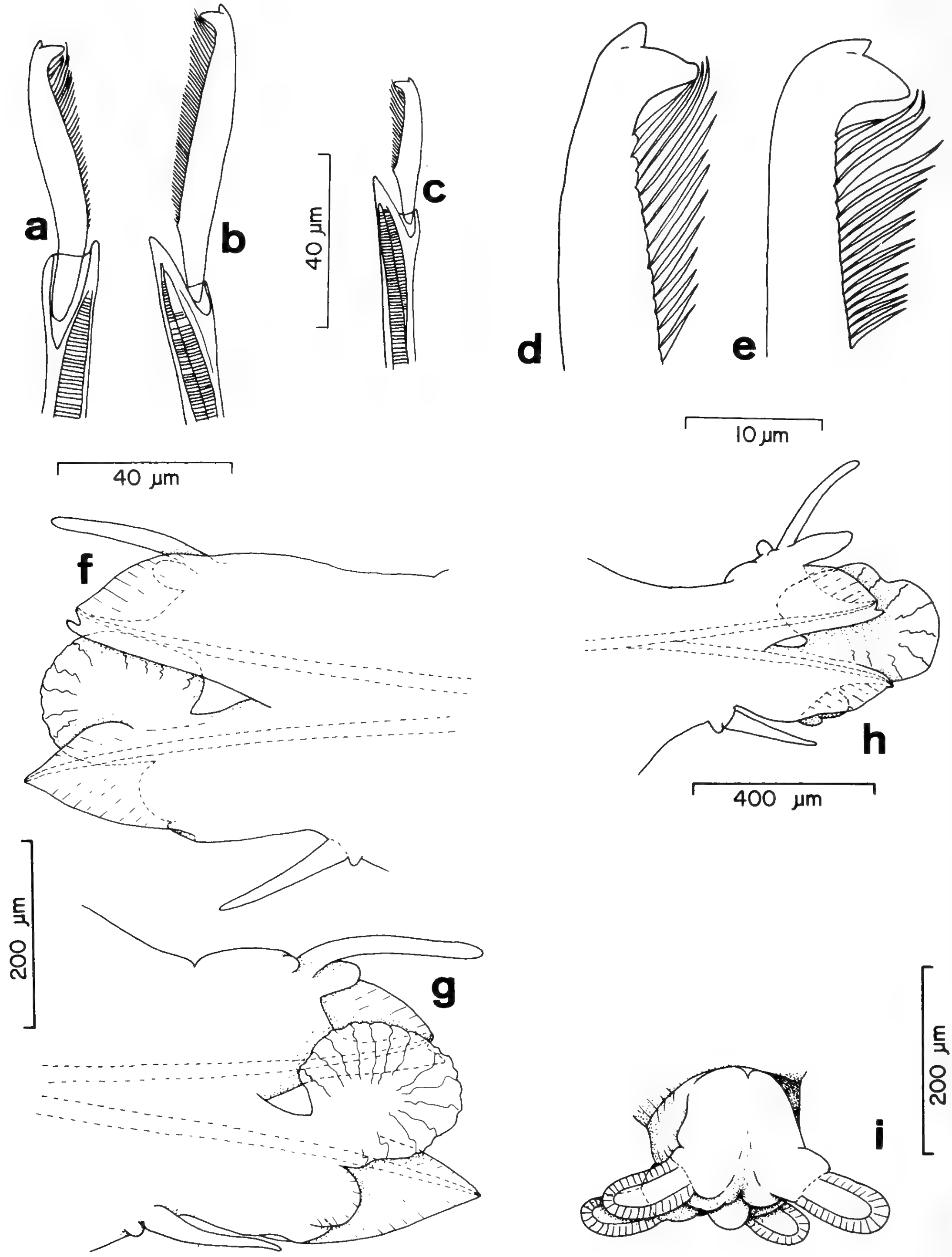

Fig. 12. *Ceratonereis longicirrata*: **a,** Notopodial falciger from setiger 25; **b,** Largest lower neuropodial falciger from same; **c,** Smallest lower neuropodial falciger from same; **d,** Tip of notopodial falciger from middle segment; **e,** Tip of neuropodial falciger from posterior parapodium; **f,** Parapodium from setiger 26,27, of female heteronereidid, anterior view; **g,** Same, posterior view; **h,** Parapodium from setiger 27 of male heteronereidid, anterior view; **i,** Pygidium of male heteronereidid, ventral view (**a–c,** holotype; **d,e,** paratype, USNM 54454; **f,g,** USNM 28166; **h,i,** USNM 28165).

2 falcigers, 4–8 spinigers beginning on setiger 35. Lower neurosetae heterogomph spinigers above and heterogomph falcigers below; blades of falcigers similar to those of upper neuropodial falcigers, becoming bidentate by about setiger 20, as long as upper falcigers above, shorter below (Fig. 12c); holotype with 12 falcigers, 6 spinigers on setiger 10; 5 falcigers, 9 spinigers on setiger 25; 3 falcigers, 7–8 spinigers on setiger 34; 6 falcigers, 3 spinigers on parapodium of fifth setiger from posterior end. Acicula in anterior parapodia of adults light brown on distal half; neuroacicula retaining most of color in posterior parapodia; uncolored proximally. Transverse rows of ciliary tufts on dorsum of setigerous segments, often prominent, appearing as raised ridges. Pygidium with anal cirri much stouter than dorsal cirri and about as long as last 10 segments.

Epitokous specimens: body divided into 3 regions, appearing constricted between regions; anterior atokous region of 15 setigers; region of about 25 segments with swimming parapodia; fusiform "tail" region of greatly shortened segments, with 25 and 30 setigers on 2 females, 40 setigers on 2 males. Eyes greatly enlarged, dark purple; palps and antennae usually bent ventrally. Parapodia of first 4 setigers of atokous region with slightly elongated, stouter dorsal cirri, slightly stouter on males than on females and somewhat sickle-shaped. Swimming parapodia (Figs. 12f–g) with natatory setae. Notopodia with single papilla above dorsal cirri, short dorsal cirrus, round-tipped upper notopodial ligule, presetal lamella above notoaciculum, lower notopodial ligule reduced to small triangular lobe below notoaciculum. Neuropodia with presetal lamella below neuroaciculum; upper part of neuropodial postsetal lamella greatly expanded laterally and dorsally behind notosetae; lower part of neuropodial postsetal lamella slightly expanded and partially fused with slightly expanded ligule; ventral cirrus similar to those of atokous parapodia; single small papilla below ventral cirrus. Males with longer, stouter upper notopodial ligules; one male with upper neuropodial postsetal lamellae much more expanded laterally and dorsally than on females. Tail region with parapodia similar to those of atokous specimens but without setae. Pygidium of females without cirri or lobes; with 4 divergent, club-shaped lobes on males (Fig. 12i).

Proboscis examined by dissection of mature specimens: area I, 0 paragnaths; II, 8–10 in 2 rows; III, small, rounded group of up to 8; IV, oval group of 8–18; V, reduced; VI, probably soft, cushion-shaped lobe; VII–VIII, no structures. Jaws small, amber-colored, with about 8 teeth.

Remarks.—I somewhat doubtfully observed soft lobes on area VI of the proboscis on one of two specimens with everted proboscis (USNM 33270, 58746). I was also unable to find diagnostic setae (notopodial falcigers and neuropodial falcigers on middle and posterior segments) on heteronereidid specimens. However, they appear to be the same species as the atokous type-specimens. Similarities are found in the shape of anterior and posterior parapodia, in the jaws and number and arrangement of paragnaths on the proboscis and in their small size.

The posterior parapodium and falcigers figured by Fauchald (1977b:23, 24, Figs. 4a–c) of a specimen from Panama reported as *C. mirabilis* appear identical with those of *C. longicirrata*. Origin of his figured specimen was not reported. Fauchald also examined single specimens reported by Monro (1933) as *C. tentaculata* from Colon on the Atlantic side, and from Gorgona Island on the Pacific side.

C. longicirrata appears to be allied with *C. excisa* in its long, slender form, in the similar development of parapodial lobes and, except for bidentate tips, in the shape of falcigers.

Etymology.—The specific name, derived from the Latin, refers to the long, dorsal cirri of the species.

Ceratonereis sp.
Fig. 13

Material examined.—VENEZUELA: Cumaná Key, Mochima [near Cumaná], 12 m, calcareous sand, R. Edwards, col., 21 Oct. 1971, atokous male anterior fragment (USNM 47771); Mochima, beach called Las Gabarras, 8 m, among *Thalassia*, poorly sorted "silted" sand, R. Edwards, col., 11 May 1971, immature anterior fragment (USNM 49709).

Description.—Atokous male anterior fragment of 36 setigers, 14 mm long, 2.8 mm wide including parapodia; smaller specimen of about 25 setigers, 7 mm long, 2 mm wide with parapodia, 1 mm wide without parapodia. Coloration of small specimen similar to that of *C. singularis* Treadwell; 2 segmental bars on anterior 3 segments, 4 on posterior segments; larger specimen uncolored. Prostomium also similar to that of *C. singularis*, on larger specimen almost identical with that of specimen figured by Ehlers (1887:Pl. 37, Fig. 1), except that antennae slightly longer and palps slightly shorter. Tentacular cirri long. Parapodia of setigers 1 and 2 subbiramous; remainder biramous (Figs. 13a–c) with dorsal cirri, upper and lower notopodial ligules, conical presetal and lamellate postsetal neuropodial lobes, neuropodial ligules and ventral cirri; setae of similar types and arrangement to other species reported herein; dorsal cirri about half as long as body width on anterior setigers and about as long as segmental width without parapodia on posterior segments of fragments; neuropodial presetal lobes reduced to acicular lobes by about setiger 20. Notopodial falcigers (Fig. 13d) stout, with rounded to pointed unidentate tips distinctly concave distally; stiff hairs uniformly stout, proximally short, slightly increasing in length, then abruptly lengthening distally and extending beyond tips. Blades of upper neuropodial falcigers of middle segments (Figs. 13e, f) very stout; tips similar to those of notopodial falcigers; stiff hairs short, fine proximally, becoming gradually

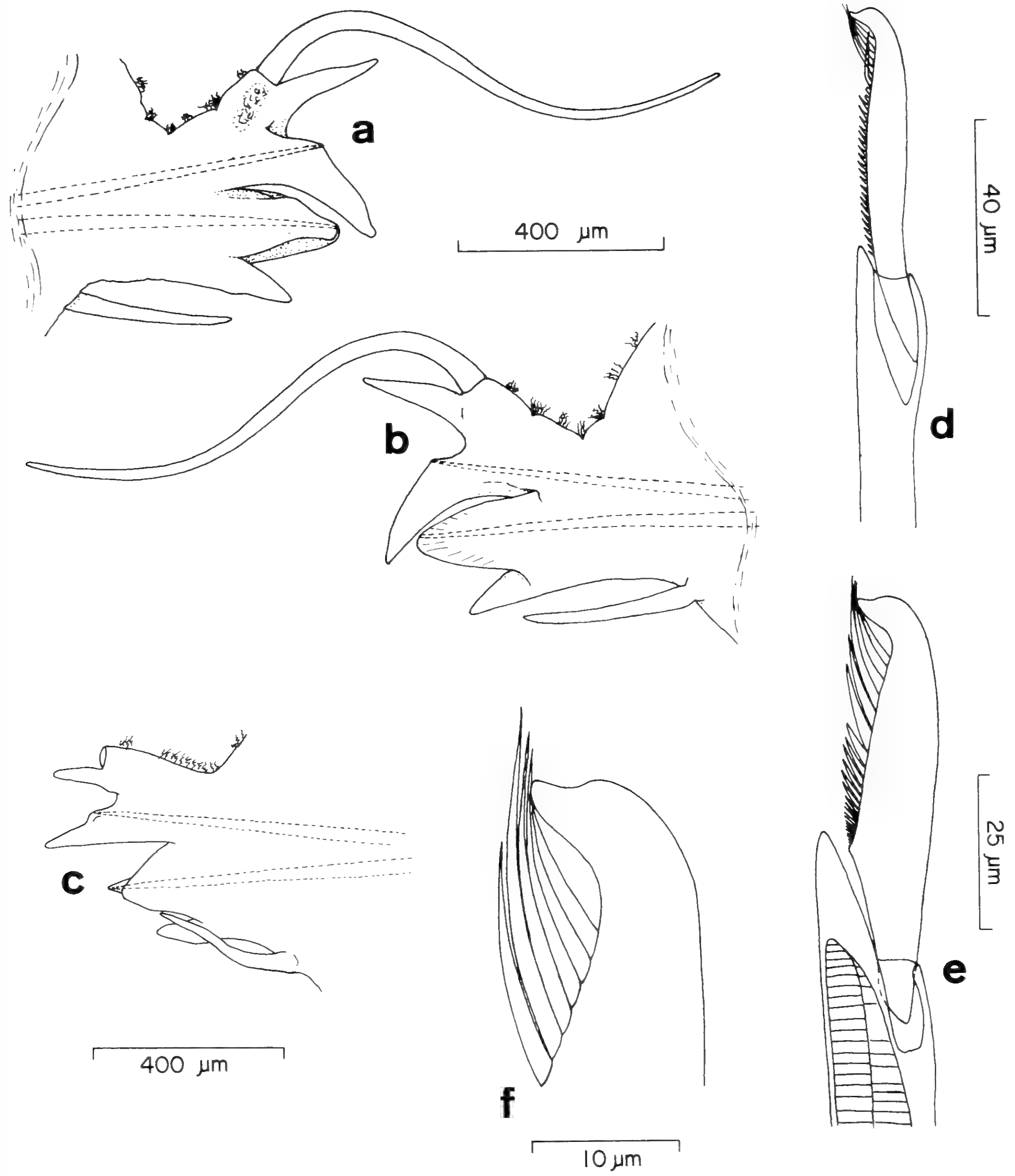

Fig. 13. *Ceratonereis* sp. (USNM 47771): **a,** Parapodium from setiger 23, anterior view; **b,** Same, posterior view; **c,** Parapodium from about setiger 30, posterior view, style of dorsal cirrus missing; **d,** Notopodial falciger from same; **e,** Upper neuropodial falciger from same; **f,** Tip of **e,** magnified.

longer and stouter, very stout distally and curving beyond tips. Blades of lower neuropodial falcigers similar to upper ones, but with more slender stiff hairs. Distal parts of acicula dark brown.

Proboscis of larger specimen examined by dissection: area I, 0 paragnaths; II, 11–12; III, about 9 in small group; IV, 13–14; V, reduced; VI, soft, cushion-shaped lobe; VII–VIII, without structures. Jaws mostly amber-colored with outer edges of tips brown, with 6–7 teeth.

Remarks.—The two specimens appear to be representatives of an undescribed new species similar to *C. singularis* Treadwell, but the fragmentary condition of the material is inadequate for a complete description. The short description is provided to facilitate the recognition of more adequate material.

Nephtyidae Grube

Nephtys Cuvier

Nephtys magellanica Augener

Fig. 14

Nephtys cirrosa var.—Ehlers, 1901:67 [not Ehlers, 1868].
Nephtys longisetosa.—Ehlers, 1901:67 [not Örsted, 1843].
Nephtys magellanica Augener, 1912:208–210, Pl. 6, Figs. 27, 28.

Material examined.—STRAITS OF MAGELLAN: 3 syntypes (3 anterior fragments and 2 fragments from near posterior end; ZMH V-1199).

Description.—Uncolored; largest anterior fragment of 66 segments about 35 mm long, 4 mm wide. Prostomium with proboscis everted (Fig. 14a) with anterior margin convex, thin, spatulate; lateral margins irregularly rounded, extending to nuchal organs; posterior margin with broad, middle projection extending to posterior third of segment 1 and concave posterolateral margins joining lateral margins behind nuchal organs; greatest width immediately behind lateral antennae. Frontal antennae conical, stout, about half as broad as length of lateral margins, attached obliquely with lateral margins longer than medial ones, continuing as raised lobe some distance from junction of medial margins and anterior prostomial margin. Lateral antennae originating ventrolaterally near neuropodia of segment 1, distinctly constricted at bases, subconical, slightly longer than frontal antennae. Notopodia of segment 1 with slightly pointed acicular lobes, broad presetal lobes and short, rounded, postsetal lobes; dorsal cirri attached to lateral margins of presetal lobes, short, digitate, about ⅓ as long as ventral cirri, extending posterolaterally to notopodia. Neuropodia of segment 1 on anterior margin, without lobes; ventral cirri lateral to neuropodia near anterior margin of segment, subequal to lateral antennae. Eyes not visible dorsally but visible on small syntype on interior part of dorsum of segment 1 when prostomium laid back. Lobes on segment 1 covering mouth small, hardly visible from dorsum when proboscis everted. Notosetae of segment 1 including preacicular laddered capillaries and smooth postacicular capillaries; neurosetae smooth capillaries. Parapodia of segment 2 similar to those of following segments but without branchiae and smaller; both rami with preacicular laddered capillaries

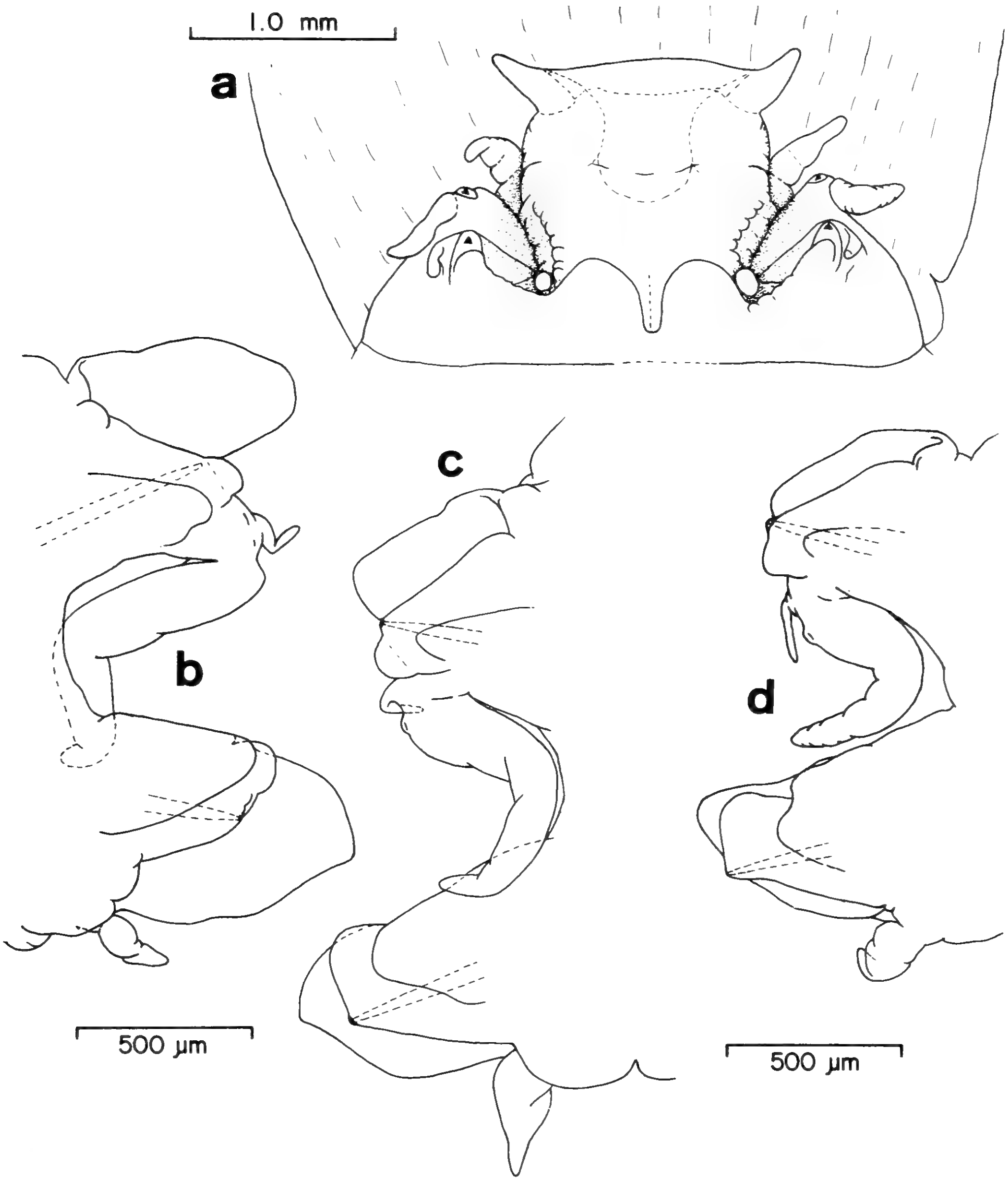

Fig. 14. *Nephtys magellanica,* syntypes: **a,** Anterior end with proboscis everted of second largest syntype, dorsal view; **b,** Parapodium from setiger 10 of largest syntype, anterior view; **c,** Parapodium from setiger 30 of same, anterior view; **d,** Parapodium from fragment of near posterior end, anterior view.

and postacicular smooth capillaries. Beginning on segment 3, parapodia similar throughout (Figs. 14b–d), fully developed by about segment 10; both notopodial and neuropodial acicular lobes indistinctly bilobed, with short lamella below notoaciculum and much broader lamella above neuroaciculum, with lobes angled and almost straight above notoaciculum and below neuroaciculum; presetal lamellae shorter than acicular lobes, rounded, with neuropodial presetal lamellae extending from upper margins of neuropodia and showing indistinct bilobation. Notopodial postsetal lamellae beginning immediately above acicular lobes, curving posteriorly around upper setae, extending for ⅓ of total length past acicular lobe on setiger 10, with rounded tips, with indistinct incision on upper margins, gradually reduced in length and shorter than acicular lobes on posterior segments; neuropodial postsetal lamellae extending about 1½ length of acicular lobes, with slightly pointed tips, only slightly longer than acicular lobes on posterior segments and rounded; notopodial cirri short, digitate, extending from rounded lobes on upper margins of branchiae, similar in length throughout; branchiae occupying about ⅔ of total length of parapodial margin between rami of middle segments, very gradually reduced in length posteriorly corresponding to reduction of parapodia, with small lobes laterally immediately below notopodial cirri. Ventral cirri constricted basally, subconical. Beginning on segment 3, setae consisting of laddered capillaries longer than acicular lobes in preacicular fasicles and capillaries 2½ times longer than parapodial lobes with lamellae (Augener, 1912:209) in postacicular fasicles. Postacicular capillaries beginning in line parallel to long axis of body below notopodial and above neuropodial acicular lobes, smooth, line of setae curving perpendicularly and setae gradually becoming very strongly toothed in middle of bundles, then gradually less strongly toothed; middle setae with extreme proximal area of numerous, small, disorganized teeth appearing hispid, changing to row of large, loosely attached cusps, each bearing transverse rows of about 6 teeth, diminishing distally to long, flattened tips with teeth on edge.

Everted proboscis (Augener, 1912:Pl. 6, Fig. 27) with 20 longitudinal rows of fleshy papillae in rows of 4–9 covering most of distal part [Augener did not figure 2 small papillae in each row near the oral end]; papillae very short proximally, gradually lengthening distally, with some rows of 4 papillae apparently merging with one another proximally, slightly longer middorsal papilla distinctly distad to others, midventral papilla absent; 10 pairs of bifurcate terminal papillae with outer bifurcations about twice longer than inner ones.

Remarks.—Specimens were received in a vial without data from the Zoologisches Museum, Hamburg, and were originally reported from both the Straits of Magellan and Chile. The large syntype has about the same number of segments, 66, and same length, 35 mm, as the largest specimen Augener reported, which was from the Straits of Magellan, but the specimen is 4 mm wide rather than 2 mm wide as he stated. The anterior fragment from which I have figured the prostomium and segment 1 (Fig. 14a) appears to be the specimen from which Augener's Fig. 27 is drawn. I have therefore indicated that the syntypes I examined came from the Straits of Magellan.

Augener's Fig. 28 of a parapodium of segment 25 may have been drawn from the large syntype, since a parapodium of that segment has been removed. However, the branchiae of the large syntype are somewhat longer than his figure indicated (Figs. 14b–d).

Specimens referred to *N. magellanica* by Hartman (1938:146, 147, Fig. 62; 1940:238, Pl. 41, Figs. 100–103; 1950:100, 101; 1968:587, 588, Figs. 1–3) from southern California to Peru are apparently *N. simoni,* n. sp.

Nephtys magellanica is apparently known only from the original report of Augener (1912) based on specimens originally reported by Ehlers (1901). In a recent synopsis of the family Nephtyidae in Chile, Rozbaczylo and Castilla (1974) reported no additional specimens of the species.

Nephtys simoni, new species
Figs. 15, 16

Nephtys magellanica.—Hartman, 1938:146, 147, Fig. 62; 1944:18; 1950:100, 101; 1968:587, 588, Figs. 1–3 [not Augener, 1912].

Nephthys magellanica.—Hartman, 1940:238, Pl. 41, Figs. 100–103 [not Augener, 1912].

Nephtys bucera.—Day, 1973:43 [in part, not Ehlers, 1868].

Material examined.—FLORIDA: Hutchinson Island, Sta. II, 27°21.6′N, 80°13.2′W, about 11 m, coarse calcareous sand, holotype (USNM 58725, R. Gallagher, col., Sept. 1972), 1 paratype (FSBC I 22641); Sta. III, 27°22.0′N, 80°12.4′W, about 7 m, medium calcareous sand, 14 paratypes (AHF POLY 1292; FSBC I 22642–22646); Sta. IV, 27°20.7′N, 80°12.8′W, about 11 m, coarse calcareous sand, 7 paratypes (USNM 58726; AHF POLY 1291; FSBC I 22647–22651); Sta. V, 27°22.9′N, 80°13.9′W, about 11 m, coarse calcareous sand, 8 paratypes (FSBC I 22652–22656). NORTH CAROLINA: off Beaufort, 34°36′N, 76°28.7′W, 10 m, sand and broken shell, J. H. Day, col., 19 Apr. 1965, 43 paratypes (USNM 55684). CALIFORNIA: Balboa, sand flats, Ricketts, col., 1930, 3 specimens (USNM 35879).

Description.—Prostomium of freshly collected specimens with red spot in middle, more conspicuous in juveniles; posterior part of prostomium and middorsal part of anterior 3 or 4 segments often light golden brown, iridescent (stippled area on Fig. 15a). Length of Atlantic specimens up to 75 mm, width 3 mm, about 125 segments; Pacific specimens larger. Prostomium (Figs. 15a–e) with anterior margin convex, thin, spatulate; lateral margins irregularly rounded, broadest between lateral antennae, extending into segment 1 to nuchal organs, posterior margin with long, narrow, V-shaped, middorsal projection extending to near posterior border of segment 1; posterolateral margins concave, joining lateral margins behind nuchal organs; dorsum always with concavity exhibiting red pigment spot; lateral sides more rounded when proboscis withdrawn (Fig. 15b); middorsal posterior projection broader on juveniles (Fig. 15e). Frontal antennae attached obliquely, appearing as raised lobes originating some distance from and

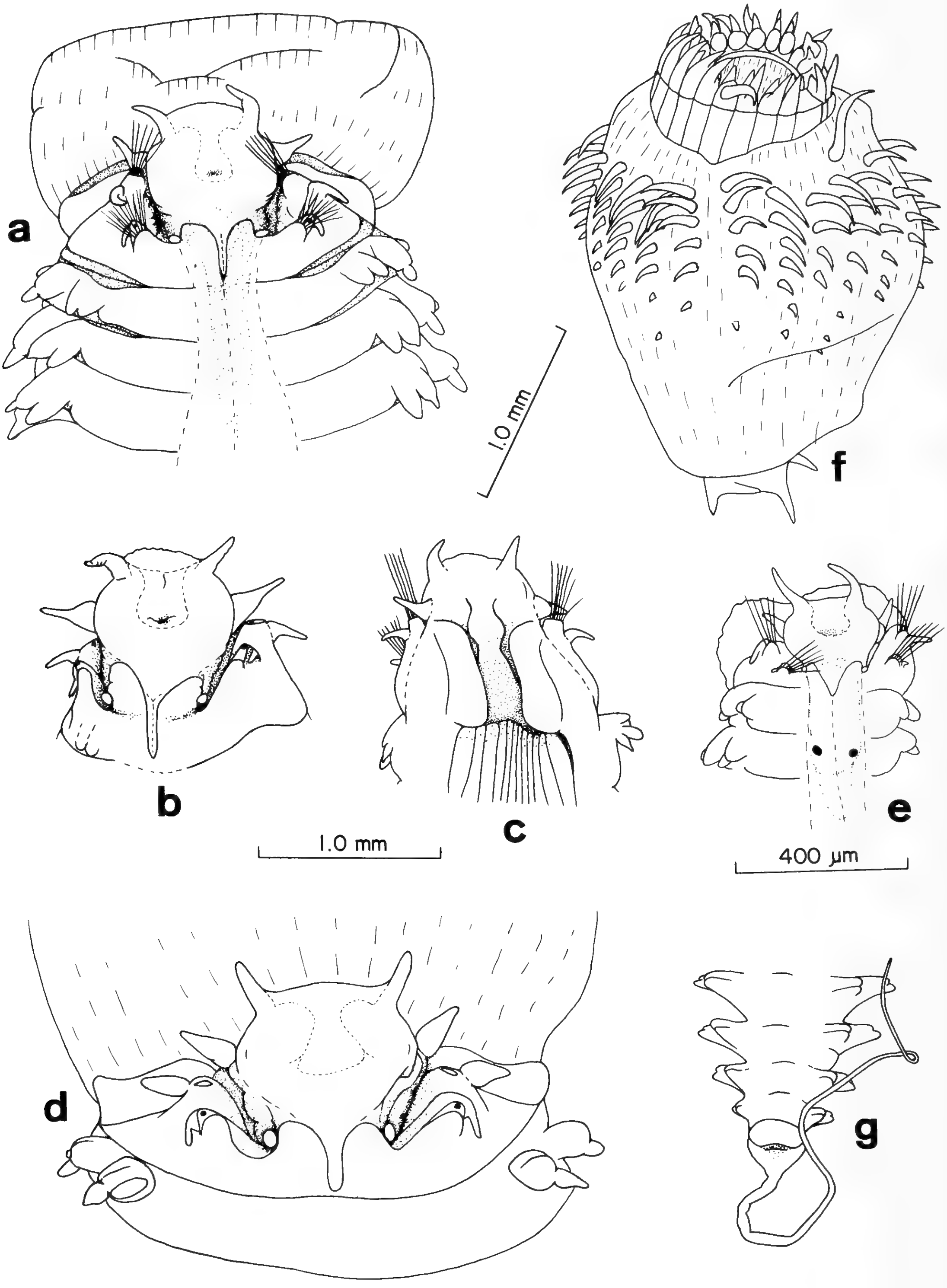

Fig. 15. *Nephtys simoni*: **a,** Anterior end, dorsal view, proboscis partially extended; **b,** Same, proboscis withdrawn; **c,** Same, ventral view; **d,** Same, dorsal view, proboscis fully extended; **e,** Same, dorsal view of juvenile; **f,** Everted proboscis, laterodorsal view; **g,** Pygidium, dorsal view (**a,** holotype; **b,c,** from North Carolina, USNM 55684; **d,** from California, USNM 35879; **e,** from Hutchinson Island; **f,g,** from Hutchinson Island, USNM 58726; **g,** not scaled).

fused with anterior prostomial margin, usually extending for slightly greater distance beyond. Lateral antennae originating ventrolaterally, slightly anterior to neuropodia of segment 1, slightly constricted at bases, with broad, flattened bases and narrow conical tips, slightly longer than frontal antennae on adults, shorter on juveniles. Deeply buried eyes visible on small juveniles on segment 3 (Fig. 15e), on slightly larger juveniles on segment 2, mostly not visible dorsally on adults and subadults of Atlantic specimens [visible on poorly preserved specimens], mostly visible dorsally on Pacific specimens, visible on interior part of dorsum of segment 1 when proboscis laid back on all adult specimens. Notopodia of segment 1 with pointed acicular lobes, broad presetal lobes, and short, rounded postsetal lobes (Figs. 15a, b, d, e); dorsal cirri attached to presetal lobes, short, digitate, about half as long as ventral cirri, extending posterolaterally from notopodia. Neuropodia of segment 1 on anterior segmental margin, without lobes; ventral cirri lateral to neuropodia near anterior margin of segment, similar but about half as large as lateral antennae, usually bent backward. Lobes on segment 1 covering mouth broad, almost completely visible from dorsum when proboscis everted (Figs. 15a, c, d). Notosetae of segment 1 including preacicular laddered capillaries and few smooth, slender postacicular capillaries; neurosetae smooth capillaries. Parapodia of segment 2 similar to those of following segment but without branchiae and smaller; both rami with preacicular laddered capillaries and postacicular smooth capillaries. Beginning on segment 3, parapodia similar throughout, fully developed by about segment 10 (Figs. 16a–d); both notopodial and neuropodial acicular lobes indistinctly bilobed with short lamellae below notoaciculum and above neuroaciculum, with irregular lobation above notoaciculum and below neuroaciculum; notopodial presetal lamellae shorter than acicular lobes, rounded; reduced on posterior segments; neuropodial presetal lamellae extending from upper margins of neuropodia, slightly bilobed below, shorter than acicular lobes except on anterior few segments, reduced on posterior segments; notopodial postsetal lamellae extending from segmental wall above acicular lobes, about twice as long as acicular lobes, with slight incision on upper margins, with rounded tips, gradually reduced in length posteriorly, shorter than acicular lobes on posterior segments; neuropodial postsetal lamellae extending about twice as far as acicular lobes, with pointed tips, only slightly longer than acicular lobes on posterior segments and rounded; notopodial cirri short, digitate, extending from upper margin of branchiae, similar in length throughout; branchiae occupying about ⅓ of total length of parapodial margin between rami of middle segments [longer on flaccid specimens], similar in length throughout except shorter on far posterior few segments, with slight lateral bump about ⅓ distance between dorsal cirri and tips. Ventral cirri constricted basally, subconical. Beginning on segment 3 and continuing to posterior end, setae consisting of laddered

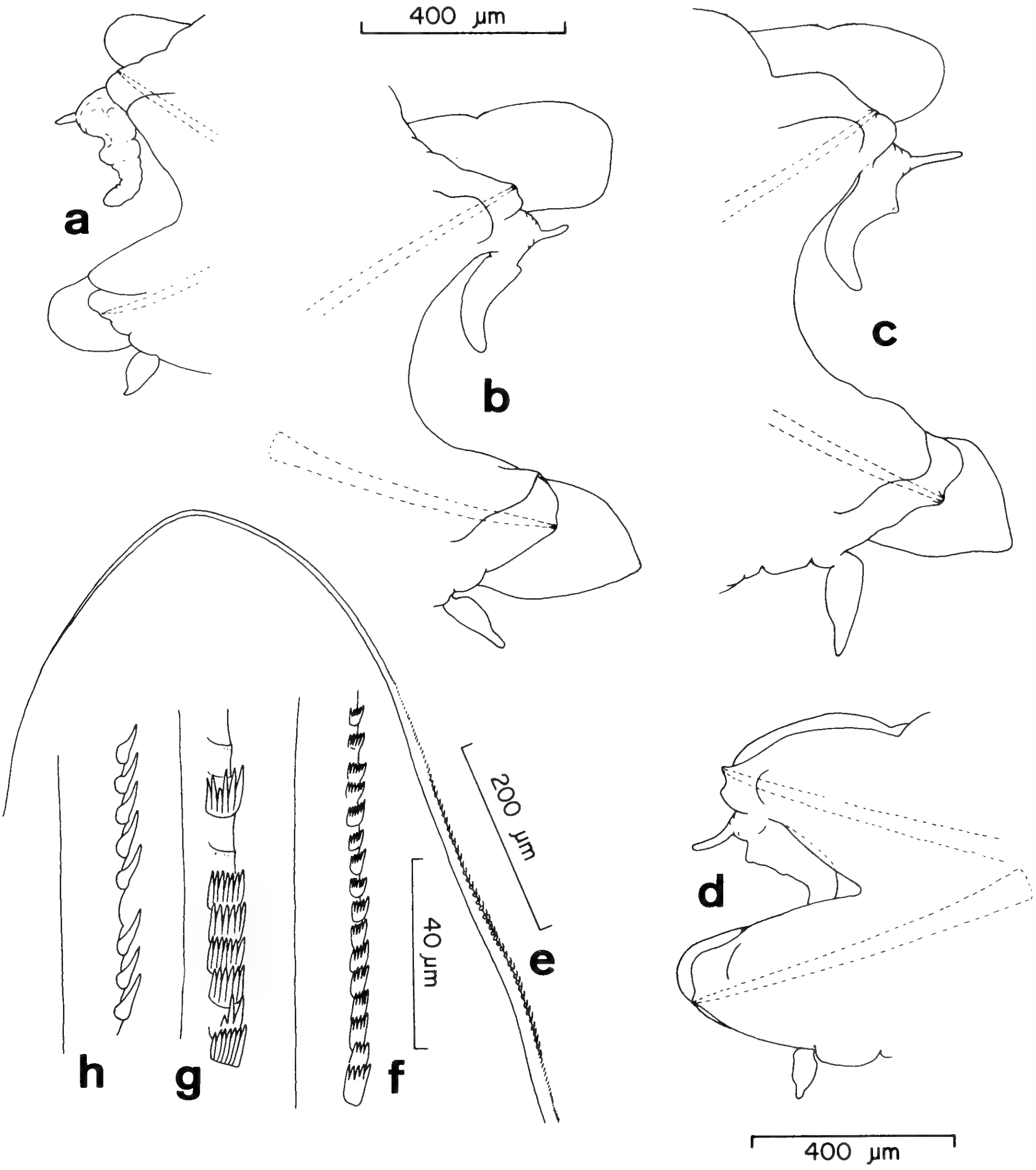

Fig. 16. *Nephtys simoni,* holotype: **a,** Parapodium from segment 3, anterior view; **b,** Same, from segment 10; **c,** Same, from segment 23; **d,** Same, from segment near posterior end; **e,** Long, toothed capillary seta from middle segment; **f–h,** Basal parts of same, magnified (**g,h,** not scaled).

capillaries longer than acicular lobes in preacicular fasicles and toothed capillaries about twice as long as total length of parapodia between smoother capillaries above and below; postacicular capillaries of lower parts of notopodial fasicles and upper parts of neuropodial fasicles, respectively, aligned parallel to long axis of body above and below acicular lobes and entirely smooth; postacicular strongly toothed capillaries with extreme proximal area of numerous, small, disorganized teeth appearing hispid, changing slightly more distally to row of large loosely attached cusps, each bearing transverse row of 5–6 teeth diminishing distally (Figs. 16e–h); postacicular capillaries above and below strongly toothed ones, except as noted above, gradually with smaller teeth. Setae of about setiger 25: 10 preacicular notopodial capillaries, 22–25 postacicular capillaries; 17 preacicular neuropodial capillaries, about 22 postacicular capillaries. Pygidium (Fig. 15g) anteriorly cylindrical, posteriorly flattened, triangular, with dorsal anus and slender median anal cirrus as long as last 10 segments.

Everted proboscis (Fig. 15f) with proximal ⅓ smooth or wrinkled; distal ⅔ with 22 longitudinal rows of 4–8 fleshy papillae, very short proximally, gradually lengthening distally, with some rows of 4 and 5 papillae apparently merging with one another proximally, slightly longer middorsal papilla distinctly distad to others, midventral papilla subequal to other papillae and only very slightly more distad; 11 pairs of bifurcate terminal papillae encircling opening, with longer branches on outher side; sides separated by low middorsal and midventral mounds. Internal pair of triangular-pyramidal, horny jaws.

Remarks.—The numerous specimens from North Carolina (USNM 51095) referred to *N. bucera* Ehlers by Day (1973:43) were examined and found to be a mixture of species. Of these, 17 small specimens agree with *N. bucera,* a species with lateral antennae not visible dorsally, lacking a posterior prostomial projection, and with teeth of postacicular setae entire rather than expressed as multidentate cusps; 13 small specimens are referred to Nephtyidae sp. (USNM 55685) and may be the young of *N. picta* Ehlers; the remaining 43 are considered to be *N. simoni* (USNM 55684, paratypes).

Nephtys simoni is very similar to *N. magellanica* Augener, from the Straits of Magellan and Chile. The prostomium of the latter is very robust, with a short, broad dorsoposterior projection; lateral antennae are subconical and subequal to ventral cirri of segment 1; and branchiae are long and cover about ⅔ of the length between rami.

Specimens from Balboa, California, identified by the Berkeleys as *N. magellanica* (USNM 35789) are *N. simoni.* Specimens reported as *N. magellanica* from eastern Pacific areas ranging from southern California to Peru by Hartman (cited in synonymy) are apparently also *N. simoni,* although the prostomium she figured is somewhat different (Hartman, 1938:Fig. 62a; 1940:Pl. 41, Fig. 100). The specimens reported by Hartman (1944:18) from Venezuela and Colombia (Atlantic side) are probably also the same species.

Other specimens reported as *N. magellanica* from Seahorse Key (Taylor, 1961:103, 104; USNM 33330) and Tampa Bay (Taylor, 1971:285–287; USNM 45582), Florida, and the Chesapeake Bay area, Virginia (Wass, 1965:16; USNM 33326–33329, 38738) were examined and found to be a species similar to *N. hombergi* Savigny, 1818; they differ from *N. hombergi* in not

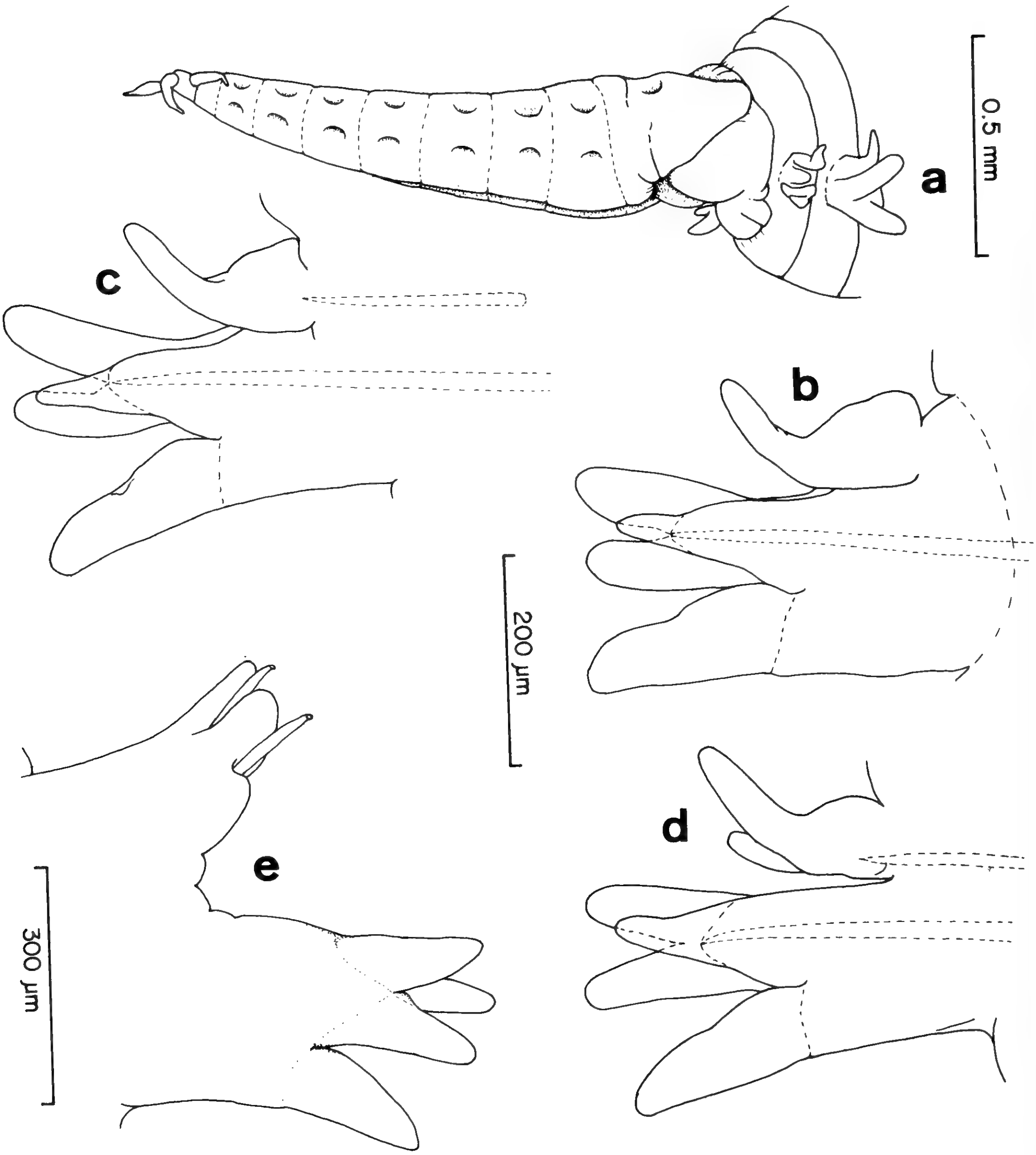

Fig. 17. *Goniada multidentopsis*, holotype: **a,** Anterior end, lateral view; **b,** Parapodium from setiger 30, posterior view; **c,** Parapodium from setiger 41, posterior view; **d,** Parapodium from setiger 64, posterior view; **e,** Parapodium from setiger 102, anterior view.

having dorsal cirri on segment 1. Specimens of *Nephtys* cf. *hombergi* could easily be misidentified as *N. simoni* since the prostomium is similar and has a red pigment spot; however, postacicular setae have subproximal teeth which are very large but entire.

Etymology.—The species is named for Dr. Joseph L. Simon of the University of South Florida, an outstanding teacher whose research and that of his students has contributed significantly to our knowledge of estuarine invertebrate fauna.

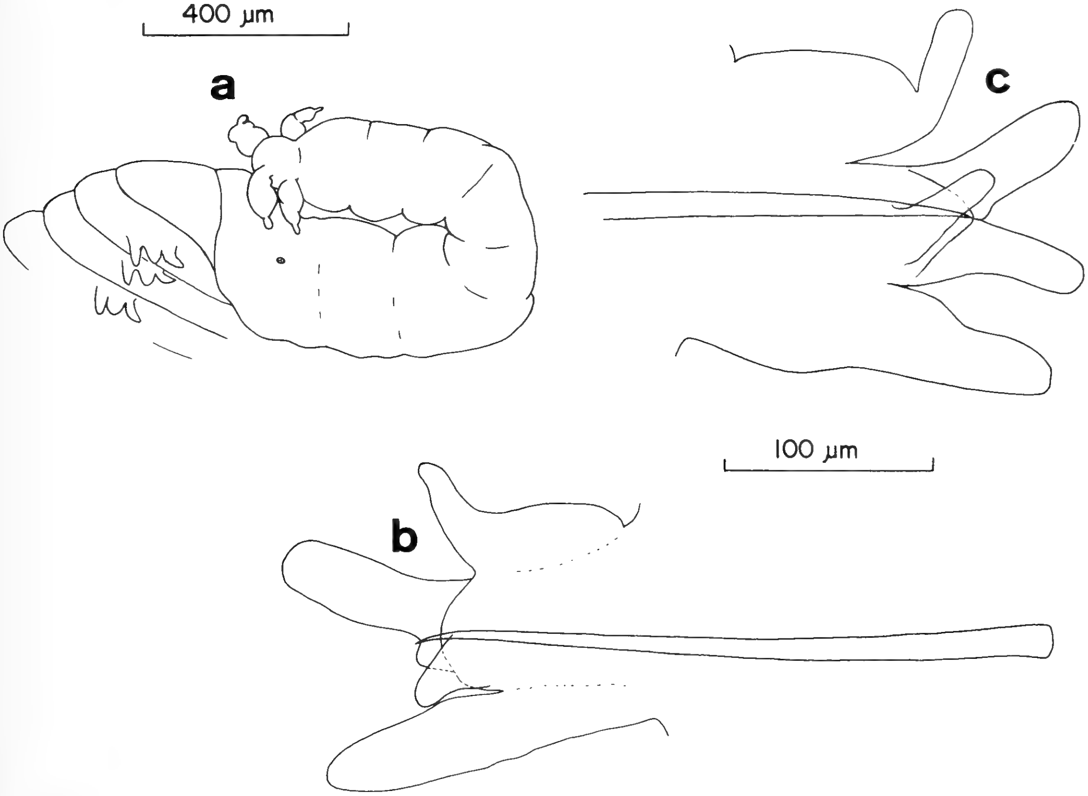

Fig. 18. *Goniada multidentopsis*, paratype: **a,** Anterior end, twisted; **b,** Parapodium from setiger 10, posterior view; **c,** Same, from setiger 26, posterior view.

Goniadidae Kinberg
Goniada Audouin and Milne Edwards
Goniada multidentopsis, new species
Figs. 17–19

Material examined.—FLORIDA: Hutchinson Island, Sta. V, 27°22.9′N, 80°13.9′W, about 11 m, coarse to very coarse calcareous sand, N. Whiting et al., cols., Mar. 1979, holotype (USNM 58753); Sta. III, 27°22.0′N, 80°12.4′W, about 7 m, medium calcareous sand, R. Gallagher, col., Jan. 1972, immature paratype (USNM 58754).

Description.—Prostomium and anterior few segments uncolored; remainder with brown pigmented areas; anterior and middle segments with fusiform middorsal spot, large rectangular area above parapodia, small spot below parapodia, dark midventral line, parapodia moderately pigmented; pigment diminishing in midregion; posterior segments, beginning on setiger 86–87 of holotype and setiger 55 of smaller paratype, with pigment pattern similar to that of more anterior segments but much darker, with additional 2 small, prominent spots midventrally on each segment at intersegmental

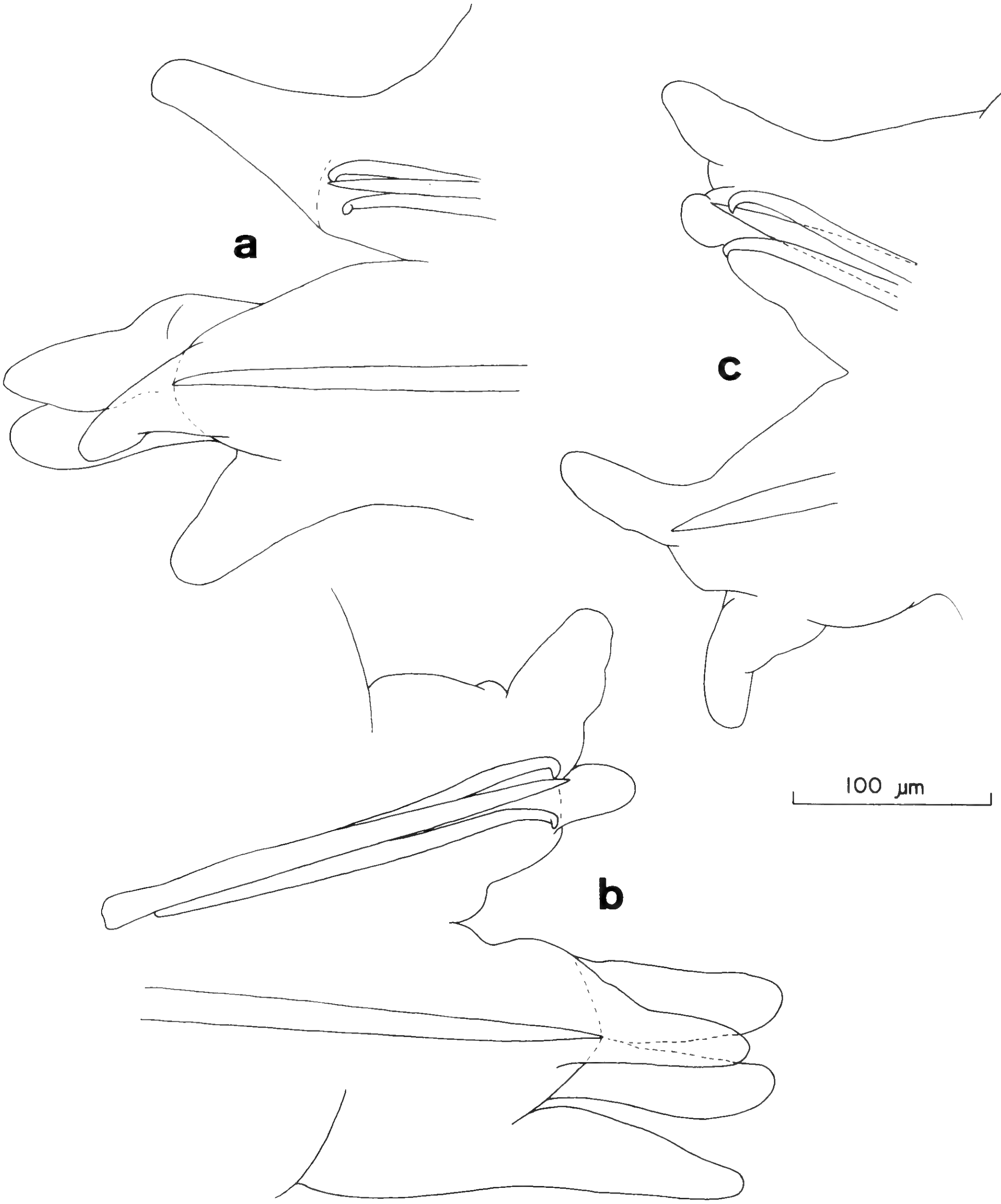

Fig. 19. *Goniada multidentopsis,* paratype: **a,** Parapodium from setiger 45, posterior view; **b,** Same, from setiger 62, posterior view; **c,** Posterior parapodium, anterior view.

grooves and segments becoming banded ventrally. Holotype of about 130 segments, incomplete posteriorly, 50 mm long, 1.8 mm wide with parapodia at about setiger 30, 1.9 mm wide with parapodia at about setiger 100, anterior and middle segments slightly flattened, posterior segments more cylindrical with longer parapodia; smaller, complete paratype of 105 segments, 43 mm long, 1 mm wide with parapodia. Prostomium (Figs. 17a, 18a) with 9–10 indistinct rings including basal and terminal rings; anterior ring with 2 pairs of subequal, biarticulate antennae, basal articles long, broad on paratype, partially dried on holotype, dorsolateral pair attached proximally on terminal ring, ventrolateral pair attached distally; basal ring with pair of deeply embedded eyespots, with pair of semicircular depressions above eyes on holotype; rings 2–8 of holotype with 2 pairs of similar depressions in opposition on lateral sides; depressions possibly sensory in function. Peristomium visible ventrolaterally and ventrally, forming lateral and posterior margins of mouth, possibly visible dorsally between lateroposterior extensions of prostomium (Figs. 17a, 18a). Parapodia of holotype uniramous for anterior 62 setigers, but with notoacicula beginning between setigers 35 and 41 (Figs. 17b, c); subbiramous to setiger 86 (Fig. 17d), with last 3 segments transitional but without notosetae; and fully-developed biramous thereafter (Fig. 17e). Parapodia of smaller, immature paratype with uniramous parapodia for anterior 40 setigers and fully-developed biramous parapodia beginning on setiger 55 (Figs. 18c, d, 19). Anterior 2 setigers of holotype (Fig. 17a) with dorsal cirri, single, presetal neuropodial lobes in supraacicular position and extending farther than ventral cirri, rounded neurosetal lobes, and ventral cirri; second presetal neuropodial lobe developing below aciculum on setiger 4; and postsetal neuropodial lobe developing on setiger 6, neuropodial lobes fully developed by setiger 15. Parapodium of setiger 30 of holotype (Fig. 17b) with dorsal cirrus constricted basally, with bulbous base and cylindrical tip, not extending as far as parapodial lobes and ventral cirrus; presetal neuropodial lobes long, flattened, parallel-sided, with rounded tips; neuropodial postsetal lobe shorter than presetal lobes, subtriangular; slightly pointed neurosetal lobe, with slender, pointed aciculum; ventral cirrus fused on basal half with neuropodium, with distal half indistinctly separated from base. Uniramous parapodia with slender, pointed notoacicula extending into bases of dorsal cirri beginning between setigers 35 and 41 of holotype (Fig. 17c) with dorsal cirri slightly longer than on more anterior parapodia. Subbiramous parapodia of middle region of holotype (Fig. 17d) with club-shaped to rounded notopodial lobes anteroventrally on dorsal cirri; dorsal cirri longer, more slender, less constricted basally than on more anterior parapodia; and presetal neuropodial lobes extending farther than postsetal lobes and ventral cirri. Fully-formed biramous parapodia of holotype (Fig. 17e) stouter, longer than those of midregion, with rami well separated, with mostly embedded, hook-tipped, acicular notosetae, singly above and below notopodial lobes; notopodial lobes stout, round-tipped, extending as far as dorsal cirri, with stout, pointed aciculum, extending into bases; neuropodia with stout, subtriangular, presetal and postsetal lobes longer than ventral cirri; ventral cirri similar to those of middle segments but stouter. Anterior uniramous parapodia of paratype (Figs. 18b, c) developing neuropodial postsetal lobe by about setiger 14, fully developed by about setiger 25. Paratype with region of "transitional" parapodia on setigers 41–54 (Fig. 19a); notopodia of transitional region with dorsal cirri but without notopodial lobes, with single aciculum and 2 nonemergent notosetae in bases of dorsal cirri. Fully-formed biramous parapodia of paratype (Fig. 19b) beginning on setiger 55, with notopodial lobe smaller than on holotype. Parapodium of far posterior segment of paratype (Fig. 19c) with notopodial lobe further reduced and only upper presetal neuropodial lobe remaining. All neurosetae compound, heterogomph spinigers with denticulate blades tapered to thin tips, with teeth longer proximally, diminishing in length distally.

Proboscis of holotype long, with about 80 chevrons on each side extending to near maxillary end; chevrons larger after first few, closely spaced near oral end, smaller and more widely spaced near maxillary end. Proboscidial papillae of one type, broad, flattened, flanged, with slightly beaked tips and central pores. Macrognaths with 4 teeth, larger dorsally, decreasing in size ventrally; two rows of micrognaths; dorsal arc with 8 large H- or X-shaped pieces in posterior row, 9 small H- or X-shaped pieces between large pieces in anterior row; ventral arc with pieces subequal to those of dorsal arc, with 5 large pieces in posterior row and 6 small ones. Proboscis of paratype with about 50 chevron pairs, one small and 7 large micrognaths in dorsal arc, 5 large micrognaths in ventral arc.

Remarks.—*Goniada multidentopsis* is similar to *G. multidentata multidentata* Arwidsson (1899:45, 46, Pl. 3, Figs. 40–42, Pl. 4, Fig. 63), from West Africa, and *G. multidentata* var. *indica* Monro (1937:284, 285, Text Fig. 11), from the Gulf of Aden and the Persian Gulf, in having numerous chevrons along each side of the proboscis. *G. multidentopsis* differs in having a body composed of three distinct regions instead of two and notosetae with hooked tips instead of pointed notosetae on middle and posterior segments. *G. multidentata* has about 90 chevron pairs on the proboscis, larger macrognaths with 12 teeth and 42 micrognaths, while var. *indica* has only 45 chevron pairs, macrognaths with 6 teeth and 26 micrognaths. Both *G. multidentata* and var. *indica* have 36 anterior uniramous segments, and the latter has 8 transitional segments, after which both have fully-formed biramous parapodia.

Etymology.—The specific name is derived from the previously described species, *multidentata,* and the Greek suffix, *-opsis,* meaning likeness, and refers to the similarity between the two species.

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DISTRIBUTION AND SYSTEMATIC RELATIONSHIP OF TWO KINDS OF SHORT-TAILED SHREWS (SORICIDAE: *BLARINA*) IN SOUTH-CENTRAL VIRGINIA

Cathy M. Tate, John F. Pagels, and Charles O. Handley, Jr.

Abstract.—Two kinds of short-tailed shrews that have until recently been regarded as subspecies of a single species, *Blarina brevicauda kirtlandi* and *B. b. carolinensis,* occur in south-central Virginia. Museum collections were examined and additional specimens were collected to delineate further the distribution of these shrews. The two taxa were collected together at two localities. Discriminant function analysis using twelve cranial measurements clearly separated the two kinds in reference samples and in test samples taken in and near areas of sympatry. Only one of 74 test specimens suggested the possibility of intergradition or hybridization. The analysis provided no evidence of panmictic intergradation of the phena in Virginia. This study supports the hypothesis that the two shrews represent distinct species, *B. brevicauda* and *B. carolinensis.*

It has been customary to recognize two species of short-tailed shrews, *Blarina telmalestes* Merriam and *Blarina brevicauda* Say. Four subspecies of the latter are thought to occur in Virginia: *B. b. carolinensis* Bachman, *B. b. churchi* Bole and Moulthrop, *B. b. kirtlandi* Bole and Moulthrop, and *B. b. talpoides* Gapper (Handley and Patton, 1947; Hall and Kelson, 1959). Recently, however, Handley (1971), Genoways and Choate (1972), Jones *et al.* (1975) and Ellis *et al.* (1978) have referred to *B. b. carolinensis* as a separate species, *Blarina carolinensis.*

The geographic distribution of *B. b. kirtlandi* in Virginia was described by Handley and Patton (1947) as the western portion of the state, west of a line drawn from King George County to Prince Edward County not including the high mountains in southwestern Virginia where *B. b. churchi* is found. They showed that *B. carolinensis* occupies the eastern portion of the state except in the Dismal Swamp where it is replaced by *B. telmalestes.* Hall and Kelson (1959) mapped the distribution of *Blarina* in similar fashion, but showed that *B. b. talpoides* occupies the Delmarva Peninsula. Handley (1971) redefined the distribution of *B. brevicauda* and *B. carolinensis* and observed that their ranges overlap in eastern Virginia.

Using characters of skin and skull, Genoways and Choate (1972) studied *B. brevicauda* and *B. carolinensis* in Nebraska. They found that the two

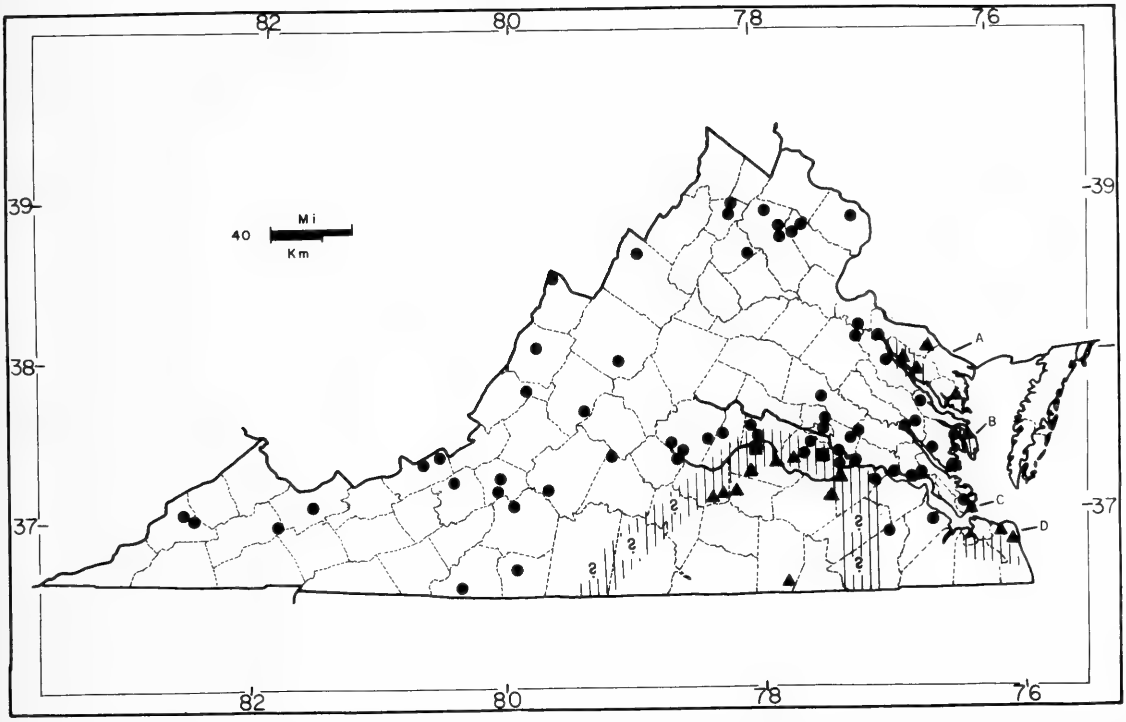

Fig. 1. Distribution of *Blarina brevicauda kirtlandi* **(circles)** and *B. carolinensis* **(triangles)** and areas of sympatry **(squares)** and contiguity **(lined areas)** in Virginia. In areas where collecting localities were close together, the data and triangles may include more than one locality. Dark meandering lines indicate the James and Appomattox Rivers in south-central Virginia. Isolated populations of *B. carolinensis* are indicated at **A**—Northern Neck Peninsula, **B**—Gwynn's Island, **C**—Old Point Comfort, and **D**—Virginia Beach.

taxa did not intergrade there. Ellis *et al.* (1978) found that *B. carolinensis* did not intergrade or hybridize with *B. brevicauda* in Illinois.

Further evidence that *B. brevicauda* and *B. carolinensis* are distinct species is provided by karyotypes (Meylan, 1967; Lee and Zimmerman, 1969; Lund, 1976; Genoways *et al.*, 1977). Genoways *et al.* (1977) found in Nebraska that *B. brevicauda* had a diploid number of 49 or 50 (fundamental number 48) while *B. carolinensis* had a diploid number of 52 (fundamental number 62).

The purpose of the present study was to search for areas of geographic overlap and possible intergradation and hybridization, and to further refine knowledge of the distribution of *B. b. kirtlandi* and *B. carolinensis* in Virginia.

Methods and Materials

For many years Handley accumulated specimens of *Blarina* from Virginia and was fairly well able to define the ranges of *B. brevicauda* and *B. carolinensis* in Tidewater, Virginia (Fig. 1). Later, Tate and Pagels conducted extensive studies in the lower Piedmont in south-central Virginia where it appeared that the two taxa might be contiguous or sympatric. The resulting collections, housed in the United States National Museum of Natural History (USNM) and the Virginia Commonwealth University Mammal Collection (VCU), together with a few other specimens in the Virginia Polytechnic Institute and State University Museum (VPI), were studied. Emphasis was on the collections of Tate and Pagels.

The field work of Tate and Pagels consisted of sampling along three transects that extended 113 km W, 113 km SW, and 81 km SE from Richmond. These transects contained a total of approximately 210 can (pit) traps that were checked periodically from spring through fall 1976. Museum special traps were used to sample other areas between the transects.

Specimens collected where the two taxa were contiguous or sympatric were compared with reference samples of *B. b. kirtlandi* and *B. carolinensis*. Reference samples were taken from a number of localities over a two state area so that geographic and individual, as well as interspecific, variation could be accounted for.

We aged specimens by toothwear as described by Choate (1968). Young, subadult, adult, and old adult classes were recognized. Only specimens of the subadult and adult age classes were used in test and reference samples. Twelve cranial measurements were taken from each specimen: occipitopremaxillary length, P^4–M^3 length, maxillary breadth, least interorbital breadth, cranial breadth, and zygomatic plate breadth (Choate, 1972); palatal length, postpalatal length, palatal breadth, and nasal width (DeBlase and Martin, 1974); braincase depth (distance from junction of lambdoidal and sagittal crests to the posterior portion of the basioccipital bone anterior to foramen magnum), and skull depth (distance from junction of lambdoidal and sagittal crests to plane intersecting lowest points of skull). Only specimens with complete cranial measurements were used in the discriminant analysis.

Univariate descriptive statistics (mean, standard deviations, minimum values, maximum values, and standard error of the means) were obtained with the MEANS procedure of Statistical Analysis System 76 (Barr *et al.*, 1976). The subprogram DISCRIMINANT of the Statistical Package for Social Sciences (Nie *et al.*, 1970) was used for the discriminant function analysis.

Results and Discussion

Only *B. b. kirtlandi* was taken in the can trap transects west and southeast of the city of Richmond, but both *B. b. kirtlandi* and *B. carolinensis* were captured in the southwestern transect. *Blarina carolinensis* was found in the southern portion of that transect in Prince Edward, Nottoway, and

Amelia counties, and both species were collected in the northern portion of the transect in Chesterfield County. Additional trapping between the western and southeastern transects resulted in the collection of both species at two localities (Fig. 1) and the location of several areas where the ranges of the two species seemed to be contiguous but where no zone of contact could be located.

Sympatry was found on the south bank of the Appomattox River, 9.8 mi N, 0.7 mi E Amelia C. H., Amelia County. At this site a specimen of *B. carolinensis* was collected on 5 November 1976 and two specimens of *B. b. kirtlandi* were taken on 6 November 1976. Sympatry was also found in Chesterfield County (locality 19) where a *B. carolinensis* was captured on 2 November 1976 and a *B. b. kirtlandi* was taken on 9 November 1976. There are two areas in Chesterfield County where the two species were found to be contiguous but no zone of contact could be found. In one area the two taxa were captured 4.7 km apart (*B. carolinensis,* locality 16; *B. b. kirtlandi,* locality 17) and in the southern portion of the county they were taken 14.5 km apart (*B. carolinensis,* City of Colonial Heights; *B. b. kirtlandi,* locality 22).

Standard univariate statistics for twelve cranial measurements and three external measurements of *B. carolinensis* and *B. b. kirtlandi* are given in Table 1. There is only slight overlap in measurements.

Discriminant analysis was conducted using 36 reference specimens of *B. carolinensis* and 70 specimens of *B. b. kirtlandi* (Fig. 2). Standardized discriminant function coefficients (Table 2) show that the cranial breadth was the most heavily weighted, that is, the most discriminating variable, of the measurements taken. Discriminant scores for *B. b. kirtlandi* ranged from −1.379 to 0.013 with a centroid of −0.68537. Discriminant scores for *B. carolinensis* ranged from 0.837 to 1.955 with a centroid of 1.33255.

All test specimens were placed either in the *B. b. kirtlandi* or *B. carolinensis* group with a probability of 1.000 with the exception of three specimens. Test specimens from localities 1 and 31 (Fig. 2) were placed with *B. b. kirtlandi* with 0.999 and 0.987 probability, respectively. The individual from locality 30 was placed into the *B. b. kirtlandi* group with 0.692 probability, indicating a possible hybrid, but is probably best identified as a small *B. b. kirtlandi.*

It should be noted that locality 10 (with two *B. b. kirtlandi*) and locality 11 (with a *B. carolinensis*) actually represent the same place although the locality notations on the specimen labels were different. These specimens, collected in the same habitat (grass-shrub vegetation along a highway right-of-way), showed no evidence of hybridization, intergradation, or convergence in characteristics. In the other area (locality 19) where the two shrews were found to be sympatric, only the larger individual was utilized in the discriminant function analysis because the smaller had a damaged skull. The

Table 1.—Measurements (mm) of *B. b. kirtlandi* and *B. carolinensis* from Virginia and North-central North Carolina.

	B. b. kirtlandi				*B. carolinensis*			
Character	Mean	SE	Range	N	Mean	SE	Range	N
Total length	114.33	0.546	98.0–126.0	104	95.59	0.861	84.0–107.0	39
Tail vertebrae	23.75	0.244	13.0–29.0	104	19.33	0.263	15.0–23.0	39
Hind foot	14.42	0.113	8.0–17.0	104	12.28	0.110	11.0–15.0	39
Occipito-premaxillary length	22.03	0.104	20.3–30.0	96	18.79	0.065	17.8–20.0	49
Palatal length	10.04	0.033	9.2–10.7	112	8.45	0.340	7.8–9.0	55
Postpalatal length	9.92	0.034	8.9–10.7	98	8.45	0.360	7.8–9.0	49
P^4–M^3 length	6.06	0.018	5.5–6.5	111	5.24	0.020	4.9–5.5	52
Palatal breadth	6.87	0.021	6.3–7.5	113	6.04	0.023	5.7–6.4	56
Nasal width	2.99	0.013	2.6–3.3	113	2.41	0.013	2.2–2.6	56
Maxillary breadth	7.68	0.029	6.9–8.8	98	6.71	0.030	6.4–7.7	48
Least interorbital breadth	5.67	0.020	5.1–6.3	110	5.06	0.022	4.7–5.5	55
Cranial breadth	12.18	0.113	11.2–12.9	93	10.27	0.043	9.8–10.8	42
Zygomatic plate breadth	2.39	0.014	2.0–2.8	113	2.13	0.016	1.9–2.5	56
Braincase depth	6.36	0.021	5.9–7.0	92	5.48	0.028	5.1–5.9	46
Skull depth	7.18	0.023	6.6–7.7	92	6.25	0.031	5.9–6.7	46

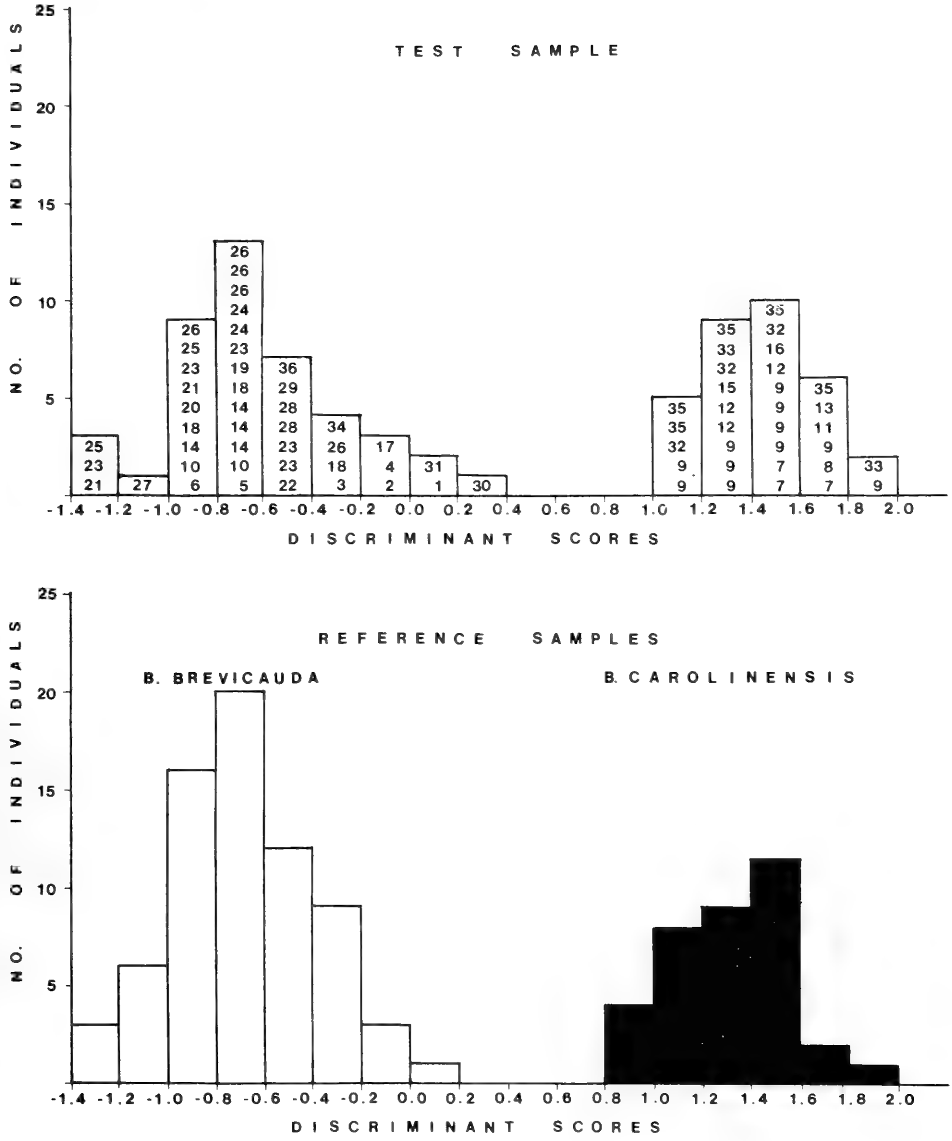

Fig. 2. Frequency histogram of discriminant scores of test and reference samples of *B. brevicauda kirtlandi* and *B. carolinensis* used in this study.

larger shrew was placed into the *B. b. kirtlandi* group by the discriminant analysis but the measurements of the smaller shrew are within the range of *B. carolinensis*. All field identifications agree with the discriminant function classification and, with the possible exception of the specimen from locality 30 discussed above, there was no evidence of intergradation, hybridization, or convergence in characteristics.

Blarina b. kirtlandi and *B. carolinensis* demonstrate a parapatric distribution atypical of Virginia mammals (Fig. 1). The isolated populations of *B. carolinensis* are relicts of a former continuous distribution in eastern Virginia (Handley, 1971). The parapatric distribution found today probably is

Table 2.—Standardized discriminant function coefficient of each discriminating variable.

Discriminating variable	Coefficients
Cranial breadth	−0.33352
Postpalatal length	−0.31472
P^4–M^3 length	−0.23559
Least interorbital breadth	−0.22726
Palatal length	−0.20534
Occipito-premaxillary length	−0.13540
Nasal width	−0.13187
Skull depth	−0.10379
Braincase depth	−0.09565
Palatal breadth	−0.05668
Zygomatic plate breadth	−0.05518
Maxillary breadth	−0.05434

maintained by competition, influenced overall by climatic factors. Graham and Semken (1976) and Handley (1971) suggested that *B. b. kirtlandi* is segregated from *B. carolinensis* by temperature extremes, *B. b. kirtlandi* being adapted to more boreal climates. In areas where the two species are sympatric, no ecological segregation has been recognized. Genoways and Choate (1972) found no ecological separation of *B. b. brevicauda* and *B. carolinensis* in Nebraska, where ". . . all specimens from the zone of contact were trapped in grassy roadside ditches in otherwise highly agricultural areas . . . ."

Specimens Examined

B. carolinensis reference sample

NORTH CAROLINA: Raleigh, USNM (15). VIRGINIA: *Brunswick Co.*: Triplett, Seward Forest, USNM (2). *Dinwiddie Co.*: 6 mi S Petersburg, VCU (1). *Lancaster Co.*: 2 mi NNE Kilmarnock, USNM (15). *Nottoway Co.*: about 1 mi E Burkville, VCU (1). Virginia Beach: Virginia Beach, USNM (2).

B. b. kirtlandi reference sample

VIRGINIA: *Bedford Co.*: Peaks of Otter, USNM (1). *Campbell Co.*: Lynchburg, USNM (4). *Charles City Co.*: 2.4 mi N, 8.7 mi W Charles City Court House (C.H.), VCU (2); E bank Chickahominy River, 5.7 mi S, 10.4 mi E Charles City C.H., VCU (1). *Giles Co.*: Various localities near Mt. Lake, USNM (21). *Gloucester Co.*: near Almonds Wharf, USNM (1); Stubble Farm, near Caphosic, USNM (2). *Hanover Co.*: Ashland, USNM (2). *Henrico Co.*: up to 8 mi E and 5.7 mi N of Richmond, VCU (7). *James City Co.*: Mainland opposite Jamestown, USNM (3); Williamsburg, William and

Mary Biol. Exp. Sta., USNM (5). *King and Queen Co.*: 3 mi SW Mascot, USNM (1). *King William Co.*: 4.5 mi NW West Point, USNM (1). *Middlesex Co.*: Jamaica, USNM (2). *Montgomery Co.*: near Blacksburg, 2,100 ft, USNM (6). *New Kent Co.*: 5 Lakes, 20 mi E Richmond, VCU (1); near Bottom's Bridge, 20 mi E Richmond, VCU (1). *Patrick Co.*: 5 mi SW Stuart, USNM (1). *Prince William Co.*: Catharpin, USNM (1); Buckland, USNM (1). City of Richmond: VCU (3). *Roanoke Co.*: Salem, USNM (1). *Rockbridge Co.*: 2 mi NE Glasgow, USNM (1). *Rockingham Co.*: 1 mi W Broadway, USNM (1).

Test Sample

The letter K preceding the locality number designates *B. b. kirtlandi;* C indicates *B. carolinensis*.

VIRGINIA: *Appomattox Co.*: K-1—Holliday Creek, 4.1 mi N, 10.8 mi E Appomattox C.H., VCU (1). *Buckingham Co.*: K-2—Buckingham-Appomattox State Forest, 5 mi S, 8.5 mi W Buckingham C.H., VCU (1); K-3—Buckingham-Appomattox State Forest, 8.5 mi S, 1.8 mi W Buckingham C.H., VCU (1). *Cumberland Co.*: K-4—4 mi N Cumberland C.H., USNM (1). *Powhatan Co.*: K-5—5 mi WNW Powhatan C.H., USNM (1); K-6—N bank Appomattox River, 3.7 mi S, 2.5 mi W. Powhatan C.H., VCU (1). *Amelia Co.*: C-7—No definite locality, USNM (3); C-8—1.5 mi S, 3.5 mi W Amelia C.H., VCU (1); C-9—Amelia C.H., USNM (10); K-10—S bank Appomattox River, 9.8 mi N, 0.7 mi E of Amelia C.H., VCU (2); C-11—0.6 mi S Appomattox River, 9.5 mi N, 0.3 mi E Amelia C.H., VCU (1); C-12—1.5 mi S of Appomattox River, 8.7 mi N, 0.3 mi E of Amelia C.-H., VCU (3); C-13—4.4 mi N, 1 mi E Amelia C.H., VCU (1). *Chesterfield Co.*: K-14—No definite locality, VCU (4); C-15—E bank Appomattox River, 1.5 mi S, 18.75 mi W Chesterfield C.H., VCU (1); C-16—8.3 mi E Appomattox River, 1 mi N, 6.6 mi W Chesterfield C.H., VCU (1); K-17—11.2 mi E Appomattox River, 1.8 mi N, 8.8 mi W Chesterfield C.H., VCU (1); K-18—2.1 mi N, 3.1 mi W Chesterfield C.H., VCU (3); K-19—14 mi SW Richmond, VCU (1); K-20—7 mi N, 0.25 mi W Chesterfield C.H., VCU (1); K-21—5.8 mi N, 0.25 mi E Chesterfield C.H., VCU (2); K-22—Chester, 1.5 mi S, 3.2 mi E Chesterfield C.H., VCU (1); K-23—8.5 mi S Richmond, VCU (5); K-24—3.7 mi W Hopewell, VCU (2); K-25—1.6 mi W Hopewell, VCU (2); K-26—Presquile National Wildlife Refuge, VCU (6). *King George Co.*: K-27—Port Conway, USNM (1). *Prince George Co.*: K-28—16 mi E Hopewell, VCU (2). *Westmoreland Co.*: K-29—Leedstown, USNM (1). *Essex Co.*: K-30—4.6 mi NW Tappahannock, USNM (1). *Richmond Co.*: K-31—1.4 mi SW Newland, USNM (1); C-32—Naylors Bridge, NW Cat Point Creek, USNM (3); C-33—3.6 mi SSW Warsaw, USNM (2). *Isle of Wight Co.*: K-34—Benns Church, USNM (1). *Mathews Co.*: C-35—Gwynn's Island, USNM (1). *Norfolk Co.*: K-36—2 mi N Wallaceton, USNM (1).

Additional Specimens (All Age Classes) Used to Plot the Distribution of *Blarina* in Virginia

B. carolinensis

VIRGINIA: *Amelia Co.*: 3.5 mi S, 6.6 mi W Amelia C.H., VCU (2). *City of Colonial Heights*: City of Colonial Heights, VCU (1). *Dinwiddie Co*: 6 mi SW Petersburg, VCU (1). *Princess Ann Co.* (*Virginia Beach*): Lynnhaven, VPI (5); Kempville, VPI (1). *Prince Edward Co.*: Directly S Prince Edward State Park, VCU (1); 9.5 mi S, 4.8 mi E Prince Edward C.H., VCU (3). *Prince George Co.*. Petersburg (Camp Lee), VPI (4). *Richmond Co.*: 0.5 to 2.2 mi SSE, S, and SW Newland, USNM (6); Warsaw, USNM (1). *Virginia Beach*: Virginia Beach, USNM (2). *Westmoreland Co.*: Kinsale, USNM (1).

B. b. kirtlandi

VIRGINIA: *Alleghany Co.*: Clifton Forge, USNM (6). *Augusta Co.*: 7 mi S Staunton, USNM (2). *Bath Co.*: Clark's Cave, 9 mi SW Williamsville, USNM (12). *Buckingham Co.*: S side Willis River, 3.2 mi S, 7.4 mi E Buckingham C.H., VCU (1); 3.4 mi S, 8.8 mi E Buckingham C.H., VCU (1). *Caroline Co.*: 4 mi SE Port Royal, USNM (2). *Fairfax Co.*: Falls Church, USNM (8). *Fauquier Co.*: 2.5 mi W Thorofare, USNM (2); Rectortown, USNM (1); 6 mi N Warrenton, USNM (6). *Franklin Co.*: 10 mi S Roanoke, VCU (7). *Giles Co.*: Castle Rock, Big. Mt., 4.2 mi NNE Mt. Lake, 4100 ft, USNM (24); Whiterocks Campsite N of Kimbalton, VCU (4); *Gloucester Co.*: 1 mi SSE Bena, USNM (1). *Henry Co.*: 4.5 mi NNW Martinsville, USNM (1). *Highland Co.*: Laurel Fork, 9 mi NNW Monterey, USNM (5); Bear Willow Run, 9.5 mi NNW Monterey, 3200 ft, USNM (2). *Mathews Co.*: Junction Rt. 14 and Rt. 3, USNM (1). *Powhatan Co.*: E side Sallee Creek, 1.7 mi N, 4.5 mi W Powhatan C. H., VCU (2). *Rappahannock Co.*: near Amissville, USNM (1). *Richmond Co.*: 1.4 mi SW Newland, USNM (2). *Roanoke Co.*: Salem, USNM (1); 5 mi S Roanoke, VCU (1). *Russel Co.*: Clinch Mt., Laurel Bed, 6 mi NNW Saltville, 3600 ft, USNM (47). *Southampton Co.*: 2 mi SE Wakefield, USNM (1). *Tazewell Co.*: Burkes Garden, USNM (54). *Warren Co.*: Front Royal, USNM (1); near Cedarville, USNM (3). *Wise Co.*: 5 mi N Wise, USNM (2); 4 mi NE Wise, USNM (1); Hurricane, USNM (3).

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REVISION OF THE COLLARED GNATWREN, *MICROBATES COLLARIS* (AVES: PASSERIFORMES)

Kenneth C. Parkes

Abstract.—Microbates collaris, a small passeriform bird of uncertain affinities, has a highly disjunct range in northern South America. Three subspecies are recognized in current literature. Two more are described, from Colombia and the Guianas; a name for the latter is already available.

The gnatwrens, of which two species (*collaris, cinereiventris*) are placed in the genus *Microbates* and one, the longer-billed, longer-tailed *melanurus,* in the genus *Ramphocaenus,* are of uncertain affinities within the Passeriformes. The history of their classification was reviewed by Rand and Traylor (1953). Their relationships are currently thought to be with the Old World warblers, which are variously given their own family, Sylviidae, or considered members of a large family Muscicapidae which includes all the so-called "Old World insect-eaters." The only other sylviid-like birds in the Neotropics are the gnatcatchers, *Polioptila,* and the gnatwrens are now uniformly placed next to *Polioptila.* Paynter (1964) gave these three genera their own subfamily, Polioptilinae, within the enlarged Muscicapidae, thus giving them equal rank with the Old World warblers (Sylviinae). At the same time he admitted in a footnote (p. 443) that "The three genera in this subfamily are presumably not closely related to one another, with the possible exception of *Microbates* and *Ramphocaenus.* Their proper taxonomic placement awaits further study." This is a highly conservative statement, as many authors believe that *Microbates* and *Ramphocaenus* are barely separable as genera.

The range of *Microbates collaris* appears to be composed of several disjunct populations, and it is probable that this is not entirely an artifact of insufficient collecting (although the species is not abundantly represented in museums). Paynter (1964) recognized three subspecies in the "Peters" Check-list. The species has not been critically studied since the description of *M. c. paraguensis* by Phelps and Phelps (1946). Material in any one museum is so limited that a full appreciation of variation in this species can be attained only by assembling specimens from several sources. The present study is based on the combined collections of Carnegie Museum of Natural History (CM) and the American Museum of Natural History (AMNH), supplemented by key specimens borrowed from the Field Museum of Natural History (FMNH) and the Los Angeles County Museum (LACM). I am grateful to John W. Fitzpatrick and Ralph W. Schreiber, respectively, for permission to borrow specimens from the latter two museums, and to Wesley E. Lanyon for use of the facilities of the AMNH.

The adult *Microbates collaris* is a small (wing chord 48–53 mm), rather long-billed (exposed culmen 17–20 mm), short-tailed (25–31 mm), superficially wrenlike bird, as suggested by the name gnatwren. The crown, back, flanks, wings, and tail are brown, ranging from olivaceous to reddish, with the crown usually somewhat darker than the back. The throat and upper breast are white. A transverse black pectoral band borders the abdominal area, which is white with gray sides. There is a complex facial pattern. A white superciliary line, beginning at the lores, is bordered below by a black transocular line; the cheeks are white, bordered below by a black moustachial streak.

The characters that have been found to be useful in assessing geographic variation in *Microbates collaris* are as follows: (1) color of upperparts, including relative contrast between crown and back; (2) color of flanks; (3) degree to which pigmentation of sides invades abdominal area; (4) width of black pectoral band; (5) width of black postocular and moustachial streaks. There is no geographic variation in size, and the sexes are alike.

As illustrated by the fine series from French Guiana in CM, the juvenal plumage of this species completely lacks the black pectoral band, white superciliary line, and black facial markings of the definitive plumage. The juvenal plumage is succeeded by a first basic plumage in which the dorsum is more rufescent than in the definitive plumage, and the remiges, wing coverts, and rectrices (retained from the juvenal plumage) have conspicuous rufescent edgings (subject to wearing away). The black pectoral band in the first basic plumage is often reduced in size, being confined in extreme individuals to a transversely elongated spot. As both dorsal color and the extent of the pectoral band are also geographically variable characters, it is obvious that series must be segregated by age before being compared. There is no evidence that either Hellmayr (in Cory and Hellmayr 1924:211, footnote) or Phelps and Phelps (1946:154) so segregated their specimens, which undoubtedly accounts for their finding that dorsal color was not completely correlated with distribution (to the extent that Hellmayr, who apparently examined only seven specimens, failed to recognize any subspecies). My study of a combined series of 58 specimens showed that two additional subspecies should be recognized, for one of which a name is already available. Characters and distribution of the five subspecies are as follows.

Microbates collaris collaris (Pelzeln)

Rhamphocaenus collaris Pelzeln, 1868, Orn. Bras. 2:84, 157 [not seen]. Barra do Rio Negro, Maribitanas, and Rio Içanna, upper Rio Negro; restricted to Barra do Rio Negros (=Manáos) by Berlepsch (1908:156).

Characters.—Upperparts and flanks somewhat rufescent, with crown differing little or not at all from back. Gray of sides relatively limited in extent. Black moustachial stripe not connected posteriorly with postocular line. Pectoral band of medium extent for the species as a whole.

Range.—From the mouth of the Rio Negro, Brazil (Manáos) and the adjacent left (north) bank of the Rio Solimões (Manacapurú) northwest along the Rio Negro at least to Maribitanas; southwestern Amazonas, Venezuela, north to the vicinity of Cerro Duida.

Specimens examined.—BRAZIL: Manacapurú, Rio Solimões, 10 (CM); Rio Manacapurú, 1 (CM); Tatú, Rio Negro, 3 (AMNH); Yucali [Yucalu of Phelps and Phelps, 1946:154], Rio Negro, 1 (AMNH). VENEZUELA: Vicinity of Cerro Duida (various localities), 7 (AMNH); Solano, left (south) bank Río Cassiquiare, 1 (AMNH); El Merey, left (south) bank Río Cassiquiare, 1 (AMNH); Río Huaynia (=Guainia), right (east) bank at junction with Río Cassiquiare, 2 (AMNH).

Microbates collaris perlatus Todd

Microbates collaris perlatus Todd, 1927, Proc. Biol. Soc. Washington 40:161. Tonantins, Rio Solimoës [sic], Brazil.

Characters.—Black pectoral collar widest in the species. Flank color little if any different from that of *collaris,* but sides grayer, impinging slightly more on the white of the median underparts. Moustachial stripe distinctly broader and tending to connect posteriorly with the black postocular line, thus restricting the white area of the ear coverts between these black lines. Upper parts darker and duller than in *collaris,* somewhat less rufescent, but difference not striking.

Range.—Known only from the type locality on the left (north) bank of the upper Rio Solimões, Brazil. Meyer de Schauensee (1951:926) postulated that "It is probable that birds from the lower Putumayo Valley and the Leticia territory [of Colombia] represent *Microbates collaris perlatus* Todd, described from Tonantins, on the left bank of the Amazon River near the mouth of the Putumayo." The wording suggests that this species has been collected in the area mentioned, but to the best of my knowledge it has not. There is a major gap in distributional records of this species in the western Amazonian region from Tonantins west to the foothills of the Eastern Andes of Colombia.

Specimens examined.—BRAZIL: Tonantins, Rio Solimões, 8 (CM), including the holotype.

Microbates collaris paraguensis Phelps and Phelps

Microbates collaris paraguensis Phelps and Phelps [erroneously cited simply as "Phelps" by Paynter, 1964:444], 1946, Bol. Soc. Venezolana Cienc.

Nat., no. 65–66:153. Salto María Espuma (300 m), Caño Espuma, Alto Río Paragua, Bolívar, Venezuela.

Characters.—Described as having the crown and anterior upperparts more reddish brown, less olivaceous than in *collaris*. In the two specimens available, the crown was faintly more rufescent, but the color of the rest of the back could be matched by many specimens of *collaris*. The gray of the sides impinges on the white of mid-abdomen even more than in *perlatus*, but the flanks are much more rufescent, less olive-brown than in that race.

Range.—Known only from the upper Río Paragua, from Salto Guaiquinima up to Salto Maiza, southeastern Bolívar, Venezuela (see map in Phelps and Phelps, 1946:160).

Specimens examined.—VENEZUELA: Salto María Espuma, Alto Río Paragua, 300 m, 1 (AMNH), the holotype; Campamento Comején, Cerro Guaiquinima, 1 (AMNH).

Microbates collaris torquatus Sclater and Salvin

Microbates torquatus Sclater and Salvin, 1873, Nomenclator avium neotropicalium: 72 (nomen nudum), 161 (description). St. George d'Oyapock, Cayenne [=French Guiana].

Characters.—Upperparts duller, less rufescent, more olivaceous brown than in any other subspecies. Crown and back approximately uniform. Flanks of a slightly more olivaceous brown than in *collaris*. Gray of sides restricted, not impinging on white abdomen as in other races. Black pectoral band broader than in *collaris*, with extreme individuals matching some *peraltus*. Black postocular line and moustachial streak also variable between extremes shown by *collaris* (narrow) and *perlatus* (broad).

Range.—Known from southern Surinam (Kaysergebergte Airstrip), French Guiana, and Amapá, northeasternmost Brazil. Two specimens from "Oyapoc" in the U.S. National Museum were erroneously attributed to "GUAYANA INGLESE" by Phelps and Phelps (1946); the specimens are from French Guiana, and the species has not been recorded in Guyana (formerly British Guiana). In view of the gap between the Surinam and French Guiana localities, it is quite possible, if not probable, that this subspecies occurs just south of the Guianas in the ornithologically little-known area of northern Pará, Brazil.

Remarks.—Sclater and Salvin (1873) described *Microbates torquatus* as a new genus and species in ignorance of Pelzeln's *Rhamphocaenus collaris*, described five years earlier. After learning of Pelzeln's name, Scalter (1883) synonymized *torquatus* with *collaris* solely on the basis of the written description of the latter, as the holotype of *torquatus* was still the only specimen he had actually seen. The name *torquatus* has remained in synonymy since 1883. Berlepsch (1908:156) compared two French Guiana specimens with one of *collaris* from the Rio Içanna, and stated that the latter showed "perhaps a little more rusty suffusion on the upperparts." Hellmayr (*in* Cory and Hellmayr, 1924:211, footnote) compared two French Guiana specimens with one from Manáos and three from the upper Rio Negro. He found that the Manáos specimen matched those from French Guiana, whereas those from the upper Rio Negro were "decidedly more rufescent, less olivaceous above." Novaes (1978) listed four specimens from Amapá, the Brazilian territory adjacent to French Guiana, as *M. c. collaris* without comment, as did Blake (1963) in reporting the first specimens of this species from Surinam. As stated earlier, the failure to appreciate the distinctiveness of the Guianan birds can undoubtedly be explained in large part by the rufescence of specimens in first basic plumage. This plumage in *torquatus* approaches in dorsal and flank color the definitive plumage of *collaris,* but it is not quite as rusty and shows more contrast between the darker crown and the dull rufous-brown back. Another pitfall is museum age, as foxing tends to redden the brown colors of this species. Adults of *torquatus* collected in 1917 have flanks that are definitely more olivaceous than adults of *collaris* collected in 1923–29. However, French Guiana specimens taken in 1902 and 1903 (AMNH) have clearly foxed. They are more reddish above, and have flanks indistinguishable from those of the 1923–29 series of *collaris.* These two specimens, from Ipousin, Approuague River, may be the ones that Hellmayr (*loc. cit.*) found to match a topotype of *collaris,* suggesting that they may have begun to fox by 1924.

Of the two Surinam specimens seen (those reported by Blake, 1963), one (FMNH 260628) is in first basic plumage and is noticeably more rufescent on crown, dorsum, and flanks than the other (FMNH 260269), a female marked as having had an enlarged ovary. The second specimen is a good match for French Guiana adults.

Although Meyer de Schauensee (1966:418) includes Amapá, northeasternmost Brazil, in the range of this species, I have seen no published record to document his statement. Novaes (1978:42) listed 4 Amapá specimens in the Museu Goeldi, Belém, Pará. In addition to these, there are 5 (Serra do Navio, 4; Porto Platon, 1) in the United States National Museum (S. Olson, *in litt.*) and 1 from Serra do Navio in LACM. The latter specimen is the only Amapá specimen I have examined; it matches Guianan specimens of *torquatus* (as do also the USNM specimens, *fide* Olson).

Specimens examined.—FRENCH GUIANA: Pied Saut, Oyapock River, 10 (CM); Tamanoir, Mana River, 5 (CM); Ipousin, Approuague River, 2 (AMNH). SURINAM: Kaysergebergte Airstrip, 2 (FMNH). BRAZIL: Serra do Navio, Amapá, 1 (LACM).

Microbates collaris colombianus, new subspecies

Holotype.—FMNH 287487, adult male, collected at San Antonio Guamuez, Putumayo, Colombia (400 m), 12 October 1969, by Kjell von Sneidern (original no. 27888).

Characters.—Gray of sides much more extensive than in any other subspecies, with only a small amount of white on midventral line. Flanks similar to those of *torquatus.* Crown rich dark chocolate brown, contrasting more with the dorsum than in any other subspecies. Dorsum between than of *collaris* and *perlatus* (duller and less rufescent than the former; slightly paler, more rufescent than the latter). Black of postocular and moustachial lines about as in *torquatus.* Pectoral band variable in size, but less extensive laterally than in adults of other subspecies, because the gray of the sides extends anteriorly to encroach on the lateral margins of the pectoral band.

Range.—Colombia, along the eastern foot of the Eastern Andes, in Putumayo and western Caquetá; may also occur in the upper Putumayo drainage in extreme northeastern Ecuador. In addition to the localities from which specimens have been examined, the species (and undoubtedly this subspecies) has been collected at Morelia and Cuembí (Meyer de Schauensee, 1951).

Specimens examined.—COLOMBIA: San Antonio Guamuez, Putumayo, 3 (FMNH); Florencia, Caquetá, 1 (AMNH). The latter specimen, collected in 1912, shows distinct foxing when compared to the 3 1969 FMNH specimens.

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REVISION OF THE TAWNY-FACED ANTWREN, *MICROBATES CINEREIVENTRIS* (AVES: PASSERIFORMES)

Storrs L. Olson

Abstract.—Three new subspecies of *Microbates cinereiventris* are described and the ranges of the seven subspecies now recognized are delimited. *M. c. semitorquatus* (Lawrence) occurs on the Caribbean slope of Central America from Nicaragua southward and is first recorded here from Colombia on the Gulf of Urabá; it crosses over to the Pacific slope only in Panamá Province, Panamá. *M. c. cinereiventris* (Sclater) occurs on the Pacific slope from Darién, Panamá, to western Ecuador. *M. c. albapiculus* subsp. nov. is confined to the Cauca Valley, Colombia, and *M. c. magdalenae* Chapman is now seen to be restricted to the Magdalena Valley, Colombia. East of the Andes, *M. c. unicus* subsp. nov. is described from a single distinctive specimen from the Mámbita llanos in Cundinamarca, Colombia; *M. c. hormotus* subsp. nov. occurs from southern Colombia to Ecuador and northeastern Peru; and *M. c. peruvianus* Chapman is here restricted to eastern Peru, from Amazonas to Puno.

The revision by Parkes (1980) of the subspecies of *Microbates collaris* and his summary of the systematic position of the gnatwrens ("Sylviidae") provides adequate background for the following revision of the only other species of the genus, *Microbates cinereiventris*. This study is based largely on previously uncurated skins from Panamá and Colombia in the National Museum of Natural History, Smithsonian Institution (USNM). This material necessitates the recognition of three new subspecies and the correction of numerous inaccuracies in the published distribution of the others.

Characters useful in separating populations of *M. cinereiventris* are (1) intensity of coloration of underparts and, to a lesser degree, the dorsum; (2) presence or absence of a dark postocular streak; (3) presence or absence of light colored tips to the rectrices; (4) intensity of coloration of the tawny cheek patches; and (5) relative development of the collar of black and white streaks on the throat.

Microbates cinereiventris semitorquatus (Lawrence)

Ramphocaenus semitorquatus Lawrence, 1862, Ann. Lyc. Nat. Hist. N. Y. 7:469. Lion Hill Station, Panama [Canal Zone].

M. [*icrobates*] *c.* [*inereiventris*] *torquatus* Chapman, 1915, Bull. Amer. Mus. Nat. Hist. 34:642. *Lapsus, nec Microbates torquatus* Sclater and Salvin, 1873.

Characters.—Underparts dark gray, whitish suffusion in middle of belly obsolete; no postocular streak; rectrices not tipped with white; crown and dorsum nearly concolorous, dark rufescent brown.

Range.—Caribbean slope from southern Nicaragua through Costa Rica and Panamá to Gulf of Urabá, Colombia; Pacific slope in both halves of Panamá Province, Panamá.

Specimens examined (*all USNM unless otherwise noted*).—COSTA RICA. No further locality (2). ALAJUELA: San Carlos (1); La Bijagua (5). LIMON: Jiménez (1). CARTAGO: Pacuare (1). PANAMA. BOCAS DEL TORO: Changuena River, 725 m (1). COCLE: Head of Río Guabal, Tigre, 475 m (1); El Uracillo, Río Indio (2). COLON: Río Indio, boca del Río Indio (2); Río Indio, Chilár (3); Río Boqueron, Peluca Hydrographic Station (2); Porto Bello (2); Cerro Bruja (3). CANAL ZONE: Río Indio, near Gatun (tributary of Río Chagres, not the previously listed Río Indio) (4); Alajuela (2). PANAMA PROVINCE: Cerro Campana (5); Cerro Azul (1). SAN BLAS: Mandinga (1); Permé (4, MCZ); Armila (4); Puerto Obaldia (5, MCZ). COLOMBIA. CHOCO: Gulf of Urabá, Acandí (1).

Remarks.—This is the only subspecies in Central America except for the population of nominate *cinereiventris* in Darién, Panamá. The specimen of *semitorquatus* from Colombia (USNM 427204, collected 14 January 1950 by M. A. Carriker) is the first reported for that country. Griscom (1932:366) referred birds from Permé and Puerto Obaldia, San Blas, Panamá, to the Colombian race *magdalenae,* obviously in the absence of comparative material, since he states that the tails were "tipped with whitish" as in that subspecies. Evidently he mistook the slightly lighter brownish edging of the tail tip, found in both *semitorquatus* and *cinereiventris,* for the distinct white spots of *magdalenae,* a subspecies that is very different from *semitorquatus* and geographically quite far removed from it. I have examined Griscom's specimens and they are perfectly typical of *semitorquatus.*

Microbates cinereiventris cinereiventris (Sclater)

Ramphocaenus cinereiventris Sclater, 1855, Proc. Zool. Soc. London 1855:76. "Pasto," Colombia (Buenaventura substituted by Cory and Hellmayr, 1924).

Characters.—Like *semitorquatus* but postocular streak present; underparts lighter; dorsum somewhat lighter, more olivaceous, contrasting with the darker crown.

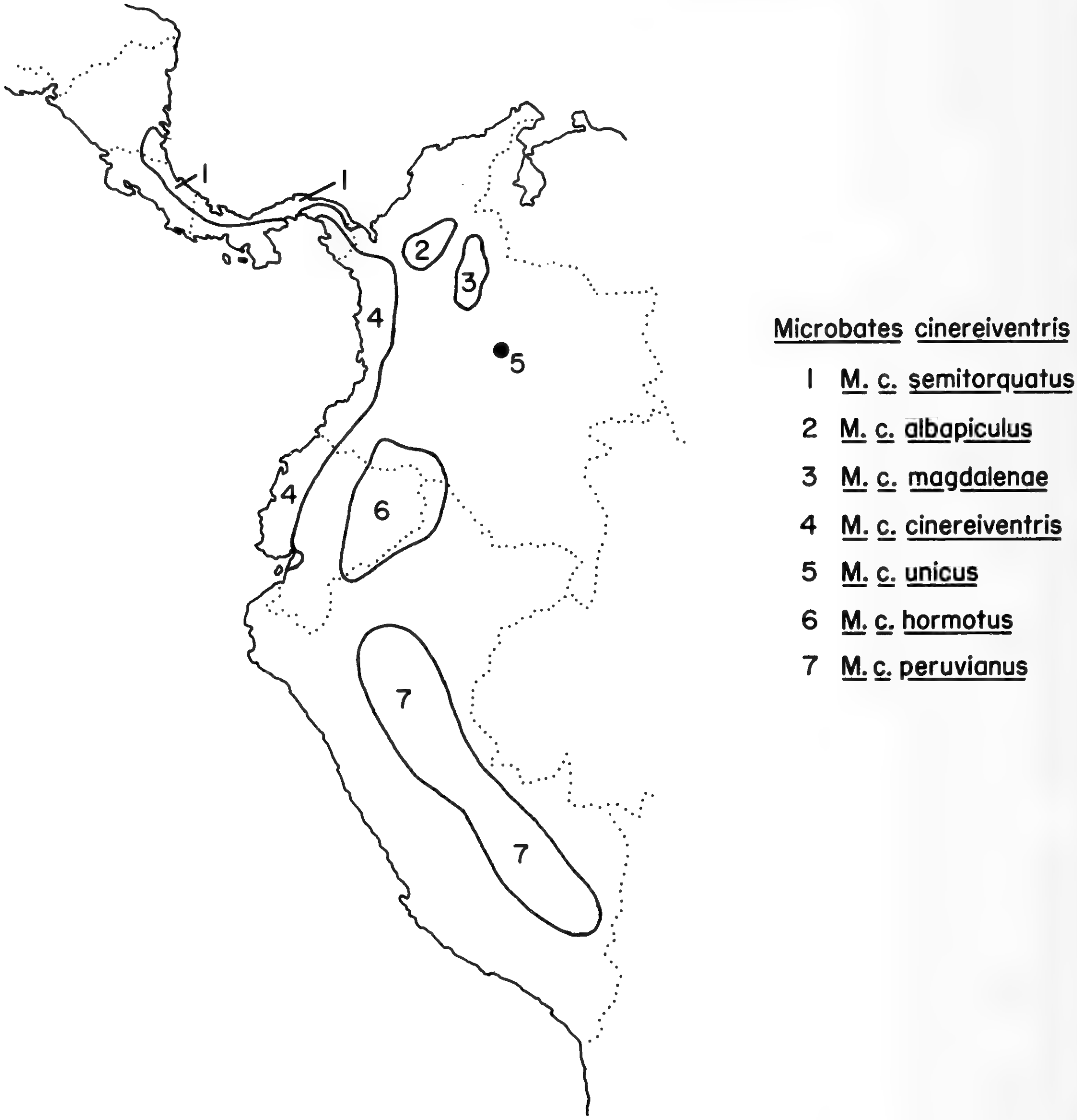

Fig. 1. Outline map of northwestern South America and adjacent Middle America showing the approximate ranges of the subspecies of *Microbates cinereiventris*. Discontinuities not the result of montane regions may be artifacts of collecting.

Range.—Pacific slope from Darién, Panamá, south through Colombia to Loja Province, western Ecuador.

Specimens examined (*all USNM unless otherwise stated*).—PANAMÁ. DARIÉN: La Laguna (2); Tacarcuna Village (2); Jaqué (6); Río Jaqué, mouth of Río Imamadó (6). COLOMBIA. ANTIOQUIA: Villa Artiaga, 7 km NE of Pavarandocito (2). CHOCO: Río Jurubidá, Baudó Mountains (1); Río Nuquí (3). VALLE: Punto Muchimbo, Río San Juan, below mouth of Río Calima (5). NARIÑO: La Guayacana (5, LSU). ECUADOR (all AMNH). ESMERALDAS: Esmeraldas (1); Cachabí (3); Río Verde (1). IMBABURA: Paramba (1). CHIMBORAZO (?): CHIMBO (2). MANABI: Río de Oro (2); Pata de Pájaro (1). LOJA: Alamor (1).

Remarks.—The Colombian birds tend to be lighter above than those from Panamá, but individual and perhaps age variation obliterates the differences. For example, a male from Jaqué, Darién (USNM 386417) is lighter than any of those from Colombia.

Microbates cinereiventris albapiculus, new subspecies

Holotype.—USNM 403270, male, from El Pescado, 12 km below Puerto Valdivia, Rio Cauca, Antioquia, Colombia, elevation 152 m. Collected 11 May 1948 by M. A. Carriker, Jr. (original number 13414).

Characters.—Like *M. c. magdalenae* in having white tips to the rectrices and lacking a postocular streak, but underparts darker gray, less whitish, upperparts and brownish portions of lower flanks darker, more olivaceous, less rufescent.

Range.—Restricted to the Cauca drainage in Antioquia, Colombia, between the Serrania de Abibe on the west and the Serrania de San Lucas on the east.

Specimens examined (all USNM).—COLOMBIA. ANTIOQUIA: El Real, Río Nechí (3); Tarazá, Rio Tarazá, 12 km NW of Puerto Antioquia, 136 m (1); El Pescado, 12 km below Puerto Valdivia, Rio Cauca (1); Hacienda Belen, 13 km W of Segovia, 240 m (3); Quebrada Salvajin, Río Esmeralda, upper Río Sinú, 180 m (2).

Etymology.—Latin *albus,* white, and *apiculus,* masculine diminutive of *apex,* top, apex, in reference to the white tips to the rectrices.

Remarks.—This subspecies combines the plumage pattern of *magdalenae* with the generally darker coloration of *cinereiventris.* The mountain ranges mentioned above seem to be effective in isolating this subspecies, as *cinereiventris* occurs immediately to the west of the Serraneà de Abibe at Villa Arteaga, whereas a large series from the eastern slope of the Serrania de San Lucas at Volador are clearly referable to *magdalenae.*

Microbates cinereiventris magdalenae Chapman

Microbates cinereiventris magdalenae Chapman, 1915, Bull. Amer. Mus. Nat. Hist. 34:642. Malena near Puerto Berrio, Magdalena Valley, Antioquia, Colombia.

Characters.—Like *albapiculus* but palest of all the races of the species, underparts whiter, lower flanks and dorsum paler brown.

Range.—Colombia, middle Magdalena Valley in Bolivar, Antioquia, and Santander.

Specimens examined.—COLOMBIA. BOLIVAR: Volador, 42 km W of Simití, 788 m (12, USNM). SANTANDER: Hacienda Santana, 13 km NE of Conchal (2, USNM); El Tambor (6, CM; 2, ANSP); El Cauca (2, CM). ANTIOQUIA: Malena (1, AMNH—holotype).

Remarks.—Despite numerous misstatements to the contrary, this subspecies is confined entirely to the Magdalena Valley.

Microbates cinereiventris unicus, new subspecies

Holotype.—USNM 372268, unsexed adult from ''Mámbita Llanos east of Bogotá,'' Cundinamarca, Colombia. Collected by Brother Niceforo Maria; date not specified; specimen cataloged in 1943 with a collection of specimens taken between 1930 and 1943.

Characters.—Like *magdalenae* and *albapiculus* in having light tips to the rectrices, but these are of a deep buffy color, rather than white; lower flanks extensively deep rufescent brown; cheek patches deeper tawny; dorsum darker and much more reddish.

Range.—Known from the type locality only.

Specimen examined.—Holotype only.

Etymology.—Latin, *unicus,* only, sole, the subspecies being known so far from a single specimen.

Remarks.—The specimen label indicates that the type was originally identified by Herbert Friedmann as *magdalenae.* It would appear that this specimen is the basis for Meyer de Schauensee's (1951) listing *magdalenae* from Mámbita and Paynter's (1964) inclusion of Colombia east of the Andes in the range of that subspecies. Considering that each of the major valley systems west of the Andes is inhabited by an endemic subspecies of *Microbates,* it would be truly remarkable if the birds on the opposite side of the Andes had not differentiated. The light colored tail tip shows this subspecies to be closer to *magdalenae* than to the birds from farther south in eastern Colombia, but the type is so different from the very pale birds in the Magdalena Valley that there can be no question of its subspecific distinction. The tail tips may be buffy in occasional specimens of *magdalenae* but are never as rusty a buff as in the type of *unicus.*

Microbates cinereiventris hormotus, new subspecies

Holotype.—AMNH 184528, female, from San José Abajo (=San José Nuevo), Napo, Ecuador. Collected 30(?) March 1926 by Olalla and sons.

Characters.—Postocular streak and light tail tips lacking. Differs from *semitorquatus* in having the tawny cheek patches of a deeper, darker shade; black streaks in necklace reduced and not as dark; underparts and upperparts, particularly the crown, lighter. Differs from *peruvianus* in having the gray of the underparts lighter with the mid-belly decidedly whitish; cheek patches lighter; necklace streaks not as reduced; and dorsum lighter, more olivaceous, less rufescent.

Range.—East of the Andes in southern Colombia in Nariño and Putumayo, eastern Ecuador, and northeastern Peru in Loreto.

Specimens examined.—COLOMBIA. NARIÑO: Churo Yacu (1, ANSP). ECUADOR. NAPO: San José Nuevo (2, AMNH—holotype); Río Suno above Avila (1, AMNH); Loreto (1, ANSP). PASTAZA: Sarayacu (1, USNM); Montalvo (1, ANSP). PERU. LORETO: Mouth of Río Cururay (2, AMNH).

Etymology.—Greek, *hormos,* a necklace, in reference to the collar of streaks characteristic of the species as a whole.

Remarks.—Hellmayr (1911) noted that the birds of eastern Ecuador differed from *cinereiventris,* west of the Andes, in the lack of a postocular streak, the darker cheeks, and allegedly darker upperparts (actually somewhat lighter). Chapman (1923) overlooked this in his description of *peruvianus.* Although he did not examine specimens from eastern Ecuador, he considered that those reported from there previously by Sclater (1890) would probably be referable to *peruvianus* and this treatment has been followed subsequently. It has probably been for lack of an adequate series of true *peruvianus* that the Ecuadorean birds were never separated, this lack being now remedied by the series from LSU listed below. Records of *peruvianus* from Nariño and Putumayo, Columbia (Meyer de Schauensee, 1964) may be based on the specimen of *hormotus* from Churo Yacu, near the border of those departments.

Microbates cinereiventris peruvianus Chapman

Microbates cinereiventris peruvianus Chapman, 1923, Amer. Mus. Novit. 86:5. La Pampa, northern Puno, Peru.

Characters.—Nearest *hormotus* but breast and belly of a more nearly uniform and darker grey; cheek patches darker, more chestnut; upperparts darker, more rufescent; collar streaks more reduced than in other subspecies.

Range.—East of the Andes in Peru from Amazonas south to Puno.

Specimens examined.—PERU. AMAZONAS: Rio Cenepa, vicinity of Aintani (1, LSU); upper Rio Cenepa, Shaim (2, LSU). HUANACO: 35 km NE Tingo Maria, Hacienda Santa Elena, ca 1,000 m (4, LSU). CUZCO: 40 km E Quincemil on Puerto Maldonado road (1, LSU). PUNO: La Pampa (2, AMNH-holotype).

Remarks.—The reduction of the collar streaks has not been noted before but is quite characteristic of this subspecies and to a somewhat lesser extent of *hormotus* as well. The deeper tawny cheeks seem to be a feature of all the birds east of the Andes and this is expressed most strongly in *peruvianus.*

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CHEIRODON ORTEGAI, A NEW MARKEDLY SEXUALLY DIMORPHIC CHEIRODONTINE (PISCES: CHARACOIDEA) FROM THE RÍO UCAYALI OF PERU

Richard P. Vari and Jacques Géry

Abstract.—*Cheirodon ortegai,* a new species of cheirodontine characoid fish, is described from the Ucayali River system of Peru. Within *Cheirodon* this species can be distinguished by its relatively stout body, horizontal midside stripe running from the supracleithrum to the caudal-fin base and slightly oblique band running above the anal-fin base. Sexually dimorphic characters distinctive for *C. ortegai* include the presence in males of pronounced lateral swellings at the base of the adipose dorsal fin and along the ventral border of the caudal peduncle, the presence of numerous bony hooks on the pelvic fins, and the cuplike form of the pelvic fins. Medially the inner rays of the pelvic fins form a partially tubular channel that extends posteriorly ventral to the male vent to the anal-fin origin. This adaptation along with the apparently glandular tissue mass at the base of the pelvic fins appears to be unique to this species among characoids.

The new species of cheirodontine characoid described herein was discovered by one of us (RPV) in a collection of upper Amazonian fishes sent to the American Museum of Natural History by Sr. Hernán Ortega of the Universidad Nacional de San Marcos, Pucallpa, Peru. The junior author independently recognized this form as undescribed from material sent to him by I. J. Isbrücker of the Amsterdam Aquarium. All specimens with definite locality data are from the region of Masisea, Peru, at or near the junction of the Río Pachitea with the Río Ucayali.

Cheirodon ortegai, new species

Figs. 1–2, Table 1

Holotype.—American Museum of Natural History (AMNH) 35950, 31.2 mm standard length (SL) collected 27 November 1976 in a woodland pool connected with the Río Ucayali at Cocha Roba, 5 km downriver from Masisea, District of Masisea, Province Coronel Portillo, Department of Loreto, Peru (approx. Lat. 8°35′S, Long. 74°22′W).

Paratypes.—3 males (AMNH 35951 and British Museum (Natural History) [BMNH] 1977. 6.9–138), 31.2–31.5 mm SL and 1 female (AMNH

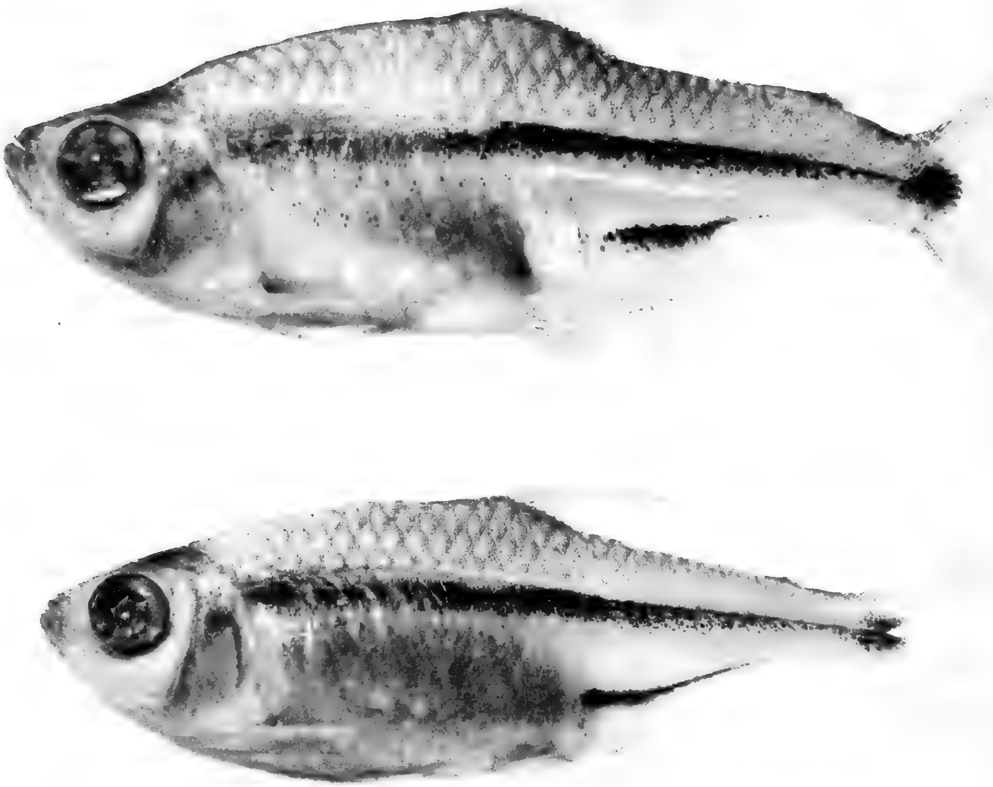

Fig. 1. *Cheirodon ortegai,* holotype (upper), male, AMNH 35950, 31.4 mm SL; and paratype (lower), female, AMNH 35951, 31.2 mm SL.

35951) 28.0 mm SL, taken with the holotype; one juvenile female? (Géry collection), collected by W. Baumler, 1965, in the Río Pachitea at its junction with the Río Ucayali; 1 male, 34.3 mm SL (Géry collection), no locality data; 1 female, 34.0 mm SL (Géry collection), no locality data.

Diagnosis.—Cheirodon ortegai can be distinguished from all other nominal *Cheirodon* species by its pronounced midside horizontal stripe and the slightly oblique pigment band running dorsal to the base of the anal fin. The only other nominal *Cheirodon* species with a black stripe above the anal fin is *C. luelingi*. That species differs from *C. ortegai* in its more slender overall form (greatest body depth 25–27% of SL, in contrast to 34–37% for *C. ortegai*) and in lacking the heavy horizontal midside stripe. Males of *Cheirodon ortegai* are also distinctive in their cup-shaped, hook-bearing pelvic fins and the presence of a foliate tissue mass at the base of the pelvic fin. These characters, together with the possession of pronounced lateral swellings at the base of the adipose dorsal fin and along the ventral border of the caudal peduncle, appear to be unique to *C. ortegai* among characoids.

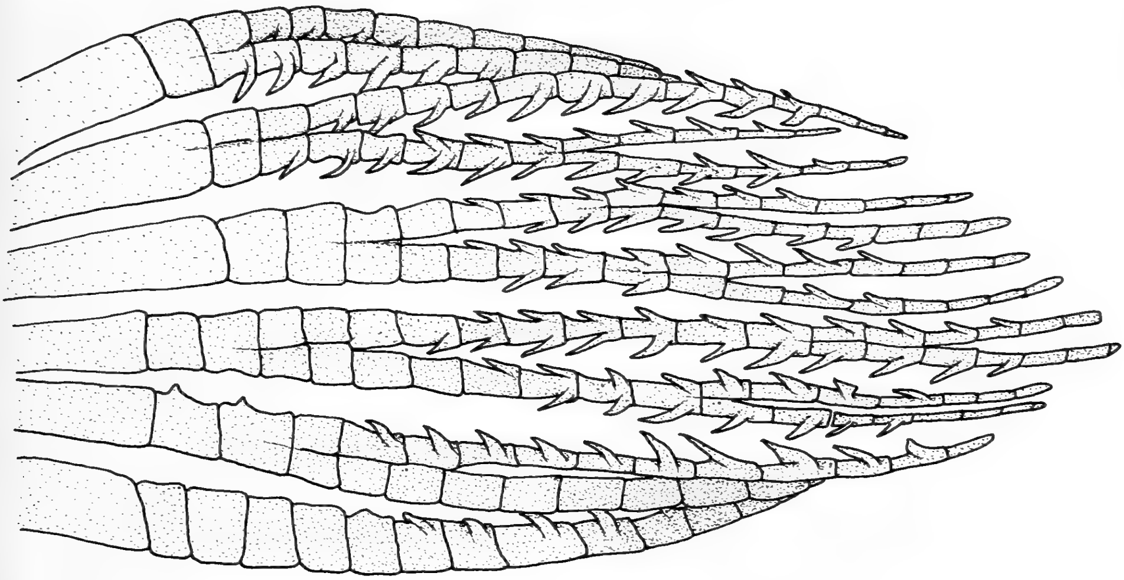

Fig. 2. Left pelvic fin of male *Cheirodon ortegai*, two medialmost pelvic-fin rays not visible.

Description.—Table 1 gives measurements of the holotype and paratypes. Body moderately deep, relatively rotund, especially that of females. Greatest body depth at anterior dorsal-fin origin. Profile in males straight from tip of snout to base of occipital process, slightly convex from rear of occipital process to dorsal-fin origin; profile in females gently convex from tip of snout to dorsal-fin origin. Body profile at base of dorsal fin straight in females, slightly convex in males. Posterior to dorsal fin, profile straight to origin of dorsal caudal-fin lobe in females, distinctly convex at adipose-fin base in males. Males with pronounced lateral expansion of body surface at adipose-fin base. Ventral profile of head smoothly convex to below pectoral-fin base in both sexes. Belly to pelvic-fin insertion only slightly convex, more so in females. Pelvic-fin musculature expanded to form a lateral bulge in males. Anal-fin base nearly straight in females, distinctly sigmoid in males with anterior portion convex and posterior region concave; change in curvature located at base of posterior-most hook-bearing anal rays. Anal fin base relatively shorter in females than males (Table 1). Head relatively large. Snout pointed with mouth slightly superior and lower jaw extending distinctly anterior of tip of snout. Maxilla relatively long; posterior tip of maxilla extends ventrally to the horizontal plane through ventral surface of eye and posteriorly to vertical plane through anterior surface of eye. Lateral surface of maxilla slightly concave with a bony laterally-directed lip along its posterior border. Eye diameter relatively large in proportion to head (33–35% of head length). Nostrils separated by a flap of skin; posterior nostril

Table 1.—Measurements of *Cheirodon ortegai*, new species. Standard length is expressed in mm; other measurements are percentages of standard length.

		Paratypes			
		4 ♂		3 ♀	
	Holotype	Range	Average	Range	Average
Standard length	31.45	31.2–34.3		18.0–34.1	
Greatest depth	34.1	33.6–37.0	34.8	34.3–37.0	35.6
Snout to dorsal-fin origin	54.0	53.3–58.0	54.9	55.4–57.6	56.4
Snout to pelvic-fin origin	56.1	55.8–59.1	56.8	55.7–58.5	56.8
Snout to anal-fin origin	68.1	67.3–70.0	68.7	67.6–70.0	68.7
Snout to pectoral-fin origin	29.0	28.5–29.2	28.7	27.6–29.3	28.2
Least depth of caudal peduncle	9.7	9.7–10.0	9.9	9.2–9.6	9.4
Length of caudal peduncle	9.6	9.9–10.1	10.0	9.2–9.7	9.5
Pectoral-fin length	22.4	21.6–22.4	22.2	19.3–21.7	20.4
Pelvic-fin length	13.0	12.7–13.7	13.0	13.2–14.0	13.7
Length of anal-fin base	25.3	23.4–24.0	23.7	21.6–22.8	22.1
Head length	28.7	28.3–28.6	28.4	27.3–29.2	28.0
Eye	9.8	9.4–9.9	9.6	9.8–10.1	9.9
Snout	6.4	6.3–6.7	6.4	6.0–6.9	6.5
Postorbital	11.2	12.2–13.1	12.6	10.9–12.5	11.8
Interorbital	9.3	9.3–9.8	9.5	9.0–9.8	9.4
Upper-jaw length	10.3	10.2–10.9	10.6	9.8–10.2	9.9

twice as large as anterior, somewhat crescent shaped. Enlarged posterior lamellae of olfactory rosette nearly reaching surface of posterior nostril. Fronto-parietal fontanele extensive; parietals completely separated, frontals in contact only at epiphyseal bar. Antorbital and first, fourth, fifth, and sixth infraorbitals not ossified. Second infraorbital reduced, triangular. Third infraorbital large, but not in contact with sensory tube of preopercle.

Teeth in a single series in each jaw. All teeth compressed, expanding outwards to a hemicircular multicuspid edge, middle cusp always longest. Premaxilla with 6 or 7 teeth, all except most lateral with 9 cusps, posteriormost tooth in series with 7 cusps. Partially formed premaxillary replacement teeth embedded in inner flesh of premaxilla. Maxilla with 2 teeth, each with 5 cusps. Dentary with 6 to 8 teeth (2 posteriormost difficult to see except in cleared and stained specimens), 5 medial teeth of each dentary of equal size, with 7 cusps; remaining teeth smaller, with 5 cusps (rarely 3 on terminal tooth). Replacement teeth of dentary all in a replacement tooth trench. All palatine and pterygoid bones toothless.

Scales cycloid, thin. Scales in a lateral series 31 in holotype (29 in 2 specimens, 30 in 2 specimens, 31 in 2 specimens, 33 in one specimen), 4 to 7 perforated lateral line scales. Transverse scales from dorsal-fin origin to anal-fin origin 10 or 11. Scales not extending onto caudal fin. Large mid-ventral scales overlapping a mass of foliate (glandular?) tissue between pelvic insertions.

Dorsal fin pointed, anterior rays longest, ii,8,i in all specimens. Anal fin ii,21 in holotype (ii,21 in two specimens, ii,22 in one specimen, iii,21 in 3 specimens, iii,22 in one specimen). Anal-fin margin nearly straight in males, distinctly emarginate in females. Anal fins in males with numerous bony hooks on each side of last unbranched and first 12 or 13 branched rays. Eleven to twelve hooks on each face of last unbranched ray, 11 to 14 hooks on side of branched rays 1 to 8; 4 to 7 hooks on remaining hook-bearing branched rays. Hooks more strongly developed on basal segments of branched rays 7 to 10. Pectoral fin i,12,1 in holotype (i,10,i in 1 specimen, i,11,i in 2 specimens, ii,10,i in 2 specimens, ii,11,i in 2 specimens). Pectoral fin pointed; first ray longest, reaching about two-thirds distance to vertical through pelvic origin. Pelvic fins, i,7 in holotype (i,6 in one specimen, i,7 in 5 specimens, i,8 in 1 specimen). Pelvic fins pointed, reaching anal-fin origin. Pelvic-fin rays in males with numerous bony hooks on lateral rays, 3 or 4 hooks on median rays. Medial separation of pelvic-fin insertions more pronounced in males, with posteriormost median scale enlarged and overlapping a mass of foliate (glandular?) tissue located between the bases of the pelvic fins. Both terminal enlarged scale and foliate tissue mass enveloped dorsally by median pelvic-fin rays. Pelvic-fin rays in preserved females oriented in a nearly horizontal plane. In males, in contrast, fins are transversely curved resulting in a ventrally-open, cup-shaped fin. Medially the inner portions of the pelvic fin form an incompletely tubular funnel extending posteriorly below the male vent. Caudal fin not sexually dimorphic, emarginate, with 4 or 5 very weakly developed procurrent rays which are only evident in cleared and stained specimens.

Coloration.—Overall color pattern reminiscent of that of *Heterocharax macrolepis,* a member of the tribe Characini (Géry, 1978:309). Ground color tan. Head dark dorsally, particularly dorsal and posterior to epiphyseal bar. Snout, premaxilla, maxilla, and region anterior to orbit pigmented. Postorbital region and cheek with a series of large chromatophores, more pronounced in males. Opercle with scattered chromatophores and an oblique stripe running across dorsal portion of bone in some specimens, others with only scattered pigmentation. A prominent horizontal midside stripe formed of large chromatophores from the supracleithrum to the caudal base; stripe thinning rapidly on caudal peduncle and barely continuous with a round spot on the rear of the caudal peduncle and anterior portion of middle caudal rays. Caudal spot relatively more diffuse in larger specimens. A series of separated chromatophores ventral to the horizontal midside stripe in two irregular, slightly posteroventrally sloping patterns; dorsal series extends from the junction of the midside stripe and supracleithrum posteriorly to the vertical through the pelvic-fin insertion and ventral series slopes posteroventrally along anterior portion of body, running parallel to dorsal series posteriorly. Ventral series less well developed in smaller females and juveniles. A dark, slightly posterodorsally oblique band extends posteriorly from an imaginary vertical through the anal-fin origin to above the base of the posteriormost anal-fin rays. Stripe thickest anteriorly; gradually thinning posteriorly in females, thicker and more abruptly thinning posteriorly in males. Scales dorsal to midside horizontal body stripe outlined posteriorly by a series of chromatophores; pigmentation heaviest dorsally, particularly along middorsal line where it forms an indistinct median stripe running from rear of head to dorsal edge of caudal peduncle. Number of chromatophores in region directly above anterior portion of midside body stripe increasing with age, evenly distributed over scales in largest specimens. Median fins with scattered chromatophores. Pigmentation heaviest on anterior rays of dorsal and anal fins, along anterior portion of adipose dorsal fin and along basal portions of caudal-fin rays. Pelvic fins with scattered chromatophores, particularly on bases of intraray membranes. Dorsalmost pectoral-fin rays pigmented, otherwise pectorals clear.

Relationships.—As discussed by Fink and Weitzman (1974), many aspects of cheirodontine phylogeny are poorly understood at this time. Those authors pointed out the difficulties associated with the retention of *Pseudocheirodon* as a taxon distinct from *Cheirodon* (*sensu stricto*). The difficulties with such a separation are further demonstrated by the characters found in *C. ortegai*. This species lacks a definitive triangular pseudotympanum (a region of reduced musculature lateral to the anterior chamber of the swimbladder) and possesses only a few reduced "interhemals" (ventral procurrent caudal-fin rays), characters supposedly diagnostic for *Pseudocheirodon*. On the other hand, *Cheirodon ortegai* has rounded cutting edges to the teeth and multiple anal-fin hooks, characters traditionally considered characteristic of *Cheirodon*. The possession by *C. ortegai* of characters supposedly diagnostic for both *Pseudocheirodon* and *Cheirodon* further supports Fink and Weitzman's (1974) merging of *Pseudocheirodon* into the latter genus.

The relationship of *Cheirodon ortegai* to other species of the genus is rather uncertain. A black stripe above the anal-fin base also occurs in *C. luelingi* (Géry, 1964). That species, which also occurs in the Ucayali system, differs, however, in overall morphology. The pronounced sexual dimorphism, long anal-fin base, and the possession of 7 to 9 tooth cusps in *C.*

ortegai also occur among *Cheirodon* species such as *C. gracilis, C. interruptus, C. insignis, C. madeirae, C. notemelas,* and *C. piaba*. However, an understanding of the significance of these similarities, those with *C. luelingi,* and the characters shared with those species previously placed in *Pseudocheirodon,* awaits a better understanding of cheirodontine phylogeny.

Remarks.—As noted previously, the lateral swellings at the base of the adipose dorsal fin and along the ventral border of the caudal peduncle, together with the foliate tissue mass at the pelvic-fin bases appear to be unique to *Cheirodon ortegai* among cheirodontines. Histological examination of the lateral swellings associated with the adipose dorsal fin and caudal peduncle show them to be formed primarily by lateral expansions of portions of the epaxial and hypaxial musculature. In addition, adipose tissue deposits are also quite prominent in the swellings. The exact function of the expanded musculature or of the fatty tissue deposits is undetermined. Similarly, given our lack of information on the reproductive habits of this species, it is impossible to determine the purpose of the foliate, evidently glandular, tissue mass at the pelvic-fin base, or if the tubular channel formed by the medial surfaces of the pelvic fins serves as a conduit for sperm delivery during reproduction. A pronounced sexual dimorphism characterized by the presence of evidently glandular tissue and associated modified scales occurs elsewhere in *Cheirodon* (*sensu* Fink and Weitzman, 1974). However, in *C. heterura* and *C. gorgonae* (previously assigned to the genus *Compsura*) the glandular tissue and specialized scales are located on the caudal peduncle and caudal base. A resolution of the significance, if any, of these seemingly analogous adaptations within *Cheirodon* must await a better understanding of cheirodontine phylogeny.

Etymology.—The trivial name, *ortegai,* honors Sr. Hernán Ortega who has collected many valuable specimens for the senior author.

Acknowledgments

Hernán Ortega of the Universidad Nacional de San Marcos, Pucallpa, Peru, and I. J. Isbrücker of the Amsterdam Aquarium donated the material that served as a basis for the description of this species. Stanley H. Weitzman and Rosemary Lowe-McConnell critically read the manuscript and offered helpful suggestions. Research associated with this paper was partially supported by a NATO-NSF Postdoctoral Fellowship and a Smithsonian Fellowship to the senior author. Research facilities for this project were provided by the Department of Zoology of the British Museum (Natural History) and Department of Vertebrate Zoology, National Museum of Natural History, Smithsonian Institution.

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FOUR NEW AND UNUSUAL AMPHIPODS FROM THE GULF OF MEXICO AND CARIBBEAN SEA

L. D. McKinney

Abstract.—Four new species of amphipods from the Gulf of Mexico and Caribbean Sea are described. These new species are *Atylus urocarinatus, Eusiroides yucatanensis, Megaluropus myersi,* and *Seba tropica.*

A number of unusual and in some cases rare amphipods have been discovered among collections from the Gulf of Mexico and Caribbean Sea. Four of these which belong to rather small and poorly known genera are described as new in this paper. They are, nonetheless, quite distinctive and represent important taxonomic discoveries which aid in our understanding of amphipod distributions within the two regions. A general discussion of these diverse taxa is not practical. Each species will, however, be treated individually within each description in an effort to help define them phylogenetically.

A short diagnosis to the families and genera of each new species is presented before each description. A brief listing of synonymies of the genera is also included when applicable. Neither the diagnosis nor synonymies are meant to be complete but are provided to help define the new species taxonomically.

Illustrations and Descriptions

The following method of lettering is used to designate the various structures illustrated and follows the system initiated by J. L. Barnard (1970a). The capital letter in the figure designates a specific structure. Lower case letters preceding the capital letter identify specific individuals. Lower case letters or numbers following the capital letter modifies the description of the part. **A** = antenna, **B** = labrum (upper lip), **C** = coxa, **D** = dactyl or pereopod, **E** = epimeron, **F** = accessory flagellum, **G** = labium (lower lip), **H** = head, **I** = inner plate or inner ramus, **J** = epistome, **K** = eye, **L** = palp, **M** = mandible, **N** = gnathopod, **O** = outer plate or outer ramus, **P** = pereopod, **Q** = mandibular molar, **R** = ramus, **S** = maxilliped, **T** = telson, **U** = uropod, **V** = urosome, **W** = pleon, **X** = maxilla, **Y** = prebuccal complex, **Z** = mandibular incisor; **a** = anterior, **b** = without, **c** = setae, **d** = finger hinge, **e** = dactyl of gnathopod, **f** = female, **h** = holotype, **i** = inner, **j** = juvenile, **k** = cuticle, **l** = left, **m** = male, **n** = palmar corner, **o** = opposite or other side, **p** = dorsal, **q** = one half side, **r** = right, **s** = setae removed, **t** = spine, **u** = flattened, **v** = ventral, **w** = palm, **x** = medial, **y** = article. Synonyms are based on those of J. L. Barnard, 1969a.

Atylidae

Diagnosis.—Body compressed; urosome carinate, urosomites 2–3 fused; mandible with 3-articulate palp.

Remarks.—This family was synonymized with Dexaminidae by J. L. Barnard, 1970b, and subsequently reestablished by Bousfield, 1973 as a monogeneric (*Atylus*) family.

Atylus Leach, 1815

Nototropis Costa, 1853:170; *Epidesura* Boeck, 1861:659; *Paratylus* Sars, 1895:462; *Anatylus* Bulycheva, 1955:205.

Diagnosis.—That of the family.

Atylus urocarinatus, new species

Figs. 1, 2

Description.—Male 5.3 mm. Head with distinct blunt rostrum; eyes large, well developed, suboval, with some clear ommatidia; cephalic lobes produced, corners rounded, inferior antennal sinus shallow, rounded; urosomite 1 with dorsal carina, fused urosomites 2–3 also with carina. Antenna 1: Length ratios of peduncular articles 1, 2, 3 = 51:30:19; flagellum with 24 articles, poorly setose; accessory flagellum uniarticulate with 2 terminal setae. Antenna 2: Article 3 and 4 of peduncle with dorsal clumps of setae, article 5 less setose and 1.4 times as long as 4, ventral edge of article 4 with 5 spines, article 5 with 4 spines; flagelum with 19 articles, poorly setose. Upper lip: Unproduced, distally rounded. Mandible: Molar triturative with accessory setae, molar flake on left; 3 accessory blades on the left, 2 on the right; multilobe lacinia mobilis also present on both; incisor well developed with 6 rounded teeth; palp with 3 articles on length ratios 13:70:92; article 2 spiculate, medioventral edge of article 2 with 4 plumose setae, 4 elongate terminal setae. Lower lip: Inner lobes present but weakly produced; mandibular process of outer lobes elongate and linear, distomedial edge of outer lobes with 3 setae each. Maxilla 1: Inner plate quadrate with 4 terminal setae; outer plate with 10–12 spine teeth; palp biarticulate, distal article elongate with 5 terminal spines and 2 subterminal setae. Maxilla 2: Inner plate with 1 stout, plumose, medial setae followed by mediodistal row of normal setae; outer plate larger than inner with stout terminal setae; 5 laterobasal setae also present. Maxilliped: Inner plate apically rounded with 10 plumose setae on mediodistal edge; outer plate with 7 chisel teeth grading

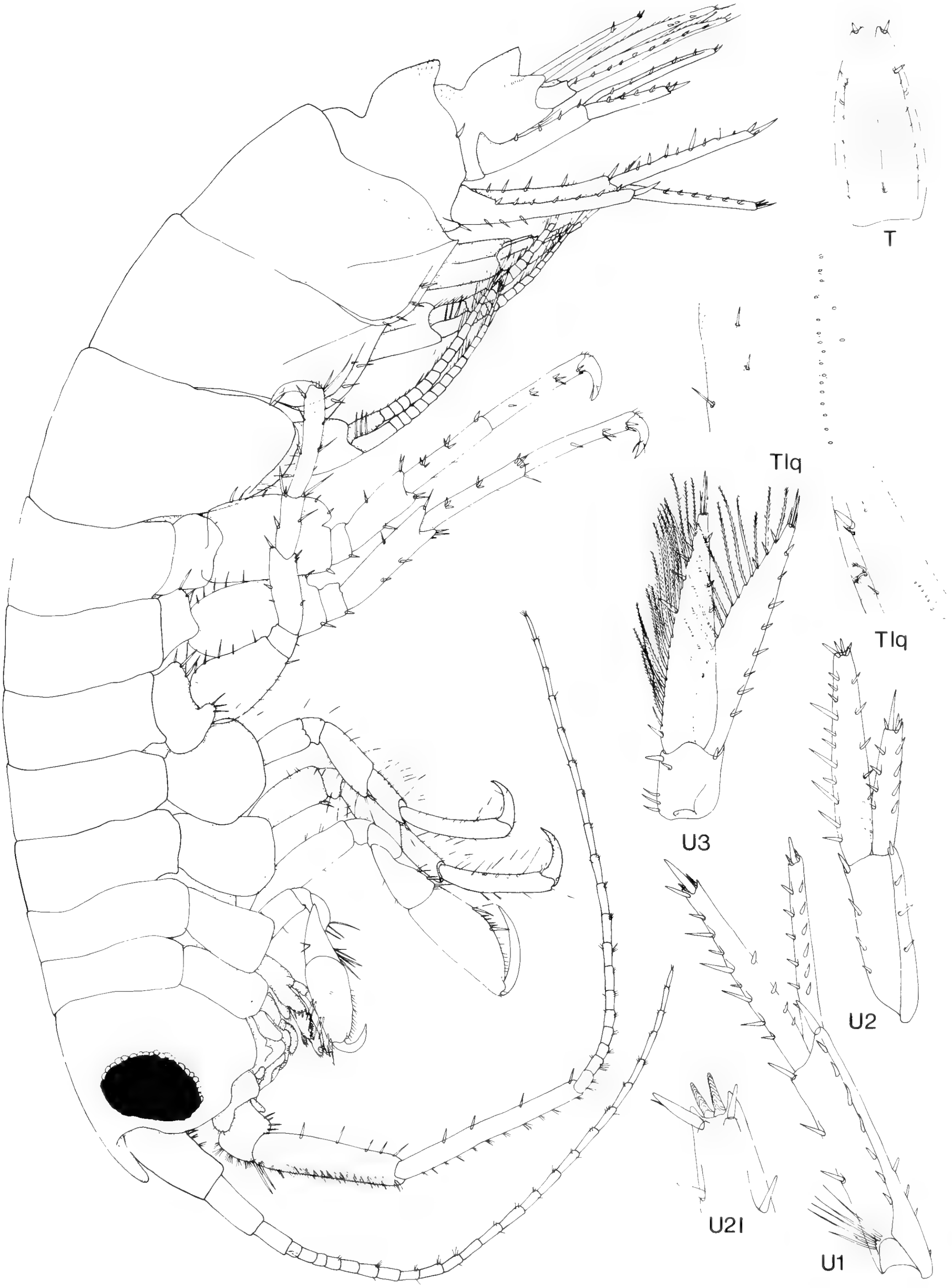

Fig. 1. *Atylus urocarinatus*, male 5.30 mm.

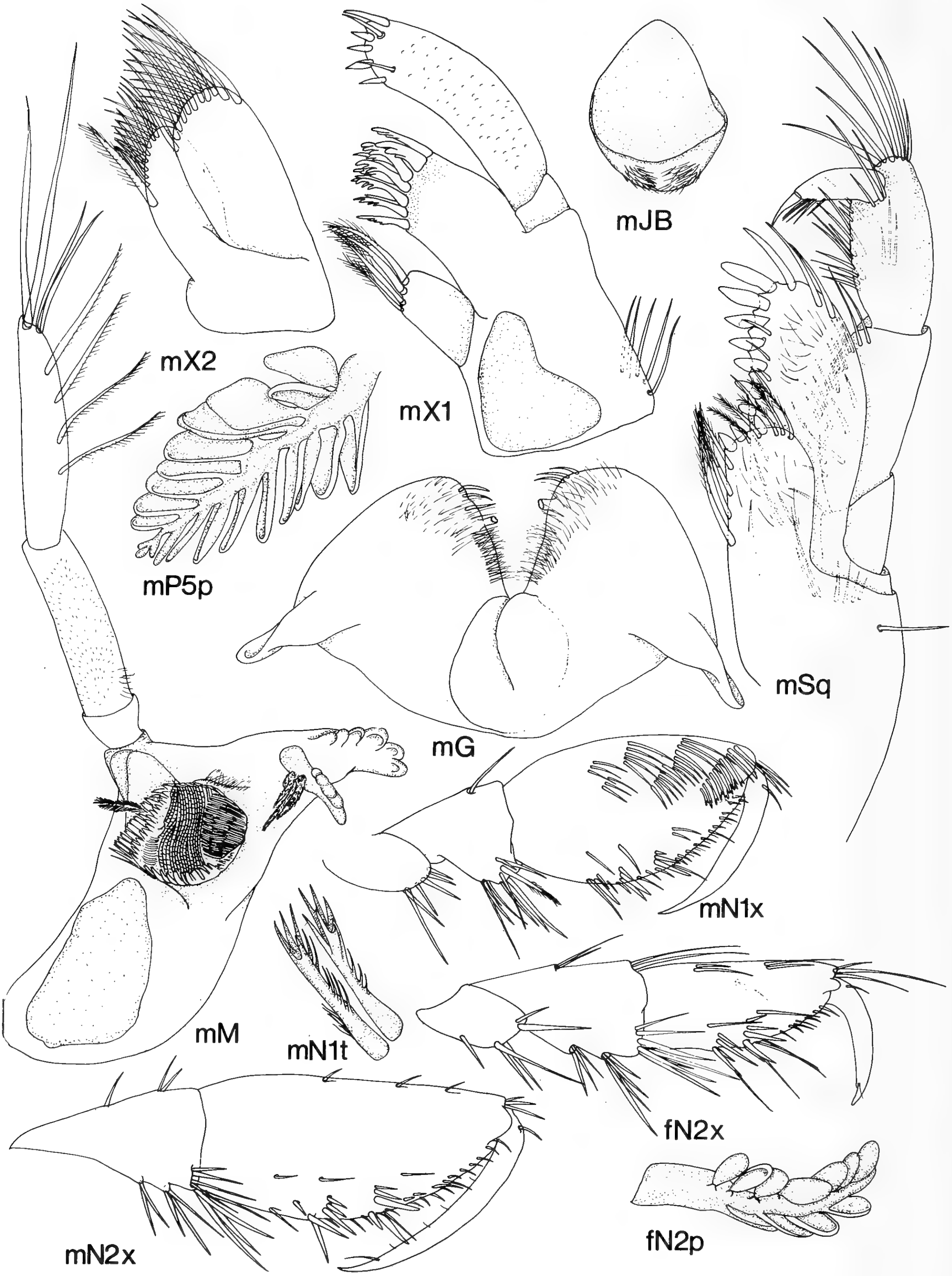

Fig. 2. *Atylus urocarinatus,* m = male 5.30 mm; f = female 5.20 mm.

into 3 stout elongate spines on apex; palp with 4 articles medially setose, article 3 with facial and elongate terminal setae, article 4 attached subterminally with accessory nail and distomedial setae. Gnathopod 1: Coxa quadrate longer than wide; article 4 distally rounded, spinous; article 5 with spinous posterior lobe; article 5 suboval, medial surface with 4 rows of normal facial spines and 1 distal row of highly sculptured facial spines; palm lined with small spines and 1 group of 3 spines medially, corner defined by 2 locking and 2 short spines, palm otherwise undistinguished from ventral margin of article 6; dactyl normal, closing on locking spines. Gnathopod 2: Coxa slightly wider than coxa 1; article 5 attached to 4 dorsomedially, triangular but without ventral lobe, posterior margin with 3 groups of spines and distomedial facial spines; article 6 longer than wide with 3 superior medial and 3 mediofacial setae; palm long, lined with small spines and 2 groups of medial spines near the poorly distinguished corner, palm 3 times as long as hind margin; dactyl elongate linear. Pereopod 3: Coxa quadrate, wider than preceding ones; article 2 linear; article 4 distally expanded, spinous anteriorly; article 5 posteriorly spinous; article 6 with 1 posteromedial spine and 2 locking spines; dactyl long, stout with 2 distal accessory setae. Pereopod 4: Coxa nearly as wide as long, posterior margin slightly incised; total length 0.9 times as long as pereopod 3, otherwise similar to it. Pereopod 5: Coxa with small spinous anterior lobe, distoventral corner with 3 spines, coxa wider than long; article 2 somewhat expanded, articles 4, 5, 6, weakly spinous with length ratios of 40:31:55; dactyl similar to preceding ones. Pereopod 6: Coxa wider than long, with 2 distoventral spines, article 2 medially expanded, posterior edge with 5 proximal spines, 1 stout anterodistal spine; article 3 with 1 anterodistal spine; article 4 with 1 medial and 2 distal spines on either margin; posterior margin of article 5 with 3 groups of 3 spines; length ratios of articles 4, 5, 6 = 1:1:1; dactyl normal; total length 1.3 times as long as pereopod 5. Pereopod 7: Coxa wider than long; article 2 expanded, quadrate, anterior and posterior margins parallel; articles 3, 4, and 5 as in pereopod 6; anterior spine formula of article 6 = 1, 3, 3, and 2 locking spines; pereopod 6 and 7 subequal in length. Epimeral plates: Epimeron 1 distally rounded and setose; epimeron 2 more quadrate than preceding one; posteroventral corner somewhat produced, ventral spine formula of 1,1,2,1; epimeron 3 with a produced posteroventral corner and ventral spine formula of 1,1,2,2. Uropod 1: Peduncle longer than rami with 3 anteroproximal, 3 inner marginal, and 7 outer marginal spines, medioproximal surface with cluster of setae and inner and outer distal corners with 1 inter-ramal spine each; inner ramus with 9 alternately large and small spines, inner margin with 4 medial spines, apex with 1 stout and 2 sculptured spines; outer ramus with 6 inner and outer marginal spines and 4 terminal spines, (two of these sculptured); rami subequal in length. Uropod 2: Peduncle with

4 inner and outer marginal spines; inner ramus 1.6 times as long as outer, inner margin with 11 spines, outer margin with 5 spines and 4 short terminal spines (of these two medial most sculptured); outer ramus with 4 inner and outer marginal spines and 4 terminal spines (one of these stout and elongate). Uropod 3: Peduncle short, with 3 slender medioproximal setae, 2 distomedial and 1 distolateral spines; rami subequal in length, foliaceous along inner margins; inner margin of inner ramus with 6 spines, outer margin with 3 distal spines, apex with a group of short slender spines; outer ramus with 3 inner marginal and 8 outer marginal spines, apex same as inner ramus. Telson: Deeply cleft, each lobe with 1 distolateral and 1 terminal spine; lobes with laterally exposed setulose ridge; dorsoproximal surface of each lobe with medial row of minute pits. Gills: Gill of coxa 7 essentially simple, with secondary lobes; gill of coxa 6 simple spatulate; gills 2–5 pinnate, gill of coxa 2 more reduced; coxa 1 without gill.

Female.—Like the male except in structure of gnathopod 2. Article 6 of the gnathopod is more linear and has a shorter palm than the male. The female gnathopod has more mediofacial spines and a more setose article 2 than the male. Gnathopod 1 of the female is smaller than that of the male. Brood plates present on pereopods 2–5.

Types.—Holotype, USNM 172174, male, 5.20 mm. Allotype USNM 172175, female, 5.30 mm and a paratype series, USNM 172176, of 10 specimens.

Type-locality.—All types from Port Mansfield, Texas, depth 1 m.

Material examined.—The types and specimens from Lizardo Lagoon, Mexico; Corpus Christi Bay, Texas; and upper Laguna Madre, Texas.

Distribution.—Gulf of Mexico south of Laguna Madre, 1 m depth.

Relationships.—This species is very close to a New Zealand species *A. taupo* J. L. Barnard, 1972. *Atylus urocarinatus* differs from *A. taupo* in that it has a slightly more elongate and slender rostrum, the cephalic lobe is more produced and quadrate, and the eyes have clear ommatidia on posterior margins only. Proximal articles of antenna 2 in *A. urocarinatus* have dorsal rows of short setae and a number of spines on the ventral margin which are lacking in *A. taupo.* Gnathopods in these two species are very similar in ornamentation and structure. Article 5 of gnathopod 1 in *A. urocarinatus* is shorter with a more pronounced posterior lobe, although less spinous; article 6 is shorter, more oval with a distal row of highly sculptured spines not apparent in *A. taupo.* The palm of gnathopod 1 is also shorter and lacks the proximobasal spines of *A. taupo.* Spination of the uropods differs in these two species.

Both *A. taupo* and *A. urocarinatus* show close affinities with the Norwegian species *A. swammerdami* (Milne Edwards, 1830) as J. L. Barnard (1972a) previously pointed out. Dorsal carination of urosome, head, and complexly pinnate gills are all very similar in these three species.

A. homochir (Haswell, 1885) from Australia is somewhat similar to this group, except for the produced anteroventral corner of the head, simple gills, and more blunt rostrum.

Ecological information.—All specimens of *Atylus urocarinatus* were collected at shallow depths in *Thalassia* beds. *A. taupo* has been collected in New Zealand from rocks and as plankton on littoral benthos. Ovigerous females of *Atylus urocarinatus* were taken throughout the year.

Eusiridae

Diagnosis.—Body smooth, pleon with dorsal carina; pleosome powerful; eyes large; inferior antennal sinus sharply incised; accessory flagellum small, usually with 2 articles; epimeral plate 3 generally serrate behind; telson cleft.

Eusiroides yucatanensis, new species
Figs. 3, 4

Description of female.—6.0 mm, head with evanescent rostrum; eyes large and suboval, with orange ommatidia; ventral edge of head covered by coxa 1. Antenna 1: Exceeding length of antenna 2; first 3 articles successively shorter; accessory flagellum with one article as long as first article of primary flagellum; primary flagellum with 40+ articles. Antenna 2: Article 5 of peduncle subequal to article 4; peduncle as long as flagellum; flagellum with 35 articles. Upper lip: Epistome normal, unproduced; labrum, rounded, apically setose. Mandible: Molar process produced, without spines or setae; accessory blades 3, lacinia mobilis with 5 cusps, present on both mandibles; palp 3-articulate, article 2 medially expanded with 5 medial setae, article 3 subequal to article 2, with 3 medial and 4 apical setae. Lower lip: Inner lobes present, somewhat reduced; outer lobes normal, apically setose. Maxilla 1: Inner plate with one apical seta, one-half the length of article 2; article 2 with 7 setae. Maxilla 2: Inner plate medially inflated, twice as wide as outer, with 7 medial spines; outer plate with 11 distal setae. Maxilliped: Inner plate with 3 chisel spines and several short setae; outer plate armed with numerous setae on medial and apical edges and posteromedial surfaces; palp expanded and well developed, article 2 produced mediodistally and armed with numerous setae, palp article 4 normal. Gnathopod 1: Coxa produced forward, with posteromedial spine and 2 mediofacial setae; article 2 normal, with 5 medial setae and 7 distal spines; article 3 produced anteriorly, article 4 produced posterodistally, with 7 distal spines; article 5 produced posterodistally with mediofacial setae, posterior edge setose; article 6 subovate, palm unproduced, armed with 5 stout spines, 2 locking spines delineating palm; article 7 normal. Gnathopod 2: Coxa subquadrate, with 1 posteromedial spine and 2 mediofacial setae; article 3 produced anteriorly;

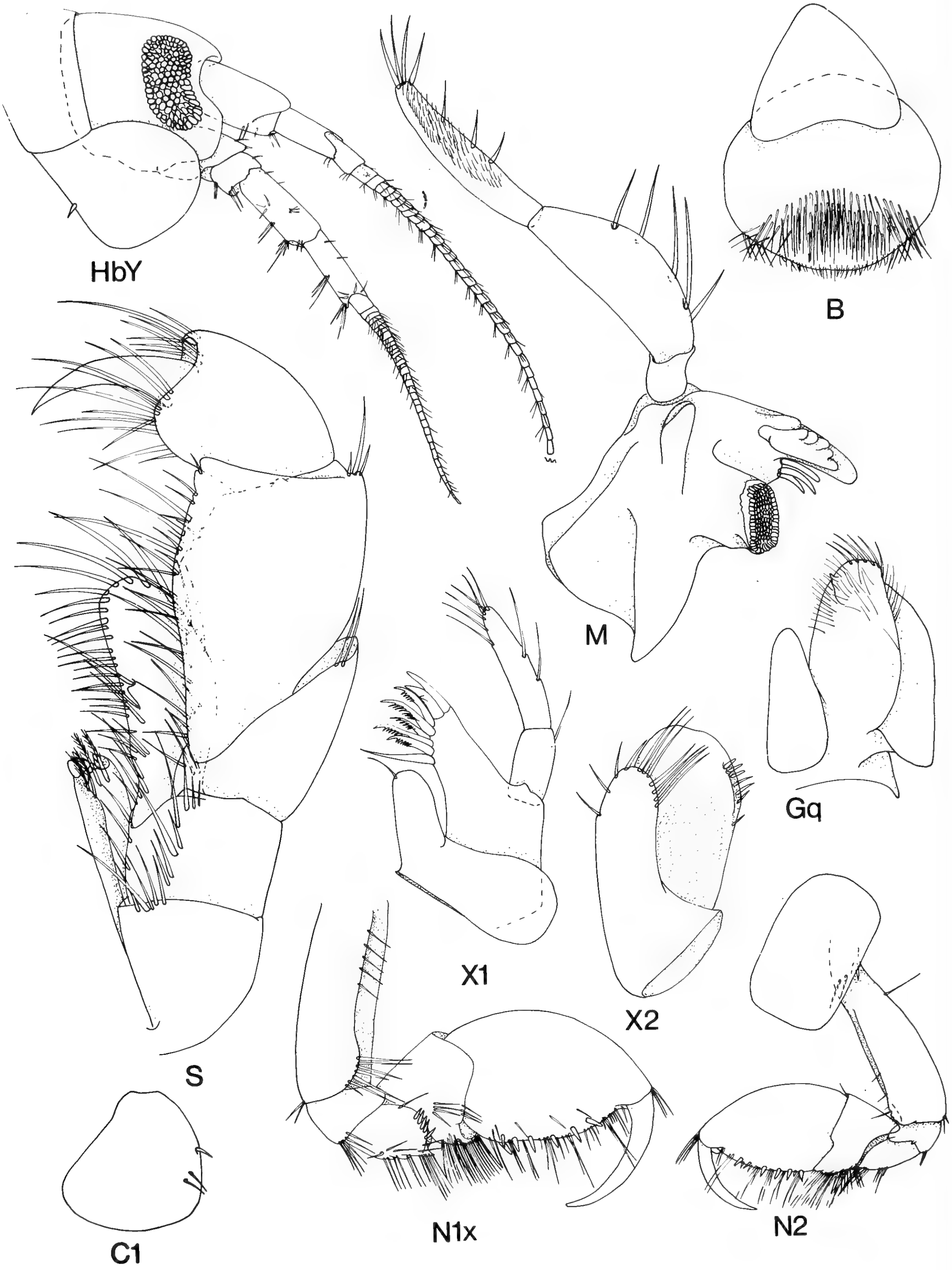

Fig. 3. *Eusiroides yucatanensis,* female 6.0 mm.

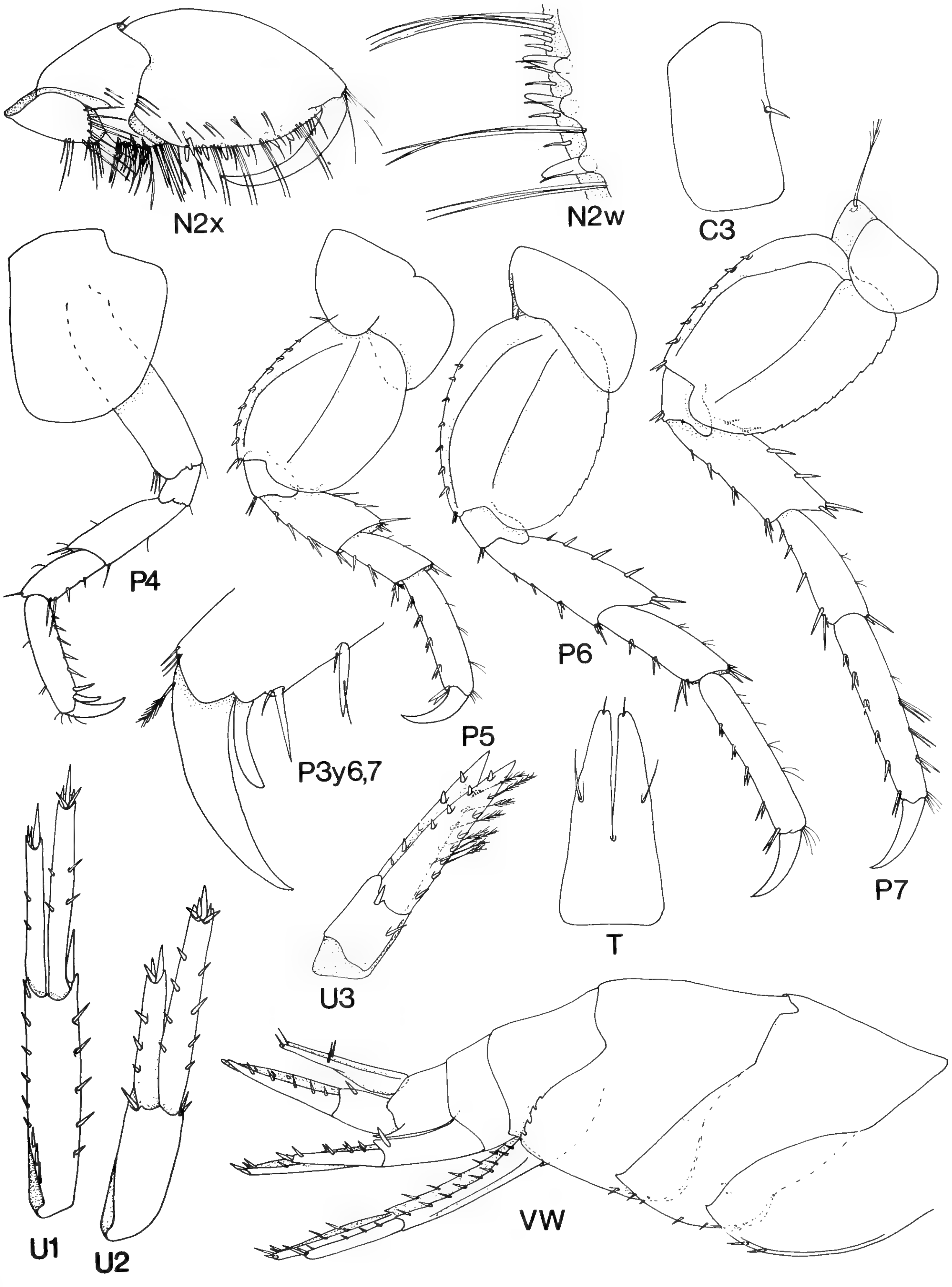

Fig. 4. *Eusiroides yucatanensis,* female 6.0 mm.

article 4 produced posterodistally, with 7 mediodistal spines; articles 5, 6, and 7 similar to those of gnathopod 1. Pereopod 3: Coxa quadrate, with posteromedial spine; article 2 linear, unproduced; article 3 produced distally; article 5 three quarters as long as article 4, with posterior spines, anterior spines; article 6 with 6 posterior spines, distal most 2 with accessory spines, 1 distal locking spine; article 7 normal. Pereopod 4: Coxa somewhat excavate posteriorly; articles 2–7 similar to those of pereopod 3. Pereopod 5: Shorter than pereopods 6 and 7. Coxa bilobed wider than long; article 2 expanded with 2 dorsoventral ridges and armed with 9 anterior spines; article 4 expanded distally, longer than 5; article 6 with posterior spine combination of 2,2,2,2, and 2 locking spines; article 7 normal. Pereopod 6: Coxa produced posteriorly; article 2 expanded, with 2 dorsoventral ridges and 10 anterior spines, posterior edge crenulate; article 3 produced posteriorly; article 4 expanded distally; article 5 shorter than 4; article 6 with spine combination of 2,2,2,2, and 2 locking spines; article 7 normal. Pereopod 7: Slightly longer than pereopod 6; coxa with long anterior setae; article 2 expanded with 2 dorsoventral ridges and 8 anterior spines, posterior edge crenulate; article 3 produced posterodistally; article 4 expanded distally; article 5 shoter than 4 or 6; article 6 with spine combination of 2,2,2,2,2 with 2 locking spines; article 7 normal. Epimeron: Posterior edge of epimeron 1 produced into small tooth with 2 medial spines; posterior edge of epimeron 2 produced into small tooth with 4 spines; posterior edge of epimeron 3 produced into 3 well-developed teeth, ventral edge armed with 3 spines. Uropod 1: Peduncle with 5 inner and 9 outer marginal spines, armed with one medial spur; inner ramus slightly longer than outer, armed with 2 inner, 2 outer marginal spines, and 5 apical spines, outer ramus with 2 outer marginal spines and 3 apical spines. Uropod 2: Peduncle armed with 2 distal spines; inner ramus longer than outer, armed with 4 inner and outer marginal spines; outer ramus with 3 outer marginal spines and 3 apical spines. Uropod 3: Peduncle short, one-half as long as rami, armed with 2 spines; rami subequal and lanceolate; inner ramus armed with 3–5 marginal spines and 3 setae, outer margin with 4 spines; outer ramus with 5 inner marginal spines and setae, outer margin with 5 spines; rami subequal to peduncle of uropod 1. Telson: Deeply cleft, lobes acute, armed with 2 medial and 2 apical setae. Gills and oostegites: Pereopods 2–7 with gills and 2–5 with oostegites.

Male.—Unknown.

Types.—Holotype, USNM 172177, female, 6.0 mm; paratype, female 5.7 mm, USNM 172178.

Type-locality.—Station 41-60 Smithsonian-Bredin Caribbean Expidition IV, Espiritu Santo Bay, Quintana Roo, Mexico, water depth 0.5–3 m, 6 April 1960.

Material examined.—The types.

Distribution.—Yucatan, Mexico, Caribbean Sea.

Relationship.—Eusiroides yucatanensis appears to have closer affinities to *E. monoculoides* Stebbing, 1888, than any of the other members of this genus. It differs in the condition of the epimeral plates, as *E. monoculoides* has a serrate epimeron 3 and *Eusiroides yucatanensis* has only 3 distinct teeth. Epimeron 1 and 2 of *E. monoculoides* are also serrate while those of *Eusiroides yucatanensis* are smooth. Telson setation and coxal spination also differ.

Megaluropus Hoek, 1889

Megalonoura Herdman, 1889 (nomen nudum); Megaluropus Hock, 1889; *Phylluropus* K. H. Barnard, 1932.

Diagnosis.—Body fossorial; coxal plates 1–4 elongate (3 smallest); pereopods strongly spinose and/or setose, pereopod 7 very long; rami of uropod 3 broadly ovate, spinose.

KEY TO THE SPECIES OF *MEGALUROPUS* (FEMALES)

1. Gnathopod 2: article 5 elongate, narrow distally; article 6 linear . . .
 . . . . *M. namaquaeenis* Schellenberg, 1953
– Gnathopod 2: article 5 expanded distally; article 6 somewhat inflated
 . . . . **2**
2. Eyes covering cephalic lobe **3**
– Eyes not extending forward onto a cephalic lobe **4**
3. Rostrum elongate; antenna 2: article 5 of peduncle much longer than 4; antenna 1: accessory flagellum uniarticulate . . . .
 . . . . *visendus* J. L. Barnard, 1969
– Rostrum short; antenna 2: article 5 of peduncle slightly longer than 4; antenna 1: accessory flagellum biarticulate, second article minute
 . . . . *M. agilis* Hoek, 1889
4. Lateral cephalic cusp lacking . . . .
 . . . . *M. longimerus longimerus* Schellenberg, 1925
– Lateral cephalic cusp present **5**
5. Posterior margin of epimeral plate 3 not serrate or only partially so
 . . . . *M. longimerus falciformis* J. L. Barnard, 1969
– Posterior margin of epimeral plate 3 with well-developed serrations along entire margin . . . . *Megaluropus myersi,* n.sp.

Megaluropus myersi, new species

Figs. 5, 6, 7

Description.—Female, 4.20 mm. Rostrum short, acute; lateral cephalic lobe with sharp anterior cusp; eyes large, reniform; body normal for genus;

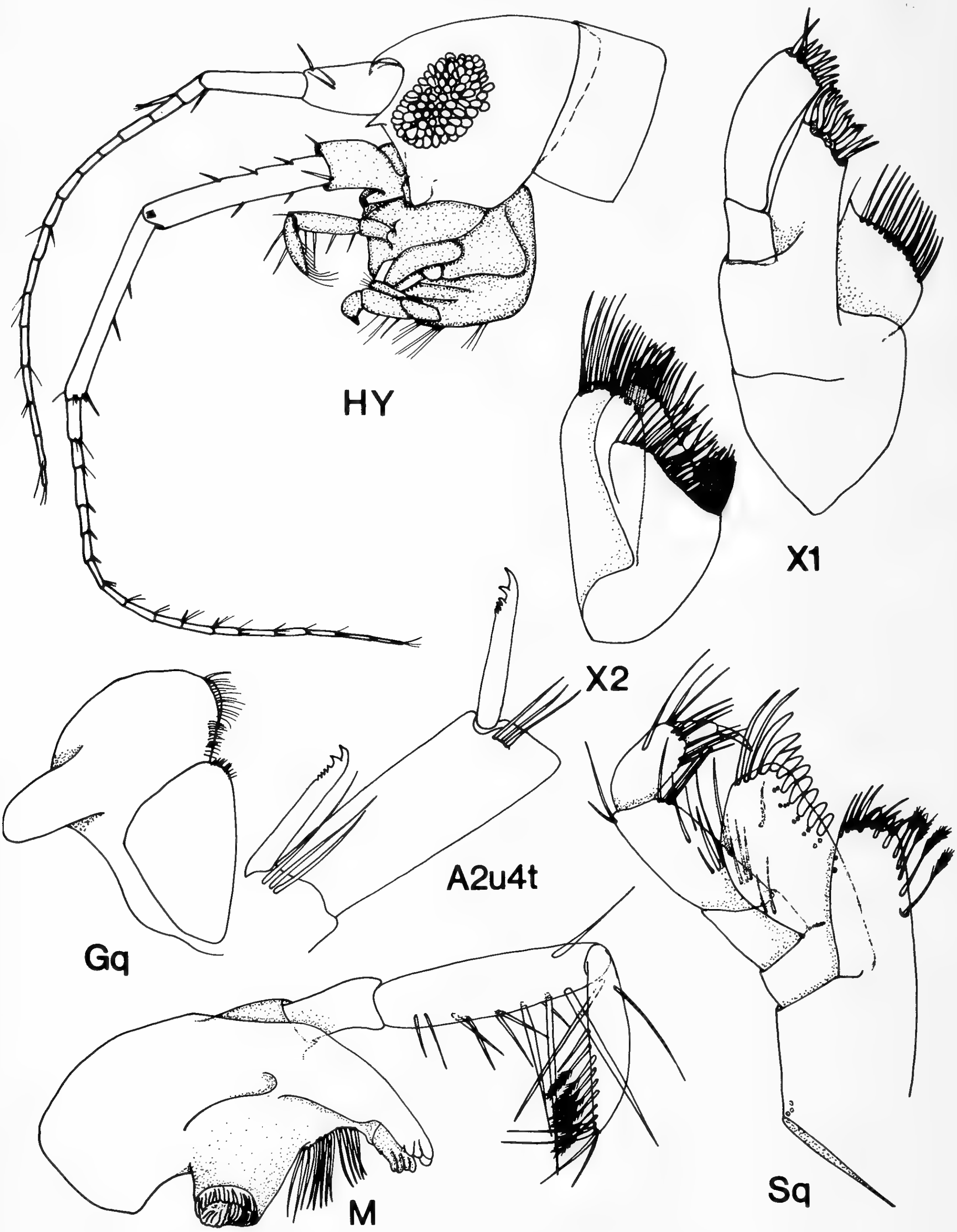

Fig. 5. *Megaluropus myersi,* female 4.20 mm.

posterodorsal edges of abdominal segments 2–6 serrate, 4–5 slightly elevated. Antenna 1: Length ratios of peduncle articles 1, 2, 3 = 16:17:4; flagellum with 14 articles, accessory flagellum biarticulate. Antenna 2: Articles 4 and 5 of peduncle subequal in length; flagellum with 17 articles 3–15, with serrate

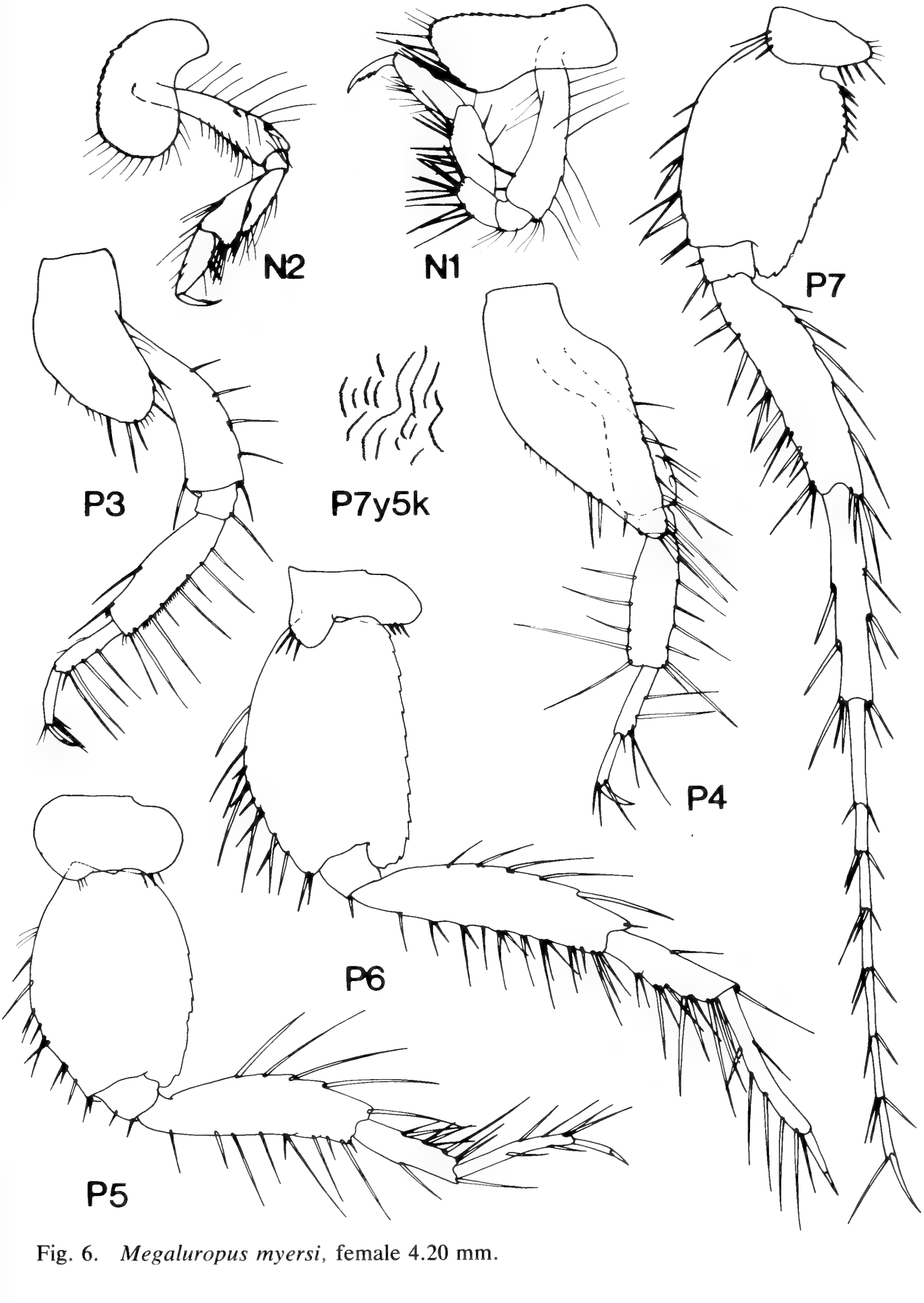

Fig. 6. *Megaluropus myersi,* female 4.20 mm.

spine on posterodistal corner. Upper lip: Rounded, with dense apical setae around cleft. Mandible: Molar triturative, well produced; 12 accessory blades; lacinia mobilis with 5 teeth; incisor somewhat elongate; palp 3-articulate, length ratios of articles 1, 2, and 3 = 28:75:60, articles 2 and 3 with ventral spines, article 3 carried at right angle to article 2. Lower lip: Inner lobes present; outer lobes with stout mandibular process. Maxilla 1: Medial margin of inner plate lined with setae; palp longer than outer plate, biarticulate, second article 2.7 times as long as the first, latter apically spinose. Maxilla 2: Inner plate medially setose along entire margin, diagonal row of setae also present; plates subequal in size. Maxilliped: Inner plate with medial setae, 3 apical chisel spines; outer plate medially expanded with a medial row of paired setae, 7 chisel spines, 3 apical spines; palp normal for genus, medial edges of articles setose; article 4 with accessory nail of subequal length. Gnathopod 1: Small, stout, simple, poorly setose; coxa reniform, serrate on anterior and distal edges, distally setose; article 2 with numerous long setae on posterior edge; article 4 with posterodistal spines; article 5 slightly longer than 6, with long posterior spines; posterior border of article with 2 locking spines and numerous setae; dactyl slender with 3 inner marginal teeth. Gnathopod 2: Small, slender, simple; coxa slightly convex posteriorly, anterior and distal margins serrate, distally setose; article 2 with long posterior setae, numerous anterodistal setae; article 4 produced distally; article 5 triangular, expanded distally; article 6 slender, poorly setose, with 1 locking spine; dactyl slender, with 3 inner marginal teeth. Pereopod 3: Coxa longer than broad, posterior margin slightly concave, distally spinose; article 2 with 2 proximal spines on anterior edge, 1 distal spine, article is narrow at base expanded distally, posterior margin with 5 spines; articles 4, 5, and 6 successively shortened, length ratios of 23:12:9; posterior margins of articles with elongate spines; dactyl with accessory nail. Pereopod 4: Coxa much larger than other coxae, much longer than wide, acuminate, distal margin reaching article 3, posterior margin crenulate, spinose; article 2 medially constricted, posterodistal margin spinose; both margins of article 4 with long spines, otherwise articles 4, 5, and 6 similar to those of pereopod 3. Pereopod 5: Coxa subquadrate, 3 posterodistal spines, article 2 expanded, posterior margin crenulate, anterior margin spinose; article 4 with 4 long posterior spines, numerous anterior spines, article 5 posteriorly spinose, shorter than either article 4 or 6; article 6 linear with 4 posterior, 2 anterior spines; dactyl with accessory nail. Pereopod 6: Coxa with short anterodistal lobe, with 4 spines, posterior margin with 3 spines; remaining articles as in pereopod 5 but more spinose; pereopod 6 1.2 times longer than pereopod 5. Pereopod 7: Coxa reduced, 4 posterior spines, article 2 expanded posteriorly, crenulate, with 6 spines, anteriorly spinose; article 4 slightly longer than 5, with 6 posterior and numerous anterior spines; article 5 with 5 posterior and anterior spines; article 6 elon-

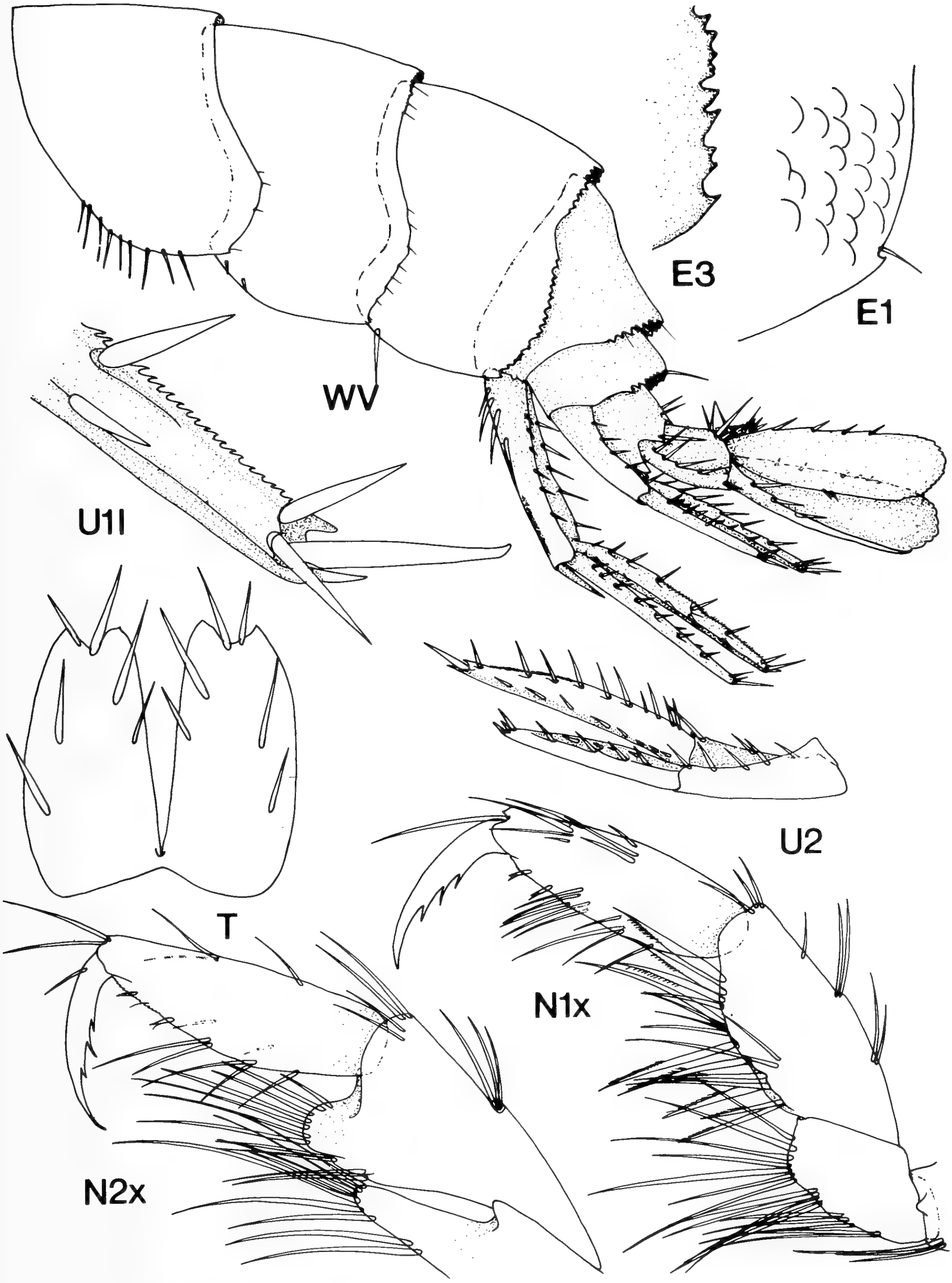

Fig. 7. *Megaluropus myersi,* female 4.20 mm.

gate, composed of 7 segments of which first twice as long as following segments, article is twice as long as article 5; dactyl with accessory nail; pereopod 7 1.3 times as long as pereopod 6. Epimeron: Posterior margins sinuous, slightly produced; epimeron 1 with 9 anterodistal spines; epimeron 2 with 2 short anterodistal spines; posterior margin of epimeron 3 serrate. Uropod 1: Peduncle with 5 inner marginal, 6 outer marginal spines, 4 elongate proximal facial spines, and 1 ventral distomedial spur; inner and outer margins of inner ramus with 6 spines, distal portion of inner margin minutely serrate, apex with 4 spines; outer ramus with 7 outer, 3 inner marginal, and 4 apical spines. Uropod 2: Peduncle with 3 inner, 4 outer marginal spines; inner ramus longer than outer, inner margin with 9 spines, outer with 8 spines, inner margin minutely serrate along distal half, 3 apical spines; outer ramus with 4 outer and inner marginal spines, 3 apical spines. Uropod 3: Normal for genus, peduncle with lateral row of 4 spines in addition to 2 dorsal and 1 distoventral spines; rami spatulate; outer ramus with 3 spines on outer margin, 6 small spines on inner margin; inner rami with 5 inner marginal, 2 outer marginal spines; both rami are otherwise similar. Telson: Cleft, tips bifid, each lobe with 2 apical spines, 2 outer and 2 inner marginal spines; telson extending further than length of peduncle on uropod 3. Gills and oostegites: present on all pereopods but 1 and 7.

Male.—Unknown.

Types.—Holotype, USNM 172178, female, 4.20 m; paratypes, 2 females, USNM 172180.

Type-locality.—Station 100-60. Smithsonian-Bredin Caribbean Expd. IV, 1960, Santa Maria Pt., Cozumel Island, Quintana Roo, Mexico, depth 1 m.

Material examined.—The types.

Distribution.—Cozumel Island, Quintana Roo, Yucatan, Mexico, Caribbean Sea.

Relationships.—*Megaluropus myersi* appears to be more closely related to *M. longimerus falciformis* Barnard, 1969, than other members of the genus. They are similar in the following aspects: (1) presence of lateral cephalic cusp, (2) structure of gnathopod 2, and (3) structure of coxae. The two species differ in the following: (1) *Megaluropus myersi* lacks the falciform setae, (2) abdominal segment 2, dorsally serrate in *Megaluropus myersi,* and (3) *M. l. falciformis* lacks lateral and medial spines on telson. The lack of the lateral cephalic cusp and differences in epimeral features separate *M. longimerus longimeris* Schellenberg, 1925 from *M. l. falciformis* and *Megaluropus myersi.*

Sebidae

Diagnosis.—Accessory flagellum biarticulate; mandibular molar obsolescent; gnathopods chelate, gnathopod 1 larger than 2; uropod 3 uniramus; urosomites 2–3 fused.

Seba Bate, 1862

Teraticum Chilton, 1884; *Grimaldia* Chevreaux, 1889; *Paravalettia,* K.H. Barnard, 1916.

Diagnosis.—That of the family (monotypic).

Seba tropica, new species
Figs. 8, 9

Description.—Female 2.56 mm. Head normal for genus, without eyes or pigment; urosomites 2–3 fused. Antenna 1: Length ratios of first 3 articles = 31:44:14; flagellum with 5 articles of decreasing size, all unarmed; accessory flagellum absent. Antenna 2: Slightly shorter than antenna 1; fifth article 0.6 times as long as article 4; flagellum with 3 articles. Upper lip: Slightly bilobed. Mandible: Molar process not evident but setose process present; accessory blades 2 on right with setose ridge between the blades and process; left mandible with 3 blades; right lacinia mobilis V-shaped, distally toothed, left linear, toothed; incisor produced, toothed; palp with 3 articles of length ratios = 31:59:56; distal portions of articles 2 and 3 setulose; article 3 with a single subterminal spine. Lower lip: Inner lobes obsolescent but a medial process present; outer lobes widely separated. Maxilla 1: Inner plate rounded, distally setulose; outer plate with 7 complex spine teeth; palp uniarticulate, elongate with 1 subterminal spine and a distal bifid spine. Maxilla 2: Inner plate with setulose medial face and 3 distal setae; outer plate with 4 distal setae. Maxilliped: Inner plates very short, with single terminal spine; outer plates shorter than article 1 of palp, with 2 terminal and 1 medial chisel spines; palp with 4 articles, medial edges of articles 2 and 3 spinose. Gnathopod 1: Chelate; article 2 somewhat elongate, unarmed; articles 4 and 5 with posterodistal spines; article 6 with posteromedial facial setae; posterodistal corner produced well forward, with pair of locking spines on the tip, palm with row of 4 setae; dactyl elongate, closing on palmar corner. Gnathopod 2: Chelate; coxa subequal to first; article 3 elongate, unarmed; article 5 elongate, 0.9 times as long as 6; tip of article 6 with single spine; dactyl with tip downturned. Pereopod 3: Coxa distally rounded; margin of article 4 produced into anterodistal lobe, with 4 spines; posterior margin of article 5 with 3 spines, anterodistal corner with 1 spine; article 6 with posterior spine formula of 1,2,2, and 2 locking spines. Pereopod 4: Coxa distally rounded, wider than preceding one; article 4 produced into anterodistal lobe, with 5 spines, posterior margin with 3–4 spines; article 6 with 3 posteromarginal spines; posterior spine formula of article 6—2,2, and 2 locking spines. Pereopod 5: Coxa with anterior lobe, 2 anterodistal spines; posterior margin of article 2 expanded, setulose; anterior margin with 6 spines; article 4 produced into a posterodistal lobe with 3 spines; article 5 with 2 anteromarginal and 1 posterodistal spine; article 6 with anteromar-

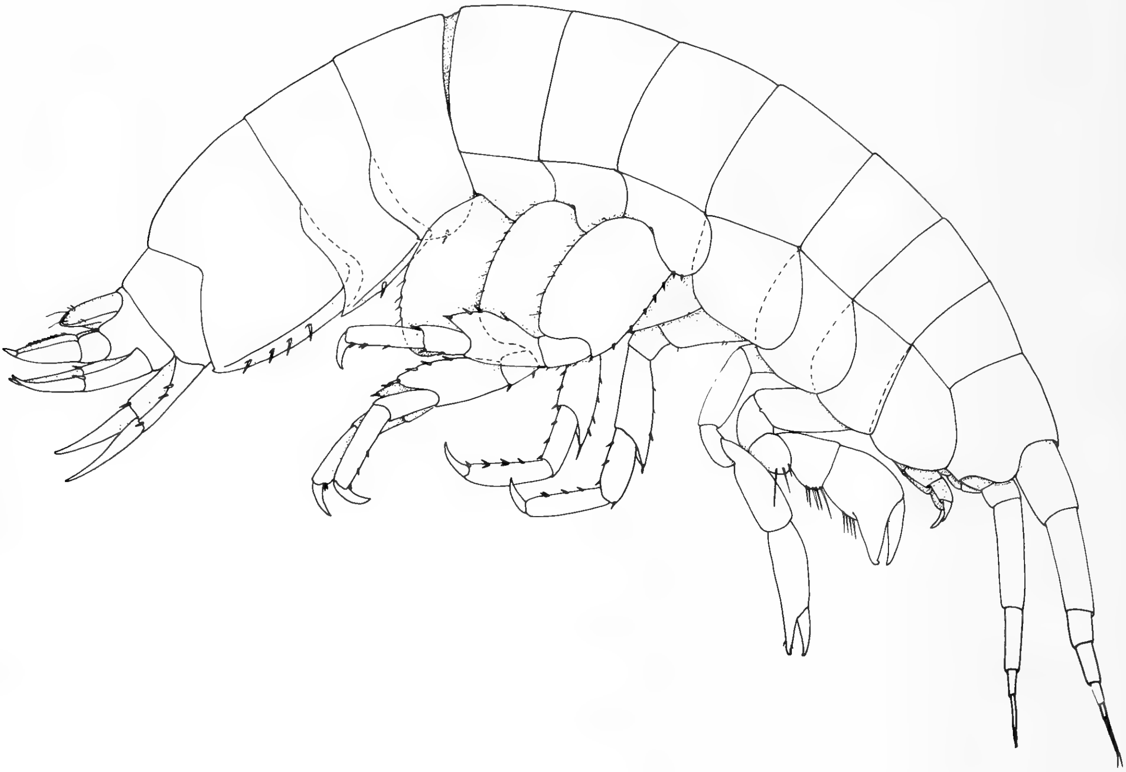

Fig. 8. *Seba tropica,* female 2.56 mm.

ginal spine formula of 1,2, and 2 locking spines. Pereopod 6: Posterior margin of article 4 with 4 spines, otherwise like pereopod 5. Pereopod 7: Posterior margin of article 4 with 3 spines, otherwise like pereopod 5. Epimeron: Epimeron 1 with single mediodistal spine, posterior margin sinuous; epimeron 2 with single mediodistal spine, posterodistal corner produced; epimeron 3 with 4 distomarginal spines, posterodistal margin somewhat sinuous. Uropod 1: Outer margin of peduncle with 2 medial, 1 distal spine, inner margin with 1 distal spine; rami subequal, lanceolate. Uropod 2: Peduncle with distal spines on inner and outer margins; rami lanceolate. Uropod 3: Peduncle short, 0.5 times as long as single ramus; inner margin of ramus with setulose ridge and single distal spine. Telson: Entire, distally rounded, dorsally depressed, lateral margins with pair of setules and 2 distal setae.

Male.—1.83 mm. Smaller than female; palm of gnathopod 2 transverse, lower corner armed as in female, hinge process with two teeth; otherwise similar to female.

Types.—Holotype, USNM 172181, 2.56 mm, female; paratype, series of 2 individuals, USNM 172182.

Type-locality.—Specimens from 26°10′N, 97°15′W (waters near Port Isabel, Texas).

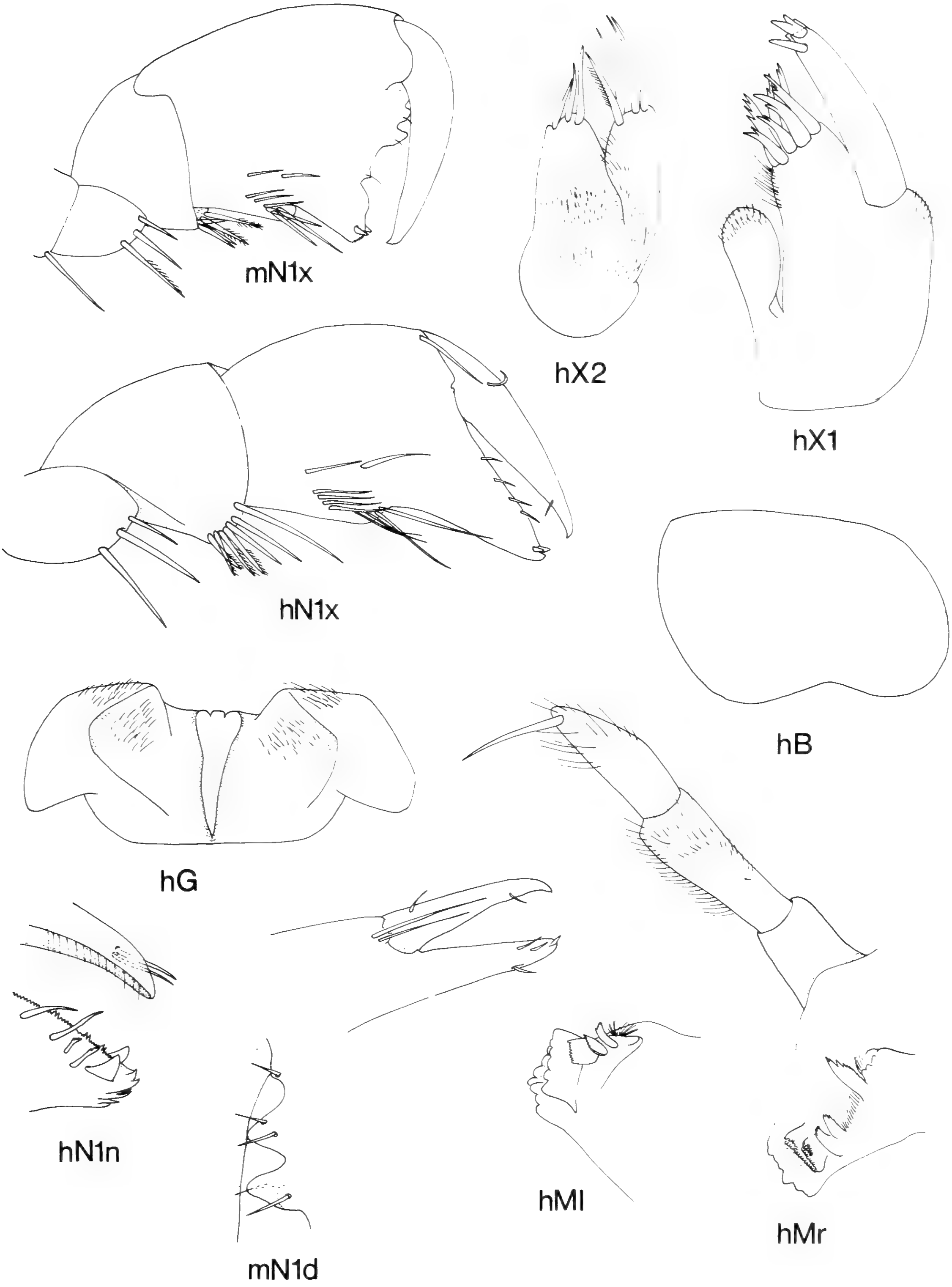

Fig. 9. *Seba tropica,* h = female 2.56 mm; m = male 1.83 mm.

Material examined.—The types and specimens from SB91-60, Nicchehabin Reef, Ascension Bay, Mexico.

Distribution.—Gulf of Mexico and Caribbean Sea.

Relationships.—*Seba tropica* is most closely related to *S. ekepuu* J. L. Barnard, 1970. Both species have similar pereopods 5–7. Article 2 of pereopod 7 is not ovate and article 4 of the three pereopods is not overly produced. The female of *S. aloe,* Karaman, 1971, is also very similar although the male pereopods have greatly produced posterior lobes on article 4. These lobes are not present on males of *Seba tropica* and unknown, but presumed absent, on *S. ekepuu. Seba tropica* differs from *S. ekepuu* in having a more elongate article 5 on gnathopod 1, spinose distal margins on epimeral plates, and a more reduced posterior margin on pereopod 7. The pigment observed on the head (in general area of the eyes) and pereopod 7 of *S. ekepuu* was evident on only one specimen of *Seba tropica* where it was more widespread than in *S. ekepuu. Seba tropica* differs from *S. aloe* in the armament of the mandibular palp, structure of the medial part of the lower lip, and the structure of gnathopod 1 in the males.

All three species appear to have close affinities with *S. typica* Chilton, 1884, but differ in the structure of the peropods.

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REVISION OF *METHARPINIA* AND *MICROPHOXUS* (MARINE PHOXOCEPHALID AMPHIPODA FROM THE AMERICAS)

J. Laurens Barnard

Abstract.—Several species of marine phoxocephalid formerly placed in *Paraphoxus* are removed to *Metharpinia* and *Microphoxus*. Because these species retain apical spination on the rami of uropods 1–2 they appear to be the most plesiomorphic of the *birubiin* group of the family in the Americas; this conclusion is based on the evolutionary scheme proposed by Barnard and Drummond (1978) in their Australian study. The species treated herein are: *Microphoxus minimus, M. cornutus, Metharpinia longirostris, M. jonesi, M. floridana,* and 2 new species, *M. oripacifica* and *M. coronadoi*. Each taxon is redescribed in the new expanded format of the family.

Metharpinia Schellenberg (1931) and *Microphoxus* J. L. Barnard (1960) appear to be the most primitive taxa of the birubiin-parharpiin group of Phoxocephalidae in the Americas. The realignment of phoxocephalids carried out by Barnard and Drummond (1978) for the Australian fauna forces reassessment of the American taxa, a course announced as in progress by Barnard and Drummond (1976). All previously described American taxa have now been reexamined and several new genera established by Barnard (1979). This paper is the first of several in which the species of American phoxocephalid genera will be redescribed under the new format proposed by Barnard and Drummond (1976, 1978).

Although each American genus of this subfamily group is distinct from genera in Australia, in most cases the distinction is small, often confined to one slim character. The relationship to certain Australian taxa is therefore deemed to be very close and to have its roots in a pool of common ancestors focused in Gondwanaland seas. In 1960 Barnard could not distinguish genera in this group; today, through expansion of character states a barely minimum distinction can be made and an evolutionary mode described. If Barnard and Drummond are correct that the geographic pattern of taxa in the Phoxocephalidae suggests an origin in Gondwana seas and that subsequent control of distribution in the group is tectonic, then one must conclude that evolution in the group outside of Australia has been very slow and not very successful. The birubiin-parharpiniin group has not diversified greatly in the North Pacific Ocean and has scarcely penetrated the North Atlantic Ocean. In Australia numerous species occur in the group but most character linkages remain extant in the evolutionary web so that little generic diversification has occurred. In other words, intermediate species have not become extinct.

Unlike most American species of phoxocephalids in the birubiin group, *Metharpinia* and *Microphoxus* retain subapical spination on the rami of uropods 1–2. This is considered to be a primitive character derived from ancestors that may have resembled *Pontharpinia pinguis,* and Australian species with many supposed plesiomorphic characters. Subapical spines in *Metharpinia* and *Microphoxus* are poorly developed and presumed to be in a long evolutionary downfall. This conclusion is based on the premise that the most diverse and widespread phoxocephalid genera are those lacking apical ramal spines. This includes taxa radiating outwards from the antiboreal phoxocephalid center into the north Pacific Ocean and into the deep seas. The evolutionary trend in phoxocephalids appears to be a simplification of armaments, reduction in size or protrusion of appendages, reduction in articulation capability of uropods and posterior body segments, reduction in size of rostrum and the increase in adaptations with commensal properties.

The following abbreviations are used in the figures included in this paper: **A,** antenna; **B,** pleon; **D,** peduncle; **E,** epimeron; **F,** accessory flagellum; **G,** gnathopod; **H,** head; **I,** coxa; **J,** molar; **L,** labrum; **M,** mandible; **N,** ramus; **O,** palmar corner of gnathopod; **P,** pereopod; **R,** uropod; **S,** maxilliped; **T,** telson; **U,** upper lip; **W,** right lacinia mobilis; **X,** maxilla; **Y,** apicomedial corner on peduncle of uropod 3; **b,** apicomedial; **d,** dorsal; **e,** broken; **f,** flattened; **h,** reconstructed; **i,** inner; **l,** left; **m,** molar; **o,** outer; **p,** medial; **r,** right; **s,** setae removed.

Lower case letters to right of capitals refer to items above; lower case letters to left of capitals refer to specimens cited in text.

Microphoxus J. L. Barnard

Microphoxus J. L. Barnard, 1960:291 (*Microphoxus minimus* J. L. Barnard, 1960, original designation).—Barnard and Drummond, 1978:414.

Diagnosis.—Eyes present. Flagella of antennae 1–2 unreduced in female, article 2 of antenna 1 ordinary, ventral setae widely spread; article 1 of antenna 2 not ensiform, article 3 with 2 setules, facial spines on article 4 in one main row (type) or 2+ rows; article 5 ordinary in size.

Right mandibular incisor with 3 teeth, molar not triturative, small, pillow-shaped, bearing 3 (type) or more splayed spines, not bearing fuzz, palpar hump small. Palp of maxilla 1 biarticulate, inner plate with one (type) or 4 setae; setation of maxilla 2 ordinary; inner plate of maxillipeds ordinary, apex of palp not protuberant, dactyl elongate, apical nail distinct, medium to elongate.

Gnathopods ordinary, small, similar, article 5 free, elongate, with weak eusirid attachment, palms oblique to almost transverse, hand ovatorectangular, heavily setose anteriorly but not trichophoxoid in shape. Article 3 on pereopod 5 of broad form, articles 4–5 of pereopods 5–6 broad, article 2 of pereopods 5–6 not setose posteriorly, pereopod 7 ordinary, article 2 naked ventrally, article 3 ordinary, dactyl normal.

Epimera 1–2 lacking (type) or bearing numerous long posterior setae, without midfacial setae above ventral facial ridge; epimeron 3 ordinary, urosomite 1 generally naked except for ventral bundle or for sparse apicoventral setae near base of uropod 1; urosomite 3 with dorsal hook or special process. Peduncle of uropod 1 normally elongate, without apicoventral spike, without special enlarged apicolateral or medial spine, peduncular apices of uropods 1–2 not combed, inner ramus of uropod 1 with 1 row of marginal spines (or none), no rami continuously spinose to apex, inner ramus of uropod 2 ordinary, uropod 3 ordinary, bearing long article 2 of outer ramus, carrying 2 medium apical setae. Telson ordinary, with 1–2 apical spines plus setules on each lobe, with special lateral setae.

Description.—Rostrum constricted, small to obsolescent. [Fuzz on article 1 of antenna 1 in male unknown, calceoli on male primary flagellum of antenna 1 unknown, calceoli on male antennae 2 unknown.] Prebuccal parts ordinary, poorly separated from each other, upper lip dominant. Right lacinia mobilis bifid, thin, article 1 of mandibular palp short, palp medium to thin, apex of article 3 oblique, article 2 without outer setae; lower lip bearing or lacking [type] cones; outer plate of maxilla 1 with 11 spines, one spine especially thickened; inner plates of maxilliped with one main apical spine, ordinarily setose. Coxae 2–4 without special anterodorsal humps. Some posterior spines on article 6 of pereopods 3–4 thin and seta-like, others thick and stiff, midapical spine or seta present, often especially enlarged; article 2 of pereopod 7 without facial setae. Peduncle of uropod 1 with dorsolateral spines confined apically, medial spines confined apically; peduncle of uropod 2 with only one medial spine or setule confined apically; peduncle of uropod 3 lacking extra subapical setae or spines. Telson with ordinary pair of midlateral or dorsal setules on each side.

Composition: *cornutus* (Schellenberg, 1931); *minimus* J. L. Barnard (1960).

KEY TO THE SPECIES OF *MICROPHOXUS*

1. Facial spine count on article 4 of antenna 2 = 1-3-4-4, spines thick .... *cornutus*
– Facial spine count on article 4 of antenna 2 = 0-5-1, several spines thin and elongate .... *minimus*

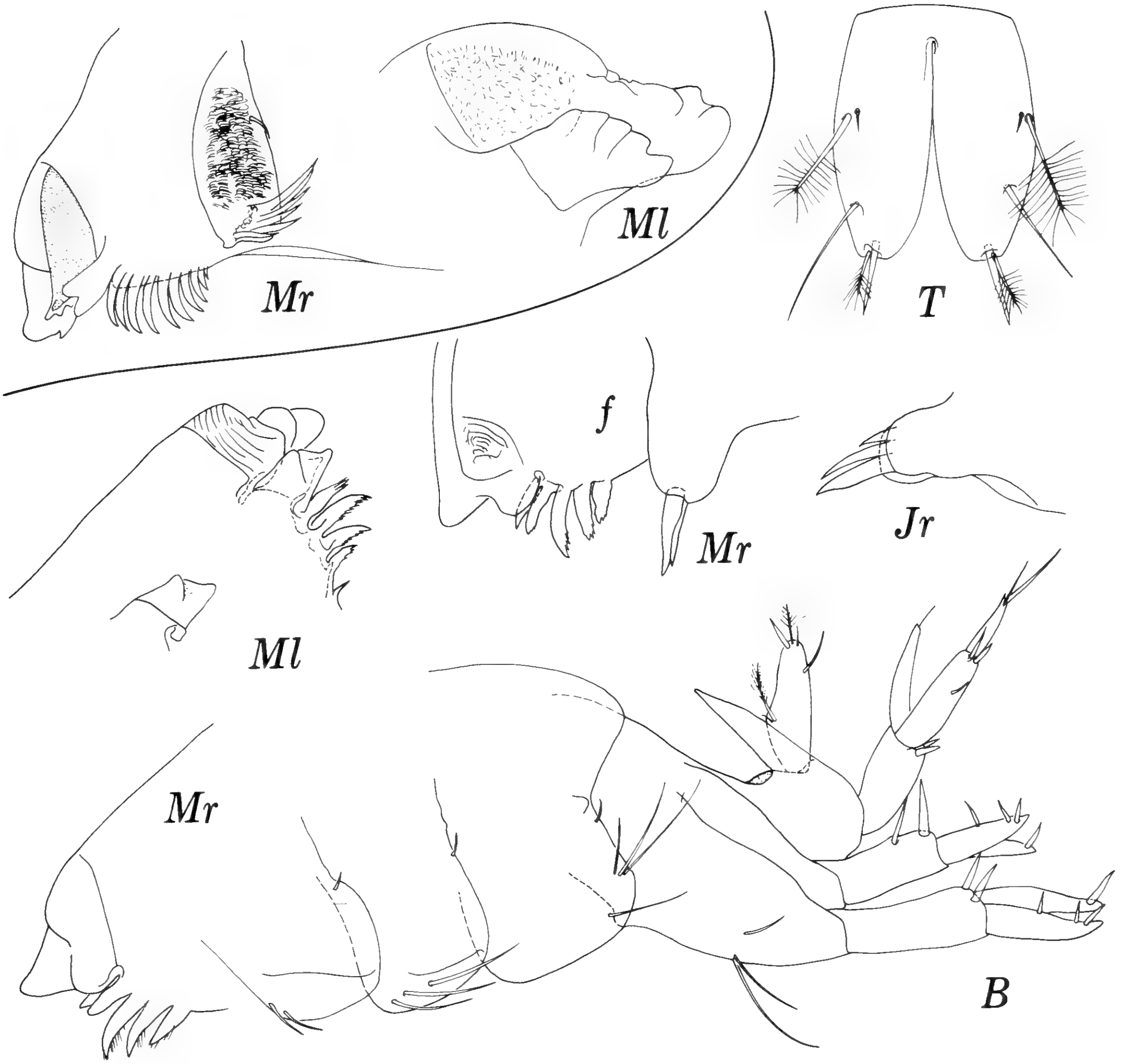

Fig. 1. Upper, *Metharpinia jonesi,* female "x" 4.04 mm; juvenile "y" 1.90 mm. Lower, *Microphoxus minimus,* female "u" 1.90 mm.

Microphoxus minimus J. L. Barnard
Fig. 1 lower

Microphoxus minimus J. L. Barnard, 1960: 291, plate 46.

Description of juvenile "u."—Head about 19% of total body length, greatest width about 85% of length, rostrum constricted, narrow, short, not reaching apex of article 1 on antenna 1. Eyes very small, clear of pigment, ommatidia few and ordinary. Article 1 of peduncle on antenna 1 about 1.3 times as long as wide, about twice as wide as article 2, ventral margin with about 6 setules, weakly produced dorsal apex with 2 setules-setae, article

2 about 0.60 times as long as article 1, with ventral row of 4–5 setae between Marks 60 and 70, primary flagellum with 5 articles, about 0.5 times as long as peduncle, bearing one short aesthetasc each on articles 4–5, accessory flagellum with 4 articles. Spine formula of article 4 on antenna 2 = 0-5-1, distal 5 very long, dorsal margin with notch bearing 4 setae, ventral margin with 5 groups of 1–2 long to medium setae plus setules, one ventrodistal long thin spine, article 5 about 0.85 times as long as article 4, facial spine formula = 1 thin, dorsal margin bearing 1–2 sets of setules, ventral margin with 3 sets of 1–2 long to medium setae, 3 ventrodistal long to medium spines scarcely set facially, flagellum about as long as articles 4–5 of peduncle combined, with 5 articles, article 1 elongate.

Mandibles with weak palpar hump, right incisor with 3 blunt teeth, left incisor with 3 obsolescent teeth in 2 branches, right lacinia mobilis deeply bifid or biramous, distal branch not shorter than proximal, both narrow, simple, pointed, left lacinia mobilis flake-like, broad, weakly bifid, right rakers 3, left rakers 4 plus 1 rudimentary, molars composed of bulbous protrusions, right and left molars with 3 primarily long spines, no spine disjunct, molars without plume, palp article 1 short, article 2 with 1 short inner apical setule, no other setae, article 3 about 1.1 times as long as article 2, oblique apex with 6 spine-setae, basofacial formula = 0. Inner plate of maxilla 1 especially small bearing one medium apical pluseta, no others, palp article 2 subtruncate, with 1 apical spine, 1 apicolateral, one apicomedial, and 3 submarginal setae; inner plate of maxilla 2 scarcely shorter than outer, outer broader than inner, outer with one apicolateral seta, inner with 1 medial seta; inner plate of maxilliped with 1 large thin apical spine, 3 apicofacial setae, 3 medial setae, outer plate with 3 medial spines and 2 medial setae, no apicolateral setae or spines, palp article 1 without apicolateral seta, article 2 with 1 apicolateral seta, medial margin of article 2 weakly setose, article 3 with 3 facial setae in triangle, 1 lateral seta, nail of article 4 long, with second large setal nail and 1 accessory setule.

Coxa 1 expanded apically, anterior margin convex, posterior straight then slightly curving posteriorly to sharp apex, main ventral setae of coxae 1–4 = 15-4-4-3, posteriormost seta of coxae 2–4 slightly shortened, anterior and posterior margins of coxa 4 almost parallel, posterior margin convex, posterodorsal corner sharp-rounded, posterodorsal margin short, v-shaped, width-length ratio of coxa 4 = 2:3. Gnathopods generally ordinary but stout and palms almost transverse, anterior margins of hands somewhat heavily setose, width ratios on articles 5–6 of gnathopods 1–2 = 33:32 and 33:32, length ratios = 66:51 and 65:47, palmar humps ordinary, palms weakly oblique, article 5 of gnathopod 1 elongate, ovate, posterior margin rounded, article 5 of gnathopod 2 elongate, ovate, posterior margin rounded.

Pereopod 4 stouter than pereopod 3 especially on article 4, facial setae formula on article 4 = 3 and 4, almost parallel to apex, on article 5 = 3 and

2, main spine of article 5 extending to M. 95 on article 6, article 5 with no proximoposterior spines and no proximal setae, spine formula of article 6 = 3 + 3 and 3 + 5, plus large middistal spine, some spines especially long; acclivity on inner margin of dactyls of pereopods 3–4 obsolescent, emergent setule almost fully immersed, midfacial pluseta absent. Coxae 5–7 posteroventral setule-seta formula = 2-3-1. Articles 4–5 of pereopods 5–6 broad, facial spine rows moderately developed, facial ridge formulas of article 2 on pereopods 5–7 = 0-1-1, width ratios of articles 2, 4, 5, 6 of pereopod 5 = 60:56:53:23, of pereopod 6 = 80:64:40:17, of pereopod 7 = 79:17:14:6, length ratios of pereopod 5 = 105:59:53:35, of pereopod 6 = 103:72:48:60, of pereopod 7 = 100:18:17:28, article 3 of pereopod 7 enlarged, article 2 exceeding apex of article 4, with 4 medium posterior serrations, medial apex of article 6 coarsely combed and bearing 1–2 digital processes. Posteroventral corner of epimeron 1 rounded, posterior margin weakly convex, anteroventral margin with 2 medium stout setae, posteroventral face without setae; posteroventral corner of epimeron 2 rounded, posterior margin convex, facial setae = 3; posteroventral corner of epimeron 3 rounded, weakly protuberant, posterior margin straight, with 3 posteroventral setae tightly grouped, ventral face with 1 seta situated posteriorly; epimera 1–3 with large setule on posterodorsal margin set in weak notch.

Rami of uropods 1–2 without true apical nails, outer rami of uropods 1–2 with 2 accessory nails, inner with 1, outer ramus of uropod 1 with 1 dorsal spine, inner with none, outer ramus of uropod 2 with 1 dorsal spine, inner with none, peduncle of uropod 1 with no basofacial setae and 1 apicolateral spine, medially with 1 apical spine, peduncle of uropod 2 with 2 dorsal spines, medially with one small apical spine, apicolateral corners of peduncles on uropods 1–2 without comb. Peduncle of uropod 3 with 1 large ventral spine, dorsally with 1 small lateral spine, 1 small medial spine, rami feminine, inner extending to M. 95 on article 1 of outer ramus, apex with 1 seta, medial and lateral margins naked, article 2 of outer ramus elongate, 0.50, bearing 2 medium setae, apicomedial margin of article 1 with pair of small setae, lateral margin with 1 acclivity, spine formula = 1–2, setal formula = 0. Telson especially long, length-width ratio = 13:10, not fully cleft, each apex of medium width, subtruncate, weakly excavate, bearing ordinary lateral setule, spine next medial longer than setule, one side with extra setule, ventral face on each side with long seta, midlateral setules highly diverse, largest of giant proportions. Articulation line of urosomite 1 incomplete, lateral surface with one seta, urosomite 3 with large hook dorsally on each side.

Holotype.—As described by Barnard (1960) with following additional description: Primary flagellum of antenna 1 with 6 articles, accessory flagellum with 5; article 2 of antenna 1 with 5 ventral setae in main row; primary flagellum about 60 percent as long as peduncle. Flagellum of antenna 2 with

7 articles. Inner plate of maxilla 1 with only 2 setae (normal phoxocephalid with 4 setae, juvenile "u" of this species with only one seta). Epimeron 3 with 3 ventral setae. Outer ramus of uropod 2 with 2 dorsal spines; inner ramus of uropod 3 with 2 setae.

Juvenile "y."—Rami of uropods 1–2 lacking marginal spines.

Material.—Five specimens from the original type-lot, including the holotype and 2 newly designated voucher specimens, juvenile "u," 1.90 mm and juvenile "y" 1.90 mm long.

Distribution.—Only the type-locality, Playa Blanca, Costa Rica, 10°56′00″N, 82°52′50″W, 3–5 fms, sand shell, 8 February 1935, material in Allan Hancock Foundation.

Microphoxus cornutus (Schellenberg), new combination
Figs. 2, 3 upper

Metharpinia cornuta Schellenberg, 1931:68–69, fig. 35.
Paraphoxus cornutus.—J. L. Barnard, 1960:271.

Description of female "w."—Head about 18% of total body length, greatest width about 75% of length, rostrum constricted, narrow, short, not reaching middle of article 2 on antenna 1. Eyes medium, clear of pigment, ommatidia ordinary. Article 1 of peduncle on antenna 1 about 1.3 times as long as wide, about 1.8 times as wide as article 2, ventral margin with about 8 setules, weakly produced dorsal apex with 2 setules-setae, article 2 about 0.83 times as long as article 1, with ventral crescent of 9 setae, primary flagellum with 9 articles, about 0.6 times as long as peduncle, bearing 1 short aesthetasc each on articles 5–8, accessory flagellum with 8 articles. Spine formula of article 4 on antenna 2 = 1-3-4-4, spines short, dorsal margin with notch bearing 1 seta and 1 spine, ventral margin with 7 groups of 1–3 long to short setae, 1 ventrodistal long spine, article 5 about 0.8 times as long as article 4, facial spine formula = 3, dorsal margin naked, bearing 2 sets of small setae, ventral margin with 5 sets of 1–2 long to short setae, 3 ventrodistal long to medium spines placed subfacially, flagellum about 0.9 times as long as articles 4–5 of peduncle combined, with 11 articles. Epistome and upperlip distinctly articulate, together forming obtuse triangle from side view.

Mandibles with weak palpar hump, right incisor with 3 teeth, left incisor with 3 humps in 2 branches, right lacinia mobilis bifid, distal branch not shorter than proximal, both proximal branches simple, pointed, left lacinia mobilis with 4 weak teeth, right rakers 9, left rakers 9 plus 2 rudimentaries, molars composed of short protrusions, demarcated mainly by spines, right molar with 4 primarily medium spines plus 1 vestigial broad spine weakly disjunct, left molar with 6 primarily medium spines, plus 1 vestigial short spine weakly disjunct, no molar with plume, palp article 1 short, article 2

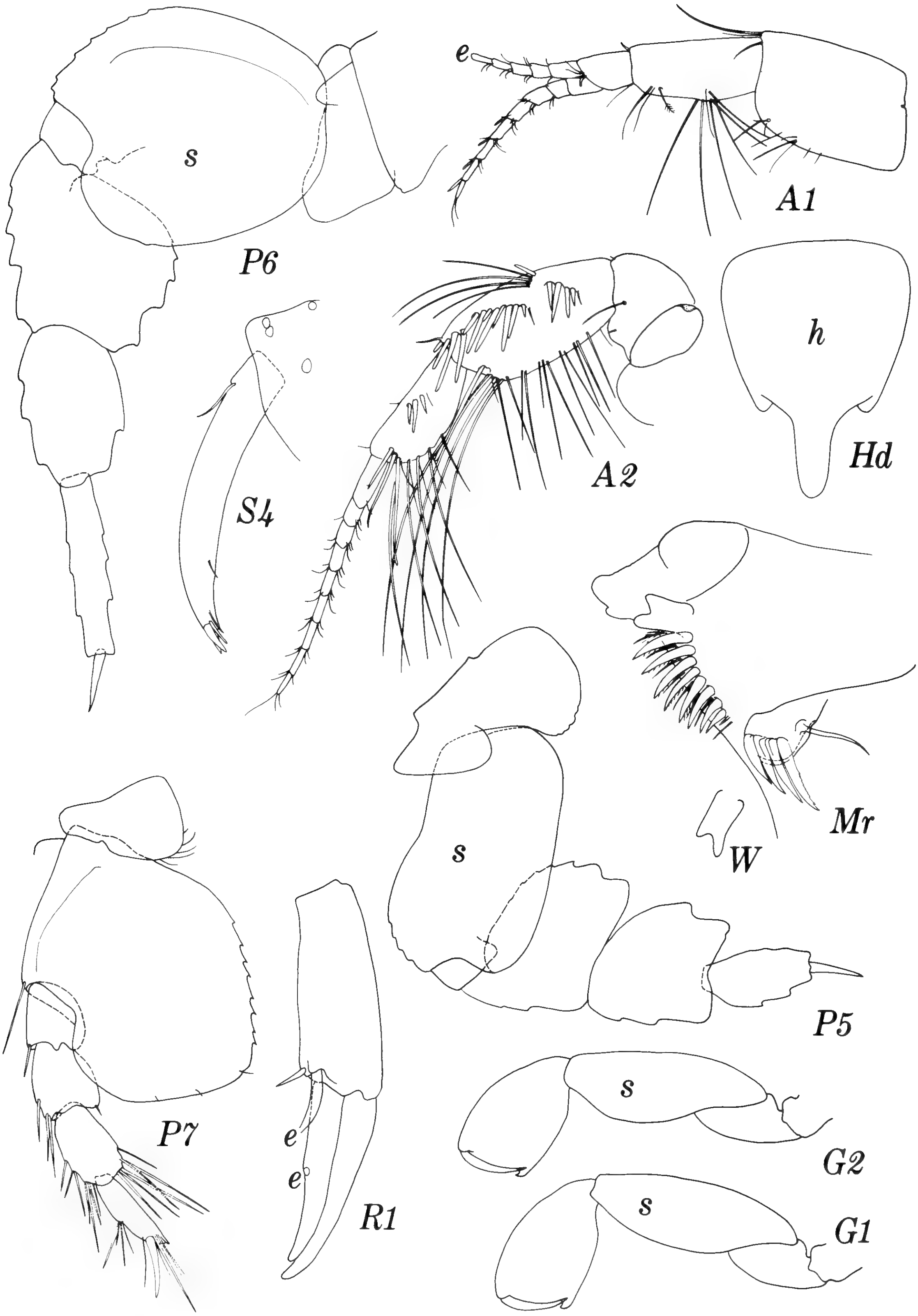

Fig. 2. *Microphoxus cornutus*, female "w" 5.09 mm.

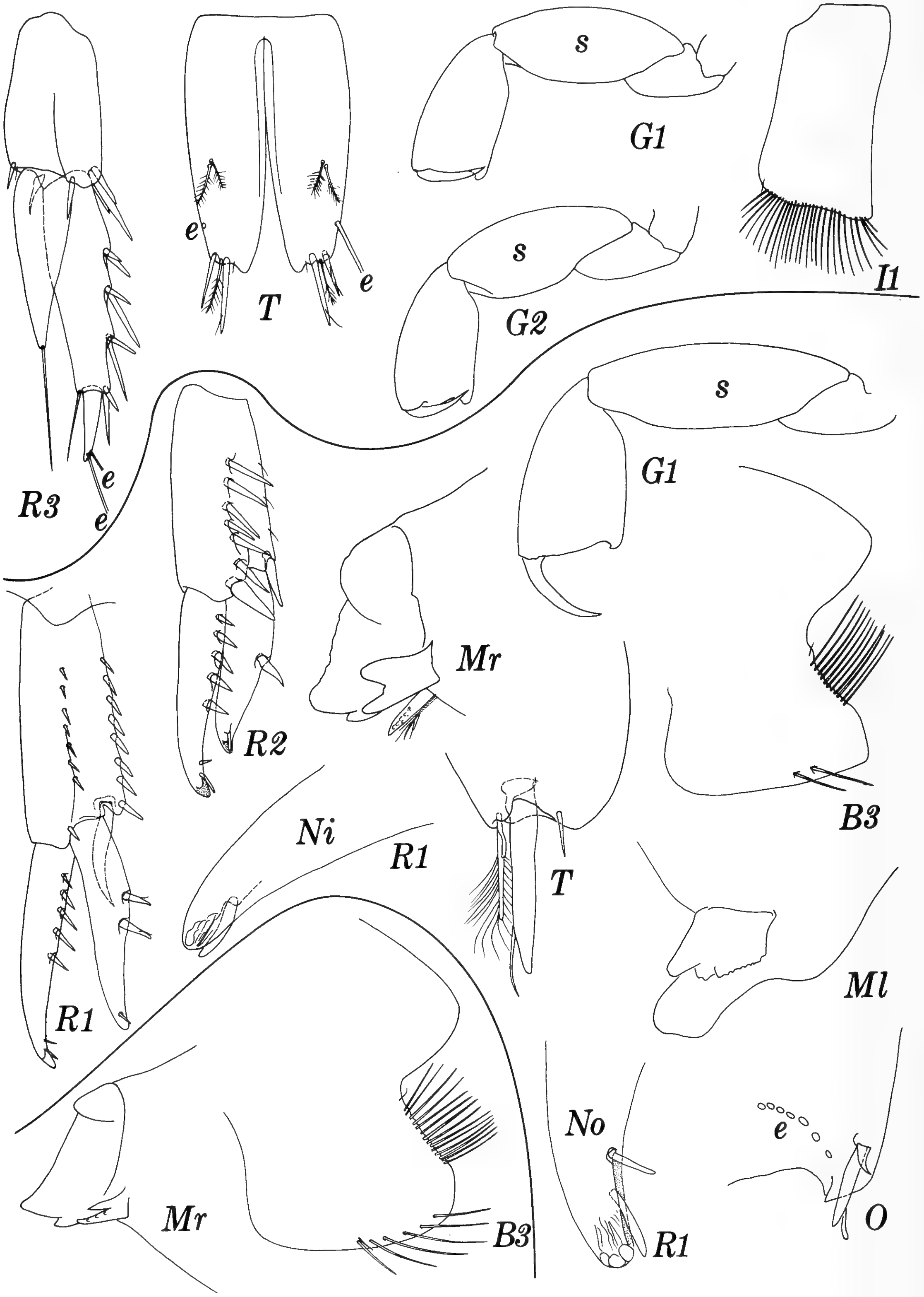

Fig. 3. Upper, *Microphoxus cornutus*, female "w" 5.09 mm. Middle, *Metharpinia coronadoi*, holotype, female "t" 6.57 mm. Lower, *Metharpinia oripacifica*, female "x" 4.0 mm.

with 1 short inner apical seta and 2–3 other short inner setae, article 3 about 1.2 times as long as article 2, strongly oblique apex with 9 spine-setae, basofacial formula = 1-1. Inner plate of maxilla 1 large, broad, bearing one medium apical pluseta, one similar apicomedial seta, 2 apicolateral slightly shorter setae, palp article 2 with 1 apical and 3 medial marginal spines and 1 apicolateral and 9 submarginal setae; maxilla 2 thin, plates extending subequally, outer broader than inner, outer with 2 apicolateral setae, inner with 1 medial seta; inner plate of maxilliped with 1 large thick apical spine, 2 apicofacial setae, 6 medial setae, outer plate with 6–7 medial spines, no apicolateral setae, palp article 1 with 1 apicolateral seta, article 2 with 4 groups of 4 lateral setae, medial margin of article 2 moderately setose, article 3 with 5 facial setae, 2 lateral setae, nail of article 4 unknown (broken), said to be well developed.

Coxa 1 scarcely expanded apically, anterior margin almost straight, main ventral setae of coxae 1–4 = 27-10-9-5 (and 7–8 posterior setae on coxa 4), posteriormost seta of coxae 1–3 very short, coxa 1 with weak posteroventral extension as in *Microphoxus minimus,* anterior and posterior margins of coxa 4 strongly divergent, posterior margin oblique, almost straight, posterodorsal corner rounded, posterodorsal margin ordinary, weakly concave, width-length ratio of coxa 4 = 13:17. Gnathopods generally ordinary, similar to *M. minimus,* width ratios on articles 5–6 of gnathopods 1–2 = 25:28 and 25:27, length ratios = 65:48 and 65:47, palmar humps slightly enlarged, palms almost transverse, article 5 of gnathopod 1 elongate, ovate, posterior margin rounded-flat, long, article 5 of gnathopod 2 elongate, ovate, posterior margin rounded. Pereopods 3–4 similar, facial setae formula on article 4 = 7 and 8, almost parallel to apex, on article 5 = 7 and 6, main spine of article 5 extending to M. 85-75 on article 6, article 5 with no proximoposterior spines, and setae absent basally, spine formula of article 6 = 5 + 7 and 6 + 8 plus large middistal spine, some spines especially long, acclivity on inner margin of dactyls of pereopods 3–4 obsolescent, emergent setule ?absent, midfacial pluseta ordinary but posteriad. Coxae 5–7 posteroventral setule-setae formula = 5-15-4. Articles 4–5 of pereopods 5–6 broad, facial spine rows dense to moderately developed, facial ridge formulas of article 2 on pereopods 5–7 = 0-1-1, width ratios of articles 2, 4, 5, 6 of pereopod 5 = 60:61:50:21, of pereopod 6 = 80:65:38:14, of pereopod 7 = 82:17:11:5, length ratios of pereopod 5 = 102:54:51:41, of pereopod 6 = 102:70:58:58, of pereopod 7 = 100:18:18:25, article 3 of pereopod 7 enlarged, article 2 exceeding apex of article 4, posterior margin with 8 small serrations, medial apex of article 6 coarsely combed and bearing 2 digital processes.

Postventral corner of epimeron 1 rounded, posterior margin deeply convex, serrate, setose (3), anterior and ventral margins with 7 long setae; posteroventral corner of epimeron 2 rounded, weakly protuberant, posterior margin weakly convex, serrate, setose (4), facial setae = 9; posteroventral corner of epimeron 3 rounded, weakly protuberant, posterior margin almost straight, serrate, setose (4), ventral margin naked, face with oblique row of 4 setae extending from ventral-posterior margin to middle; epimera 1–3 with setule on posterodorsal margin set in weak notch.

Rami of uropods 1–2 without true apical nails, outer rami of uropods 1–2 with 2 accessory nails, inner with 1, outer ramus of uropod 1 with 3 dorsal spines, inner with 1, outer ramus of uropod 2 with 2–3 dorsal spines, inner with 1 dorsomedial spine; peduncle of uropod 1 with no basofacial setae and 1 apicolateral spine, medially with 1 marginal setule and 1 apical spine; peduncle of uropod 2 with 3 dorsal spines, medially with 1 medium apical spine (like larger of inner ramus), apicolateral corners of peduncles on uropods 1–2 without comb. Peduncle of uropod 3 with 5 ventral spines, dorsally with 1 lateral spine, 1 medial spine and setule, rami feminine, inner extending to M. 75 on article 1 of outer ramus, apex with 1 seta, medial and lateral margins naked, article 2 of outer ramus elongate, 0.34, bearing 2 medium setae, apicomedial margin of article 1 with 1 seta, lateral margin with 3 acclivities, spine formula = 2-2-2-2, setal formula = 0. Telson especially long, length-width ratio = 8:5, almost fully cleft, each apex of medium width, subtruncate, but then produced medially, apex bearing medium lateral and long medial spines separated by medium to long setule, with at least 1 long thick lateral seta each side, midlateral setules apicad, weakly diverse, larger of medium size. Urosomite 1 without setule at base of uropod 1, with ventral setal brush, articulation line almost absent, urosomite 3 with large hook dorsally on each side.

Telson possibly with other lateral setae but sockets not clear.

Male "s" and female "t": Telson with 1 long lateral seta on each side; article 2 of uropod 3 with 1 medium, 1 elongate apical setae, the medium seta as long as article 2, the longer seta twice as long; young male not sufficiently advanced to warrant description; terminal male unknown.

Material.—Female "w," 5.09 mm, Punta Arenas [Tierra del Fuego, Chile], Sandboden mit Algen, 4 XII 95, 323, Swedish State Museum 2699. Juvenile male "s" 4.19 mm, and female "t" 4.24 mm, Gallardo HKK2, (east end of Magellan Strait), 11 m, 12-4-76, fine sand.

Relationship.—This species differs from *M. minimus* in: (1) the multiple spine formula on article 4 of antenna 2, the spines being short; (2) the more strongly spinose mandibular molar, with 5–6 spines in contrast to 3 on *minimus*; (3) the presence of four setae on the inner plate of maxilla 1, in contrast to 1 seta for *minimus*; (4) the presence of posterior setae on coxa 4; (5) the presence of posterior setae on epimera 1–2; (6) the wide span of the posterior setae on epimeron 3.

Microphoxus minimus is clearly much more apomorphic in its characters than is *M. cornutus,* the former being very close to the condition of the subfamily Brolginae because of the reduction in armaments on antenna 2, mandibular molar and epimeron 3.

Distribution.—South America, southern tip at Punta Arenas and Ushuaia, 1–15 m.

Metharpinia Schellenberg, revised

Metharpinia Schellenberg, 1931:65 (*Metharpinia longirostris* Schellenberg, 1931, selected by Barnard and Drummond, 1978).—Barnard and Drummond, 1978:415.

Diagnosis.—Eyes present. Flagella of antennae 1–2 unreduced in female, article 2 of antenna 1 ordinary, ventral setae widely spread. Article 1 of antenna 2 not ensiform, article 3 with 2 setules, facial spines on article 4 in 2 or more rows, article 5 ordinary in size.

Right mandibular incisor with 3 teeth, molar not triturative, small, pillow-shaped, bearing 4 or more splayed spines, usually not bearing fuzz, palpar hump small. Palp of maxilla 1 biarticulate, inner plate with 4 setae; setation of maxilla 2 ordinary; inner plates of maxillipeds ordinary, apex of palp not protuberant, dactyl elongate, apical nail mostly immersed.

Gnathopods small, similar, gnathopod 2 weakly or not enlarged, article 5 of gnathopods elongate, without eusirid attachment, palms oblique, hands ordinary, ovatorectangular, moderately to poorly setose anteriorly. Article 5 of pereopods 3–4 setose posteroproximally, article 3 of pereopod 5 of broad form, articles 4–5 of pereopods 5–6 broad, article 2 of pereopods 5–6 not setose posteriorly, pereopod 7 ordinary, article 2 naked ventrally, article 3 ordinary, dactyl normal.

Epimera 1–2 bearing numerous long posterior setae, without midfacial setae above ventral facial ridge, epimeron 3 of "ordinary" classification and diverse. Urosomite 1 without large lateral facial spines, bearing one or more midventral crescents or bundles of setae, or generally naked except for sparse apicoventral setae or spines near base of uropod 1, urosomite 3 without dorsal hook or bearing vestigial process. Peduncle of uropod 1 normally elongate, without apicoventral spike, with displaced enlarged apicolateral spine, peduncular apices of uropods 1–2 not combed, inner ramus of uropod 1 with 1 row of marginal spines, some rami continuously spinose to apex (with accessory apical nails), inner ramus of uropod 2 ordinary, uropod 3 ordinary, bearing article 2 of outer ramus, carrying 2 short to long apical setae. Telson ordinary, with 1–4 apical spines or setae on each lobe plus setules, with special dorsal and lateral spines or setae.

Description.—Rostrum fully developed, constricted. Fuzz on article 1 of antenna 1 in male[unknown], calceoli on male primary flagellum of antenna 1[unknown], calceoli on article 5 and flagellum of male antenna 2[unknown]. Prebuccal parts ordinary, poorly separated from each other, upper lip dominant. Right lacinia mobilis bifid, flabellate or thin, article 1 of mandibular palp short, palp medium to thin, apex of article 3 oblique, article 2 without outer setae; lower lip bearing or lacking cones; outer plate of maxilla 1 with 11 spines, one spine especially thickened; inner plates of maxilliped with 1–2 main apical spines, ordinarily setose. Coxae 2–4 without special anterodorsal humps. Posterior spines on article 6 of pereopods 1–2 thick and stiff, midapical spine present, often especially enlarged; article 2 of pereopod 7 without facial setae. Peduncle of uropod 1 with dorsolateral spines confined apically, medial spines confined apically or widely spread, peduncle of uropod 2 with 1 medial spine confined apically or spines widely spread; peduncle of uropod 3 lacking extra subapical setae or spines. Telson with ordinary pair of basolateral or dorsal setules on each side.

Composition.—coronadoi, new species; *floridana* (Shoemaker); *jonesi* (J. L. Barnard); *longirostris* (Schellenberg); *oripacifica,* new species.

Relationship.—This genus is probably the basic American genus of phoxocephalid in the birubiin-parharpiniin group (therefore not harpiniin, not phoxocephalin) which remains extant and may be slightly more primitive than *Birubius,* the diverse and basic Australian genus. Like *Parharpinia, Metharpinia* has supernumerary dorsal armaments on the telson but differs from *Parharpinia* and *Protophoxus* in the untapering article 2 of pereopod 5. Like *Birubius, Metharpinia* has the untapered article 2 of pereopod 5 but differs in the presence of supernumerary telsonic setation.

The wide span of ventral setae on coxa 1 might be a good generic character for this genus and *Microphoxus* but one species of *Metharpinia* (*jonesi*) unfortunately does not conform.

KEY TO THE SPECIES OF *METHARPINIA*

1. Ventral setae on coxa 1 narrowly spread, epimeron 3 with large tooth . . . . *jonesi*
– Ventral setae on coxa 1 widely spread, tooth on epimeron 3 small or absent 2
2. Only outer ramus of uropod 2 with accessory apical nail, epimeron 2 with slight posteroventral tooth, ventral setae on epimeron 1 arranged in disjunct groups . . . . *longirostris*
– All rami of uropods 1–2 with accessory apical nails, epimeron 2 smoothly rounded posteroventrally, epimeron 1 continuously setose ventrally **3**
3. Peduncle of uropod 1 with 7+ lateral spines in adults, inner ramus of uropod 2 with marginal spine, epimeron 3 with only 2–3 ventral setae . . . . *coronadoi*
– Peduncle of uropod 1 with one lateral spine in adults, inner ramus

of uropod 2 without marginal spines, epimeron 3 with 4+ ventral setae in adults 4
4. Inner plate of maxilliped with 1 stout apical spine .... *floridana*
– Inner plate of maxilliped with 2 stout apical spines .... *oripacifica*

Metharpinia longirostris Schellenberg
Figs. 4, 5 upper

Metharpinia longirostris.—Schellenberg, 1931:65–67, fig. 34; 1935:232.
Paraphoxus longirostris.—J. L. Barnard, 1960:273, pl. 43.

Description of female "*x*."—Head about 20% of total body length, greatest width about 75% of length, rostrum constricted, narrow, elongate, slightly exceeding apex of article 1 on antenna 1. Rostrum very long and thin but antenna 1 also large. Eyes[dispersed and damaged].

Article 1 of peduncle on antenna 1 about 1.4 times as long as wide, about 1.8 times as wide as article 2, ventral margin with about 9 setules, unproduced dorsal apex with 2 setules-setae, article 2 about 0.83 times as long as article 1, with ventral crescent of 7 setae, primary flagellum with 8 articles, about 0.55 times as long as peduncle, bearing 1 short aesthetasc each on articles 4–7, accessory flagellum with ?6 (broken) articles. Spine formula of article 4 on antenna 2 = 1-3-8-4, dorsal margin without notch but bearing medially 4 setae and 1 spine, ventral margin with 7 groups of 1–4 long to medium setae, 1 ventrodistal long spine, article 5 about 0.73 times as long as article 4, facial spine formula = 3, dorsal margin naked, bearing 2 small setae, ventral margin with 5 sets of 1–2 long to medium setae, 3 ventrodistal long to medium spines set subfacially, flagellum about 0.85 times as long as articles 4–5 of peduncle combined, with 9 articles.

Mandibles with weak palpar hump, right incisor with 3 very weak teeth, left incisor with 3–4 humps in 2 branches, proximal hump forming callus, right lacinia mobilis flabellate, bifid, distal branch little shorter than proximal, both branches broad and short, left lacinia mobilis with 5 teeth, two of these weakly bifid, right and left rakers 8 plus 1 rudimentary, molars composed of bulbous plaques, each molar with 4 primarily stout spines, plus one thin spine strongly disjunct, molar without plume, palp article 1 short, article 2 with 1 short inner apical seta and 2 other short inner setae, article 3 about 1.2 times as long as article 2, oblique apex with 8–9 spine-setae, basofacial formula = 1-1 offset or 0-1. Inner plate of maxilla 1 large, broad, bearing one medium apical pluseta, one long apicomedial seta, 2 short apicolateral setae, palp article 2 with 1 apical spine, 1 apicolateral, 2 medial and 3 submarginal setae; inner plate of maxilla 2 shorter than outer, outer much broader than inner, outer with 3 apicolateral setae, inner with 2 medial setae; inner plate of maxilliped with 1 large thick apical spine, 3

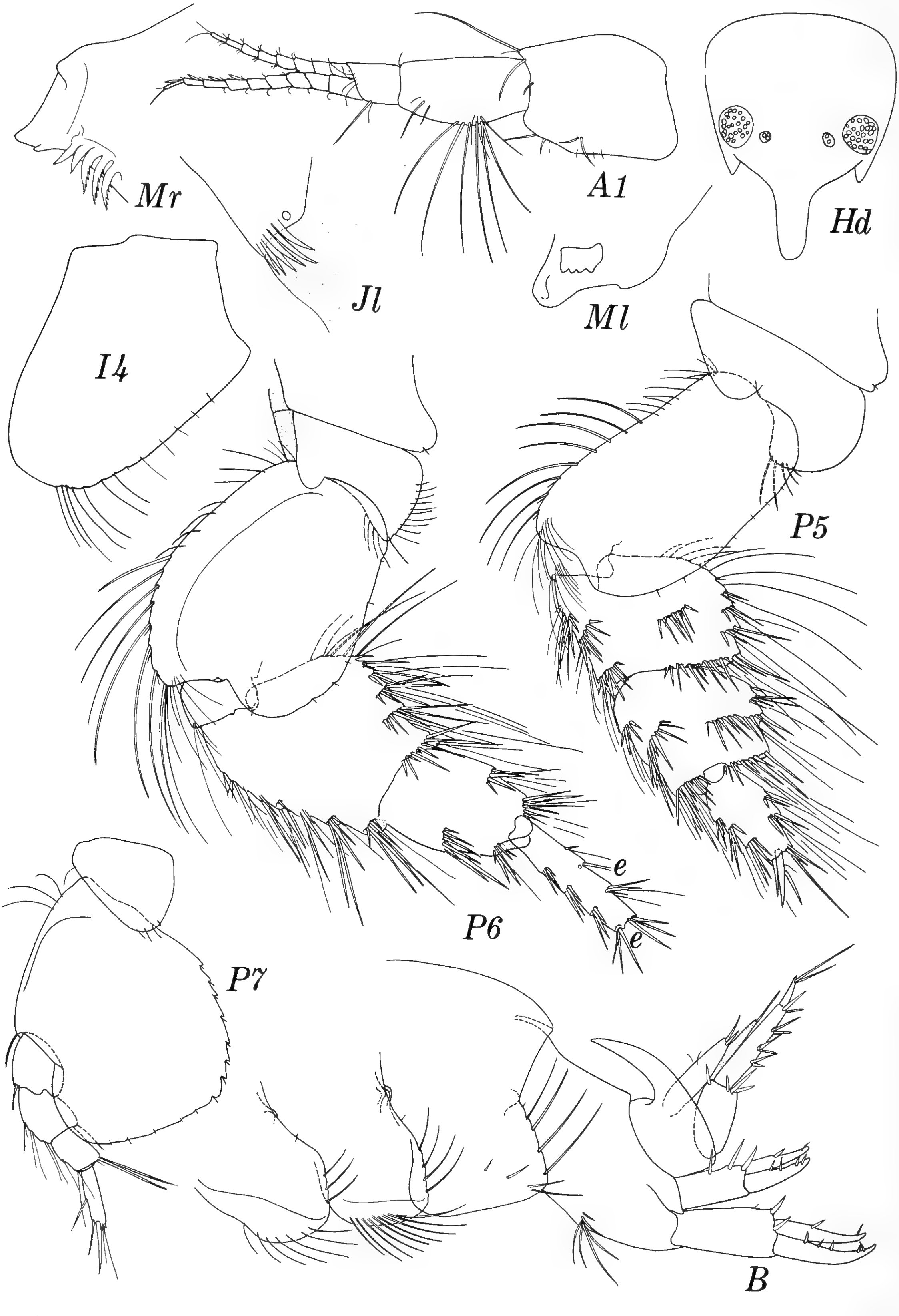

Fig. 4. *Metharpinia longirostris,* female "x" 5.15 mm.

apicofacial setae, 6 medial setae, outer plate with 7 medial spines, no apicolateral setae, palp articles 1–2 with lateral setae, medial margin of article 2 moderately setose, article 3 with 6 strewn facial setae, 1 lateral seta, nail of article 4 short, almost fully immersed and fused, with 3 accessory setules.

Coxa 1 moderately expanded apically, anterior margin almost straight, main ventral setae of coxae 1–4 = 14-6-6-3 (and 6 posterior setae on coxa 4), posteriormost seta of coxae 1–3 shortest, setae of coxa 1 widely spread but sparser than in related species, coxa 1 with weak posteroventral extension as in *Microphoxus minimus,* anterior and posterior margins of coxa 4 divergent, posterior margin oblique, convex, posterodorsal corner rounded, posterodorsal margin short, concave, width-length ratio of coxa 4 = 4:5. Gnathopods generally ordinary but wrists very elongate, width ratios on articles 5–6 of gnathopods 1–2 = 22:26 and 22:26, length ratios = 65:42 and 62:38, palmar humps ordinary, palms almost transverse, article 5 of gnathopod 1 elongate, ovate, posterior margin rounded-flat, long, article 5 of gnathopod 2 elongate, ovate, posterior margin rounded-flat. Pereopod 4 slightly stouter than pereopod 3 especially on article 5, facial setae formula on article 4 = 6 and 5 almost parallel to apex, on article 5 = 6 and 5, main spine of article 5 extending to M. 85-70 on article 6, article 5 with 2 and 1 proximoposterior spines, but proximal edge naked for long distance, spine formula of article 6 = 5 + 6 and 5 + 7 plus large middistal spine, some spines especially long, acclivity on inner margin of dactyls of pereopods 3–4 sharp, produced as tooth, emergent setule short, midfacial pluseta ordinary. Articles 4–5 of pereopods 5–6 broad, facial spine rows dense to sparse, facial ridge formulas of article 2 on pereopods 5–7 = 0-1-1, width ratios of articles 2, 4, 5, 6 of pereopod 5 = 54:55:42:20, of pereopod 6 = 87:59:36:13, of pereopod 7 = 83:22:18:10, length ratios of pereopod 5 = 93:50:49:40, of pereopod 6 = 100:65:60:65, of pereopod 7 = 100:25:31:33, article 2 of pereopod 5 almost reaching apex of article 4, posterior margin with 8 small serrations, medial apex of article 6 very finely combed, bearing 7–8 digital processes.

Posteroventral corner of epimeron 1 rounded, posterior margin straight below, then weakly convex, serrate, setose (4), corner without setule, anteroventral corner subquadrate, anterior face and margin with 5 long medium setae, posteroventral face with 2 long setae set horizontally above margin; posteroventral corner of epimeron 2 rounded, posterior margin straight below, weakly convex above, serrate, setose (7), facial setae = 6; posteroventral corner of epimeron 3 rounded-quadrate, posterior margin weakly convex, serrate, setose (5), these setae widely spread on dorsal ⅔ of margin, ventral margin with 2–3 setae near posterior margin; epimera 1–3 with small setule on posterodorsal margin set in weak notch.

Rami of uropods 1–2 without apical nails, outer rami of uropod 1 with one internal vestige or socket of accessory nail, outer rami of uropod 2 with one

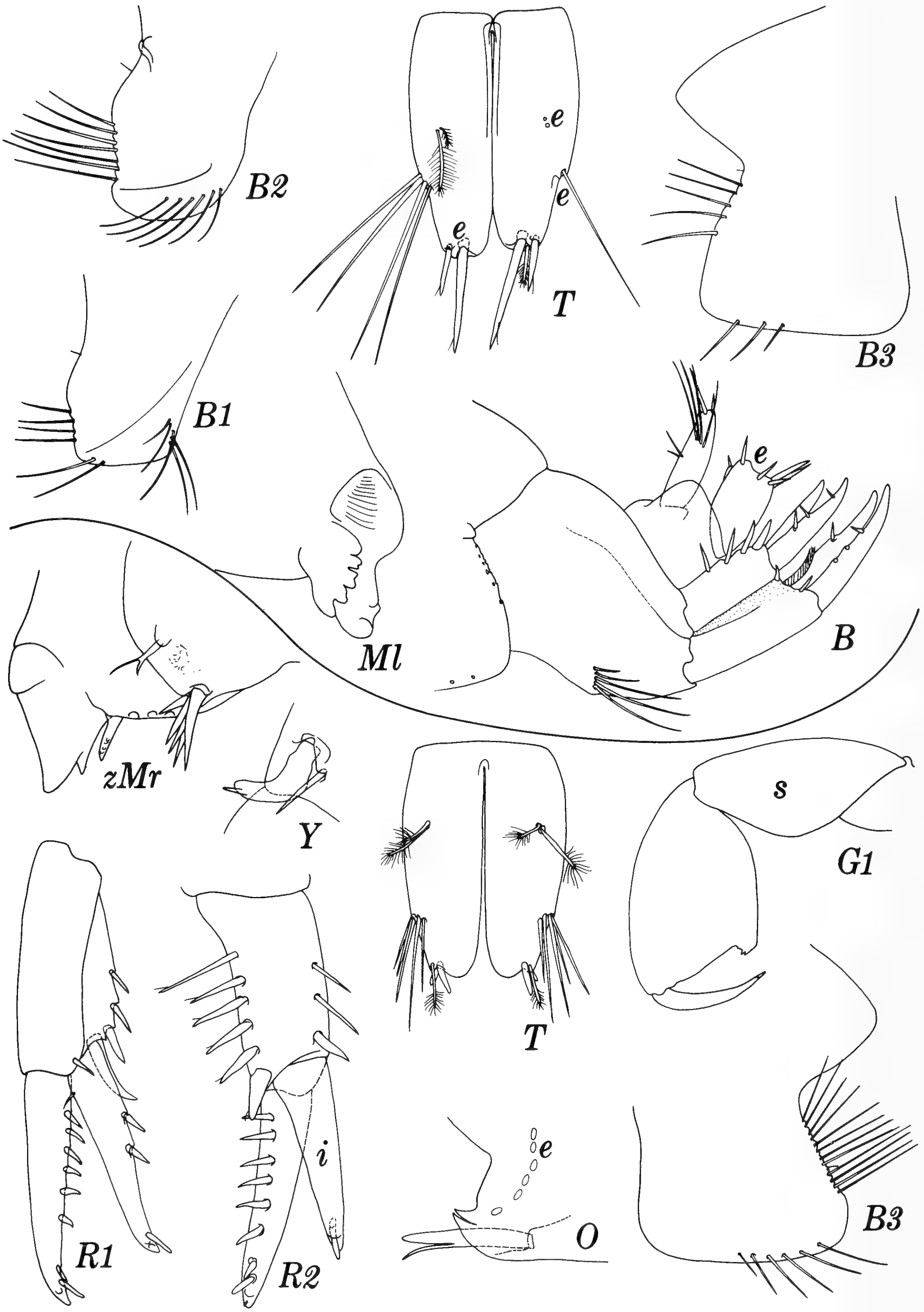

Fig. 5. Upper, *Metharpinia longirostris,* female "x" 5.15 mm. Lower, *Metharpinia floridana,* female "r" 6.93 mm; z = female "z" 6.45 mm.

subapical accessory nail-spine, outer ramus of uropod 1 with 3 dorsal spines, inner with 1, outer ramus of uropod 2 with 2 dorsal spines, inner with no dorsomedial spines, inner ramus of uropod 2 shortened by invagination into peduncle, peduncle of uropod 1 with no basofacial setae and 1 small apicolateral spine, medially with 1 small apical spine and 1 enlarged displaced apical spine, peduncle of uropod 2 with 4 dorsal spines, apicalmost thick, medially with 1 medium apical spine (same size as penultimate lateral spine), apicolateral corners of peduncles on uropods 1–2 without comb. Peduncle of uropod 3 with 4 ventral spines, dorsally with 1 lateral spine, 1 medial spine and 1 setule, rami missing. Telson thick and fleshy, especially long, length-width ratio = 37:26, fully cleft, each apex of medium width, subtruncate, acclivity absent, with short lateral and long medial spines separated by short setule, each side with brush of 4 long setae, midlateral setules diverse, larger of large size. Urosomite 1 with ventral brush of setae, articulation line incomplete but long, urosomite 3 scarcely protuberant dorsally.

Remarks.—Female "x" in 3 pieces in poor condition, body soft, rami of uropod 3 missing; epistome and upper lip destroyed; lower lip lacking cones but edematous and cones possibly destroyed; palp of maxilla 1 definitely 2-articulate and outer plate with 11 spines.

Material.—Female "x," 5.15 mm (in 3 pieces), Valparaiso, [Chile], Swedish State Museum No. 3642.

Relationship.—The single specimen examined differs from Schellenberg's original description mainly in the poor nail on the maxillipedal dactyl; I have not seen the holotype or other material and must leave open the possibility that this specimen is abnormal. This species differs from both species of *Microphoxus* in: (1) right lacinia mobilis broad, flabellate, poorly bifid; (2) presence of disjunct spine on mandibular molar; (3) short and immersed nail on maxillipedal dactyls; (4) dactyls of pereopods 3–4 with sharp tooth and normally medial setule; (5) pereopods 3–4 with 1–2 posteroproximal spines on article 5; (6) normal articles 3–6 of pereopod 7 (in *minimus* and *cornutus* articles 4–6 are reduced in size relative to article 3 so that article 3 appears enlarged); (7) presence of more digital processes on article 6 of pereopod 7 and sparsity of apical combs; (8) uropod 1 with displaced spine on peduncle; (9) lack of tooth on urosomite 3.

Distribution.—South America, Valparaiso to vicinity of La Plata River, 9–13 m.

Metharpinia jonesi (J. L. Barnard), new combination
Fig. 1 upper

Paraphoxus jonesi J. L. Barnard, 1963:463–464, fig. 7; 1969:197.

Description of female "x."—Head about 20% of total body length, greatest width about 65% of length, rostrum constricted, narrow, elongate, spatulate, reaching middle of article 2 on antenna 1. Eyes medium to large, largely occluded with pigment, ommatidia ordinary. Article 1 of peduncle on antenna 1 about 1.6 times as long as wide, about 1.8 times as wide as article 2, ventral margin with about 9 setules, weakly produced dorsal apex with 2 setules-setae, article 2 about 0.8 times as long as article 1, with ventral crescent of 10 setae and 3 apicolateral setae, primary flagellum with 9 articles, about 0.63 times as long as peduncle, bearing 1 short aesthetasc each on articles 4–8, accessory flagellum with 8 articles. Spine formula of article 4 on antenna 2 = 1-3-7-5, dorsal margin without notch but bearing 1 seta and 1 spine widely disjunct, ventral margin with 6 groups of 1–5 long to short setae, 1 ventrodistal long spine, article 5 about 0.8 times as long as article 4, facial spine formula = 3, dorsal margin bearing 2 sets of small setae, ventral margin with 5 sets of 1–4 long to short setae, 1 ventrodistal long seta, 3 subdistal long to medium facial spines, flagellum as long as articles 4–5 of peduncle combined, with 11 articles.

Mandibles with medium palpar hump, right incisor broad, with 3 teeth, left incisor with 3 apical teeth, lateral callus and irregular toothing (illustrated), right lacinia mobilis bifid, distal branch little shorter than proximal, broad, proximal branch simple, pointed, with marginal denticles, left lacinia mobilis with 4 teeth plus 1 accessory tooth, teeth coalesced (illustrated), right rakers 9 plus 1 rudimentary, left rakers 12 plus 1 rudimentary, molars composed of elongate plaques, granulate, right molar with 7 primarily long spines, plus 1 flagellate spine strongly disjunct, left molar with 6 primarily long spines, plus 1 flagellate spine strongly disjunct, no molar with plume, palp article 1 short, naked, article 2 with 1 short inner apical seta and 5 other long and short inner setae, article 3 about 1.25 times as long as article 2, oblique apex with 10 spine-setae, basofacial formula = 0-3. Lower lip with 1 cone on each inner lobe. Inner plate of maxilla 1 ordinary, bearing 1 medium apical pluseta, 1 similar apicomedial seta, 2 apicolateral much shorter setae, palp article 2 with 1 apical spine, 1 apicolateral and 3–4 apicomedial setae, 4–5 submarginal setae; plates of maxilla 2 extending subequally, outer broader than inner, outer with 3 apicolateral setae, inner with 3 medial setae; inner plate of maxilliped with 2 large thick apical spines, 3 apicofacial setae, 6 medial setae, outer plate with 8 medial spines, no apicolateral setae, weak apical cusp, palp article 1 with 2 lateral setae, article 2 with 4 groups of 4 lateral setae, medial margin of article 2 strongly setose, article 3 with 6–8 facial setae in row, 2 lateral setae, nail of article 4 short, almost fully fused, with 2 accessory setules.

Coxa 1 scarcely expanded apically, anterior margin straight, main ventral setae of coxae 1–4 = 13-10-10-9, all but 1–3 very short, posteriormost seta of coxae 1–3 shortest or short, posteriormost seta of coxae 1 and 3 situated on posterior margin, setae of coxa 1 not widely spread, anterior and posterior margins of coxa 4 weakly divergent, posterior margin almost straight, posterodorsal corner sharp-rounded, posterodorsal margin short, weakly concave, width-length ratio of coxa 4 = 8:9. Gnathopods generally ordinary but hands stout, width ratios on articles 5–6 of gnathopods 1–2 = 24:29 and 24:29, length ratios = 65:40 and 57:35, palmar humps ordinary, ornamented (hooked but not slit as in *floridana*), palms weakly oblique, article 5 of gnathopod 1 elongate, ovate, posterior margin rounded, long, article 5 of gnathopod 2 elongate, ovate, posterior margin rounded, short, almost lobate.

Pereopod 4 stouter and longer than pereopod 3 especially on articles 4–5, posterior margin of article 4 more strongly setose on pereopod 4, facial setae formula on article 4 = 7 and 8 almost parallel to apex, on article 5 = 7 and 5, main spine of article 5 extending to M. 75 on article 6, article 5 with 2 or 1 (small) proximoposterior spines, spine formula of article 6 = 6 + 7 and 6 + 7 plus elongate middistal spine, some spines especially long, acclivity on inner margin of dactyls of pereopods 3–4 sharp, produced as tooth, emergent setule short, midfacial pluseta ordinary, somewhat proximad. Coxae 5–7 posteroventral setule-seta formula = 17-26-14, mostly short. Articles 4–5 of pereopods 5–6 of ordinary width, to broad, facial spine rows dense, facial ridge formulas of article 2 on pereopods 5–7 = 0-1-1, width ratios of articles 2, 4, 5, 6 of pereopod 5 = 55:55:40:15, of pereopod 6 = 77:58:31:13, of pereopod 7 = 80:17:14:8, length ratios of pereopod 5 = 87:61:52:42, of pereopod 6 = 90:65:58:70, of pereopod 7 = 101:20:20:30, article 2 of pereopod 7 reaching apex of article 4, posterior margin with 12 medium serrations, only lateral apex of article 6 scarcely combed, bearing 8 large digital processes. Article 2 of pereopod 5 with weak anterodistal hump.

Posteroventral corner of epimeron 1 with very small tooth, posterior margin weakly convex, serrate, setose (8), corner without setule, ventral margin with 14 long to short setae; posteroventral corner of epimeron 2 with small sharp tooth not guarded by setule sinus, posterior margin weakly convex, serrate, setose (11), ventral facial setae = 11, one middle pair set vertically, upper face with 5 tiny setae in widely spread row; posteroventral corner of epimeron 3 with large tooth, posterior margin straight, serrate, setose (8) with 1 setule notch, ventral margin with 4 setae all posterior but evenly spread, face with 1 tiny seta.

Rami of uropods 1–2 lacking apical nails, outer and inner rami of uropods 1–2 with 1 and 2 accessory nails respectively, outer ramus of uropod 1 with 4 small dorsal spines, inner with 1 larger spine, outer ramus of uropod 2 with 4 larger dorsal spines, inner without spines, peduncle of uropod 1 without basofacial setae, with 1 small apicolateral spine, medially with 3 marginal spines, apicalmost enlarged, proximalmost small, plus 1 large displaced spine, peduncle of uropod 2 with 5 dorsal spines, apicad thick, proximad thin, short, medially with 1 medium apical spine, apicolateral corners of peduncles on uropods 1–2 without comb. Peduncle of uropod 3 with 6 ventral spines, dorsally with 2 lateral spines, 1 medial spine, 1 setule, 1 seta, rami submasculine, inner extending to M. 100 on article 1 of outer ramus, apex with 2 setae, medial margin setose, lateral margin with 2 setae, article 2 of outer ramus elongate, 0.42, bearing 2 short to medium setae, medial margin of article 1 setose, lateral margin with 2 acclivities, spine formula = 3-3-3, setal formula = 0. Telson especially long, length-width ratio = 5:3, almost fully cleft, each apex of medium width to narrow, almost truncate, medial apex slightly protuberant, apex weakly concave, bearing ordinary lateral setule, spine next medial of length equal to setule, next spine elongate, next short (3 spines total), or 2 spines only, 1 long, 1 short, midlateral setules diverse, larger of medium size, with subapical brush of 7–8 setae. Urosomite 1 with 2 tiny lateral setae near base of segment, plus spray of ventral setae emerging onto lateral surface, with articulation line almost absent, urosomite 3 unprotuberant dorsally.

Male "y."—Rostrum narrower than in female. Article 1 of antenna 1 with 16 ventral setules, article 2 with 9 ventral setae, primary flagellum with 10 articles, 1 calceolus each on articles 1–5, aesthetascs absent, accessory flagellum with 8 articles. Facial spine formula of article 4 on antenna 2 = 3-7-4, medial face fuzzy, with group of 1 spine and 2 setae in dorsomedial position (not set truly dorsally), article 5 with 5 dorsal sets of male setae and 1 calceolus, ventrodistal apex with 2 thin spines and 1 setule, flagellar formula of calceoli = 1, 2, 4, 6 . . . n. Right lacinia mobilis broader than in female, basofacial setal formula of article 3 on mandibular palp = 0-3; dactyl of maxilliped with distinct short nail. Coxa 4 not broadened. Pereopods 3–4 more slender than in female; article 2 of only pereopod 7 narrower than in female; apex of article 6 uncombed. Epimera 1–3 scarcely broadened, posterior margin of epimeron 3 not shortened, setae shortened, setal formulas similar to female but posterior setae of epimeron 3 more crowded together towards ventral margin, 6 in number. Uropods 1–2 generally like female; uropod 3 like female but more strongly setose, apical setae on article 2 of outer ramus very short. Telson elongate, only lateralmost distal spine more shortened than in female, denticle rows in single file.

Material.—Female "x" 4.38 mm and male "y" 4.04 mm, southern California, 33°36′54″N, 117°56′48″W, 10.4 m, 16 December 1957, [sea bottom not stated].

Distribution.—Southern California, 0–18 m, sand bottom.

Metharpinia floridana (Shoemaker), new combination

Fig. 5 lower

Pontharpinia floridana Shoemaker, 1933:5–8, figs. 3, 4; 1948:2.
Paraphoxus floridanus. J. L. Barnard, 1960:226–230, pl. 21.

Description of female "r."—Head about 23% of total body length, greatest width about 63% of length, rostrum constricted, spatulate, broad to narrow, elongate, almost reaching apex of article 2 on antenna 1. Eyes medium, stained with pigment, ommatidia ordinary to small. Article 1 of peduncle on antenna 1 about 1.5 times as long as wide, about 2.2 times as wide as article 2, ventral margin with about 13 setules, weakly produced dorsal apex with 2 setules-setae, article 2 about 0.6 times as long as article 1, with ventral, tightly constrained crescent of 8 setae, and 3 lateral setae near apex, primary flagellum with 14 articles, about 0.8 times as long as peduncle, lacking aesthetascs; accessory flagellum with 13 articles. Spine formula of article 4 on antenna 2 = (1-3)-5-4, dorsal margin with notch bearing 2 setae and 1 spine, ventral margin with 5 groups of 4 long to short setae, 1 ventrodistal long spine, article 5 about 0.8 times as long as article 4, facial spine formula = 4, dorsal margin bearing 2 small apical setae, ventral margin with 5 sets of 1–3 long to medium setae, 3 ventrodistal long to medium spines or setae, 1 of these set facially; flagellum almost 1.4 times as long as articles 4–5 of peduncle combined, with 17 articles. Epistome and upper lip forming obtuse triangle from lateral view.

Mandibles with weak palpar hump, right incisor with 3 teeth, left incisor with 3 humps in 2 branches, right lacinia mobilis bifid, distal branch much shorter than proximal, distal branch narrow, simple, proximal branch pointed, with marginal denticles, left lacinia mobilis with 5 teeth, middle teeth scarcely shortened, right rakers 9, left rakers 11, molars composed of bulbous humps, very weakly granulated, on plaque, right molar with 7 primarily long spines plus 1 short bifid (dendritic) spine strongly disjunct, left molar with 6 primarily long spines, plus 1 long spine strongly disjunct, no molar with plume, palp article 1 short, article 2 with 1 long, 1 short inner apical setae and 5–6 other long and short inner setae, and 1 outer seta, article 1 also with 1–2 outer setae, article 3 about 1.1 times as long as article 2, oblique apex with 11–12 spine-setae, basofacial formula = 0-2. Each lobe of lower lip with 1 cone. Inner plate of maxilla 1 ordinary, bearing 1 medium apical pluseta, 1 similar apicomedial seta, 2 apicolateral much shorter setae, palp article 2 with 1 apical spine, 1 apicolateral seta, 2 apicomedial setae, and 3 submarginal setae, plates of maxilla 2 extending subequally, outer scarcely broader than inner, outer with 4 apicolateral setae, inner with 3 medial setae; inner plate of maxilliped very broad, with 1 large thick apical spine, 2 apicofacial setae, 4 medial setae, outer plate with 6 medial spines and 1–2 medial setae, no apicolateral setae or cusp, palp article 1 with 2 lateral setae, article 2 with 6 groups of 7 lateral setae, medial margin of article 2 strongly setose, article 3 with 10 slightly strewn facial setae, 1 lateral seta, nail of article 4 barely distinct or fully fused, with 2 accessory setules.

Coxa 1 scarcely expanded apically, anterior margin straight, main ventral setae of coxae 1–4 = 21-15-11-10 (in 3 groups), widely spread, posteriormost seta of coxae 1–3 strongly shortened, anterior and posterior margins of coxa 4 scarcely divergent, posterior margin convex, posterodorsal corner sharp-rounded, posterodorsal margin short, concave, or weakly undulate, width-length ratio of coxa 4 = 1:1. Gnathopods generally ordinary, width ratios on articles 5–6 of gnathopods 1–2 = 28:38 and 29:37, length ratios = 65:63 and 60:58, palmar humps large, ornamented, palms oblique, article 5 of gnathopod 1 elongate, ovate, posterior margin rounded, short, article 5 of gnathopod 2 elongate, ovate, posterior margin rounded, short, almost produced.

Pereopods 3–4 similar, facial setae formula on article 4 = 7 and 7, almost parallel to apex, on article 5 = 7 and 6, main spine of articles extending to M.85+ on article 6, article 5 with 3 and 3 proximoposterior spines, spine formula of article 6 = 7 + 7 and 7 + 8 plus middistal spine, some spines especially long, acclivity on inner margin of dactyls of pereopods 3–4 weak, sharp, produced as tooth, emergent setule short, midfacial pluseta short, position ordinary. Coxae 5–7 posteroventral seta formula = 12-17-7. Articles 4–5 of pereopods 5–6 of ordinary width, facial spine rows sparse to moderately developed, facial ridge formulas of article 2 on pereopods 5–7 = 0-1-1, width ratios of articles 2, 4, 5, 6 of pereopod 5 = 52:54:44:20, of pereopod 6 = 83:56:33:14, of pereopod 7 = 85:19:15:8, length ratios of pereopod 5 = 95:53:45:46, of pereopod 6 = 100:63:57:75, of pereopod 7 = 102:22:23:30, article 2 of pereopod 5 almost reaching apex of article 4, posterior margin with 7 small teeth and 1 short ventroposterior seta, anteromedial and lateral apex of article 6 and medial apex of article 5 coarsely combed, also bearing 9 large smooth digital processes on pereopod 7.

Posteroventral corner of epimeron 1 rounded-subquadrate, posterior margin weakly convex and serrate, setose (7), corner without setule, anterior and ventral margins with 15–17 short to medium setae; posteroventral corner of epimeron 2 rounded-subquadrate, posterior margin weakly convex, serrate, setose (9), setae starting well above ventral margin, facial setae = 12 in straight row; posteroventral corner of epimeron 3 narrowly rounded, weakly protuberant, posterior margin almost straight below, excavate above, serrate, setose (12) in dorsal two thirds only, 1 setule notch, ventral margin with 6 setae all in posterior half but evenly spread, face naked.

Rami of uropods 1–2 with fused, immersed, obsolescent apical nails, outer rami of uropods 1–2 with 2 accessory nails, inner rami with 1, outer ramus of uropod 1 with 6 dorsal spines, inner with 2 large, outer ramus of uropod 2 with 6 dorsal spines, inner with none, peduncle of uropod 1 with no basofacial setae and 1 small apicolateral spine, medially with 3 marginal spines, apicalmost enlarged, plus 1 huge displaced spine, peduncle of uropod 2 with 6 dorsal spines, distalmost thick, proximalmost thin and slightly elongate, medially with large apical spine and 3 thin marginal spines, apicolateral corners of peduncles on uropods 1–2 with comb very weak or absent. Peduncle of uropod 3 with 5 ventral spines, dorsally with 1 lateral spine, 1 hooked medial spine and 1 setule, rami submasculine, inner extending to M. 95 on article 1 of outer ramus, apex with 2 setae, medial margin setose, article 2 of outer ramus elongate, 0.40, bearing 2 medium setae, medial margin of article 1 setose, lateral margin with 2 acclivities, spine formula = 3-3-3, setal formula = 0. Telson especially long, length-width ratio = 3:2, almost fully cleft, each apex of medium width, rounded, lateral acclivity weak, bearing ordinary lateral setule, spine next medial shorter than setule, next spine intermediate, lateral margins each with subapical brush of 5 setae, midlateral setules diverse, larger large. Urosomite 1 with 1 midlateral seta, ventral setal bundle riding upward along ventral face, articulation line short, almost absent, urosomite 3 unprotuberant dorsally.

Male "*q.*"—Rostrum slightly narrower than in female; article 1 of antenna 1 with 18 ventral setules, article 2 with 6 ventral setae, primary flagellum with 14 articles, 1 calceolus each on articles 1–7, aesthetascs absent, accessory flagellum with 12 articles. Facial spine formula on article 4 of antenna 2 = 3-4-4, article 5 = 3, also with 3 dorsal sets of male setae and 1 calceolus, ventrodistal apex with 2 thin spines and one setule, calceolus formula on elongate flagellum = 2, 3, 5, 7 . . . n or 1, 2, 3, 4, 6, 8 . . . n. Basofacial setal formula of article 3 on mandibular palp = 0-2. Coxa 4 not broadened. Article 2 of only pereopod 7 narrower than in female. Epimera 2–3 broadened, posterior margin of epimeron 3 not shortened; setal formulas, epimeron 1 ventral = 18, posterior = 4, epimeron 2 facial = 12, posterior = 9, epimeron 3 posterior = 12, facial = 0, ventral = 5. Urosomite 1 with 2 small facial setae. Spine formulas of uropods: uropod 1 peduncle apicolateral = 1, basofacial = 0, uropod 2 peduncle dorsal = 8, basalmost not elongate, dorsal spines on outer ramus of uropod 1 = 4, of uropod 2 = 4, inner ramus of uropod 1 = 2, of uropod 2 = 0, ventral spines on peduncle of uropod 3 = 6, apicomedial corner with spine and 3 setae, spine formula on article 1 of outer ramus = 3-3-4, setal formula = 0. Telson elongate, distal spines scarcely shortened, occasionally 1 lobe with 3 spines, inner short; each denticle stripe composed of aligned or zigzag pairs of denticles.

Female "*z.*"—Right lacinia mobilis simple, perhaps divided so deeply that distal member assuming appearance of raker spine; on antenna 1 last three articles on flagellum before ultimate article each with aesthetasc; 1 telsonic apex with large penicillate setule and 3 spines (situated ventrally); article 2 of mandibular palp with 3 outer setae.

Remarks.—Original description based on male, that male showing only 3 setae in telsonic brush and only one midlateral setule (latter depiction probably erroneous); that male also with posterior edge of epimeron 2 bearing 6 setae, ventral margin of epimeron 3 with 6 setae, posterior margin with 11; coxa 4 with 13 setae; basofacial formula on article 3 of mandibular palp = 0-3. Epimeron 3 of *floridana* similar to figure herein of *coronadoi* thus posterior setae reaching almost to corner in male but not in female.

Large specimens with posteroventral corner of epimeron 3 very broadly rounded and outer ramus of uropod 2 with 6 dorsal spines and almost continuously spinose to meet 2 apical nails.

Material.—Holotype as cited by Shoemaker (1933) reexamined for comments noted in Remarks; Female "r," 6.93 mm and male "q" 6.09 mm, 16 miles off Sapelo Island, Georgia, U.S.A., townet, Fish Hawk Station 8259, 3 May 1915; female "z" 6.45 mm, Beaufort, North Carolina, 31 July 1941, coll. A. S. Pearse; 1 specimen north of Loggerhead Key, Florida, 22 June 1925, 15–20 feet, rock dredge over eel grass; 1 specimen, Tortugas Islands, Florida, 9 June 1925, Fish. 249.

Distribution.—South Carolina to Cuba, 0–3 m.

Metharpinia oripacifica, new species
Fig. 3 lower

Paraphoxus floridanus.—J. L. Barnard, 1960:226–230, pl. 21 (not Shoemaker, 1933).

Description of holotype female "h."—Head about 21% of total body length, greatest width about 67% of length, rostrum constricted, broad, elongate, not reaching middle of article 2 on antenna 1. Eyes medium, clear of pigment (very old), ommatidia ordinary. Article 1 of peduncle on antenna 1 almost 1.7 times as long as wide, about 2.2 times as wide as article 2, ventral margin with about 6 setules, weakly produced dorsal apex with 2 setules, article 2 almost 0.7 times as long as article 1, with tight ventral crescent of 6–7 setae, primary flagellum with 11 articles, about 0.6 times as long as peduncle, bearing short aesthetascs, accessory flagellum with 9 articles. Spine formula of article 4 on antenna 2 = 1-3-5-5, dorsal margin with notch bearing 5 setae and 1 spine, ventral margin with 7 groups of 2–8 long to short setae, 1 ventrodistal medium spine, article 5 about 0.9 times as long as article 4, facial spine formula = 4, dorsal margin bearing 2 sets of short setae, ventral margin with 6 sets of 1–3 medium to long setae, 3 ventrodistal, long to medium spines set slightly facially, flagellum about 0.95 times as long as articles 4–5 of peduncle combined, with 13 articles. Epistome and upper lip forming obtuse triangle from lateral view.

Mandibles with weak palpar hump, right incisor with 3 teeth, left incisor with 4 teeth in 2 humps, right lacinia mobilis bifid, distal branch much shorter than proximal, narrow, sharp, proximal branch pointed, with marginal denticles, left lacinia mobilis with 5 teeth, middle teeth scarcely shortened, right rakers 11 plus 2 rudimentaries, left rakers 13, molars composed of elongate plaques, each with 6 primarily short to medium spines plus one short spine strongly disjunct, molars without plume, palp article 1 short, article 2 with 1 short inner apical seta and 7 other long and short inner setae, article 3 about 1.2 times as long as article 2, oblique apex with 11 spine-setae, basofacial formula = 0-2. Inner plate of maxilla 1 ordinary, bearing 1 long apical pluseta, 1 similar apicomedial seta, 3 apicolateral much shorter setae, palp article 2 with 1 apical spine, 1 apicolateral seta, 1 medial spine, 2 medial setae, and 4 submarginal setae; plates of maxilla 2 extending subequally, outer slightly broader than inner, outer with 3 apicolateral setae, inner with 5 medial setae; inner plate of maxilliped with 2 long thick apical spines, 2 apicofacial setae, 4 medial setae, outer plate with 6 medial spines, 2–3 medial setae, palp article 1 with 2 apicolateral setae, article 2 with 10 lateral setae, medial margin of article 2 moderately setose, article 3 with 5 facial setae, group of 3 lateral setae, nail of article 4 short, with 2 accessory setules.

Coxa 1 scarcely expanded apically, anterior margin convex, main ventral setae of coxae 1–4 = 20-13-?-18, posteriormost seta of coxae 1–3 shortest, anterior and posterior margins of coxa 4 almost parallel, posterior margin almost straight, posterodorsal corner sharp, posterodorsal margin short, concave, width-length ratio of coxa 4 = 1:1. Gnathopods generally ordinary, width ratios on articles 5–6 of gnathopods 1–2 = 27:32 and 25:32, length ratios = 65:61 and 63:57, palmar humps ordinary, palms weakly oblique, article 5 of gnathopods 1–2 elongate, ovate, posterior margin rounded.

Pereopods 3–4 similar; on pereopod 4 only facial setae formula on article 4 = 8, on article 5 = 7, main spine of article 5 extending to M. 100 on article 6, article 5 with no proximoposterior spines, spine formula of article 6 = 6 + 8 plus middistal spine, some spines especially long, acclivity on inner margin of dactyls of pereopods 3–4 sharp, produced as tooth, emergent setule short, midfacial pluseta short. Coxae 5–7 posteroventral seta formula = 14:23:10. Articles 4–5 of pereopods 5–6 broad, facial spine rows dense, facial ridge formulas of article 2 on pereopods 5–7 = 0-1-1, width ratios of articles 2, 4, 5, 6 of pereopod 5 = 52:51:40:19, of pereopod 6 = 79:50:29:12, of pereopod 7 = 83:15:13:8, length ratios of pereopod 5 = 89:40:49:39, of pereopod 6 = 103:56:50:62, of pereopod 7 = 105:20:19:32, article 2 of pereopod 7 reaching middle of article 4, with 8 small posterior serrations, medial apex of article 6 finely combed.

Posteroventral corner of epimeron 1 rounded, posterior margin straight, weakly serrate, setose (8), corner without setule, anteroventral margin and face with many long to medium setae, posteroventral margin with 5 long setae; posteroventral corner of epimeron 2 rounded, posterior margin straight, weakly serrate, setose (10), facial setae = 10 in row, none in pairs, posteroventral corner of epimeron 3 rounded, posterior margin straight, weakly serrate, setose (16), with 1–2 setule notches, ventral margin with 7 setae mainly posterior but widely spread.

Rami of uropods 1–2 without articulate or fused apical nails, outer and inner rami of uropods 1–2 with one and two accessory nails respectively, outer ramus of uropod 1 with 5 dorsal spines, inner with 2, outer ramus of uropod 2 with 5 dorsal spines, inner with no dorsomedial spines, peduncle of uropod 1 with no basofacial setae and 1 apicolateral spine, medially with 4 marginal setae and spines, and large displaced spine, apicalmost of marginals an ordinary spine, peduncle of uropod 2 with 7 dorsal spines, medially with 1 large apical spine, and margin with 2 pairs of setae, apicolateral corners of peduncles on uropods 1–2 without comb. Peduncle of uropod 3 with 6 ventral spines, dorsally with 1 lateral spine and setule, 1 medial spine, rami submasculine, inner extending to M. 95 on article 1 of outer ramus, apex with 2 setae, medial and lateral margins setose, article 2 of outer ramus elongate, 0.42, bearing 2 medium setae, apicomedial margin of article 1 with several setae, lateral margin with 2 acclivities, spine formula = 2-2-2, setal formula = 0-0-1. Telson especially long, length-width ratio = 10:7, almost fully cleft, each apex wide, rounded, lateral acclivity shallow, narrow, bearing ordinary lateral setule, spine next medial longer than setule, each lobe with dorsolateral brush of 7 setae, midlateral setules diverse, larger member of medium size. Urosomite 1 without lateral setule at base of uropod 1 but ventral brush extending widely onto lateral face at proximal end of segment, articulation line absent, urosomite 3 unprotuberant.

Remarks.—Antenna 2 with weak ensiform lobe on article 1. Although no disjunct greatly enlarged posteroproximal spines occur on article 5 of pereopod 4 (and 3), there is a row of 5 submarginal spine-setae besides the regular posterior setae and in addition there is a set of 3 setules farther removed from the margin.

Female "t."—Spine formula on article 1 of outer ramus on uropod 3 = 3-3-3; each lobe of telson with 3 setae in brush; epimeron 3 with only 2 ventral setae; latter 2 characters unusual in light of large body size.

Female "x."—Apices of peduncles on uropods 1–2 with weak comb; epimeron 3 with 6 ventral setae; each lobe of telson with 6 setae in brush.

Nomenclature.—All of the citation of Barnard (1960) for *P. floridanus* belongs with *M. oripacifica* and *P. coronadoi* as all of that earlier material was from the Pacific Ocean and *P. floridanus* apparently is confined to the Atlantic Ocean and Caribbean Sea.

Holotype.—USNM 172473, female "h," 7 mm, cited in plate 21 of J. L. Barnard (1960).

Type-locality.—Salinas Bay, Costa Rica, 11°03′20″N, 85°43′30″W, 2 fms, coarse sand, 11 February 1935, *Velero III* station 477-35.

Etymology.—Name derived from the Latin words *origo,* source; *pacificus,* peaceful.

Material.—Female "t" 5.09 mm from *Velero III* 257-34 and female "x" 4 mm from *Velero III* 461-35 (cited on plate 21 of Barnard, 1960).

Remarks.—All 3 specimens belong to USNM collections as they were donated many years ago by the Allan Hancock Foundation. Specimens of this species remain in Hancock Foundation collections misidentified as "*Paraphoxus floridanus*" and at some future time must be reidentified; one presumes *floridanus* is confined to the Atlantic Ocean.

Relationship.—Differing from *M. floridana* in the presence of 2 main apical spines on the inner plate of the maxilliped, *M. floridana* having only one main spine. This small difference at the moment consistently reflects the geographic separation of *oripacifica* from *floridana* but may not actually signify more than subspeciation.

These specimens at first appeared more distinctive than later concluded. The model specimen described for the west coast form differed from Atlantic *floridana* in the longer wrists of the gnathopods, the seemingly lower extension of posterior setae on epimeron 3, the full posteriorwards extension of ventral setae on epimeron 1, the simple disjunct molarial spine and finally the presence of 2 main apical spines on the inner plate of the maxilliped. Numerous specimens of east coast *floridana* were examined and all but the final character proved to be figmentary or subject to variation and optical illusion in undissected view sufficient to ameliorate these differences. The only consistent difference found is the maxillipedal spination number. However, only a few west coast specimens have been examined and the variability in east coast specimens is so extreme that there is need for more study as to the possibility of morphological overlap between the Atlantic *floridana* and *oripacifica*. Variability in gnathopods, right lacinia mobilis and molarial disjunct spines suggests that *floridana* on the east coast has an unusually high expression of phenotypes possibly typical of species in impoverished faunas. Phoxocephalid diversity in the west northern Atlantic (6 species) is very low in comparison to California (19+ species) and southern Australia (89+ species).

Distribution.—Pacific Costa Rica at Salinas Bay, Port Culebra and Playa Blanca, 2–10 fms.

Metharpinia coronadoi, new species
Fig. 3 middle

Description of holotype female "t."—Head about 20% of total body length, greatest width about 67% of length, rostrum constricted, weakly spatulate, broad to narrow, elongate, not reaching middle of article 2 on antenna 1. Eyes medium, stained with pigment, ommatidia ordinary to small. Article 1 of peduncle on antenna 1 about 1.7 times as long as wide, about 1.7 times as wide as article 2, ventral margin with about 10 setules, weakly produced dorsal apex with 2 setules-setae. Article 2 about 0.83 times as long as article 1, with ventral tightly constrained crescent of 10 setae and 3 lateral setae near apex, primary flagellum with 12 articles, about 0.8 times as long as peduncle, bearing 1 each short and difficult to distinguish aesthetasc on articles 6–11, accessory flagellum with 11 articles. Spine formula of article 4 on antenna 2 = 1-3-6-6, dorsal margin with notch bearing 2 setae and 1 spine, ventral margin with 5 groups of 2–5 long to short setae, 1 ventrodistal long spine, article 5 about 0.8 times as long as article 4, facial spine formula = 4, dorsal margin bearing 2 sets of small setae, ventral margin with 5 sets of 2–5 long to short setae, 3 ventrodistal long to medium spines or setae, 1 of these set facially, flagellum almost 1.2 times as long as articles 4–5 of peduncle combined, with 15 articles.

Mandibles with weak palpar hump, right incisor with 3 teeth rather poorly developed, left incisor with only 2 humps, right lacinia mobilis broad, bifid, distal branch not shorter than proximal, broad, proximal branch simple, bluntly pointed, with marginal denticle in crotch, left lacinia mobilis with 2–3 teeth plus 1–2 accessory teeth, middle teeth not shortened, right rakers 11 plus 2 rudimentaries, left rakers 10 plus 1 rudimentary, molars composed of elongate, bulbous plaques, weakly granulated, each molar with 7 primarily long spines, plus 1 thin simple spine strongly disjunct, molars without plume, palp article 1 short, article 2 with 1 short inner apical seta and 12 other long and short inner setae, no other setae, article 3 about 1.2 times as long as article 2, oblique apex with 11 spine-setae, basofacial formula = 0–3. Each outer lobe of lower lip with 1 cone. Inner plate of maxilla 1 ordinary, bearing 1 medium apical pluseta, 1 similar apicomedial seta, 2 apicolateral much shorter setae, palp article 2 with 1 apical spine, 1 apicolateral, 3 apicomedial spine and 5 submarginal setae; inner plate of maxilla 2 shorter than outer, outer much broader than inner, outer with 4–5 apicolateral setae, inner with 2 medial setae in pair; inner plate of maxilliped with 2 thick apical spines, 3 apicofacial setae, 6 medial setae, outer plate with 9 medial spines, and 1 medial seta, palp article 1 with 1 apicolateral seta, article 2 with 4 groups of 5 lateral setae, medial margin of article 2 strongly setose, article 3 with 7 scarcely strewn facial setae, 2 lateral setae, nail of article 4 barely distinct but not fully fused, with 2 accessory setules.

Coxa 1 scarcely expanded apically, anterior margin straight, main ventral setae of coxae 1–4 = 16-12-15-6, posteriormost seta of coxae 1–3 strongly shortened, coxa 1 also with 1 small posteroventral seta, anterior and posterior margins of coxa 4 scarcely divergent, posterior margin convex, posterodorsal corner sharp, posterodorsal margin short, concave, width-length ratio of coxa 4 = 20:23. Gnathopods generally ordinary, width ratios on articles 5–6 of gnathopods 1–2 = 22:27 and 20:28, length ratios = 65:42 and 56:37, palmar humps large, ornamented, palms oblique, article 5 of gnathopod 1 elongate, ovate, posterior margin rounded, long, article 5 of gnathopod 2 elongate, ovate, posterior margin rounded, long. Pereopod 4 stouter than pereopod 3 especially on article 4, facial setae formula on article 4 = 7 and 8 almost parallel to apex, on article 5 = 6 and 5, main spine of article 5 extending to M. 80-90 on article 6, article 5 with 2 proximoposterior spines on each pereopod, spine formula of article 6 = 6 + 7 and 6 + 7 plus long middistal spine, some spines especially long, acclivity on inner margin of dactyls of pereopods 3–4 weak, sharp, emergent setule short, midfacial pluseta ordinary. Articles 4–5 of pereopods 5–6 broad, facial spine rows dense to moderately developed, facial ridge formulas of article 2 on pereopods 5–7 = 0-1-1, width ratios of articles 2, 4, 5, 6 of pereopod 5 = 60:54:44:20, of pereopod 6 = 85:62:36:16, of pereopod 7 = 81:19:15:8, length ratios of pereopod 5 = 98:50:51:44, of pereopod 6 = 100:65:65:78, of pereopod 7 = 100:21:20:29, article 2 of pereopod 7 reaching middle of article 5, posterior margin with 11 small serrations and 1 ventroposterior seta, anteromedial and lateral apex of article 6 and medial apex of article 5 coarsely combed, article 6 also bearing 7–8 combed digital processes.

Posteroventral corner of epimeron 1 rounded-quadrate, posterior margin weakly convex and serrate, setose (10), corner without setule, anterior and ventral margins with 18 short to medium setae; posteroventral corner of epimeron 2 rounded-quadrate, posterior margin almost straight, weakly serrate, setose (11), setae starting well above ventral margin, facial setae = 13 in 2 arcs; posteroventral corner of epimeron 3 subquadrate, posterior margin straight below, excavate above, serrate, setose (11), in dorsal two thirds only with 1 setule notch, ventral margin with 2 posterior setae.

Rami of uropods 1–2 with fused, immersed, obsolescent apical nails, outer rami of uropods 1–2 with 2 accessory nails, inner rami with 1, outer ramus of uropod 1 with 5 dorsal spines, inner with 2 large, outer ramus of uropod 2 with 3 dorsal spines, inner with 1 large dorsomedial spine, peduncle of uropod 1 with no basofacial setae and 8 small dorsolateral spines, medially with 8 marginal spines, apicalmost slightly enlarged plus 1 huge displaced spine, peduncle of uropod 2 with 9 dorsal spines, apicalmost thick, proximalmost thin, medially with 1 large apical spine and 3 marginal setules, apicolateral corners of peduncles on uropods 1–2 without comb. Peduncle of uropod 3 with 6 ventral spines, dorsally with 2 lateral spines, 1 medial spine and 2 setules, rami submasculine, inner extending to M. 95 on article 1 of outer ramus, apex with 2 setae, medial and lateral margins setose, article 2 of outer ramus elongate, 0.30, bearing 2 medium to long setae, medial margin of article 1 setose, lateral margin with 2 acclivities, spine formula = 3-3-3, setal formula = 0. Telson especially long, glandular, length-width, ratio = 4:3, almost fully cleft, each apex of medium width, rounded, lateral acclivity weak, bearing short lateral setule, then longer setule, spine next medial longer than adjacent setule, then another short setule medially, lateral margins each with brush of 4 setae, midlateral setules diverse, larger large. Urosomite 1 with lateral setule at base of uropod 1, ventral setal bundle scarcely riding upward, articulation line short, almost absent, urosomite 3 unprotuberant dorsally.

Male "h."—Rostrum narrower than in female. Article 2 of antenna 1 with 8 ventral setae, primary flagellum with 13 articles, 1 calceolus each on articles 2–6, aesthetascs weakly developed, no medial fuzz on article 1. Facial spine formula on article 4 of antenna 2 = 0-3-5-6, article 5 with 3 dorsal sets of male setae and 1 calceolus, ventrodistal apex with 2 thin spines and 1 setule, flagellar calceoli = 1, 2, 3, 5, 7 . . . n. Basofacial setal formula of article 3 on mandibular palp = 0-3. Coxa 4 smaller in relation to coxa 1 than in female. Pereopods 3–4 narrower than in female; article 2 of only pereopod 7 narrower than in female. Epimera 1–3 broadened, posterior margin of epimeron 3 not shortened, not protuberant, quadrate, setae extending downward (as in *floridana*) almost to ventral corner, setal formulas: epimeron 1 anteroventral = 8, then gap, or not, ventral = 8, posterior = 8, epimeron 2 facial = 13, posterior = 10, epimeron 3 posterior = 9, facial = 0, ventral = 3. Spine formulas of uropods, uropod 1 peduncle dorsolateral = 9, basofacial = 0, uropod 2 peduncle dorsal = 8–10, dorsal spines on outer ramus of uropod 1 = 5, of uropod 2 = 5, inner ramus of uropod 1 = 1–2, of uropod 2 = 7 (one inner ramus of uropod 2 with aberrant 2 apical nails). Ventral spines on peduncle of uropod 3 = 3, spine formula on article 1 of outer ramus = 3-3-3, setal formula = 0; apical setae on article 2 diverse but short. Shape of telson like female, distal spines scarcely shortened, variable formulas, 1 side with supernumerary second medial setule, each lobe with short row of dorsal denticles.

Juvenile "j."—Ventral setae on article 2 of antenna 1 = 5 tightly constrained, primary flagellum with 10 articles, accessory flagellum with 8 articles. Spine formula on article 4 of antenna 2 = 1-3-5-4, on article 5 = 2, flagellum with 11 articles. Mandibles and inner plate of maxillipeds like adult. Epimeral setal formulas: epimeron 1 anteroventral = 3, then gap, posteroventral = 4, posterior = 5; epimeron 2 facial = 6 straight, posterior = 6; epimeron 3 ventral = 2, posterior = 7. Peduncle of uropod 1 with 3 widely spaced dorsolateral spines, medial = 4 spines plus displaced spine, outer ramus = 2, inner = 1; peduncle of uropod 2 with 4 dorsal spines, medially with 1 apical spine, no setules, outer ramus = 2, inner ramus = 1; peduncle of uropod 3 with 4 ventral setae, inner ramus reaching to M. 55 on article 1 of outer ramus, with 1 apical seta only, outer ramus with 3-3 lateral setae, article 2 on outer ramus 0.37 times as long as article 1. Telson like adult but no medial setule on apices, lateral brushes each with 2 setae.

Holotype.—AHF No. 5823, female "t" 6.57 mm.

Type-locality.—*Velero IV* Allan Hancock Foundation 5605-58, off Pt. Loma Light, California, 32°33′10″N, 117°13′15″W, 43 m, 18 February 1958.

Etymology.—Named for the Spanish explorer, Francisco Vásquez de Coronado, 1510–1554.

Material.—Male "h" 5.37 mm, *Velero IV* 4745; male "v" 6.55 mm and juvenile "j" 4.04 mm, *Velero* 5190; female identified, *Velero* 4908.

Relationship.—This species differs from *M. floridana* in the presence of 2 (not 1) main spines on the inner plate of the maxilliped, the presence of 9 (not 1) dorsolateral spines on the peduncle of uropod 1, the greater size of the armaments on the medial margin of the peduncle on uropod 2 (spines instead of setules), the presence of a marginal spine on the inner ramus of uropod 2 (none in *floridana*), the presence of only 2 (female) or 3 (male) ventral setae on epimeron 3 (generally 4+ in *floridana*) and in the subtleties of shape on the gnathopods (see illustrations here and in Barnard, 1960). *Metharpinia coronadoi* differs from *oripacifica* in all the above listed characters except that of the maxilliped.

Distribution.—Coastal shelf of southern California, 18–43 m.

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A NEW SPECIES OF *MUNNA* KRØYER FROM NIGERIA (CRUSTACEA: ISOPODA: MUNNIDAE)

Brian Kensley

Abstract.—A new species of marine isopod, *Munna powelli,* is described from a mangrove creek in Nigeria, west Africa. The subgenera of *Munna* are discussed, and the unsatisfactory state of the taxonomy of *Munna* is commented on. Possible criteria for subgeneric separation are suggested.

Amongst some crustaceans submitted for identification to the Smithsonian Institution by Mr. C. B. Powell of the University of Port Harcourt, Nigeria, were several small munnids. These proved to be an undescribed species of *Munna*. As the shallow-water intertidal and mangrove fauna of west Africa is poorly known, it was thought useful to describe the species.

Suborder ASELLOTA
Family Munnidae

Munna powelli, new species
Figs. 1, 2

Description.—Body widest at pereonites 3 and 4. Integument with diffuse red-brown pigmentation, forming denser blotches middorsally. Anterior margin of cephalon broadly convex; shallow curved impression running across cephalon anterior to eyes. Coxae visible on pereonites 2–7, latter each with shallow transverse dorsal groove. Pereonite 3 widest and longest. Pleon consisting of single anterior segment lacking free lateral margins, plus globose pleotelson; margin between uropods broadly convex.

Antennule of 2 broad basal segments followed by 2 shorter and narrower segments and 2 slender more elongate articles; single aesthetasc on terminal segment. Antennal peduncle of 3 short basal segments followed by 2 more elongate segments, fourth segment almost five-eighths length of fifth; flagellum equal in length to peduncle, of 14 articles. Mandible lacking palp; incisor of 3 cusps; lacinia present unilaterally, distally expanded into 4 teeth; spine row of 3 or 4 fringed spines; molar process stout, distally truncate with rounded tubercles on margin of grinding surface. Maxilla 1 inner ramus narrow, distally curved, bearing 2 spines; outer ramus with about 9 stout spines. Maxilla 2 with rami tipped with fringed and simple spines. Maxillipedal epipod oval, reaching second palpal segment; endite bearing several fringed spines/setae at inner distal angle, 3 retinaculae on inner margin; palp

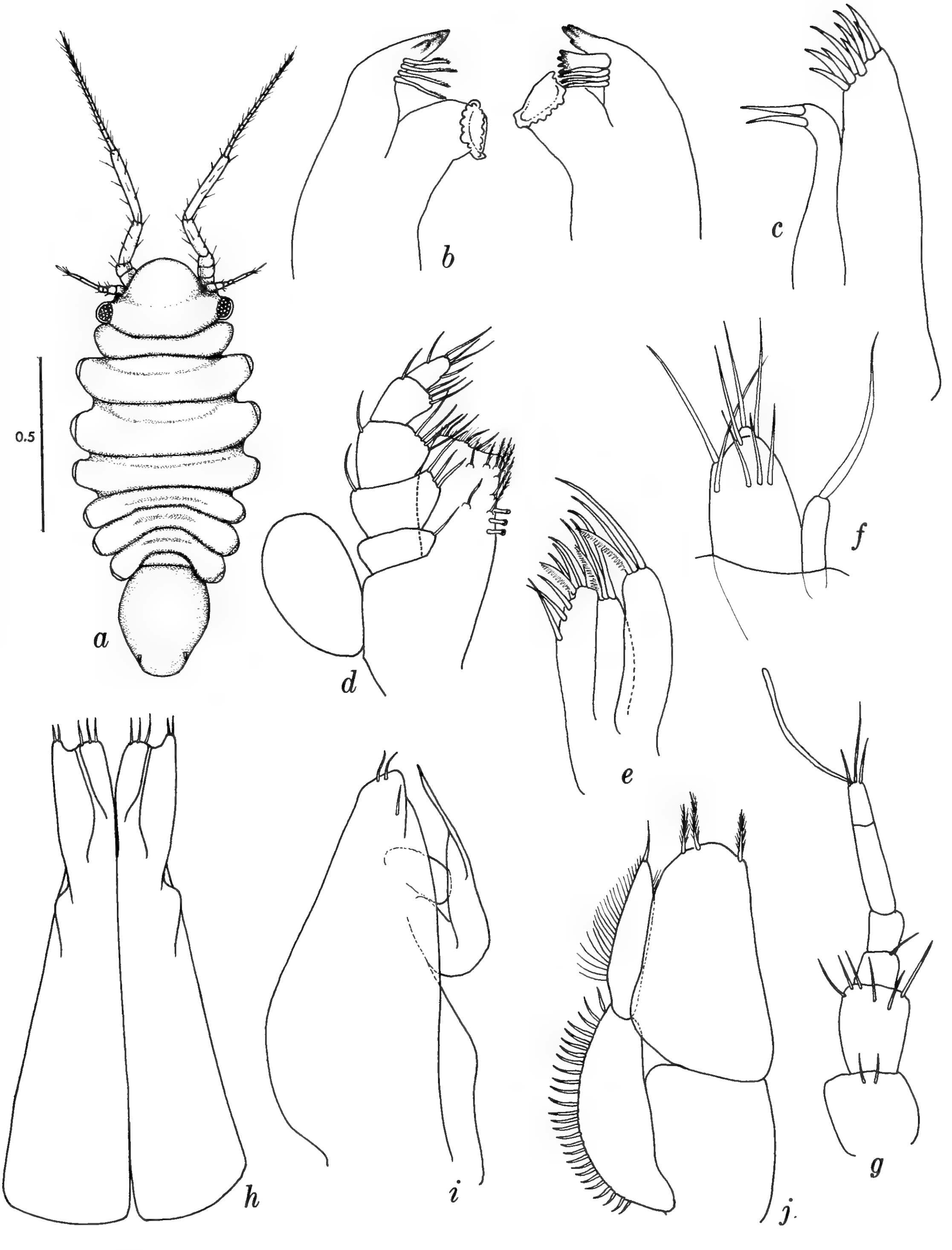

Fig. 1. *Munna powelli*: **a,** Female in dorsal view; **b,** Left and right mandibles; **c,** Maxilla 1; **d,** Maxilliped; **e,** Maxilla 2; **f,** Uropod; **g,** Antennule; **h,** Pleopod 1 ♂; **i,** Pleopod 2 ♂; **j,** Pleopod 3 ♂.

Fig. 2. *Munna powelli*: **a,** Antenna; **b,** Pereopod 1; **c,** Pereopod 2; **d,** Three distal segments of Pereopod 7.

of 5 segments each bearing setae on inner margins. Pereopod 1 much shorter than following legs, similar in ♀ and ♂; unguis almost half length of curved dactylus, with short supplementary spine; propodus narrowing distally, with 3 spines on inner margin; carpus shorter than propodus, with 3 spines at ventrodistal angle. Pereopods 2–7 increasing in length; pereopod 2 unguis equal in length to rest of dactylus, with stout supplementary spine; propodus 3 times longer than wide, with 3 spines on distal half of ventral margin; carpus longer than propodus, with 2 spines on ventral margin; merus almost triangular, with single spine on distodorsal angle. Pereopod 7 unguis longer than rest of dactylus; propodus 9 times longer than wide, with series of 8 stout ventral sensory spines; carpus 4 times longer than wide, with 3 ventral sensory spines, 4 dorsodistal spines; merus with 2 dorsodistal spines. Operculum of ♀ as long as broad, apex truncate-rounded. Pleopod 1 ♂ basally broad; inner lobe of apex truncate, slightly shorter than narrowly rounded outer lobe. Pleopod 2 ♂ apex rounded. Pleopod 3 ♂ endopod broader than exopod; latter with single terminal setae, former with 3 distal plumose setae. Uropod lacking peduncle; inferior ramus about twice length and 4 times width of superior ramus; former with 8 distal setae, latter with single elongate seta.

Material.—Holotype, USNM 172997, ovigerous ♀ TL 1.3 mm. Allotype, USNM 172998, ♂ TL 1.2 mm. Paratypes, USNM 172999, 11 ♂, 15 ♀ Port Harcourt, Nigeria: 4°47.3′N, 6°56.6′E. Collected 25 November 1978. Taken from colonies of hydroid *Garveia franciscana* (Torrey), growing in mesohaline mangrove creek.

Etymology.—The species is named for Mr. C. B. Powell, who collected the material, as well as other interesting crustaceans.

Remarks.—Menzies (1952:118) discussing the genus *Munna* (s.l.) states "Even today this genus remains inadequately understood and contains a vast number of species." In the ensuing 27 years the situation has hardly altered, except that several new species names have been added to the list. At least 50 names now exist in the literature. Although Menzies (1952) indicated a possible division of the genus based on uropodal, pleopod 1 ♂, ♀ and ♂ gnathopods, and pleopod 3 ♂, in 1962a he proposed the formation of 3 subgenera (*Uromunna, Neomunna,* and *Munna*), based solely on uropodal structure, a very difficult feature to see with certainty in such small animals. That the genus requires reevaluation is obvious; the basis for such reevaluation should probably be a combination of features, including the presence or absence of a mandibular palp. This latter is used to separate *Coulmannia* Hodgson from the rest of the munnid genera (Menzies, 1962b, Wolff, 1962) but within the genus *Munna* (s.l.) are species both possessing (e.g. *ubiquita* Menzies, *stephenseni* Menzies, *nana* Nordenstam) or lacking (e.g. *reynoldsi* Frankenberg and Menzies, *santaluciae* Gascon and Mañe-Garzon, *sheltoni* Kensley) mandibular palps. From these 2 groups, *M. ubiquita* and *M. reynoldsi* both belong to the subgenus *Urommuna.* The value of the mandibular palp as a generic and/or subgeneric character requires assessment.

The present species possesses a rounded inferior uropodal ramus lacking recurved spines, which places it in the subgenus *Munna*. However, it lacks a mandibular palp, while the gnathopods (pereopod 1) of the ♂ and ♀ are similar. *M. powelli* quite closely resembles *M.* (*M.*) *sheltoni* Kensley, 1977 from South Africa, in the general structure of the appendages, especially the gnathopods, posterior pereopods, and mouthparts. The South African species, however, is a relatively squatter form, with a broader pleotelson; the apex of pleopod 1 ♂ is not as obviously bilobed as in *M. powelli,* and the inferior uropodal ramus is less setose. Finally, the distinctive cruciform pigmentation of *M. sheltoni* is not seen in the Nigerian species.

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FIRST RECORD OF A COPEPOD PARASITIZING THE OSTRACOD FAMILY RUTIDERMATIDAE (MYODOCOPINA: CYPRIDINACEA): *SPHAERONELLA SPINOSA* N. SP. (COPEPODA: CHONIOSTOMATIDAE)

Janet M. Bradford

Abstract.—*Sphaeronella spinosa,* a new species of Choniostomatidae (Copepoda) from the continental shelf off South Carolina and Georgia, U.S.A., is described and illustrated. This is the first record of a copepod parasitizing the ostracod family Rutidermatidae (Myodocopina: Cypridinacea).

I am grateful to Dr. Louis S. Kornicker, Smithsonian Institution, who brought to my attention two female choniostomatid copepods and one copepodite, parasitic on a new species of the ostracod *Rutiderma* from the continental shelf off South Carolina and Florida, U.S.A. These are the first copepods recorded parasitizing the myodocopid ostracod family Rutidermatidae (superfamily Cyridinacea). Copepods have previously been recorded parasitizing the other families in the Cypridinacea (see Bradford, 1975). The copepods proved to be undescribed but closely related to *Sphaeronella monothrix* (Bowman and Kornicker, 1967), *S. anarthronis* Bradford, 1975, *S. philomedesi* Bradford, 1975. The specimens were mounted in glycerine and observed whole between two cover glasses fixed in a metal holder. The ostracod is being described by Kornicker as *Rutiderma darbyi* Kornicker (in litt.) (deliberate nomen nudum herein).

Sphaeronella spinosa, new species
Fig. 1

Holotype.—Female, length 0.306 mm, width 0.276 mm, from host USNM 158003 deposited in the National Museum of Natural History, Smithsonian Institution (USNM 158277).

Paratypes.—Female (USNM 158278), length 0.300 mm, width 0.259 mm from host USNM 158109. Copepodite (USNM 158279), length 0.144 mm from host USNM 158003.

Type-locality.—Off the coast of Florida, U.S.A. at 31°05′N, 80°35′W at 26 m depth.

Etymology.—This species is named for the relatively greater amount of head ornamentation compared with its close relatives.

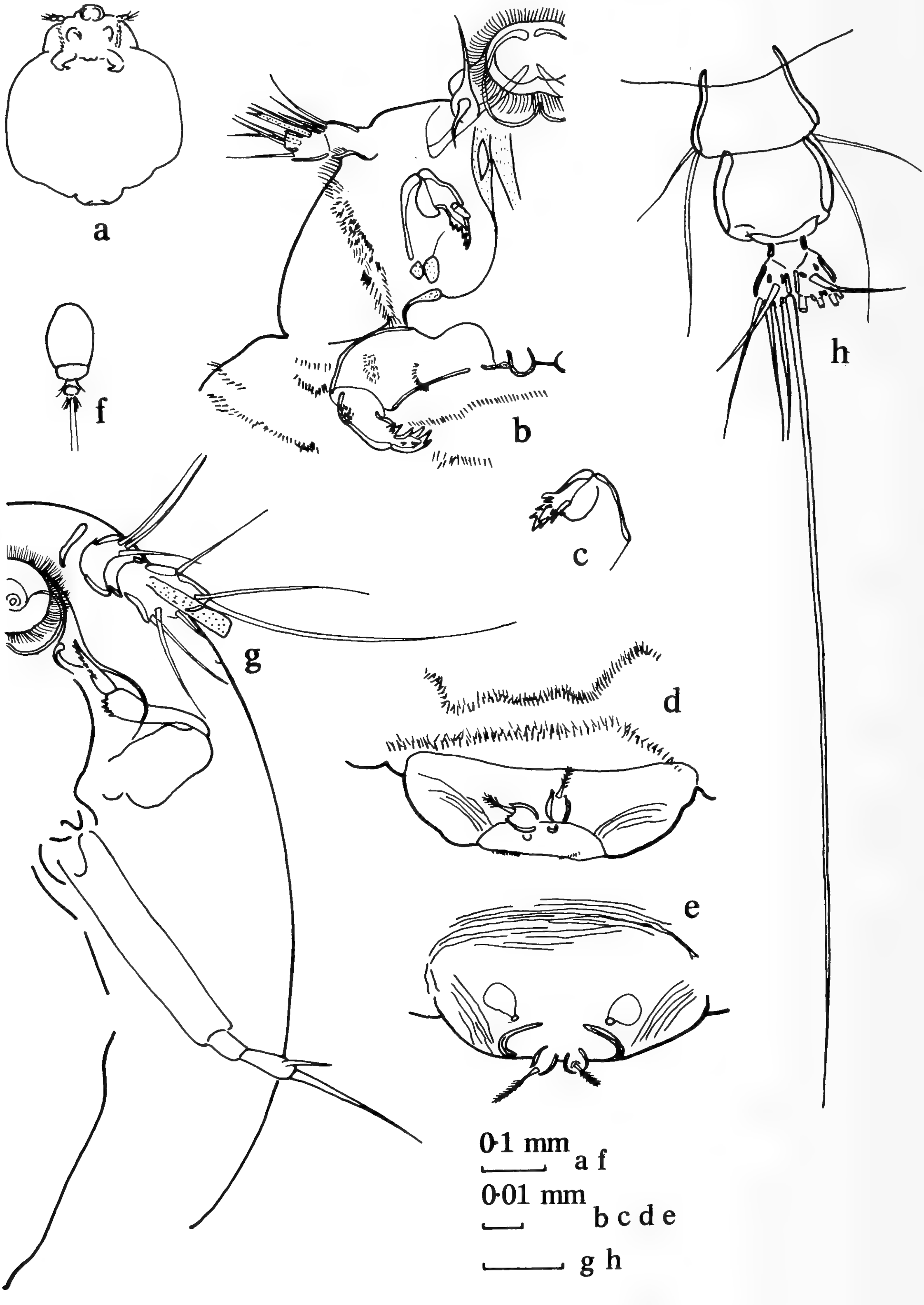

Fig. 1. *Sphaeronella spinosa*. Female: **a,** Ventral view; **b,** Head, ventral view; **c,** Detail of maxilla 2; **d,** Genital area, dorsal view (holotype); **e,** Genital area, ventral view (paratype). Copepodite: **f,** Dorsal view; **g,** Cephalothorax, ventral view; **h,** Urosome, dorsal view.

Material examined.—One female (holotype), 1 copepodite from host USNM 158003, Stn 0225-3 (5D) 25 Feb. 1977, 31°05′N, 80°35′W, 26 m. One female (paratype) from host USNM 159109, Stn 0177-3 (3E), 32°01′N, 79°31′W, 43 m, off South Carolina, 18 Feb. 1977. The material was collected by Dr. W. E. Pequegnat.

Description.—Female: length 0.306 mm, width 0.276 mm. Body globular in dorsal view. Head on anterior border, frontal margin bordered by row small spinules on dorsal surface. Antenna 1 2-jointed, aesthete slightly longer than joint 2. Antenna 2 absent. Maxilla 1 2-branched. Maxilla 2 terminal joint with 2 rows of teeth along inner border and a not well sclerotized lobe. Maxilliped 3-jointed; basal joint with row of inner edge spinules and patch of more distal spinules on ventral surface, joint 2 with several spines on inner distal corner and patch of proximal spinules on outer border, joint 3 inner border with 2 rows of teeth. Submedian skeleton not well sclerotized, ridges posterior to maxilla 1, at base of maxilla 2 and in form of pair of semicircular processes located between maxillipeds. Lateral margins of head ornamented with broad band of spinules which terminate anteriorly on dorsal surface anterior to antenna 1. Trunk ornamented on dorsal and anteroventral surface with semicircular rows of spinules. Legs not evident. Genital area posteriorly placed on trunk, raised, without ornamentation, borders of plate not obvious, openings of seminal receptacles anterior to genital apertures on ventral surface. Caudal rami just on dorsal surface of holotype, terminal on paratype, consisting of simple cylindrical joint with one terminal plumose seta.

Male: Unknown.

Copepodite: Length 0.144 mm. Cephalothorax length 1.3 times width. Antenna 1 3-jointed, aesthete scarcely longer than joint 3 but may be damaged. Antenna 2 apparently absent. Maxilla 1 3-branched. Maxilla 2 distal part of joint 2 and terminal claw with toothed inner borders. Maxilliped 4-jointed. Legs 1 and 2 apparently similar to those of *S. anarthronis* although this could not be completely confirmed because of position in which limbs are mounted. Abdomen with 2 setae on posterior angle of segment 1, longest extends beyond caudal rami. Caudal rami and abdominal segment 3 separate. Caudal rami each with 5 setae, inner seta longest almost as long as cephalothorax, 1 seta on dorsal surface.

Variation.—The paratype female has less trunk ornamentation on the posterodorsal surface than the holotype female. Also on the paratype female the inner edge row of spinules on maxilliped joint 1 is not evident.

Remarks.—*Sphaeronella spinosa* was found posterodorsally in the carapace of the host, a female *Rutiderma darbyi* (Fig. 2). *Sphaeronella spinosa* most closely resembles *S. monothrix, S. anarthronis* and *S. philomedesi* which also have antenna 1 2-jointed, antenna 2 absent, maxilla 1 2-branched and the maxilliped 3-jointed. *Sphaeronella spinosa* differs from *S. monoth-*

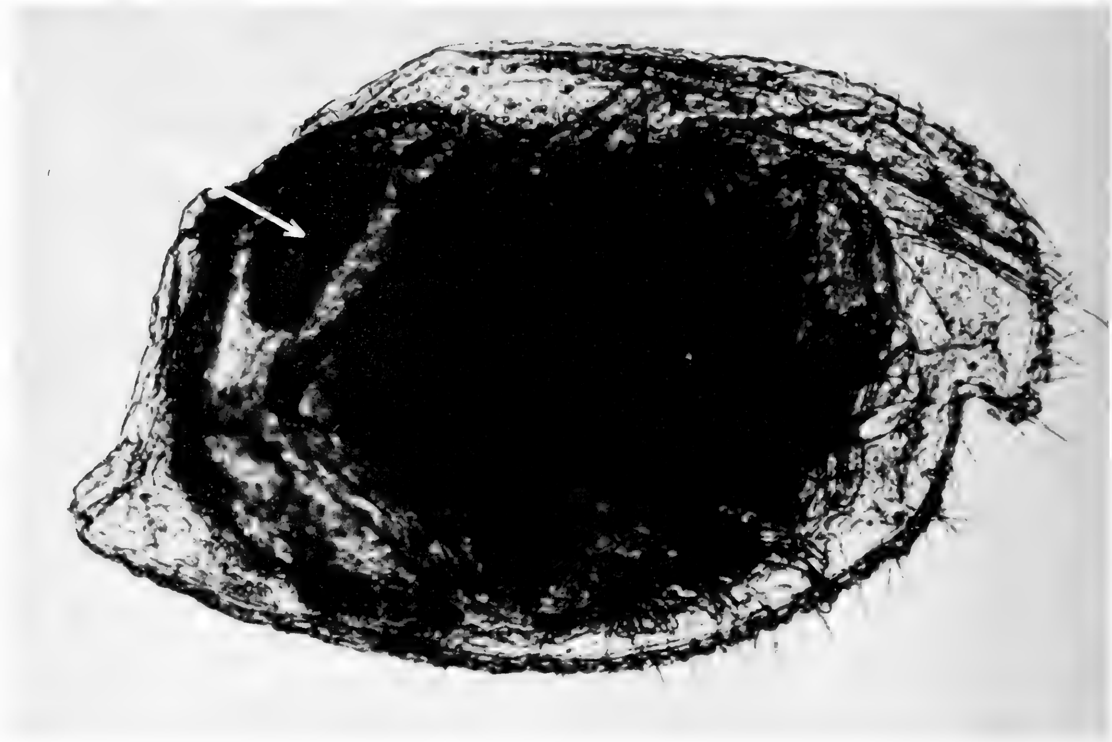

Fig. 2. Photomicrograph of host ostracod, a female *Rutiderma* USNM 158003, length 1.3 mm, indicating position of parasitic choniostomatid female *Sphaeronella spinosa*, holotype USNM 158277.

rix because the latter has no ornamentation on its maxilliped, and is without spinules on the lateral borders of the head; from *S. anarthronis* which has the maxilliped differently ornamented and is without surface patches of spinules on the ventral surface of joint 1 and outer proximal surface of joint 2; from *S. philomedesi* which has very little ornamentation on its maxilliped and is without the large projection on the distal portion of joint 2. The copepodite of *S. spinosa* appears to differ from that of *S. anarthronis* in having no antenna 2.

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RANGE EXTENSIONS OF SIX WESTERN ATLANTIC FROG CRABS (BRACHYURA: GYMNOPLEURA: RANINIDAE) WITH NOTES ON THE TAXONOMIC STATUS OF *LYREIDUS BAIRDII*

Gary D. Goeke

Abstract.—Range extensions are given for 6 species of raninids that occur in the western Atlantic: *Ranilia muricata, Raninoides lamarcki, R. laevis, R. louisianensis, Symethis variolosa,* and *Lyreidus nitidus,* n. comb. Four of the new range records are extensions into or within the Gulf of Mexico with the remaining being the first records from South American waters. One form, *Raninoides louisianensis,* has previously been thought to be endemic to the Gulf of Mexico, but the many examples examined extend the known range south to Surinam. Intraspecific morphological variation is noted for each species and comparisons are made with specimens from well within the older established ranges to point out the extent of variation. The taxonomic status of *Raninoides nitidus* is reviewed and *L. bairdii* Smith is designated a junior synonym.

The family Raninidae has a pantropical distribution with 7 species now known to occur in the Gulf of Mexico. The crabs of this family are burrowing animals that possess a unique combination of characters usually regarded as both specialized for their mode of existence and the result of a hypothesized early divergence from the main line of brachyuran evolution (Bourne, 1922; Stevcic, 1974).

Specimens examined are from collections deposited in the U.S. National Museum of Natural History (USNM), the University of Miami Rosenstiel School of Marine and Atmospheric Science (UMML), and the Systematic Collection of Marine Organisms at Texas A&M (TAMU). I would like to acknowledge the kind assistance of Drs. Linda H. Pequegnat (TAMU) and Gilbert Voss (UMML), as well as Dr. Bowman and the staff of the Division of Crustacea, National Museum of Natural History. Dr. H. W. Levi (Museum of Comparative Zoology) graciously loaned type-material of *Raninoides nitidus*. This paper has greatly benefited from the criticisms of Drs. Richard W. Heard, Jr. (Gulf Coast Research Lab), and Darryl L. Felder (University of Southwestern Louisiana). Numerals which represent carapace lengths of specimens follow the specimen counts in each section under Material examined.

Ranilia muricata H. Milne-Edwards, 1837

Ranilia muricata H. Milne-Edwards, 1837:196. Rathbun, 1937:18. Williams, 1965:142. Costa, 1970:34.

Previous records.—North Carolina (Hay and Shore, 1918:420; Williams, 1965:142) to eastern Gulf of Mexico and Caribbean (Rathbun, 1937:18); 9–102 m.

Material examined.—TAMU 2-1262, 30 June 1962, N. W. Gulf of Mexico, 29°04′30″N, 94°16′W, 1 female, 33.7, 12 m.

Remarks.—The northwestern Gulf specimen closely agrees with H. Milne-Edwards' original description. It differs from eastern Gulf forms in that the ventral surface is more setose and in that the frontal margin of the carapace is not as strongly denticulate. Another female specimen (USNM 97667) was taken by Hulings (unpublished thesis, TCU 1955) from the Heald Bank (Sabine), Texas, but I did not examine the specimen.

The genus *Ranilia* was established in 1837 by Milne-Edwards with *muricata* as the type-species. Eight species are currently recognized, 4 of which occur in American waters. Correa (1970) listed a species from off Brazil and briefly compared it to *R. muricata*; the Brazilian species was described as *R. saldanhai* Costa, 1970. I have been unable to borrow specimens of *R. saldanhai*; until a detailed comparison between these two species is made the validity of *R. saldanhai* will remain uncertain.

Raninoides lamarcki A. Milne-Edwards & Bouvier, 1923

Raninoides laevis var. *lamarcki* A. Milne-Edwards & Bouvier, 1923:299. Chopra, 1933:84. [Not *Raninoides laevis lamarcki* Boone, 1930:48.]
Raninoides lamarcki: Rathbun, 1937:13. Chace, 1940:5. Pequegnat, 1971: pl. 1.

Previous records.—Greater Antilles to Panama (Rathbun, 1937:13); 46–366 m.

Material examined.—TAMU 2-1983 (in part), 22 September 1971, SW Gulf of Mexico, 18°57′30″N, 95°34′30″W, 1 male, 39.0, 80 m; TAMU 2-2614 (in part) 10 July 1972, central western Gulf of Mexico, 23°29′N, 97°26′W, 1 female (ovig.), 23.5, 77 m; UMML, 32-3157, 14 July 1966, 9°59′N, 76°02′W.

Remarks.—These collections of *Raninoides lamarcki* are the first reported records of this species within the Gulf of Mexico. The Gulf specimens differ from Caribbean forms in that the Gulf specimens have (1) a larger number of teeth on the ventral surface of the propodus of the chelae, (2) the sixth sternal plate more rounded and less inflated posteriorly, and (3) differences in the orientation and relative development of terminal spines on the male pleopods.

Raninoides lamarcki is most closely related to *R. louisianensis* Rathbun. Although the frontal regions of the carapaces of the two species differ considerably in the development of the spines and the chelae differ in the number of spines, the two forms are very similar in many other respects. However, the male of *Raninoides louisianensis* has 4 spines on the end of the first pleopod, 1 small terminal spine at the apex and 3 well-developed subterminal spines surrounding the apex; whereas the male of *R. lamarcki* has the 4 spines of the pleopod similarly arranged but all well-developed.

Raninoides laevis (Latreille, 1825)

Ranina laevis Latreille, 1825:26.
Ranina laevis: H. Milne-Edwards, 1837:197.
Raninoides loevis: Rathbun, 1921:64; 1937:8. Chace, 1956:17. Correa, 1970:9.

Previous records.—Southeast of Cape Hatteras (Herbst, Williams and Booth 1979), west coast of Florida to north coast of South America, (Rathbun, 1937:9), off Tabasco, Mexico (Chace, 1956), Guianas to Bahia, Brazil (Correa, 1970:9); 18–186 m.

Material examined.—TAMU 2-0958, 29 June 1964, NW Gulf of Mexico, 28°30′N, 93°37′W, 2 male, 1 female (ovig.), 28.6–31.4, 42 m; TAMU 2-0959, 29 June 1964, NW Gulf of Mexico, 28°56′N, 94°35′W, 1 male, 2 females, 15.8–28.1, 26 m.

Remarks.—The western Gulf specimens differ little from the eastern Gulf forms and were compared to specimens collected from the Florida Middle Grounds. The 2 forms differed only in the shorter and stouter male pleopods and the broader, more rounded sixth sternite of the Texas specimens. No appreciable differences could be seen at the tip of the male pleopods or in the development of the chelae.

Other specimens labeled as *R. laevis* (USNM 97665, 97666, 96468) collected from the Heald Bank (Sabine), Texas, were not examined by the author. There appears to be a small population of this species in the western Gulf with a low concentration of individuals.

Recent workers (Guinot-Dumortier, 1959; Knight, 1968) note that the distribution of *R. laevis* as given by Rathbun (1937:9) is quite extensive, including records in the Pacific along the coasts of Panama and Colombia. Knight examined this problem and many of the Pacific specimens that Rathbun had identified as *R. laevis*. Her conclusions agree with Guinot-Dumortier (op. cit.) in that some of the characters used to differentiate *R. laevis* from *R. benedicti* are not valid in smaller individuals. Knight used the first male pleopods to separate the species and concluded that all of the specimens from the Pacific coast of Panama should be referred to as *R. benedicti* and that *R. laevis* is probably restricted to the Atlantic and Gulf waters.

Raninoides louisianensis Rathbun, 1933

Raninoides louisianensis Rathbun, 1933:186; 1937:12. Chace, 1940:5; 1956:17. Leary, 1967:30. Pequegnat, 1970:81; 1971:pl. 1.

Previous records.—East of Mississippi Delta (Rathbun, 1937:12) to Campeche Banks (Chace, 1956); 55 to possibly 677 m.

Material examined.—USNM 121658, 27 May 1964, Colombia, 07°50.5′N, 76°53.5′W, 1 male 58.0, 73 m; USNM 121659, Gulf of Venezuela, 11°58.1′N, 81°26.3′W, 12 males, 9 females (2 ovig.), 20.8–71.2, 109–295 m; UMML 32:2642, February 1963, Surinam, 08°01′N, 54°21′W, 1 male, 1 female (ovig.), 29.6–49.3.

Remarks.—The Surinam specimens examined represent new southern range extensions for *R. louisianensis* which had been considered an endemic to the Gulf by previous workers (Pequegnat, 1970, 1971). It has also never been reported from the southeastern region of the Gulf. The many specimens collected from the Caribbean and off Surinam do not differ greatly from individuals in the Gulf of Mexico, apart from many being considerably larger in carapace lengths. In comparing the Surinam individuals with Gulf specimens, no obvious differences were noted in the pleopods of males or spermathecal pits of the females. The frontal spines, chelae, and ambulatory legs of the Surinam specimens all closely match the original description of the animal.

In discussing the bathymetric distribution of *R. louisianensis* in the Gulf of Mexico, Pequegnat (1970) pointed out that the two deep-water records by the Oregon (366 m and 402 m) may be due to animals not picked out of the trawl from previous shallower stations where *R. louisianensis* would probably be found. While this may be, specimens from 677 m have since been collected in the western Gulf (TAMU 2-2615), surpassing the previous questionable depths. However, this record may show either a broader bathymetric range than previously recognized, or contamination of the sampling gear from shallower stations.

Symethis variolosa (Fabricius, 1793)

Hippa variolosa Fabricius, 1793:476.

Symethis variolosa: Weber, 1795:92. Rathbun, 1937:26. Cerame-Vivas and Gray, 1966:263. Correa, 1970:10.

Eryon trilobatus de Freminville, no date (Fide Rathbun, 1937).

Zanclifer caribensis de Freminville, 1832:275, Henderson, 1888:34. Bourne, 1922:66.

Previous records.—Florida to Bahia, Brazil and Panama (Pacific) (Rathbun, 1937:26), North Carolina (Cerame-Vivas and Gray, 1966:263); 18–137 m.

Material examined.—TAMU 2-2243, western Gulf of Mexico, Isla de Lobos, 21°27′N, 97°14′W, 8 October 1972, 1 male, 14.5, 7.6 m.

Remarks.—The western Gulf specimen was compared with specimens collected off the west coast of Florida and differed in the following respects: carapace slightly less eroded and granulated than the eastern Gulf forms, palm of cheliped smoother, chelae not as bulky and pleopod of the male specimen less massive than Florida specimens. However, many of these differences may be attributable to the immaturity of the western Gulf specimen.

This constitutes the first published record of *S. variolosa* from the western Gulf. This species appears to occur rarely even within its previously established range and is restricted to broken shell substrates.

The geographic distribution of this species, as given by Rathbun (1937:26), includes the Pacific coast of Panama. The Pacific record was based on a single female specimen collected by the Hancock Galapagos Expedition at Bahia Honda, Panama in 1934. The USNM also has in its holdings a second lot of this species, collected from Puerto Refugio, Baja California, Mexico in April 1939 from a depth of 27 m. I have examined these specimens and conclude that they represent an undescribed species. The *Symethis* form in the eastern Pacific closely resembles the Atlantic form and will be described in a forthcoming paper.

Lyreidus nitidus (A. Milne-Edwards, 1880) n. comb.

Raninoides nitidus A. Milne-Edwards, 1880:34. A. Milne-Edwards and Bouvier, 1923:298. Rathbun, 1937:17. Serene and Umali, 1972:36.

Lyreidus bairdii Smith, 1881:420. Rathbun, 1937:23. Chace, 1940:6. Leary, 1967:30. Pequegnat, 1970:180; 1971:pl. 1.

Previous records.—Martha's Vineyard (Smith, 1881:420), Gulf of Mexico and Greater Antilles (Rathbun, 1937:23 and Pequegnat, 1970:180); 119–823 m.

Material examined.—Type male, MCZ 10762, Grenada, British West Indies, Blake Station 259, 288 m; USNM 78626, off Tortugas, Florida, 2 females (1 ovig.); USNM 136821, 24 March 1963, "Oregon" Station 4302 off Surinam, NE of Paramaribo, 07°35′N, 54°W, 2 males, 4 females, 21.5–31.5, 457 m; USNM 121651, 10 October 1963, "Oregon" Station 4447, north coast of Venezuela, off Puerto Cabello, 10°52′N, 67°56′W, 1 juv., 14.0, 366 m.

Remarks.—This record extends the known range of the species southward to the north coast of Surinam. The specimen from Venezuela is atypical in that the extraorbital spines are more pronounced than the rostral spine. The frontal spines of *L. nitidus* from the Gulf of Mexico are normally equal in length. This variation is attributable to the small size of the specimen.

Lyreidus nitidus is the only known Atlantic representative of the genus; all other described species are from the Indo-West Pacific region. *Lyreidus nitidus* occurs in relatively deep waters over most of its range and may be the most abundant raninid in the Gulf of Mexico (Pequegnat, 1970). The bathymetric range of this species extends to at least 823 m, which gives *Lyreidus nitidus* the deepest range of all the American frog crabs. In his revision of the genus *Lyreidus* DeHaan, Griffin (1970) recognizes only 5 of the 11 previously named species as valid; he considers the remaining 6 species as junior synonyms of these 5. Although he continues to recognize *Lyreidus bairdii* (= *Raninoides nitidus*) as a valid species, his comparative studies of male pleopods suggest that this species is closely related to *Lyreidus channeri* Wood-Mason from the Indo-West Pacific.

The taxonomic status of *Raninoides nitidus* has been uncertain. No specimens other than the type male have been available for study. This species, however, has been considered a part of the western Atlantic fauna. *Raninoides nitidus* was described from a single male specimen collected by the Blake (Station 259) off Grenada, British West Indies from 288 m. No additional collections have been reported in the literature. Rathbun (1937) included this species in her account of the oxystomatous crabs of America but had no specimens available for examination. She reproduced Milne-Edwards' and Bouvier's (1923) figure of the animal and reported that the type was "not located." However, the type-specimen was located at the Museum of Comparative Zoology during this study.

Specimens of *R. nitidus* examined for this study consisted of the type male (MCZ 10762), a second male (USNM 78626) and 2 females (1 ovig.) (USNM 78365), the latter 3 specimens identified by W. L. Schmitt. These specimens were collected in 1932 and 1939, respectively, from 244 to 283 m off Tortugas, Florida. A close examination of the type male and the above specimens has shown that *Lyreidus bairdii* Smith (1881) must be considered synonymous with *Raninoides nitidus* A. Milne-Edwards. Since Milne-Edwards' description has priority over Smith's publication, *L. bairdii* must be designated the junior synonym.

The type-specimen, the original description (A. Milne-Edwards, 1880) and figure (A. Milne-Edwards and Bouvier, 1923) of *Raninoides nitidus* all agree very well with Smith's (1881) description of *Lyreidus bairdii,* with only a slight discrepancy in the illustration. In the figure, the fronto-orbital region is more than half the greatest carapace width when normally it is less than half. However, the type male is immature (8 mm) and in young specimens the relative width of the frontal region is much greater than in mature individuals. The type of *Raninoides nitidus* also has a well-developed tooth between the posterolateral spine and the extra-orbital spine. This agrees with Smith's description of a "spinule" at this location for the type of *L. bairdii* (USNM 21363). Gulf of Mexico specimens often differ from this with the tooth reduced to a lump along the anterolateral margin.

Lyreidus bairdii was described from 183 m off Martha's Vineyard and has since been reported numerous times from Massachusetts to Puerto Rico (Rathbun, 1937:21) and all parts of the Gulf of Mexico (Leary, 1967:30; Pequegnat, 1970:180). Pequegnat (1970) noted that this species is common in deeper waters and gave figures which estimated the population density as it varies with depth. He called *L. bairdii* the most abundant raninid in the Gulf of Mexico.

Raninoides nitidus readily conforms to the generic description of *Lyreidus* De Haan as given by Griffin (1970), and agrees in all of the following characters: fronto-orbital width less than one-half greatest carapace width, eyestalks stout and cornea small, antennal peduncle stout, not covering antennular peduncles, merus of third maxilliped slightly longer than ischium, shape of sternum, as well as cheliped and pereiopod forms. For these reasons *Raninoides nitidus* is hereby transferred to the genus *Lyreidus* and designated *Lyreidus nitidus* (A. Milne-Edwards, 1880) n. comb.

Several workers (Henderson, 1888, Chopra, 1933 and Serene and Umali, 1972) had noted that *R. nitidus* is an aberrant member of the genus *Raninoides* because of the presence of two lateral spines behind the extra-orbital teeth. Serene and Umali (1972) suggested that *Lyreidus channeri* and *Lyreidus nitidus* may belong to a new genus intermediate between *Lyreidus* and *Raninoides*. They noted that *L. channeri* also differs from the other Indo-West Pacific members of the genus *Lyreidus* by the presence of the two lateral spines posterior to the extra-orbital spines as well as short, stout eye peduncles and other characteristics.

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THE FUNCTION OF EGGLESS CAPSULES AND LEAF IN NESTS OF THE FROG *PHYLLOMEDUSA HYPOCHONDRIALIS* (ANURA: HYLIDAE)

William F. Pyburn

Abstract.—*Phyllomedusa hypochondrialis* makes a purse-like nest over water by folding a leaf around its egg mass. The egg mass contains eggs (embryos) and fluid-filled, eggless capsules. The enclosing leaf and eggless capsules prevent drying and death of embryos during the 8–9 day, non-aquatic, prehatch period. A long prehatch period allows the embryos to attain a relatively advanced developmental stage before entering the water, where they are exposed to many aquatic predators.

Differences in mating characteristics between species in the genera *Phyllomedusa* and *Agalychnis* are due to different physiological and behavioral mechanisms that insure a continuous water supply to the prehatch embryos.

Mating, oviposition, embryonic development and leaf nest formation of *Phyllomedusa hypochondrialis* were observed by Budgett (1899) in the Paraguayan Chaco. Budgett's work was extended by Pyburn and Glidewell (1971) and Pyburn (1976), who observed populations of *P. hypochondrialis* on the western llanos of Colombia. Males of *P. hypochondrialis* begin calling from grasses and shrubs around pools that form during the first heavy rains of the rainy season. With few exceptions only gravid females come to the pools where males are calling. An egg-laden female approaches a calling male, the pair enters into amplexus and the female lays one egg mass on a leaf over water (Fig. 1). The first eggs emerge onto the upper surface of the leaf near its distal end. As laying continues the pair moves upward toward the petiole and both members of the pair, using their hind limbs, fold the leaf around the eggs, making a purse-like nest. After laying, the female disengages herself from the male and immediately leaves the breeding site. According to Budgett (*op. cit.*) spawning is sometimes continued on another leaf, but I have been unable to confirm this.

The leaf-nest contains about 80 eggs. Each egg is surrounded by its vitelline membrane and, outside of the membrane, by a thick, gelatinous capsule. Distributed among and over the surface of the egg-containing capsules are about 300 fluid-filled, eggless capsules. The fluid in the eggless capsules is probably metabolic water, produced in the body wherever oxidative processes take place (Thorson, 1955). As the eggs (embryos) develop, the space between embryo and vitelline membrane increases and fills with fluid. At the same time the fluid in the eggless capsules diminishes. Before hatching, the walls of the embryonated capsules become thin and tightly stretched. At hatching, the embryo, now a larva, breaks out of its capsule and usually falls into the pool below. If the larva falls on the ground it is capable of flipping into the water with its muscular tail.

Agar (1910) observed that during the development of *Phyllomedusa sauvagii,* a species whose nests are similar to those of *P. hypochondrialis,* the volume of vitelline fluid increased, causing the capsules containing the embryos to swell to twice their original size. Agar stated that the eggless capsules provided fluid for the developing embryos and observed that eggs near the surface of the mass died if they were not covered by the nest leaves.

My objective in the following observations and experiments was to test the hypothesis that the enclosing leaf and eggless capsules of *Phyllomedusa hypochondrialis* nests are necessary to the survival of the embryos during their nonaquatic developmental period.

Materials and Methods

The South American llanos is a vast savanna that extends from the Orinoco River southwesterly, in Colombia, to near the base of the eastern Andes. Its approximate southern boundary is marked by the Guaviare River (Bates, 1948), which, with its tributaries, flows northeasterly into the Orinoco. South of the Guaviare the drainage is southeasterly into the Amazon, and the vegetation is predominantly rain forest. In the Colombian llanos, the grass-covered uplands are broken by islands of close-growing trees known locally as "mata montes." In the humid lowlands broad-leaved trees and mauritia palms form isolated woodlands around lakes and extensive gallery forests along the streams (Beard, 1953).

The work reported herein was done in June and July, 1974, and in April and May, 1976, in and near the villages of Lomalinda and Puerto Lleras. These villages lie near the Ariari River in the southwestern part of the Colombian llanos. Although subject to sudden heavy rains and short dry intervals during the rainy season, the climate of the southwestern llanos is nevertheless regularly cyclic and predictable from year to year. The rainy season begins in early April and lasts 8 months. The average annual rainfall (1975–1977) at Lomalinda is 305 cm (J. K. Salser, personal communication), almost all of which falls between April and November. In the 4-month dry

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Fig. 1. Mating sequence in *Phyllomedusa hypochondrialis.* **Upper right,** calling male; **upper left and center,** gravid female and calling male approaching each other; **lower left,** amplectant pair ovipositing in leaf; **lower right,** separation of pair after laying.


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season very little rain falls and there may be long periods, 50 days or more, with no rain at all.

I observed developing egg clutches under both natural and artificial conditions. In either case I attempted to disturb the embryos as little as possible except for the variable being tested. Details of methods of handling differed in different circumstances and are stated in the appropriate places below. Temperature readings were made to the nearest 0.1 C with a Schultheis, narrow bulb quick-stabilizing thermometer. Developmental stages are those of Pyburn (1963) as modified from Gosner (1960). Egg nests used in indoor experiments were held in open plastic pans on a table about 75 cm above the floor and were not exposed to the direct sun. The room was ventilated by windows in its eastern and western walls, but the room temperature was not constant. The maximum recorded room temperature was 28.1 C; maximum recorded outside shade temperature was 43.0 C.

Experiments with Naturally Occurring Nests

I studied naturally occurring nests of *Phyllomedusa hypochondrialis* at several grassy pools at Lomalinda and nearby Finca Bon Aire. The pools were partly lined with low shrubs, and supported dense stands of emergent cane-like grass. Other frogs breeding at these pools at this time were *Hyla blairi, H. crepitans, H. leucophyllata, H. punctata, H. rostrata, H. wandae, Phrynohyas venulosa,* and *Pseudis paradoxus.* In addition to the larvae of these species the pools supported populations of dragonfly naiads, belostomatid bugs, ditiscid beetles (all of which prey on anuran larvae) and many other invertebrates.

The *P. hypochondrialis* enclosed their eggs in leaves of the emergent grass and in shrub leaves overhanging the pools from a few cm to about 1 m above the water. In order to test the effect of the enclosing leaf on embryo survival under natural conditions, I exposed the embryos of 6 nests at one pool by folding the leaf back to its original flat shape. Otherwise, I left each leaf in place with its egg mass undisturbed and firmly fixed to the leaf surface. Six nearby egg nests were noted but left unopened to serve as partial controls. I tried opening and resealing several nests but found that, once opened, the leaves would not stay closed of their own accord. Eggs of the exposed clutches were too compactly fused to each other and to the leaf to permit counting at the beginning of the experiment without weakening their attachment. Mortality figures for the experimental clutches were therefore based upon estimates of the number of dead or missing embryos in each clutch relative to the average number of embryos in the control clutches.

The 6 experimental clutches were exposed at about 2200 h, 14 April and were examined at 24 h intervals on the following 3 nights. A heavy rain fell about midnight on the 14th, after the leaves had been opened. No rain fell on the 15th and none fell during the day on the 16th. Both days were hot; at Lomalinda the air temperature rose to 43 C by noon on the 16th. A hard rain fell the night of the 16th.

Examination of the 6 egg nests on the next evening after they were opened revealed that 4 were developing normally, that most of another clutch was developing normally but about 30% of its embryos were missing, and that one entire clutch was missing from its leaf. Loss of embryos of the latter 2 clutches was most likely due to predation. By the evening of the 17th all the embryos in another clutch were dead and dried and the 4 remaining clutches all contained some dead and dried embryos. In all clutches the eggless capsules had collapsed and dried and the fluid of the embryonated capsules (perivitelline fluid) had darkened. Estimated mortality in the 6 experimental clutches was 100%, 100%, 5%, 40%, 65%, and 72%.

The 6 control clutches showed no evidence of predation or mechanical disturbance. When opened after the termination of the experiment, two clutches were developing normally and 4 contained dead embryos in the following percentages: 11.8%, 1.9%, 7.1%, and 1.3%. The perivitelline fluid of the live embryos had darkened. The mean number of eggs in the control clutches was 80.0 (range, 66 to 105). In all control clutches the mortality was 3.8%. Mortality in the 6 experimental clutches, based on an average of 80 eggs per clutch, was 65.8%.

Outdoor Experiments under Artificial Conditions

In order to test further the possible protective function of the enclosing leaf I attached 6 leaf nests to the vertical side of a western facing wooden, dark brown wall at 1200 h, 2 May 1976. The leaves were attached 1.5 m above the ground, in pairs, 15 cm between pairs and 2 cm between members of a pair. Eaves sheltered the clutches from the midday sun but not from the afternoon and evening sun, nor from rain coming from the west. The leaf of one member of each pair was opened, the other opened and reclosed. Each leaf was attached to the wall by a small brad. The condition of the eggs on the opened leaves was noted 8 times at irregular intervals over the next 3 days. During the day the weather was sunny to partly cloudy and warm. Rain fell irregularly in the daytime and every night. The highest air temperature recorded was 30.3 C at 1540 h on 2 May. At noon, 2 May, temperature readings of 2 clutch pairs were: 1st pair—air midway between clutches, 26.8 C; jelly of open clutch, 24.8 C; jelly of closed clutch, 26.4 C; 2nd pair—air midway between clutches, 28.5 C; jelly of open clutch, 26.4 C; jelly of closed clutch, 27.4 C. These data indicate a greater rate of evaporative water loss from the open clutches than from the closed clutches.

Evidence of shrinkage and excessive darkening (yellowing) of the capsular fluids was first noted in the three open clutches about 1530 h on 2 May.

Later that evening the clutches were wet by rain and all had recovered from the shrinkage of the previous day by 0645 h, 3 May. By 1115 h, 3 May, shrinking, drying, and yellowing were again in evidence and this trend continued until all of the embryos on the open leaves died. The eggless capsules became completely dry and the embryonated capsules shrank and became yellowish amber brown. By 1030 h, 4 May the embryos had shrunk to tiny amber-like beads and all were dead.

Among the 3 unexposed clutches, one nest had one dead embryo at the upper end of the clutch where it had not been covered by the leaf and five live embryos had shrunken capsules. About half of the eggless capsules in each nest had lost water and collapsed. Otherwise all of the embryos were developing normally when the leaves were opened at 1030 h, 4 May.

Indoor Experiments

To test the hypothesis that the eggless capsules contribute necessary water to the embryos (Fig. 3), I divided a clutch of *P. hypochondrialis* embryos (stage 18) into three lots as follows: 32 embryonated capsules, lot A, were transferred from the original leaf to another leaf of the same plant (*Lantana* sp.) and the leaf was folded around the embryos in the manner of a naturally formed nest. The edges of the leaf were fastened together with an insect pin. About 150 eggless capsules were included in this lot. A group of 21 embryonated capsules (lot B) was treated in the same way except that no eggless capsules were included with this lot. Neither of the leaves containing lots A and B was moistened during the experiment. The remaining 10 embryonated capsules (lot C) were submerged, without eggless capsules, in pond water. The lots were inspected irregularly and any dead embryos were counted and removed.

The submerged embryos (lot C) did not die immediately, contrary to the statement of Budgett (1899), but none advanced beyond stage 19 (heartbeat) and all died within 52 h after submergence.

The embryos of lot B began dying after 25 h (Fig. 4) although the developmental rate of the survivors did not fall behind the rate of the controls (lot A) until about 75 h from the beginning of the experiment. Mortality in lot B accelerated after 68 h and none survived beyond 99 h. Death of embryos began at either end of the mass, where the leaf was open, and proceeded inward, those embryos at the center being the last to die. Deaths

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Fig. 2. Mating sequence in *Agalychnis callidryas*. **Upper left and right,** calling male approached by gravid female; **lower left,** amplectant pair descending to pool; **lower right,** pair in pool taking up water; **middle right,** pair ascending; **lower middle,** pair ovipositing on leaf.

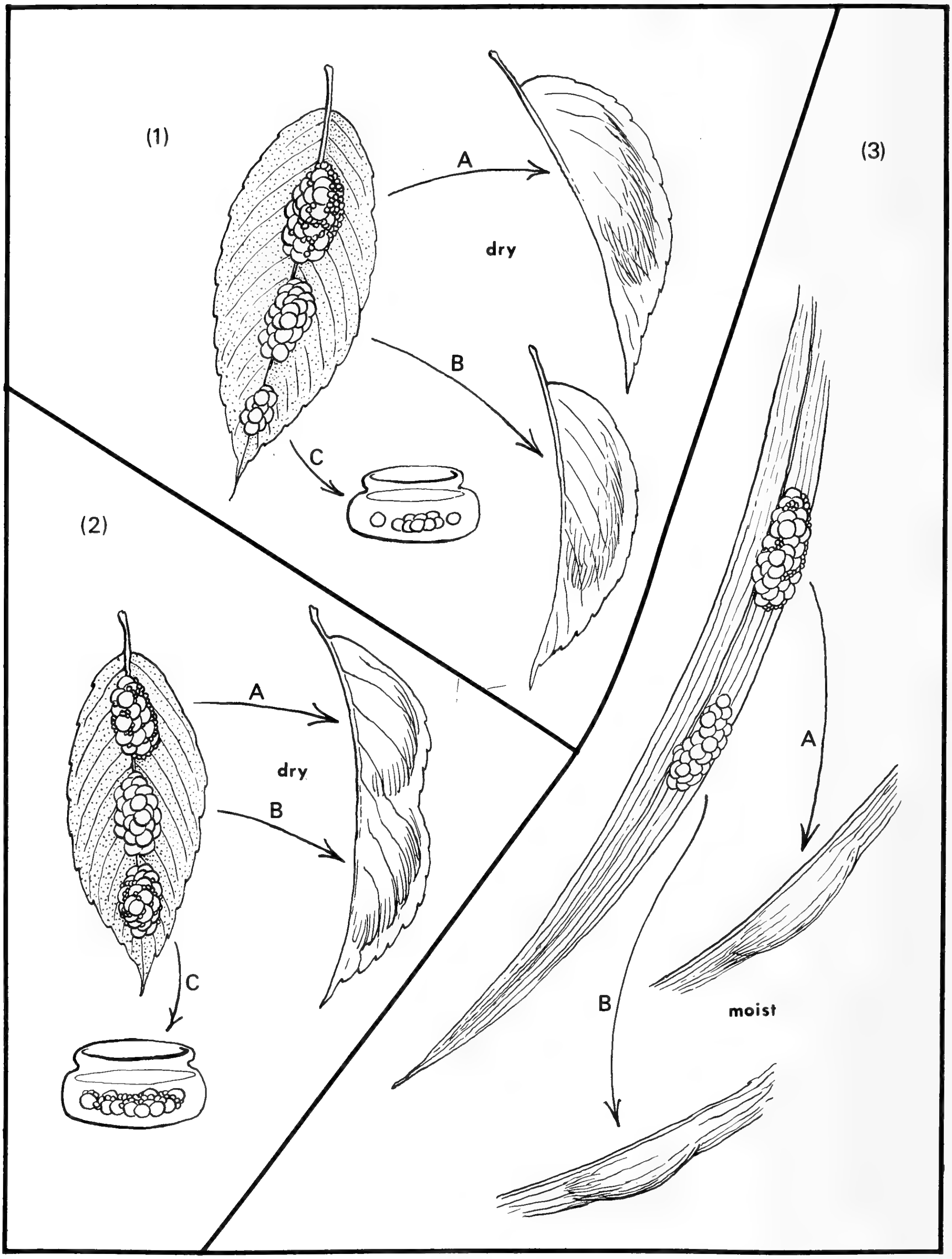

Fig. 3. Test of hypothesis that eggless capsules (**small circles**) contribute essential water to capsuled embryos (**large circles**) during terrestrial development. Numbers in parenthesis indicate sequence of experiments and letters designate egg lots as discussed in the text.

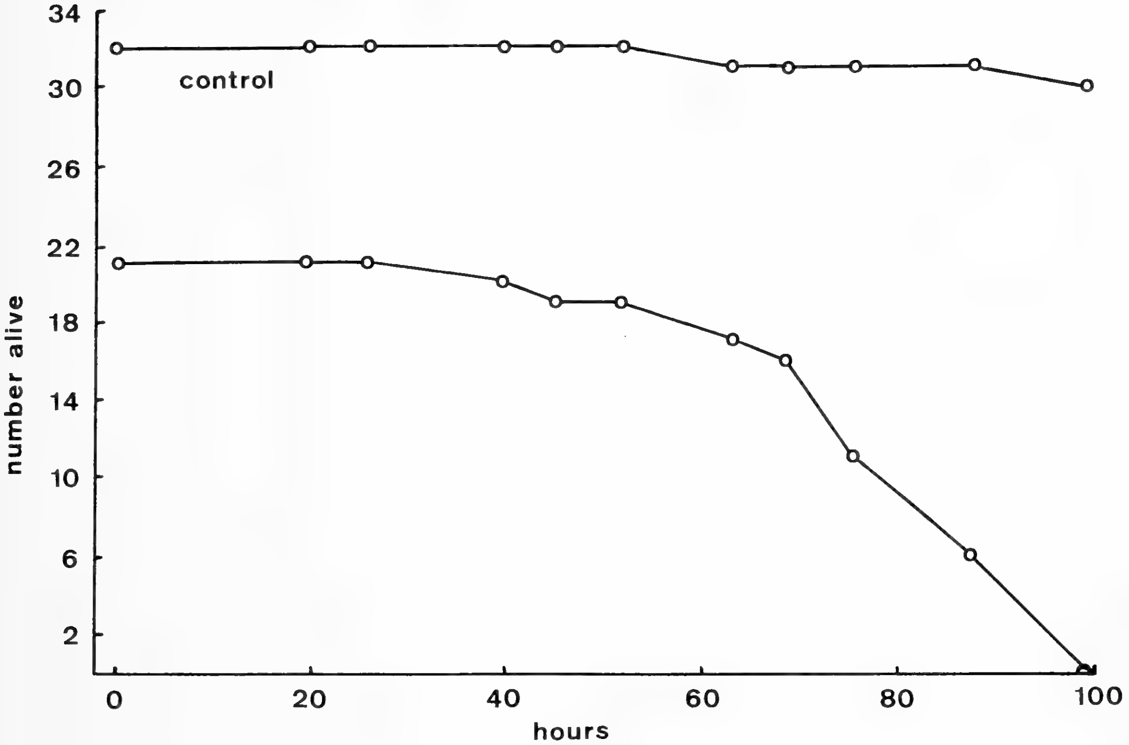

Fig. 4. Mortality of embryos of *Phyllomedusa hypochondrialis* in the absence of eggless capsules. See Fig. 3 (1).

were always preceded by reduction in capsular volume. Ninety-four per cent of the controls (lot A) survived beyond 99 h. As the leaf dried the eggless capsules adhered closely to the surface of the embryonated capsules and became smaller as the latter enlarged.

I repeated the experiment, with certain modifications, and obtained similar results (Fig. 5). In this second experiment two groups of 23 (lot A) and 25 (lot B) embryonated capsules were separated from each other but were wrapped in the original leaf. Lot A included about 100 eggless capsules, lot B none. A third group (lot C) of 21 embryonated capsules and about 100 eggless capsules was submerged in pond water. All embryos were from the same clutch and all were in stage 20 (gill circulation) at the beginning of the experiment. The submerged embryos advanced very little, none past late stage 20, and all eventually died. Most of the embryos of lot B developed normally during the first 20 hours then died between 20 and 32 hours after the beginning of the experiment. During the latter interval the capsules lost volume, which greatly restricted the movement of the embryos. The embryos of lot A (controls) developed normally and all survived beyond 32 hours. In the latter part of the experiment the volume of the eggless capsules decreased and some adhered closely to the surface of the embryonated capsules.

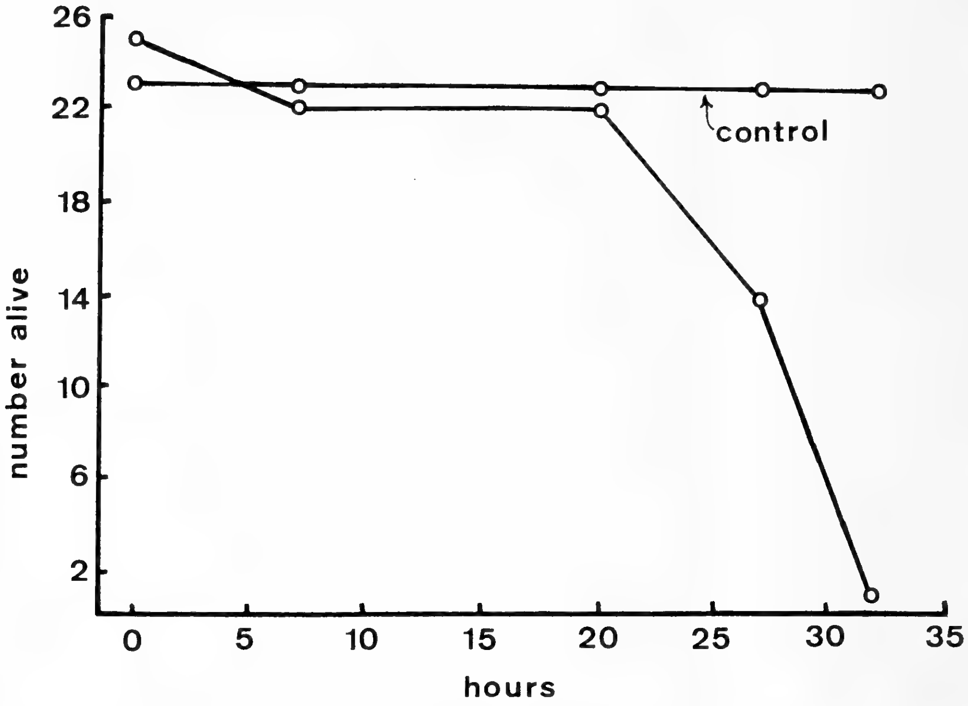

Fig. 5. Mortality of embryos of *Phyllomedusa hypochondrialis* in absence of eggless capsules. See Fig. 3 (2).

In a third experiment (Fig. 6) I divided a newly deposited egg mass into two groups of 32 (lot A) and 28 (lot B) encapsulated embryos. About 100 eggless capsules were included with lot A and none with lot B. The two lots were wrapped in separate leaves and the leaves wrapped in moist paper towels. Both lots were kept moist with pond water throughout the experiment. After about 12 hours, 10 embryos in lot A were destroyed by a cockroach (*Periplaneta* sp.), and toward the end of the experiment four eggs in lot B died from unknown causes. Otherwise all embryos developed normally and hatched after eight days.

In all of these experiments the capsular fluid of both experimental and control groups darkened as the embryos aged.

Results

The embryos of *Phyllomedusa hypochondrialis* usually died, even in the presence of eggless capsules, if exposed to the normal conditions of their habitat by opening the leaf cover. However, rain delayed or prevented the death of exposed embryos. The enclosing leaf of unopened nests protected the embryos against drying and death.

The leaf did not prevent the death of embryos in the absence of eggless capsules, unless the embryos received water from some other source. The

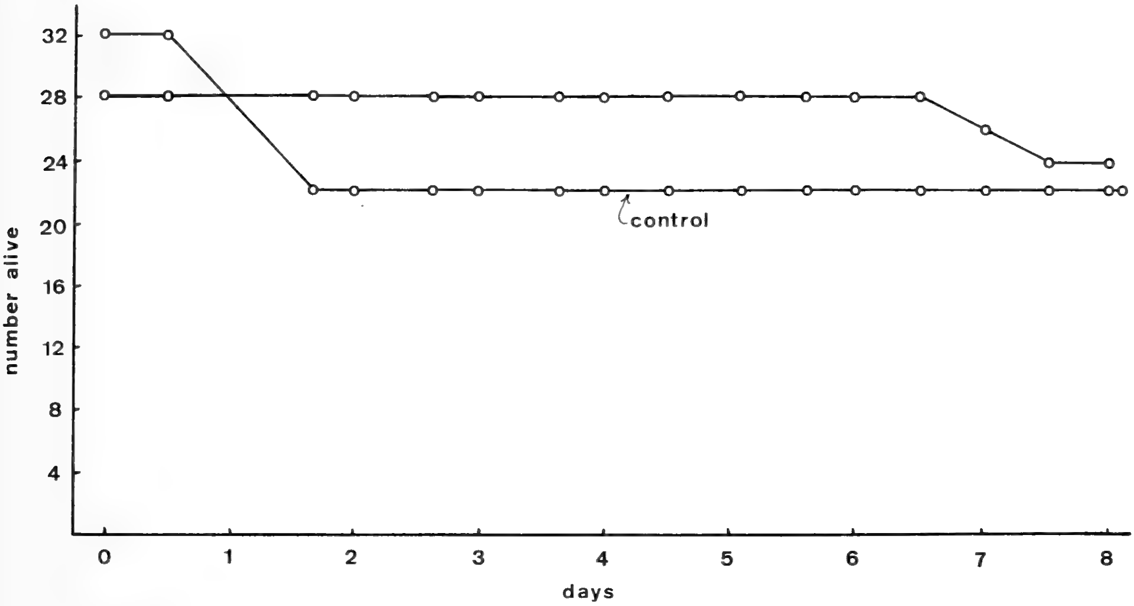

Fig. 6. Survival of embryos of *Phyllomedusa hypochondrialis* in the absence of eggless capsules when kept moist. See Fig. 3 (3).

embryos survived if eggless capsules were left with the clutch or, in the absence of eggless capsules, if the clutch was artificially moistened with pond water.

The results of the experiments and observations support Agar's (1910) statement that the eggless capsules supply water to the developing embryos. Furthermore, the results show that both leaf and eggless capsules are necessary for maximum survival of embryos during the nonaquatic period of development.

Discussion

Phyllomedusa hypochondrialis, like other phyllomedusine frogs (Agar, 1910; Kenny, 1966; Lescure, 1975; Lutz and Lutz, 1939; Oliver, 1937; Pyburn, 1970; Salthe and Duellman, 1973; Wiewandt, 1971), lays relatively small clutches of large-yolked eggs that have a long prehatch developmental period. Hence phyllomedusines may be said to have K-selected life history strategies in the sense of MacArthur and Wilson (1967:149), relative to frogs that lay large numbers of small-yolked eggs directly in water (see Crump, 1974). Eggs of frogs in the latter group often hatch as helpless embryos in stages 16–18 after only 24–28 h of development (Limbaugh and Volpe, 1957; Pyburn, 1967; Zweifel, 1964), whereas *P. hypochondrialis* eggs undergo 8–9 days of prehatch development (Pyburn, 1976) and upon hatching enter the water as advanced (stage 23), highly mobile larvae. As a result of their advanced condition at hatching phyllomedusines are immediately capable of detecting and escaping the many aquatic predators that commonly attack tadpoles (see Herreid and Kinney, 1966; Young, 1967; Brockelman, 1969; Heyer *et al.* 1975; McDiarmid and Heyer, 1974). The long prehatch period of *P. hypochondrialis* is possible not only because of each embryo's large yolk supply, but also because the enclosing leaf and water-storing capsules prevent drying and death during the terrestrial period. The leaf-nest of *P. hypochondrialis* is functionally analagous to an amniote egg.

The use of water from the eggless capsules by the embryos of *Phyllomedusa* can be explained from studies of species whose embryos normally develop in pond water and from well-known principles governing the movement of materials in solution. In *Rana,* shortly after fertilization, the ovum shrinks away from the vitelline membrane (Løvtrup, 1962) and secretes corticle granules containing polysaccharides into the perivitelline space (Konopacki, 1924; Salthe, 1965). The membrane is apparently impermeable to the polysaccharides which therefore exert an osmotic pressure causing water intake from the pond into the perivitelline space. As development continues proteins are secreted into the perivitelline fluid along with metabolic products of low molecular weight, including ammonia and urea. The membrane is permeable to these metabolites, which are continuously secreted at an increasing rate (Salthe, 1965). Ammonia and urea are toxic in high concentrations, but because they diffuse readily through the vitelline membrane they are not hazardous to embryos developing in pond water.

To nonaquatic embryos like *P. hypochondrialis,* that must rely on a limited external water source (the eggless capsules), the accumulation of nitrogenous wastes is a potential danger. In early developmental stages the increasing osmotic pressure of the perivitelline fluid causes water to diffuse from the adjacent eggless capsules into the fluid around the embryo, diluting the fluid and preventing the waste concentration from reaching a lethal level. Furthermore, there is initially a net movement of ammonia and urea from the perivitelline fluid into the fluid of the eggless capsules. However, because of the presence of proteins and polysaccharides, the initial loss of metabolites does not effectively lower the osmotic pressure of the perivitelline fluid, into which water continues to diffuse from the eggless capsules. The resulting increase in volume enclosed by the embryo's capsule and vitelline membrane permits free movement of the embryo's elongating tail and branching gills, while the capsule wall and membrane become thinly stretched. Because of the limited amount of water stored in the eggless capsules, a point is eventually reached at which the rate of dilution of waste can no longer keep pace with the increasing waste concentration in the perivitelline fluid. Excessive accumulation of metabolites in late prehatch stages is evidenced by the darkening amber color of the perivitelline fluid. At this point the embryo hatches. Thinning and eventual rupture of the capsular wall (hatching) may be due to the action of hatching enzymes

(Kobayashi, 1954), but rupture of the capsule seems to be aided by tail movements of the embryo, which increase in vigor as metabolite concentration increases.

Supplying the embryos with a large yolk reserve and stored water, and enclosing them in a shell-like leaf are all forms of parental care that require expenditure of reproductive energy, but at the same time permit a long prehatch developmental period that enhances the probability of survival of each hatchling after it enters the water.

Probably all phyllomedusines lay their eggs out of water and have prolonged prehatch periods, but strategies for delayed hatching differ among the species. Members of the genus *Agalychnis* (*callidryas, dacnicolor, moreleti*) oviposit on open leaves (Lutz, 1950) and do not supply the clutch with eggless capsules. Instead, the amplectant frogs go into the pool before laying, where they take up water to be released later as the eggs are deposited on a leaf (Fig. 2; Pyburn, 1970). The released water is stored in the copious jelly around the eggs and gradually diffuses into the perivitelline fluid as the osmotic pressure of the fluid increases. *Agalychnis callidryas* and *A. moreleti* sometimes oviposit on leaves that are several m above water (Fouquette, 1968; Duellmann, 1970:115). Nevertheless, before depositing each egg mass the mated pair goes back into the pool to replenish its water supply. These long trips between pool and oviposition site, in addition to increasing the time of exposure to predation, necessitate an energy expenditure by *Agalychnis* that could be spent otherwise if pond water were not required for embryonic development.

Unlike *Agalychnis, Phyllomedusa hypochondrialis* does not take water from the pool while in amplexus, and therefore is not as long exposed to predation during the egg-laying process. However, as in other members of the genus *Phyllomedusa* (Crump, 1974), *P. hypochondrialis* must allocate energy for nest construction and the production of the fluid-containing capsules, which are probably formed in the oviduct (Agar, 1910). Thus differences in mating characteristics between species in the genera *Agalychnis* and *Phyllomedusa* are due to different physiological and behavioral mechanisms for insuring a continuous supply of water to the prehatch embryos.

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THE GRAMMAR OF FAMILY-GROUP NAMES AS EXEMPLIFIED BY THOSE OF FISHES

George C. Steyskal

Abstract.—A review of the family-group names cited in Fishes of the World (Nelson, 1976) revealed that 71 of the approximately 900 names were in some way contrary to the Rules of Zoological Nomenclature or Latin grammar. These cases are discussed and corrections given to illustrate certain principles of nomenclatural grammar.

The review by Hubbs (1978) of Fishes of the World (Nelson, 1976) suggested to me that Nelson's work might serve as the basis of a review of the formation and grammar of family-group names, with the 450 names of families of fishes, as well as the equally large number of subfamily, tribal, and suprafamilial names serving as a quite typical example. The availability of such a large part of the family-group names in zoology under one convenient and timely cover serves well the general subject of biological nomenclature, and I hope that the results of this review of the names will promote at least to a small extent the regularity and stability of nomenclature.

The current nomenclature of the highest categories of fishes is shown to be no worse and perhaps somewhat better than that of other comparably sized branches of Animalia. I discuss here all cases that I consider to be in need of correction. I found 71 such cases among approximately 900 names. I give reasons for my opinions and mention some cases that are perhaps questionable and discuss them. It is hoped thereby to illustrate many similar cases in other groups of animals.

Although the source of the majority of generic and family-group names is classical Greek, the basis of their grammar is Latin, recognized in general in Article 11 (b) of the International Code of Zoological Nomenclature and also in Article 29, which concerns the grammatical procedure for forming family-group names based upon the name of a type-genus, sometimes known as a basonym.

The group names here discussed are those formed upon a basonym to which suffixes and compounding elements are added. Suffixes are formative elements not derived from a base word. Such are -idae (for families), -inae (for subfamilies), and -ini (for tribes). Compounding elements are based upon a word to which an ending or endings indicating case, number, and gender are added when the compounding element is final in the name. When the element is nonfinal only a combining vowel is usually added to it. The complete compounding element when final is often treated as a suffix, such as -oidea, -oidae, -oidei (based upon Greek *eidos* 'form, shape,' for superfamilial and subordinal names), -morpha (from Greek *morphē* 'form,' for superordinal names), and -formes (from Latin *forma* 'form,' for ordinal names). Of these, the International Code recognizes only -idae and -inae for regular use and recommends -oidea for superfamily names and -ini for tribal names. Nelson uses -oidae instead of -oidea for the superfamily rank and -oidei for suborders. There is some potential confusion in the use of -oidae for the superfamily rank, inasmuch as a genus name ending in -oa would form a family name ending in -oidae. Names for other higher ranks are not based upon a genus name and are not regulated by the Code.

Whatever formative element is used, it is applied to the stem of the basonym, the part of the genitive case of the name left when its case, number, and gender ending (French désinence) is subtracted. The form of the genitive case is cited in classical dictionaries. A few examples follow.

a) The Greek word *ichthys* 'fish' is cited in the Liddell and Scott Greek-English Lexicon (using classical Latin transcription and omitting accent marks, which are irrelevant to nomenclature, and references): "*ichthys* . . . . *yis. ho,* acc. *ichthyn,*" etc. This indicates by '*yis*' (in literal transcription *yos*) that *ichthyis* is the genitive and *ichthyn* (in nomenclature, incidentally) is the accusative, thus showing that *ichthy-* is the stem, and that the gender is masculine by citation of the masculine article '*ho.*'

b) The Greek word *stoma* 'mouth' is cited in the Liddell and Scott Lexicon: "*stoma, to* . . . gen. *stomatis,*" etc. This indicates by the article '*to*' that the gender is neuter and by '*stomatis*' (in literal transcription *stomatos*) that the stem is *stomat-*.

c) The Latin word *conger* 'sea-eel' in Harper's Latin Dictionary: "*conger* (access. form *congrus,* acc. to . . .) *gri,* m.," etc. This indicates that the genitive is *congri* and that the stem is therefore *congr-,* and by 'm.' that the gender is masculine. There is also an indication that the word in Latin is a loan-word from Greek.

d) The Latin word *salmo* 'a salmon' is cited in Harper's Dictionary: "*salmo, ōnis,* m.," etc., thereby indicating that the genitive is *salmonis* (with a long *o* upon which the stress falls). that the stem is therefore *salmon-,* and that the gender is masculine.

A little knowledge of how words are declined in the classical languages is necessary in order to recognize what part of the genitive case of the word is the stem. Enough knowledge of the Greek writing system to enable a systematist to use a Greek dictionary is not at all a formidable task and is well worth the trouble. Anyone who deals with nomenclature should also clearly recognize the difference between literal and classical transcription from Greek to Latin, for example that *cetus* is the classical Latin transcription of a Greek word transcribed literally as *kētos*.

Cases

A. The many family-group names formed with *-ichthys* as the last element of the basonym are correctly cited, e.g., Derichthyidae from *Derichthys* and Nemichthyidae from *Nemichthys*. However, when the final element is given the Latinized form *-ichthus* the stem must be *-ichth-*. Therefore, Ophichthidae and Ophichthinae (from *Ophichthus*) are correct, but

1) Ophichthyoidae must be a lapsus for Ophichthoidae.

Inasmuch as *Pteroidichtys* Bleeker may be considered an obvious lapsus or error for *Pteroidichthys,* the name of the subfamily Pteroidichthyinae cited by Nelson can be considered correct.

B. Basonyms in *-is* are to be treated variously according to the grammatical properties of the words they end. The most numerous category of *-is* names is of feminine gender and has the genitive in *-idis* with the stem therefore in *-id-*. The following generic names are cited in Greek lexicons as having such stems: *Cobitis, Echeneis, Eleotris, Engraulis, Heterotis* (cf. *Myosotis* in botany), *Latris, Liparis, Monocentris* (*Centris*), *Pempheris, Pholis, Scorpis*. Therefore,

(2) Cobitidae should be Cobitididae;
(3) Cobitinae should be Cobitidinae;
(4) Echeneidae should be Echeneididae;
(5) Eleotridae should be Eleotrididae;
(6) Engraulidae should be Engraulididae;
(7) Ephippinae should be Ephippidinae;
(8) Heterotinae should be Heterotidinae;
(9) Latridae should be Latrididae;
(10) Liparinae should be Liparidinae;
(11) Monocentridae should be Monocentrididae;
(12) Pempheridae should be Pempherididae;
(13) Pholinae should be Pholidinae;
(14) Scorpinae should be Scorpidinae.

The name *Cranoglanis,* formed on *glanis,* is also in this category, but the name cited by Nelson, Cranoglanididae, is correct.

Names in *-aspis* have the stem *-aspid-*; all are correct.

Names in *-lepis* have the stem *-lepid-*. Grammicolepididae, Muraenolepididae, Paralepididae, and Zaniolepididae are correct, but

(15) Muraenolepoidei should be Muraenolepidoidei, and
(16) Pristolepinae should be Pristolepidinae.

Names in *-batis* have the stem *-batid-*. The following require correction:

(17) Anacanthobatinae should be Anacanthobatidinae;
(18) Arhynchobatinae should be Arhynchobatidinae;
(19) Batoidimorpha should be Batidoidimorpha; and

(20) Myliobatidae and Myliobatinae should be Myliobatididae and Myliobatidinae.

When the ending of *-batis* is changed to *-us* or *-os,* the stem is simply *-bat*. *Rhynchobatus* therefore correctly forms Rhynchobatinae and *Rhinobatos* forms Rhinobatidae, as cited by Nelson.

The generic name *Dasyatis* is an unusual case. Agassiz (1845) supposed it to be an error for *Dasybatis*. Such an error cannot be emended, but it seems reasonable to treat *Dasyatis* as the names in *-batis* in the same Order are treated. Therefore,

(21) Dasyatidae should be Dasyatididae, and

(22) Dasyatinae should be Dasyatidinae.

However, it would be desirable to obtain a ruling from the International Commission on Zoological Nomenclature on this.

Many names in *-is* do not have the *-id-* stem. Names formed from *ophis* 'serpent' are in this category (Greek genitive *opheōs* or *opheos*), although the diminutive is *ophidion*. They should be treated as are Latin words in *-is,* that is, the genitive stem is the same as that of the nominative and the *-is* ending simply deleted when a different suffix is added. The treatment of such words in Appendix D, Table 2B, of the Code should be emended.

(23) Nemophididae should be Nemophidae;

(24) Percophididae should be Percophidae; and

(25) Percophidinae should be Percophinae.

Names formed from *Pristis, Pterois, Chromis, -aclis* (*Pteraclis*), and *-opsis* (*Cetopsis, Percopsis*) are also in this latter category and have correctly formed family-group names.

Lampris Retzius, 1799 was stated by Agassiz to be based upon the Greek adjective *lampros*. Inasmuch as *lampris* is not attested in Greek lexicons that word can only be considered as having a changed ending (*-os* replaced by Latin or Greek *-is*). The form of the family cited by Nelson, Lampridae, may be considered correct because of lack of evidence that *Lampris* has the stem *lamprid-*. Furthermore,

(26) Lampridiformes should be Lampriformes, and

(27) Lampridoidei should be Lamproidei.

The name *Chirolophis* is not formed from *ophis,* but from *lophos* 'ridge' with a replaced ending. The tribal name Chirolophini is therefore correct.

The name *Omosudis* is derived from *Sudis,* cited by Agassiz as a proper name. The only *sudis* in classical lexicons is Latin and does have a genitive differing from the nominative. The family named Omosudidae is therefore correct.

Names formed from *actis* have the stem *actin-*. Therefore, the names cited by Nelson, Aploactininae (from *Aploactis*) and Gigantactinidae (from

Gigantactis) are correct, but

(28) Bathyaploactinae should be Bathyaploactininae.

C. Names in *-as* are also treated variously according to the grammatical properties of the word they end. Nouns (not participles) in *-as* after a consonant (not *-ias*) are feminine and have a stem in *-ad-*. The following, based upon *Bembras* and *Premnas,* should be corrected:

(29) Bembrinae should be Bembradinae, and

(30) Premninae should be Premnadinae.

The name *Doras* Lacepède, 1803 was considered by Agassiz to be derived from Greek *dory.* It is not attested in Greek lexicons but may be considered to belong to the same small class of Greek words which includes the foregoing (Bembras, Premas) and such words as *lampas, deiras,* and *niphas.* The family name used by Nelson, Doradidae, may therefore be considered correct.

Another kind of word ending in *-as* are participles, a kind of verbal adjective used in the capacity of generic names as nouns. Nelson cites Anabantidae (from Anabas) correctly; it is a participle of the Greek verb *anabainō* 'to go up.' Another generic name in this category is *Anarhichas* Linnaeus; it can only be derived from the Greek verb *anarrhichaomai* 'to clamber up.' Verbs in *-omai* do not have participles in *-as,* but it seems reasonable to consider that Linnaeus intended to form a participle similar to *Anabas,* and to treat it similarly, that is, to use the stem in *-nt-* with it, rather than either *-ad* or *-at-*. For this reason,

(31) Anarhichadidae should be Anarhichantidae.

Names in *-ias* are masculine and have the stem in *-i-*, in other words, the *-as* ending is deleted when applying other endings. The following names are therefore correct: Alopiinae, Ceratiidae, Diceratiidae, Clariidae, Dalatiinae, Eulophiini, Galaxiidae, Xiphiidae. The following should be corrected:

(32) Melanostomiatidae should be Melanostomiidae;

(33) Oryziatidae should be Oryziidae;

(34) Stomiatidae should be Stomiidae;

(35) Stomiatoidae should be Stomioidae; and

(36) Stomiatoidei should be Stomioidei.

D. Names in *-ma* are usually neuter in gender and have a stem in *-mat-*. They are of Greek origin and end in the letter alpha. There are, however, a few which end in eta in Greek, are feminine in gender, and have a stem in *-m-*. There are even a few cases of verbal nouns formed from the same verb, one ending in alpha and the other ending in eta. Both of such words appear in classical Latin transcription as *-ma*. The word *gramma* is one of these. There was a semantic difference between the two forms, but even the Greeks had trouble applying it, and it seems reasonable for nomenclatural purposes to consider all names ending in *-ma* for which there is a form in alpha as neuter and to have *-mat-* stems. There are a few, such as *toma,* which have only the form ending eta; these of course should be feminine and have the *-m-* stem. And of course when the word ending in *-ma* is part of a nomenclatural name with a replaced ending, such as *-us, -is,* or *-um,* the stem will also be simply *-m-*.

Some frequently used final elements of names are in the neuter *-ma* class, including *-gramma, -soma, -stoma,* and *-omma*. The following group names in Nelson are correct: Dorosomatinae, Elassomatinae, Oreosomatidae, Sparisomatinae, Etheostomatini, Gonostomatidae, Gonostomatoidae, Microstomatinae, Moxostomatini.

The following names require correction:

(37) Cyemidae should be Cyematidae;
(38) Grammidae should be Grammatidae;
(39) Pseudogrammidae should be Pseudogrammatidae;
(40) Ariommidae should be Ariommatidae;
(41) Dysommidae should be Dysommatidae;
(42) Dysomminae should be Dysommatinae;
(43) Glaucosomidae should be Glaucosomatidae;
(44) Branchiostomidae should be Branchiostomatidae;
(45) Nettastomidae should be Nettastomatidae.

Because of the replaced endings, Aulostomidae (from *Aulostomus*), Anostomidae (from *Anostomus*), and Solenostomidae (from *Solenostomus*) are correct.

E. Another class of participles are certain words ending in *-on*. These have a long *ō* in Greek, are of masculine gender, and have a stem in *-ont-*. Four names of fishes are formed on *-myzon,* a participle of the verb *myzō* 'to suck.' Two of them have correctly formed family-group names: *Erimyzontini* and Gastromyzontinae. The other 2 should be corrected:

(46) Mayomyzoninae should be Mayomyzontinae;
(47) Petromyzonidae should be Petromyzontidae;
(48) Petromyzoninae should be Petromyzontinae; and
(49) Petromyzoniformes should be Petromyzontiformes.

The case of *Petromyzon* is Case No. Z.N. (S.) 2045 before the International Commission on Zoological Nomenclature. It was published in the Bulletin of Zoological Nomenclature, vol. 30, p. 198–199, and I commented on it in the same journal, vol. 32, p. 21.

F. Names in *-odus* are usually from Greek *odous* 'tooth,' are of masculine gender, and have a stem in *-odont-*. The following are correct in Nelson: Chauliodontidae, Chilodontidae, Distichodontidae, Hemiodontinae, Micromischodontinae, Prochilodontidae, Synodontidae. Agassiz stated that his genus *Ceratodus* is derived from *odous*; therefore:

(50) Ceratodidae should be Ceratodontidae.

Pimelodus Lacepède, 1803 was unjustifiably emended to *Pimelodes* by Duméril in 1805. Agassiz recognized that *Pimelodus* is the Greek word *pimelōdēs* with a replaced ending. The family name Pimelodidae is therefore correct.

G. Names in *-pus* are frequently derived from Greek *pous* 'foot,' are of masculine gender, and have a stem in *-pod-*. The names based upon *Ateleopus* (Ateleopodidae, etc.) are therefore correct. *Lepidopus* is evidently also so derived. Agassiz stated that *Carapus* Rafinesque is also derived from *pous*. Therefore:

(51) Lepidopinae should be Lepidopodinae;
(52) Carapidae should be Carapodidae; and
(53) Carapinae should be Carapodinae.

H. Names formed on the Greek word *gaster* 'abdomen' are feminine, elide *e,* and form a stem *gastr-,* similar to the way *conger* and *scomber* form their stems *congr-* and *scombr-*; therefore:

(54) Anoplogasteridae should be Anoplogastridae;
(55) Canthogasterinae should be Canthogastrinae;
(56) Korsogasteridae should be Korsogastridae;
(57) Pristigasterinae should be Pristigastrinae; and
(58) Trichogasterinae should be Trichogastrinae.

I. Adverbs as generic names. The generic name *Odax* is a Greek adverb meaning 'by biting with the teeth,' and is therefore strictly speaking not in one of the categories of words available for names of genera. However, if it be considered a neologistic noun by virtue of its use as a generic name, it may be treated as Latin to the extent that it would have a stem similar to those of Latin nouns of similar form, viz., it would have the stem *Odac-*. The family-group name cited in Nelson may therefore be considered proper.

J. Miscellaneous. Two cases of family-group names lacking a letter i are based upon *Oxylebius* and *Proscyllium,* which respectively have the stems *Oxylebi-* and *Proscylli-*; therefore:

(59) Oxylebinae should be Oxylebiinae, and
(60) Proscyllini should be Proscylliini.

Names in *-e* generally drop that letter for their stems, as do *Belone, Mene, Narcine, Narke,* and *Thalassophryne* in forming Belonidae, Menidae, Narcininae, Narkini, and Thalassophryninae, respectively. There seems to be no reason why the name *Schilbe* should not be treated likewise:

(61) Schilbeidae should be Schilbidae.

Names ending in *-es* drop that syllable for their stems; therefore:

(62) Helogeneidae should be Helogenidae, and
(63) Melamphaeidae should be Melamphaidae.

Bembrops has the stem *Bembrop-*; therefore:

(64) Bembropsinae should be Bembropinae.

Peronedys must be derived from Greek *pēros* + *nēdys* and have a stem *Peronedy-*; therefore:

(65) Peronedysidae should be Peronedyidae.

The word used in Latin as *cerdo,* a loanword from Greek *kerdos,* has the stem *cerdon-*; therefore:

(66) Galeocerdini should be Galeocerdonini.

The generic name *Sillago* Cuvier, 1817 is stated by Agassiz to be derived from the Greek adjective *sillos* 'squint-eyed.' It may therefore be considered to have the Latin formant *-ago* applied to it and to have a stem similar to those of Latin words in *-ago,* such as *farrago, imago, virago,* viz., *sillagin-*. On this basis the family name Sillaginidae is correct.

The genus *Kasidoron* and the family Kasidoroidae were proposed by Robins and De Sylva in 1965 without indication of derivation. The name *Kasidoron* is derived from Greek *kasis* + *dōron,* signifying something like 'a gift from a brother.' It is therefore of neuter gender (not originally indicated) and has the stem *Kasidor-*; therefore:

(67) Kasidoroidae should be Kasidoridae.

In 2 cases diminutives have been treated as if they were participles. The genus name *Ostracion* is a diminutive, of neuter gender, and has the stem *Ostraci*; therefore:

(68) Ostraciontidae should be Ostraciidae;

(69) Ostraciontinae should be Ostraciinae; and

(70) Ostraciontoidae should be Ostracioidae.

The other diminutive is *Zenion* Jordan and Evermann. The authors stated that it is a diminutive of *Zeus*; as such, it will have the stem *Zeni-*. Therefore:

(71) Zeniontinae should be Zeniinae.

Inasmuch as the generic name *Capros* is simply the Greek word for 'goat' and has the stem *capr-*, Jordan and Evermann, and Gill before them, recognized that Capridae would conflict with family-group names for goats and used the form Caproidae. Nelson's citation of that form, as well as Caproinae, is therefore justified; however, the usage should be legalized by submission of an application to the Commission. The goats at present constitute a subfamily Caprinae.

Two spellings of a name, *Noemacheilus* and *Nemacheilus,* are noted in Zoological Record as published by the same author in the same year. Whatever is the valid original spelling of the genus, the family-group name based upon it will be formed upon that name as far as the "*l*" followed by the appropriate family-group suffix. Nelson uses Noemacheilinae.

Index to Basonyms

If a name is discussed, reference is given to the Case number in parentheses; otherwise the closest following Case number is given, except for 3 names in the final paragraphs, which are referred to by "(final)."

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STUDIES OF NEOTROPICAL CADDISFLIES XXV: THE IMMATURE STAGES OF *BLEPHAROPUS DIAPHANUS* AND *LEPTONEMA COLUMBIANUM* (TRICHOPTERA: HYDROPSYCHIDAE)

Oliver S. Flint, Jr., and J. Bruce Wallace

Abstract.—Larvae, pupae, and larval catchnets are described and illustrated for *Blepharopus diaphanus* Kol. and *Leptonema columbianum* Ulm. All data indicate that *Blepharopus* is closely related to, but distinguishable from, *Macronema. L. columbianum* is easily distinguished from its known congeners. Notes on habitats and behavior are presented.

The trichopterous family Hydropsychidae is represented in South America by two subfamilies, the Hydropsychinae and the Macronematinae. Only a single hydropsychine genus, *Smicridea* composed of two subgenera, is known from that continent. Larvae and pupae of several species in both subgenera have been described (Ulmer, 1909; Ross, 1944; Flint, 1974; Wiggins, 1977; etc.). Within the South American Macronematinae, however, there is considerably more generic diversity as shown by the eight known genera (*Blepharopus, Centromacronema, Leptonema, Macronema, Neoleptonema, Plectromacronema, Pseudomacronema,* and *Synoestropsis*). Our knowledge of the immature stages of these genera is very poor, however, and often based on association by elimination. Larvae of three species of *Leptonema,* and one species of *Macronema* are apparently all that have been described with firm associations of the life stages. All other generic or specific attributions are based on similarities, supposition, and elimination. We have made concerted efforts to associate by the metamorphotype method the immature stages and adults of more genera and species, but have been singularly unsuccessful with the following two exceptions.

The larvae and pupae of *Blepharopus diaphanus* Kol. are firmly associated by the presence of numerous ♂ and ♀ metamorphotypes in one collection. Their discovery removes any possibility that the larvae described by Marlier (1964) as Genus A and tentatively attributed to *Blepharopus* are that genus. Genus A in all probability is a distinctive species group of the genus *Leptonema.*

Leptonema columbianum Ulm. is associated with its larva and pupa for the first time on the basis of several female metamorphotypes. This species belongs to a group of species quite distinct from those other species whose larvae are known. Consequently it is not surprising to find the immature stages of this species showing distinct differences from its known congeners.

Blepharopus diaphanus Kolenati
Figs. 1–2, 5–6, 9–24

Blepharopus diaphanus Kolenati, 1859, p. 242.—Fischer, 1963, p. 164.—Flint, 1978, p. 395, 404.

Blepharopus is a monotypic genus known from Argentina, Brazil, and Venezuela. Adults are often collected at lights adjacent to the larger rivers throughout the region. Immature stages of the genus have not been described before, in spite of the Marlier (1964) suggestion to the contrary.

The larval, pupal, and adult morphology all agree in indicating a close relationship to *Macronema*. In all the *Macronema* larvae described, each genal half possesses a carina, the two converging at the apex of the frontoclypeus. In *Blepharopus* this carina is poorly developed, and is farther from the frontoclypeal sutures at the posterior of the head than at the anterior. The head, thoracic nota, and abdomen are apparently naked, except for a few scattered long setae, whereas in most other *Macronema* species the abdomen, at least, bears a sparse covering of short, dark setae. The basic structure of the mouth parts, legs, gills, etc. seems to be the same in both genera.

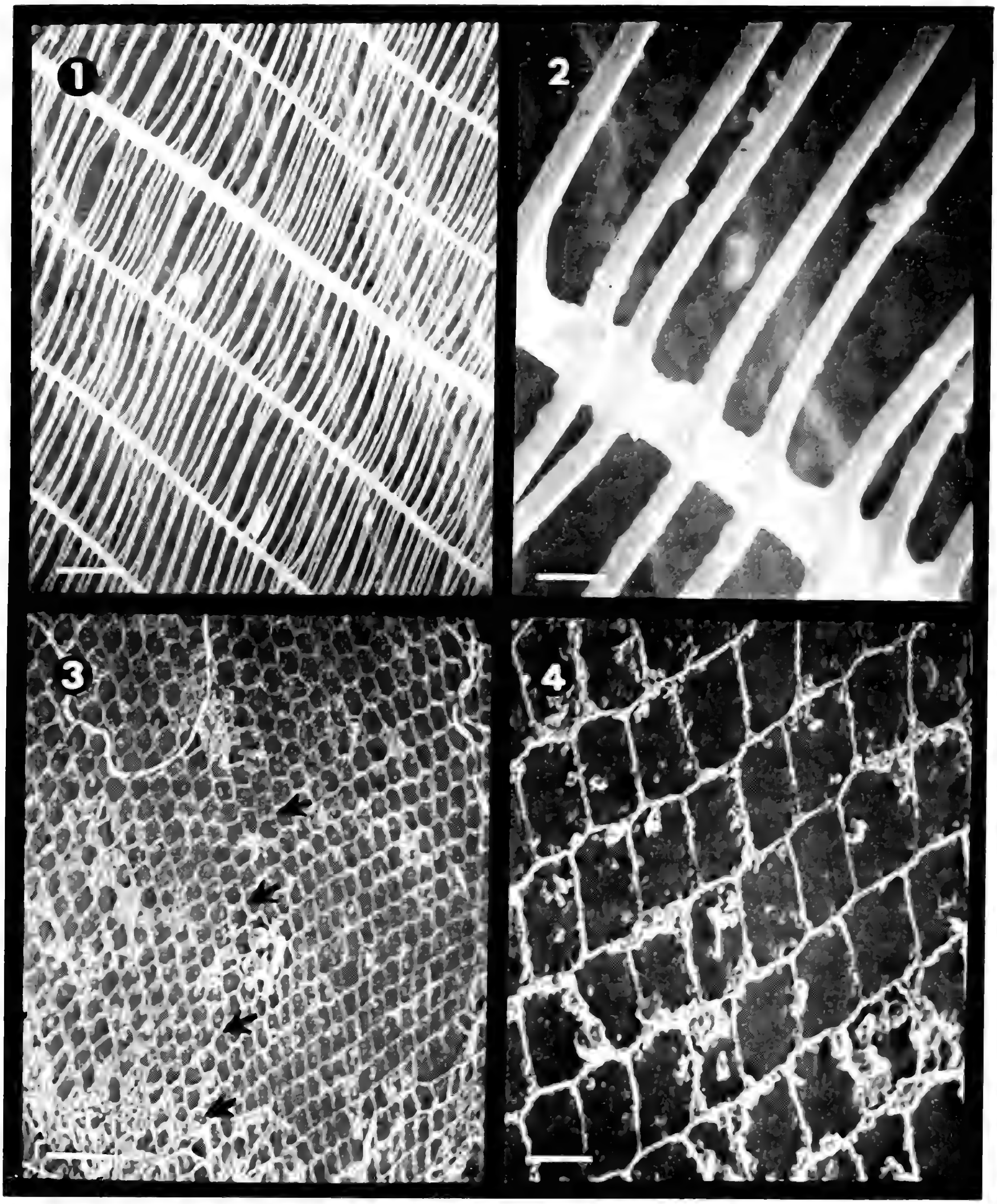
In the pupal stage there appears to be one distinctive structure, that of the raised knobs of the face which bear many long setae. There is no mention of such a structure in any of the described species of *Macronema*. The mandibles, hook plates, and apical processes seem nearly identical or only specifically different from *Macronema*.

The adult is also very closely related to *Macronema,* differing primarily in the structure of the head of the male. The protruding dorsomesal keel with bulging lateral warts is undoubtedly due to the enlargement of the eyes which have "pushed" these normally unobtrusive structures into such an obvious position. The head and thorax of the insect are extremely hairy, very different from any *Macronema* known to us.

The nets are remarkably similar to those found in *Macronema,* and are obviously adapted for sieving minute particles from the passing water. The dense brushes of the labrum and forelegs are also similar to those found in *Macronema* and are undoubtedly used in feeding on small particles captured by the net.

In sum, all life stages show a genus very closely related to *Macronema,* but with enough specializations to still deserve generic recognition.

Larva.—Length 16–18 mm, width 2.5–3 mm. Sclerites pale reddish-brown to golden-yellow, muscle scars yellow.



Figs. 1–4. **1,** A portion of the catchnet of *Blepharopus diaphanus* (SEM at 500×; scale line at lower left = 20 μm). **2,** Same, at 10,000×; scale line = 1 μm; note that all smaller strands overlie the larger support strand. **3,** Catchnet of *Leptonema columbianum* (SEM at 50×; scale line = 200 μm); arrows denote approximate location of the central seam of the net. **4,** Same, at 200×; scale line = 50 μm.

Head: Slightly wider than long; surface smooth and shining. Color pale reddish-brown, muscle scars pale yellow. Gena with a low, sharp carina from anteriad of eye almost to posterior margin; carina diverging from the frontoclypeal suture posteriad. Anterior margin of frontoclypeus slightly concave. Gena ventrally with anterior 10 stridulatory lines widely separated, the transition to the close posterior lines very abrupt. Labrum with a large membranous basal region bearing 2 transverse sclerites adjacent to frontoclypeus; with large lateral brushes on lobes; anterior margin with a dense fringe of hair; dorsal surface with scattered pale setae and a pair of long dark setae anteromesally. Mandibles strongly asymmetrical; without mesal tuft of hairs. Submentum with anterior margin concave; anterolateral angle bearing 2 large, black, setae, and a group of shorter setae.

Thorax: Sclerites pale reddish-brown, grading to golden-yellow; muscle scars pale yellow. Pronotum with 1 pair of well-developed dorsal setae, and a few anterolateral setae; smooth and shining. Prosternum broadly transverse; with a small triangular sclerite posteromesally. Meso- and metanota each with 2 pairs of erect dorsal setae, and a few laterally; surface smooth and shining. Foretrochantin broadly triangular with a marginal row of spiniform setae. Coxa of foreleg with a pad of short, spiniform setae posteromesally. Foreleg with femur bearing a slender, digitate basomesal process; femur and trochantin with a sparse fringe of long hair ventrally; tibia and tarsus with a dense fringe of long, silky, hairs primarily on outer surface. Mid- and hindlegs similar; with scattered long setae; apex of tibia with a comb of 4–5 broad, spiniform setae anteriorly. Tarsal claw of foreleg almost straight, with a spiniform basal seta; claws of mid- and hindlegs, curved, basal seta stout, arising from a produced, slightly fimbriate, pointed, basal lobe. Mesosternum with 1 pair of gills; metasternum with 2 pairs.

Abdomen: Gills ventrally, laterally, and dorsolaterally as in figure 24. Lateral line totally lacking. Integument with scattered setae; smooth and shining. Sternum 8 with 1 pair of long, dark, setae, and 1 pair of shorter, paler, setae. Segment 9 with tergum divided into a pair of small, pale, lateral plates each bearing 2 long, dark setae, and 2 short, branched setae; a small, linear, lateral sclerite with a row of long setae; sternum with a pair of ovoid plates covered with pale spiniform setae and 3 or 4 long, black setae posteriorly. At least 4 anal gills. Anal proleg short; lateral sclerite with row of long, black setae laterally; anal claw as long as lateral sclerite, curved ventrad, without accessory teeth; with 2 pale setae ventrobasally.

Pupa.—Length, ♂ 14 mm, ♀ 10 mm.

Head: Mandibles tapering regularly to a pointed apex; inner margin with 3 teeth; inflated basally, with a group of setae on outer face. Labrum small and rounded, with 2–3 basolateral setae. Face with a bilobed, protruding area whose integument is spiculate and bears a number of very long, hooked setae on each side. Vertex with a small group of setae on each side and a pair anteromesally.

Thorax: Meso- and metanota with 1 or 2 pairs of erect submesal setae. Tibia and tarsus of midleg broad and flattened, with well-developed lateral fringes.

Abdomen: Lacking lateral fringe or lobes; gills present. Hook plates anteriorly on segments 3–8; posteriorly on segment 3. Dorsum of segment 2 and 3 regularly, but sparsely, covered with short spiniform setae; segment 4 with an irregular row of long setae along posterior margin. Apical processes tapering to a blunt point; ventral and lateral surface bearing long, pale, slightly hooked setae from well developed tubercles.

Larval catchnet.—Individual meshes 0.5 to 2.5 μm wide ($\bar{x}$ = 1.85 μm; s.e. mean = ±0.2284) and 9 to 55 μm long ($\bar{x}$ = 26.3; s.e. mean = ±1.64). Total catchnet area ca. 30 mm^2; thus, about 600,000 meshes per net.

Pupal shelter.—Length approx. 15 mm, width 5 mm. Firmly constructed of small sand grains. Anterior end often "crowned" by a marginal "fence" of sand grains with a distinct closing lid. Inside of anterior lid a regular mesh-like sieve membrane attached around edge of lid; posteriorly without such a distinct lid, but internally with the same sieve membrane.

Material.—Brazil, Edo. Rio de Janeiro, Mun. Rio Claro, Rio Pirai, 8 Apr. 1977, C. M. & O. S. Flint, Jr., many hundred larvae, pupae, ♂ ♀ metamorphotypes, and adults.

Remarks.—Although the vast majority of adult collections of this species made by the senior author are from near large rivers, the situation at the Rio Pirai is quite different. This collection was made in a riffle area where the stream is only about 5 meters wide and one-third of a meter deep. The water is slightly turbid and greenish, temperature 25°C, and the bottom of the riffle composed of sand, gravel, and rubble. Below (and probably upstream also) the stream is wider and deeper, almost lotic in aspect. In common with the larger riversites, however, the stream is open everywhere to full sun with the probable consequence of higher water temperature and perhaps greater primary productivity.

Although the exact details of the larval dwelling were not noted, they were constructed of sand grains attached to stones and appeared similar to that described previously for *Macronema zebratum* Hagen (Wallace, 1975; Wiggins, 1977). The catchnets are obviously not spun in the same manner as typical Hydropsychinae (see Sattler, 1955, 1958), since the smallest

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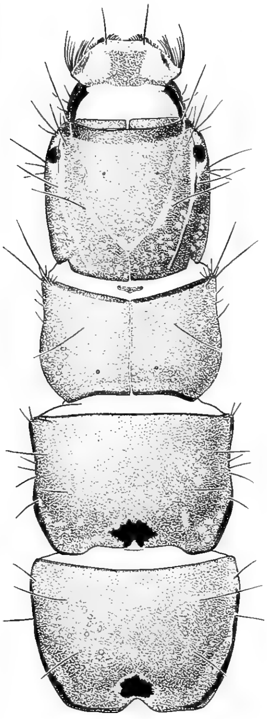
Figs. 5–8. *Blepharopus diaphanus*: **5,** larval head and thoracic nota, dorsal; **6,** larva, lateral. *Leptonema columbianum*: **7,** larval head and thoracic nota, dorsal; **8,** larva, lateral.



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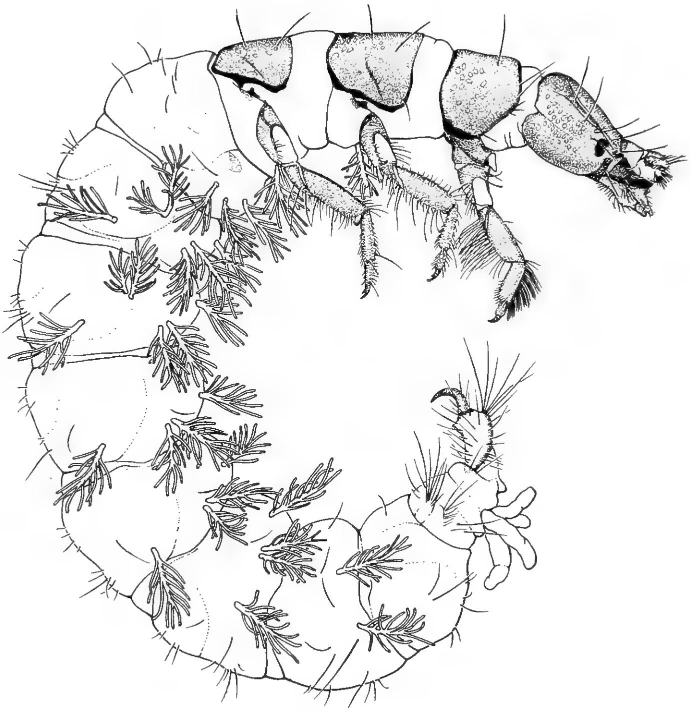

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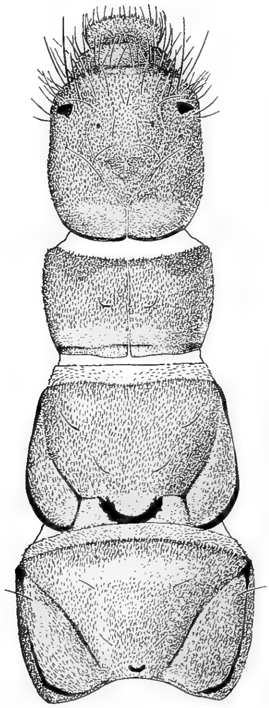

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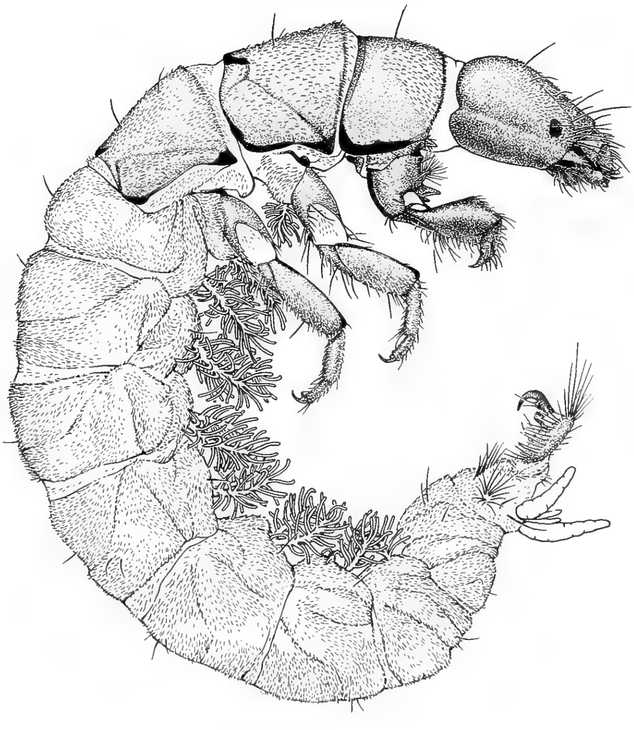

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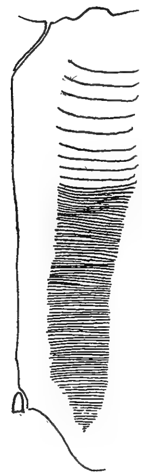
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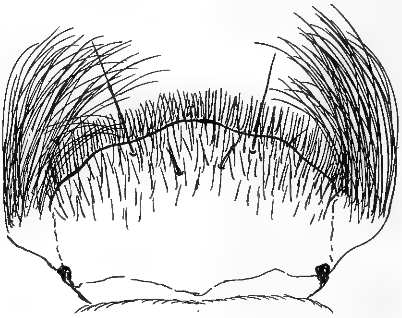
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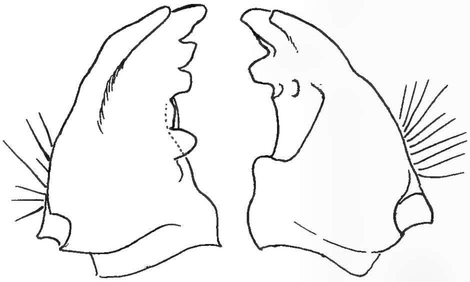
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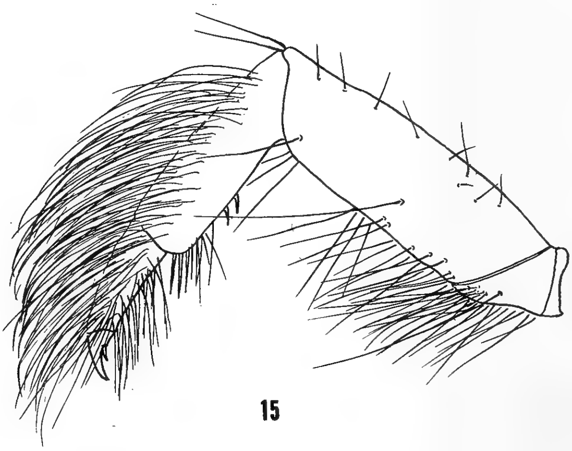
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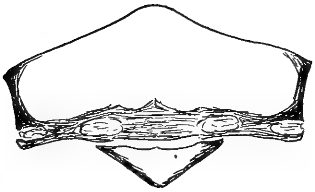
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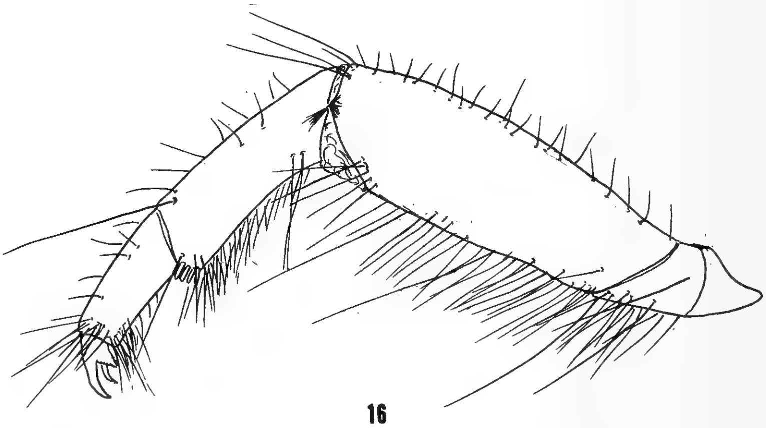
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strands overlie the larger support strands (Figure 2). They are, however, virtually identical to those of *Macronema* (Sattler, 1963; Wallace, 1975), but the individual meshes are the smallest yet reported for the Hydropsychidae. The pupal shelters were often attached on one side to a larger stone, or rarely free in the sandy substrate.

Leptonema columbianum Ulmer
Figures 3–4, 7–8, 25–38

Leptonema columbianum Ulmer, 1905, p. 61.—Fisher, 1963, p. 168.—Flint, 1978, p. 385.

This is one of the more widely distributed species of *Leptonema,* occurring from Colombia to Argentina, generally on the eastern side of the Andes. Judging from adult collections, it is most frequently, perhaps exclusively, inhabiting large rivers. It has been recorded (Flint, 1978), from numerous localities in the Rio Solimões–Amazonas area.

Larvae, generally of unknown species of the genus, were first described in the late 1800's. Until now the larvae of only the following species are securely associated and described: *L. albovirens* (Walk.) (Flint, 1968), *L. archboldi* Flint (Flint, 1968), and *L. eugnathum* (Müller) (Müller, 1921). On the basis of these descriptions, the published descriptions of unassociated larvae, and several undescribed but associated species in the collections of the National Museum of Natural History, the larvae of *columbianum* possess a number of distinctive characteristics. These are primarily in the area of the foreleg, especially the coxa. The forked ventral and digitate anterior processes, between which is found a hairy lobe, produce a unique conformation of the coxa. Only *Leptonema* species 2 (Roback, 1966) is similar, but this is a much larger species which lacks the hairs from the lobe between the processes. Together with *L.* sp. 2, *columbianum* shares the very broad, almost circular, outline of the fore femur. In all other known species of the genus the femur, although slightly enlarged, is proportionately much more elongate. Considering the overall similarity of *L.* sp. 2 to *columbianum,* it seems quite possible that sp. 2 might be *L. crassum* Ulmer.

Larva.—Length 10–12 mm; width 2–2.5 mm. Sclerites golden-yellow with fuscous marking.

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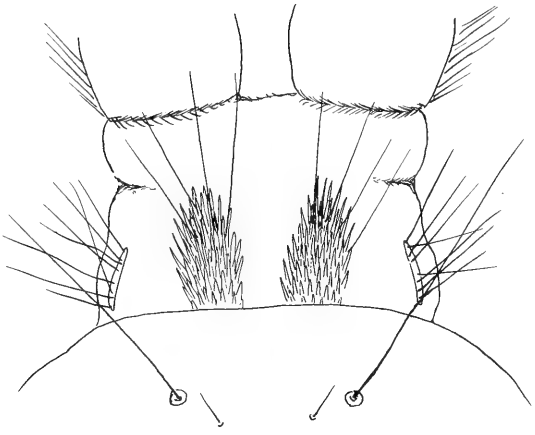
Figs. 9–16. *Blepharopus diaphanus*: **9,** larval maxillolabium, ventral; **10,** larval gena showing stridulatory lines, ventral; **11,** larval labrum, dorsal; **12,** larval mandibles, ventral; **13,** larval propleuron and coxa, lateral; **14,** larval prosternum, ventral; **15,** larval foreleg, anterior; **16,** larval hindleg, anterior.



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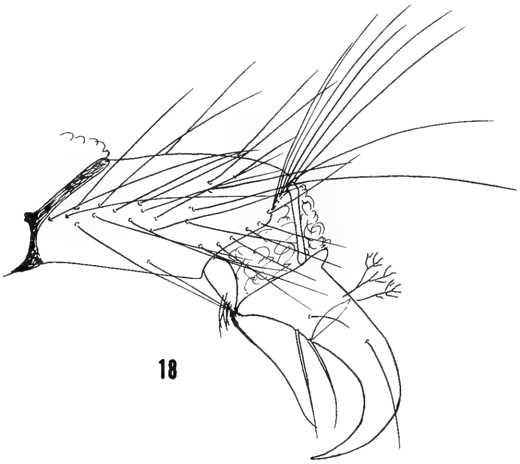

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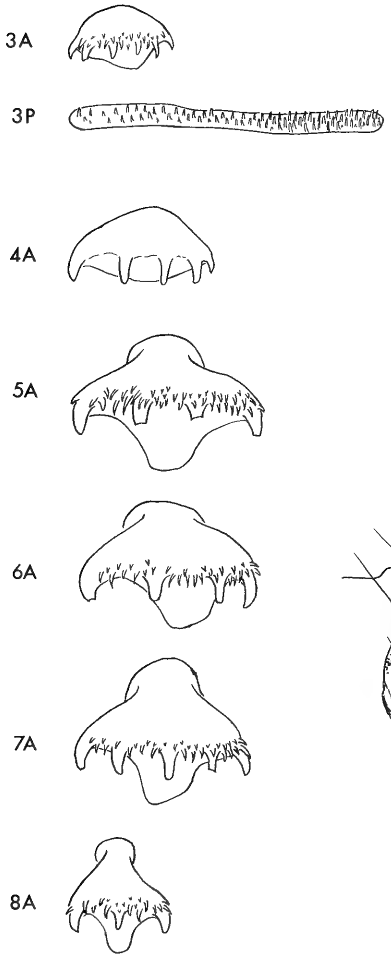

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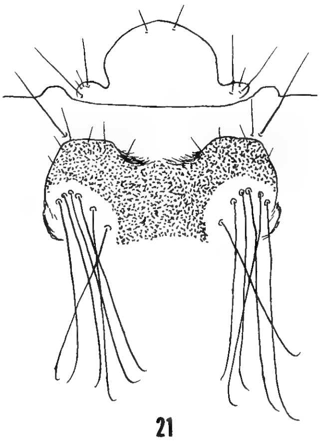

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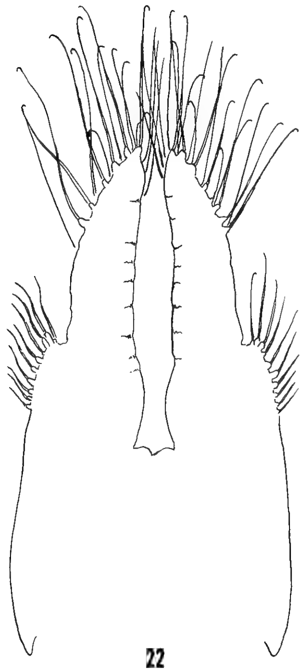

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Figs. 17–22. *Blepharopus diaphanus*: **17,** larval eighth and ninth sterna, ventral; **18,** larval anal proleg, lateral; **19,** pupal mandibles, ventral; **20,** pupal hookplates, dorsal showing abdom-

Fig. 23. *Blepharopus diaphanus,* biotope; Rio Pirai.

Head: Slightly longer than wide; golden-yellow, immaculate. Anterior ¾ of dorsal surface regularly covered with short, pale, blade-like setae. Anterior fourth of dorsum with scattered, long, light and dark setae. Anterior margin of frontoclypeus produced, truncate in center. Labrum transverse, surface with many, mostly pale, hairs; anterolateral angle with a short brush of hairs. Mandibles asymmetrical; left with a mesal tuft of fine hairs, with a double basal, 4 mesal, and 2 additional apicodorsal teeth; right with a double basal, 3 mesal, and 1 additional apicodorsal tooth. Submentum with anterior margin nearly straight. Anterior ventral apotome transversely triangular.

Thorax: Sclerites golden-yellow, with fuscous markings. Pronotum with 1 pair of well-developed dorsomesal setae; surface with many small, fine dark setae and very short, pale, blade-like setae. Prosternum, transversely rectangular; with a lightly sclerotized, rectangular, posteromesal lobe. Meso-

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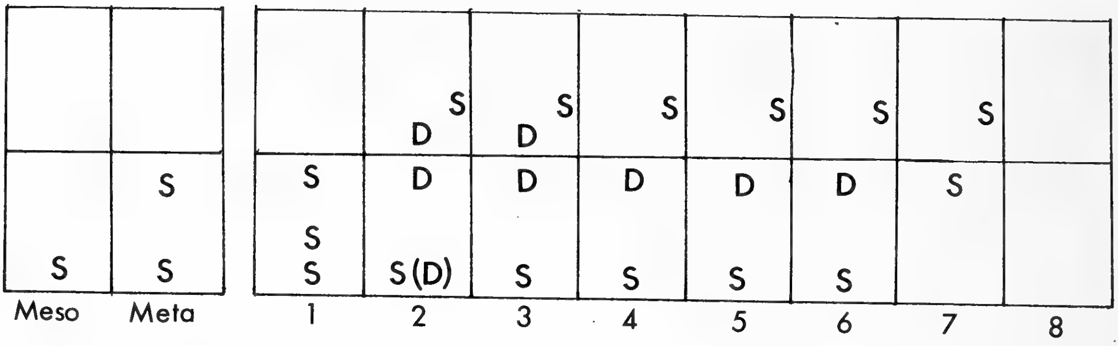
inal segment number and anterior or posterior position; **21,** pupal labrum and ventral half of face, anterior; **22,** pupal apical appendages, dorsal.



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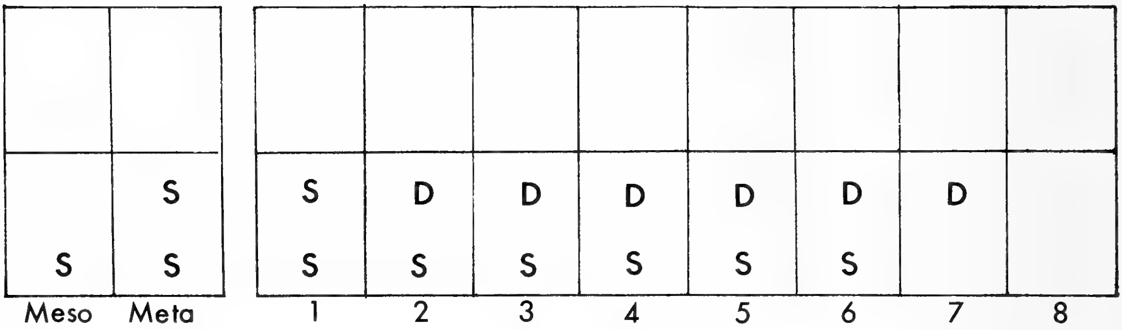

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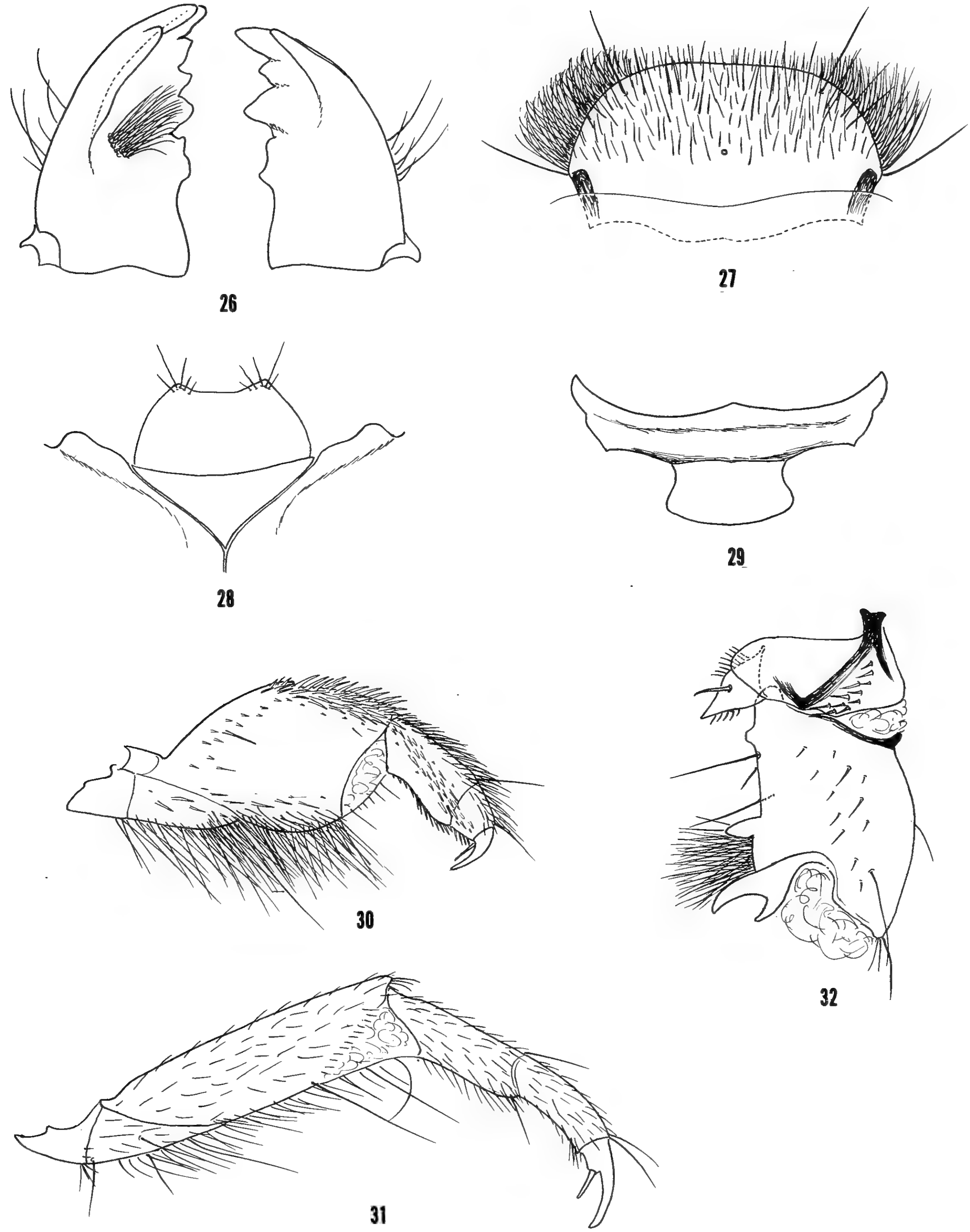
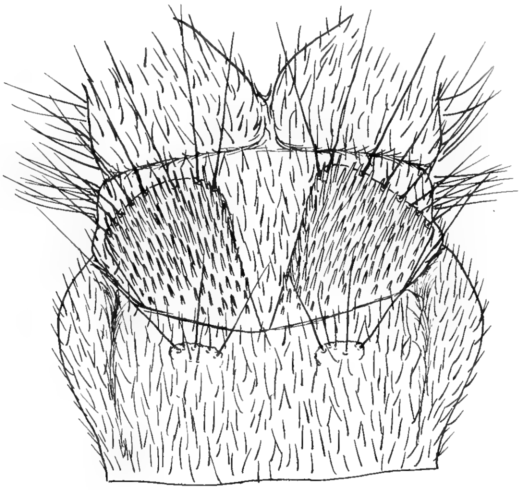
Figs. 24–25. *Blepharopus diaphanus*, **24**; *Leptonema columbianum*, **25**. Schematic gill diagrams of the lateral aspect of the meso- and metathorax and first 8 abdominal segments. **S** = a single long central filament with numerous lateral filaments; **D** = 2 S-type filaments with adjacent bases.

and metanota each with 2 pairs of erect dorsal setae; surface densely covered by short, dark setae. Fore trochantin tapering to an apical point, with numerous setae. Coxa of foreleg bearing a forked anteroapical process, and a digitate process on anterior margin, between processes a densely hairy lobe. Foreleg with anterior surface with pale, blade-like setae, posterior face with only a few normal setae; femur very broad, almost circular in outline. Mid- and hind legs virtually identical in shape and structure; posterior surfaces with many, pale, blade-like setae. Tarsal claw of foreleg with basal setae slender, spiniform; basal setae of mid- and hind claws very broad and enlarged. Mesosternum with 1 pair of gills; metasternum with 2 pairs.

Abdomen: Ventral gills only; as in figure 25. Lateral line virtually lacking; small tufts of hair present posteriorly on segment 3–7. Integument densely covered with blunt, slightly broadened, elongate, black setae. Segments 1–8 each dorsally with 3 pairs of long, erect setae: 1 pair sublaterally, 2nd



Figs. 26–32. *Leptonema columbianum*: **26,** larval mandibles, ventral; **27,** larval labrum, dorsal; **28,** larval submentum and anterior gular sclerite, ventral; **29,** larval prosterum, ventral; **30,** larval foreleg, posterior; **31,** larval hindleg, posterior; **32,** larval propleuron and coxa, lateral.



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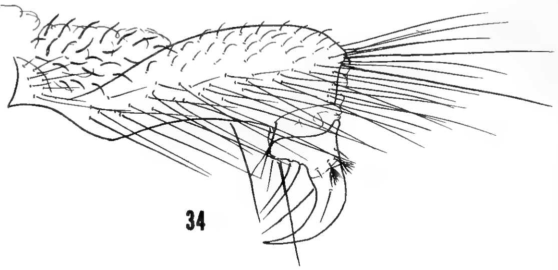

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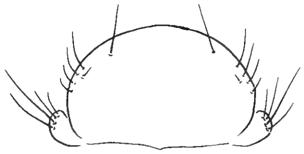

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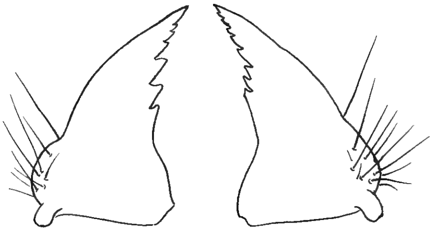

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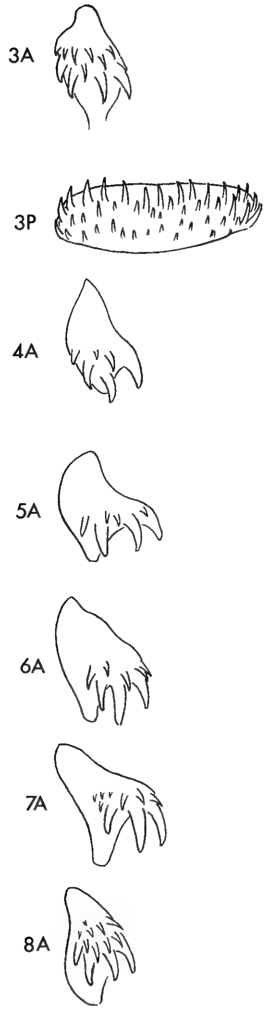

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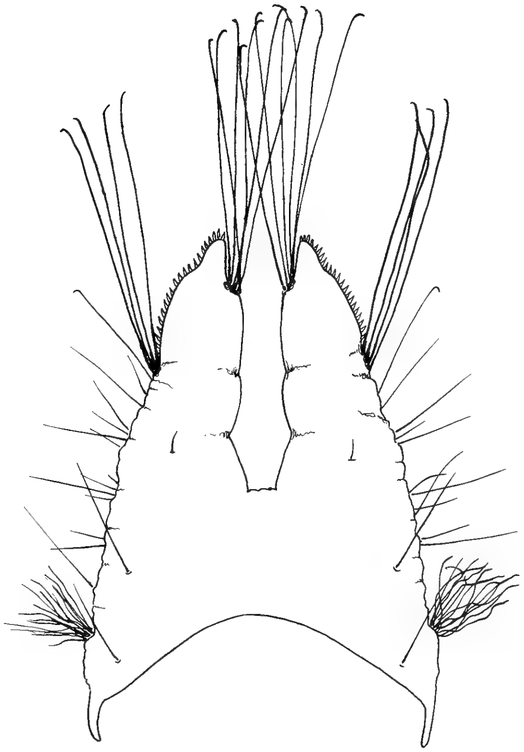

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anteromesally, 3rd posteromesally (this group sometimes with 1 or 2 extra setae); ventrally segments 1–7 each with 1 pair of such setae sublaterally near base of lateral-most gill. Sternum 8 with posterior plates recognizable only by long, black setae they bear. Sternum 9 with a large pair of plates covered with short, golden, spike-like setae, and a row of long, black setae along posterior. Segment 9 with tergite divided into 2 small, inconspicuous, sublateral plates bearing 2 long, black setae, and a feathered seta between; with a small, round, lateral sclerite bearing many long, black setae. At least 4 anal gills. Anal proleg bearing a fringe of long, slender hairs on each side of lateral sclerite; anal claw sharply angled ventrad, without accessory teeth.

Pupa.—Length of female pupa, 9 mm.

Head: Mandibles tapering regularly to a pointed apex; inner margin regularly serrate; outer face basally with a cluster of dark setae. Labrum with anterior margin semicircular, with basolateral lobes; each lobe with a group of 4–5 setae, and anterolateral margin with a row of 5–6 setae. Front of face with a group of shorter setae anterolaterally, 2 groups of long, dark, hooked setae mesally, and a few scattered setae laterally above base of mouth parts, and behind and in front of eye. Vertex with a few dark setae on each side and anteriorly. Basal segment of antenna with a group of short setae.

Thorax: Mesonotum with a small group of setae anterolaterally; meso- and metanota each with a pair of submesal setae posteriorly. Mesothoracic legs with a hair fringe on both sides of tarsus; tibia and tarsus flattened.

Abdomen: Segments 1–7 with deeply bifid lateral membranous lobes; segment 3 with a short, single lobe. Gills ventrally. Hook plates anteriorly on segments 3–8, plates 5–7, with teeth on a distinctly elevated lobe; posteriorly on segment 3. Dorsum of segment 4 with surface sparsely covered by long, dark setae; segments 1–3 with a few short dorsolateral setae; segments 5–7 with a few, long, dorsolateral setae. Apical processes with a group of basolateral dark setae, and a scattering of lateral setae; each process with 2 groups of long, golden, hooked setae, the lateral group of 4 setae, the mesal group of 5–7; between these groups of hooked setae a short, upturned lobe covered ventrally with short, spinous setae.

Larval catchnet.—Individual meshes (Figures 3 and 4) are ca. 40.5 × 80 μm at the base of the net and ca. 47.5 × 83.5 μm at the outer net periphery.

Pupal shelter.—Length 11 mm, width 4 mm. Ovoid, ventral area attached to substrate, closed by silk. Surface evenly formed of sand grains and small

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Figs. 33–38. *Leptonema columbianum*: **33,** larval eighth and ninth sterna, ventral; **34,** larval anal proleg, lateral; **35,** pupal labrum, dorsal; **36,** pupal mandibles, ventral; **37,** pupal hook-plates, dorsal showing abdominal segment number and anterior or posterior position; **38,** pupal apical appendages, dorsal.

pieces of organic matter. Each end with small respiratory openings left in silk between particles.

Material.—Brazil, Edo. Amazonas, Rio Solimões, ca. 4 km upstream from junction with Rio Negro, 10 Feb. 1977, 9 larvae; Rio Solimões, nr. Ilha Jurupari, 14 Feb. 1977, 14 larvae, 1 ♀ metamorphotype; Rio Solimões, nr. Lago de Coari, 15 Feb. 1977, 7 larvae; Rio Solimões, nr. Tefé, 17 Feb. 1977, 6 larvae, 1 ♀ metamorphotype; Rio Icá, nr. junction with Rio Solimões, 23 Feb. 1977, 5 larvae; Rio Solimões, nr. São Paulo de Olivença, 27 Feb. 1977, 6 larvae, 1 ♀ metamorphotype. Peru, Dept. Loreto, Rio Amazonas, nr. junction with Rio Atacuari, 4 Mar. 1977, 3 larvae. All collected by J. B. Wallace, *et al.*

Remarks.—*L. columbianum* was the only hydropsychid larva commonly encountered in the Rio Solimões or its larger tributaries from the junction with the Rio Negro upstream to Peru. No larvae of *L. columbianum* were encountered in smaller streams along the main river. Larvae inhabit woody substrates consisting of fallen, submerged trees and branches along the banks of the larger rivers. Their retreats and nets are found in depressions and crevices in the woody substrate and their structure is similar to that described previously for *Hydropsyche* (Sattler, 1955; Kaiser, 1965). The nets of *L. columbianum* are of typical hydropsychid construction and possess the central seam (Figure 3) which results from the figure-eight spinning motion used in their construction (Sattler, 1955, 1958). The meshes of *L. columbianum* are much smaller (ca. 40.5 × 80 μm) than those made by the larva of another *Leptonema* species from a mountainous Costa Rican stream. This latter larva had catchnet meshes of ca. 430 × 167 μm.

Acknowledgments

We express our gratitude to L. Michael Druckenbrod for the habitus figures (5–8), and to Duilio J. Fernandes and Dr. Newton Dias dos Santos, Museum Nacional, Rio de Janeiro for making it possible to visit the collecting site of *B. diaphanus*.

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NEW DWARF CRAYFISHES (DECAPODA: CAMBARIDAE) FROM MEXICO AND FLORIDA

Horton H. Hobbs, Jr.

Abstract.—*Cambarellus chihuahuae,* described from northern Chihuahua, Mexico, has its closest affinities with *C. areolatus* (Faxon, 1885) and *C. alvarezi* Villalobos (1952). *Cambarellus blacki,* known from a small cypress pond in Escambia County, Florida, is closely related to *C. schmitti* Hobbs (1942) and *C. lesliei* Fitzpatrick and Laning (1976).

The two crayfishes described here are the third and fourth members of the genus *Cambarellus* named since Hobbs (1974) listed 12 members of the genus in his checklist of North and Middle American crayfishes. The description of *Cambarellus texanus* Albaugh and Black (1973:177) from southern Texas appeared before the publication of the checklist but too late to be listed. *Cambarellus lesliei* Fitzpatrick and Laning (1976:138), ranging in southern Alabama and southeastern Mississippi, is the most recently described. The crayfishes reported here are distantly related species, one occurring in the northern part of Chihuahua, Mexico, and the other in the western part of the panhandle of Florida.

Cambarellus chihuahuae, new species
Fig. 1

Diagnosis.—Pigmented, eyes well developed. Rostrum with marginal spines or tubercles, median carina absent. Carapace without cervical spine. Areola 1.4 to 2.5 (average 1.9) times as long as broad and constituting 26.0 to 30.8 (average 28.4) percent of total length of carapace (34.7 to 40.4, average 37.3, percent of postorbital carapace length). Suborbital angle acute to slightly obtuse. Branchiostegal spine small or rudimentary. Postorbital ridge with acute cephalic extremity. Antennal scale approximately 2.4 times as long as broad, widest at midlength. Merus of cheliped with dorsal, ventral, and distolateral spines; carpus with distal ventrolateral spine. Hooks on ischia of second and third pereiopods simple, that on latter occasionally very weakly bituberculate, both overreaching basioischial articulation and neither opposed by tubercle on corresponding basis; coxae of fourth and fifth pereiopods with comparatively well developed caudomesial bosses, that on fifth subtuberculiform, and fourth with prominent cephalomesial boss. First pleopods of first form male symmetrical, arched caudally at distal end of proximal third, lacking both subapical setae and shoulder on cephalic surface; terminal elements consisting of subdistally directed mesial process bearing longitudinal trough-like groove mesially, truncate distally, and not reaching so far distally as other 2 elements; central projection corneous, tapering apically, and curved caudodistally with tip directed at angle of about 35 degrees to distal two-thirds of shaft of appendage; and caudal process slender, extending caudodistally at about 40 degrees to shaft and reaching caudally beyond other 2 terminals. Annulus ventralis about 1.5 to 1.6 times as broad as long, caudal face with prominent proximomedian concavity receiving postannular sclerite when annulus moved posteriorly; subtransverse, undulating sinus situated either dextrally or sinistrally, extending from just lateral to distal part of proximomedian concavity laterally, ending on lateral surface of annulus. Postannular sclerite subconical, diameter at base 1.5 to 1.6 times height and almost two-thirds that of annulus.

Holotypic male, form I.—Cephalothorax (Fig. 1a, j) subovate, somewhat compressed. Greatest width of carapace slightly less than height at caudodorsal margin of cervical groove. Areola 1.9 times as long as wide with 6 or more punctations in narrowest section, its length constituting 26.7 percent of entire length of carapace (36.6 percent of postorbital carapace length). Surface of carapace punctate, many if not all punctations with short or long simple setae. Rostrum with slender lateral carinae gently converging anteriorly, terminating in short spines flanking base of broad, short acumen; latter almost reaching distal margin of penultimate segment of antennular peduncle; dorsal surface concave with usual submarginal setiferous punctations and scattered ones between rows. Subrostral ridge very weak but evident in dorsal view along caudal third of rostrum. Postorbital ridge rather low and short, terminating cephalically in small acute spine. Suborbital angle prominent, and, although with rounded apex, subacute. Branchiostegal spine rudimentary, reduced to angle on anteroventral flank of cervical groove. Cervical spine absent.

Abdomen and carapace subequal in width (6.5 and 6.6 mm). Pleura of third through fifth segments truncate ventrally and lacking angles. Cephalic section of telson with 2 spines in each caudolateral corner. Cephalic lobe of epistome (Fig. 1l) broadly joined to main body, rather short with undulating anterolateral borders and prominent anteromedian projection; main body with wide median depression occupying large part of area between epistomal zygoma and cephalic lobe. Epistomal zygoma broadly arched, its medial anterior-posterior length almost half that of main body of epistome, proximal podomere of antennular peduncle with strong ventromesial spine at about midlength. Antennal peduncle with well defined spine on distolateral surface of basis and very small one on ventral side of ischium; flagellum extending caudally to second abdominal tergum. Antennal scale (Fig. 1e) 2.3 times as long as broad, widest at midlength; mesial margin of lamellar area broadly rounded but with suggestion of angle anteromesially; distola-

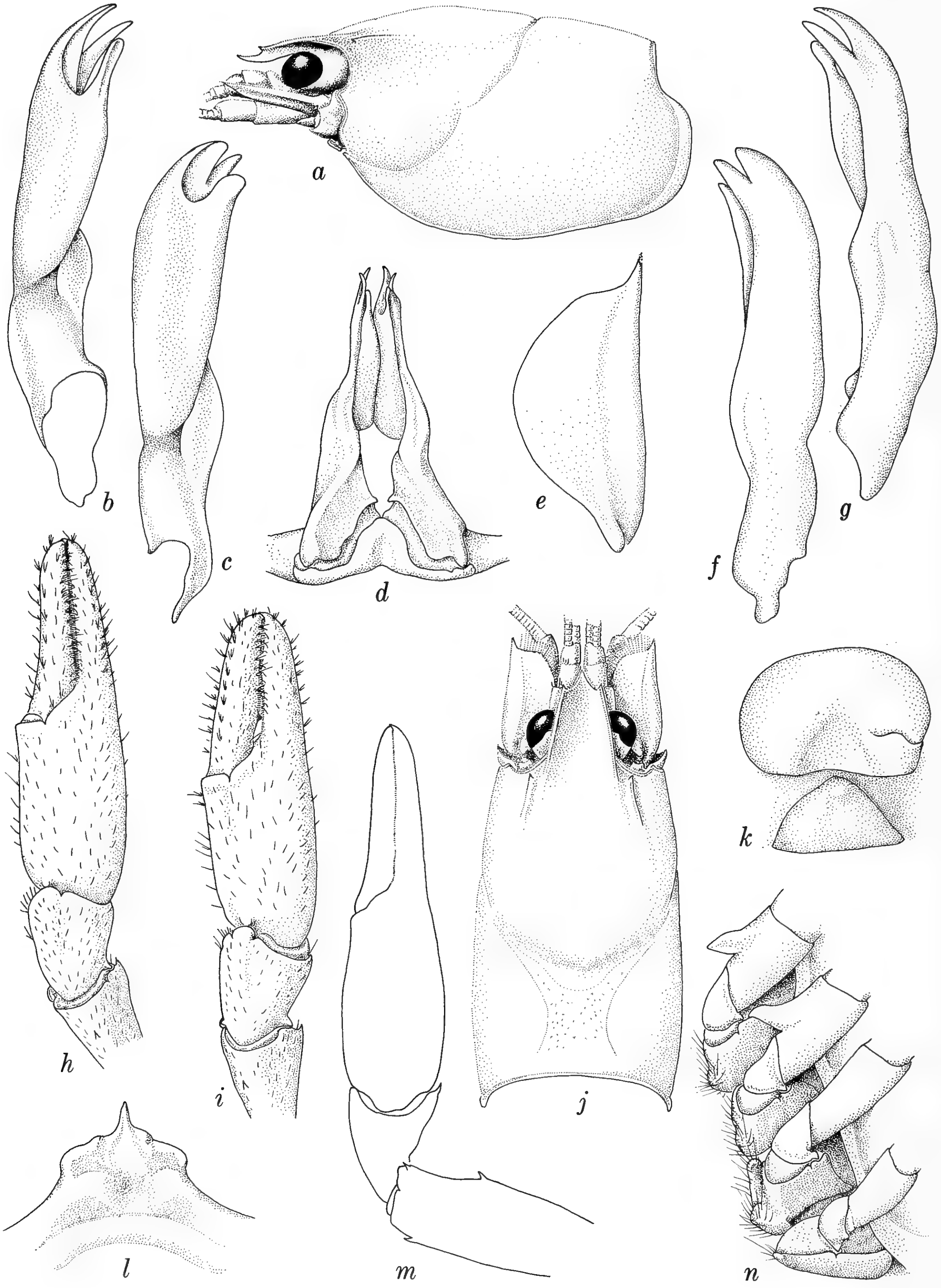

Fig. 1. *Cambarellus chihuahuae* (all illustrations are of holotype except **c** and **f** of morphotype, and **i** and **k** of allotype): **a,** Lateral view of carapace; **b, c,** Mesial view of first pleopod; **d,** Caudal view of first pleopods; **e,** Antennal scale; **f, g,** Lateral view of first pleopod; **h, i,**

teral spine broken on right scale but that on left reaching slightly beyond ultimate podomere of antennular peduncle.

Third maxilliped extending cephalically well beyond tip of rostrum, slightly overreaching antennal peduncle; mesial half of ischium with broad band of stiff simple setae, and single row of short plumose ones flanking ventromesial side of lateral costa; distolateral angle not produced; exopod reaching midlength of carpus.

Right chela (Fig. 1h, m) subovate in cross section, not strongly depressed; surface, except for opposable margins of fingers, lacking clearly defined tubercles and spines but bearing punctations studded with setae, most of which small but few long, conspicuous ones present, and mesial and lateral clusters arranged in rows on fingers; setae in cluster rows flanking opposable surfaces of fingers very conspicuous. Opposable margins of both fingers with broad band of minute denticles, that of dactyl also with single prominent tubercle at about one-fifth length of finger from base.

Carpus of cheliped almost 1.5 times as long as broad, bearing setiferous punctations, and with shallow depression dorsally; distal ventrolateral articular condyle with strong spine. Merus, likewise with setiferous punctations, bearing 3 conspicuous spines: one dorsodistally, another ventrally on level short distance proximal to dorsal spine, and third on distal ventrolateral angle. Ischium with setiferous punctations, without spines or tubercles, and sufflamen in form of right angle, not produced.

Hooks on ischia of second and third pereiopods (Fig. 1n) simple and overreaching corresponding basioischial articulation, neither opposed by tubercle on bases; that on third tapering and somewhat clawlike. Coxa of fourth pereiopod with prominent setiferous caudomesial and cephalomesial bosses, latter directed cephalically; coxa of fifth pereiopod with tuberculiform caudomesial boss also studded with long stiff setae.

Sternum between second, third, and fourth pereiopods rather deep; lateral margins not strongly produced ventrally and setae borne on them not conspicuous.

First pleopods (Fig. 1b, d, g) as described in "Diagnosis." Both lobes of proximal podomere of right uropod with prominent spine; distomedian spine on mesial ramus premarginal.

Allotypic female.—Differing, other than in secondary sexual features, from holotypic male in following respects: rostral margins slightly convex

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Dorsal view of distal podomeres of cheliped; **j,** Dorsal view of carapace; **k,** Annulus ventralis; **l,** Epistome; **m,** Lateral view of distal podomeres of cheliped; **n,** Proximal podomeres of second through fifth pereiopods.

laterally, subrostral ridges evident dorsally almost to base of marginal spines on lateral rostral carinae; acumen reaching slightly beyond midlength of ultimate podomere of antennular peduncle; suborbital angle slightly obtuse; cheliped (Fig. 1i) with merus bearing moderately well defined ventromesial row of 9 tubercles; mesial margin of ischium with row of 3 minute tubercles. See ''Measurements'' in Table 1.

Annulus ventralis and postannular sclerite (Fig. 1k) as described in ''Diagnosis.''

Morphotypic male, form II.—Differing from holotypic male in following respects: main body of epistome with prominent anteromedian fovea; exopod of left third maxilliped regenerated, not reaching carpus; spines on carpus and merus of cheliped much reduced; hooks on ischia of second and third pereipods distinctly reduced in size and not reaching corresponding basioischial articulation. First pleopod (Fig. 1c, f) more nearly straight than in holotype; terminal elements disposed as in latter but all shorter, heavier, and central projection non-corneous; caudal process lacking longitudinal sulcus mesially.

Color notes: (These are based on a 2 × 2 transparency kindly donated to me by Mr. Smith.) Ground color bluish gray overlain by complex markings of brown to charcoal. Rostral margins and postorbital ridges very dark and dorsal surface of rostrum only slightly paler. Hepatic region with large irregular splotch extending dorsally onto gastric region. Charcoal arcs superimposed on branchiocardiac grooves, and dark transverse bar joining them in anterior part of areola and much paler one across posterior part. Branchiostegites with prominent brown to charcoal longitudinal stripes dorsolaterally, mesial margin of stripes regular but ventral margin produced in two or three cephaloventrally directed prominences, latter becoming progressively paler ventrally. Posterior part of dorsolateral stripes on carapace continuous with paired, broad, dorsolateral stripes on abdomen, latter stripes flanking median longitudinal pale one, it broad and almost white on first abdominal segment, tapering and becoming darker posteriorly to sixth segment where ending. Dorsolateral stripes with pale subelliptical spots on each of segments 2 through 5. All of first and dorsal part of second through sixth pleura white; latter area on posterior 5 segments flanked ventrally by longitudinal almost black marking separating dorsal white area from smaller white spot on pale tan ventral region. Telson mostly dark, especially lateral parts of anterior section, lateral cleft areas, and posteromedian section. Uropods with basal podomere very dark, lateral half of each ramus very pale to white for most part, and mesial halves brownish; distal borders with irregular dark splotches. Pereiopods gray with dark markings; dactyl of cheliped strikingly dark. Flagella of antennules and antennae orange tan.

Size.—The largest specimen available is a first form male having a carapace length of 17.0 (postorbital carapace length 13.0) mm. Corresponding

Table 1.—Measurements (mm) of *Cambarellus chihuahuae*.

	Holotype	Allotype	Morphotype
Carapace:			
Entire length	12.3	12.4	11.6
Postorbital length	9.3	9.1	8.6
Width	6.6	6.8	6.1
Height	6.7	7.1	6.3
Areola:			
Width	1.8	2.0	1.5
Length	3.4	3.5	3.2
Rostrum:			
Width	2.3	2.1	2.0
Length	3.0	3.2	2.9
Chela:			
Length, palm mesial margin	3.9	2.9	3.8
Palm width	2.5	2.0	2.2
Length, lateral margin	8.3	6.6	7.8
Dactyl length	4.0	3.0	3.5
Abdomen:			
Width	6.5	6.6	5.9
Length	14.8	14.5	14.7

lengths of the smallest first form male and of the single ovigerous female are 10.0 (7.5) and 11.9 (9.1) mm, respectively. The latter was carrying 59 eggs 1.2 to 1.3 mm in diameter.

Type-locality.—Ojo de Carbonera, 4.3 km south of Ejido Rancho Nuevo approximately 36 airline km west of Villa Ahumada (106°51′, 30°35′N), Chihuahua, Mexico. The specimens were collected by R. R. Miller[1], M. L. Smith, E. Marsh, and B. Chernoff (see "Range and Specimens Examined"), and the following data were supplied by the former two. Ojo de Carbonera is one of five springs in the southern part of the endorheic basin in which the Ejido Rancho Nuevo is situated. Water arises from a cluster of boils emerging through solution holes in carbonate rock and flows about 100 m before being dispersed in an irrigation complex. The stream is some 1 to 2.5 m wide and, except in solution pockets, no more than 10 cm deep. The clear water (27°C on 28 May 1978 and 6 June 1979) flows with a moderate current over a sand or gravel bed and supports a sparse vegetation consisting of filamentous algae, *Chara* sp., *Nasturtium* sp., and submerged grass. Most of the crayfish were collected in the grass and among the vegetation hanging

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[1] Work in Mexico by Dr. Miller was supported by a grant: NSF DEB 77-17315.

in the water. A few were seen crawling over sand or fine gravel where the current was not strong, and others were observed on the walls of solution holes, in crevices, and beneath overhanging ledges.[2]

Disposition of types.—The holotypic male, form I, allotypic female, and morphotypic male, form II, are deposited in the National Museum of Natural History, Smithsonian Institution, nos. 148895, 148896, and 148897, respectively. Of the paratypes, 1♂I, 1♀, and 1♂II, are deposited in the British Museum (Natural History), a like series in the Rijksmuseum van Natuurlijke Historie, and the remaining ones consisting of 37♂I, 43♀, 42♂II, 12 juv.♂, 16 juv. ♂, and 1 ovig. ♀ in the National Museum of Natural History.

Range and specimens examined.—Known only from the type-locality and three nearby springs: (1) type-locality, 31♂I, 37♀, 38♂II, 10j♂, 9j♀, 1 ovig ♀, 28 May 1978, RRM, MLS, EM, coll.; 3♂I, 3♀, 4♂II, 2j♂, 4j♀, 1 Jun 1979, MLS, BC. (2) Ojo del Apache, about 3 km SW of Ojo de Carbonera, 2♂I, 1♀, 1♂II, 31 May 1979, MLS, BC. (3) Ojo El Medio, about 0.5 km N of Ojo de Carbonera, 4♂I, 5♀, 2♂II, 2j♀, 2 June 1979, MLS, BC. (4) Ojo Solo about 3 km N of Ojo de Carbonera, 1j♀, 2 Jun 1979, MLS, BC.

Variations.—Attention has been called in the "Diagnosis" to most of the variations noted. Among those not included there are slight variations in the position of the lateral rostral carinae and the relative position of the apex of the acumen. The lateral carina is visible in dorsal aspect for only a short distance at the base or from there to any level along the length of the rostrum to the marginal spine; the apex of the acumen reaches from the midlength of the penultimate podomere of the antennular peduncle to the distal extremity of the ultimate podomere. While there is considerable variation in the contour of the anterolateral margins of the cephalic lobe of the epistome, the latter is consistently short, excluding the cephalomedian projection, little longer than the anterior-posterior median length of the epistomal zygoma; the median depression of the main body of the epistome leads to a distinct fovea in some specimens and in others consists of no more than a broad, shallow excavation. The hook on the ischiopodite of the third pereiopod in a number of specimens bears a small angular prominence on the side opposing the podomere that is reminiscent of the proximal tubercle in those species in which the hook is distinctly bituberculate. Although there is variation in the sizes of the spines on the several podomeres of the cheliped, the arrangement described in the holotype appears to be consistent. The ventromesial row of tubercles on the merus of the cheliped of the allotype is rarely evident; however, vestiges, represented by an irregular ventrome-

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[2] Additional information on the type-locality is presented by M. L. Smith and R. R. Miller in their "Systematics and variation of a new cyprinodontid fish, . . . , from Chihuahua, Mexico" published in volume 93, number 2 of this journal.

sial margin, of the row may be discerned in almost all of the specimens. In at least two of the first form males, the mesial process of the first pleopod is almost spiculiform. In the largest male, the dextral pleopod is aberrant and obviously has been regenerated; and the slender mesial process on the sinistral pleopod appears to have been regenerated. In another male, however, the process on both appendages is tapering, and there is no evidence of injury or regeneration.

Relationships.—There is every reason to believe that this crayfish has closer affinities with the Mexican segment of the genus than with those species occurring in the United States. Evidence of this kinship is best observed in the structure of the first pleopod of the first form male. In respect to the broad areola it is more similar to *Cambarellus areolatus* (Faxon, 1885:123) and *C. alvarezi* Villalobos (1952:525), species the ranges of which are closest to that of *C. chihuahuae,* than to any others. It differs from both of these crayfishes in possessing a distinctly shorter, more distally directed mesial process on the first pleopod of the male, and in exhibiting spines on the merus and carpus of the cheliped. The broad areola, less than three times as long as wide, will serve to separate it from other species reported from Mexico (see Hobbs, 1974).

Cambarellus blacki, new species
Fig. 2

Diagnosis.—Pigmented, eyes well developed. Rostrum with marginal spines or tubercles, median carina absent. Carapace with or without small cervical spine. Areola 2.5 to 3.0 (average 2.8) times as long as broad and constituting 28.2 to 31.2 (average 30.1) percent of total length of carapace (37.3 to 41.7, average 40.1, percent of postorbital carapace length). Suborbital angle acute to subacute. Branchiostegal spine very small to obsolete. Cephalic extremity of postorbital ridge acute or rounded. Antennal scale approximately 2.5 times as long as wide, broadest at about midlength. Merus and carpus of cheliped with or without spines. Hooks on ischia of second and third pereiopods bituberculate, neither reaching basioischial articulation nor opposed by tubercle on corresponding bases; coxae of fourth and fifth pereiopods with prominent cephalo- and caudomesial bosses, former somewhat laterally disposed; coxa of fifth pereiopod devoid of caudomesial boss. First pleopods of first form male symmetrical, with distinct hump on cephalic surface at about midlength, same surface lacking both subapical setae and shoulder; terminal elements consisting of heavy subtriangular mesial process disposed caudally but with free apical part bent somewhat distally; central projection corneous, tapering from base, strongly curved caudally with tip directed at about 90 degrees to shaft of appendage, not reaching so far caudally as caudal process; latter similar in shape to and situated caudolaterally and subparallel to central projection; caudal and mesial processes reaching about same level caudally. Annulus ventralis semicircular in outline with basal caudomedian surface excavate; sinuous sinus extending either dextrally or sinistrally from more ventral part of excavation to lateral surface of annulus and flanked toward base of annulus by inflated region intensifying asymmetry of structure. Postannular sclerite subtriangular in outline, about 1.8 times as broad as high, with free apex directed cephaloventrally, and caudoventral surface bearing median ridge terminating on latter apex; sclerite partly enveloped in excavation on caudal surface of annulus when brought into contiguous position.

Holotypic male, form I.—Cephalothorax (Fig. 2a, j) subovate, slightly compressed. Greatest width of carapace subequal to height at caudalodorsal margin of cervical groove. Areola 3.0 times as long as wide with 5 punctations in narrowest section, its length constituting 30.0 percent of entire length of carapace (39.1 percent of postorbital carapace length). Surface of carapace punctate, many punctations bearing short or long simple setae. Rostrum with slender lateral carinae converging anteriorly, terminating in short spines marking base of rather slender acumen; latter reaching base of ultimate podomere of antennular peduncle; dorsal surface subplane and densely studded with setiferous punctations; many setae subtending mesial margin of lateral carinae, and submarginal ones on acumen decidedly longer than those borne on remainder of dorsal surface; setae progressively dense from base of rostrum to apex of acumen. Subrostral ridges weak but evident in dorsal aspect along slightly more than basal half of rostrum. Postorbital ridge low and short, terminating anteriorly in subacute tubercle. Suborbital angle obtuse. Branchiostegal spine obsolete. Cervical spine absent.

Pleura of third through fifth segments truncate ventrally and with posteroventral extremity subangular to angular. Cephalic section of telson with 2 spines in left and 1 in right (second detached) caudal corner. Cephalic lobe of epistome (Fig. 2i) broadly joined to main body, subtriangular, and with short anteromedian projection and large median depression at base invading main body; epistomal zygoma broadly arched and comparatively large. Proximal podomere of antennular peduncle with prominent spine on ventromesial angle just distal to midlength. Antennal peduncle with small spine

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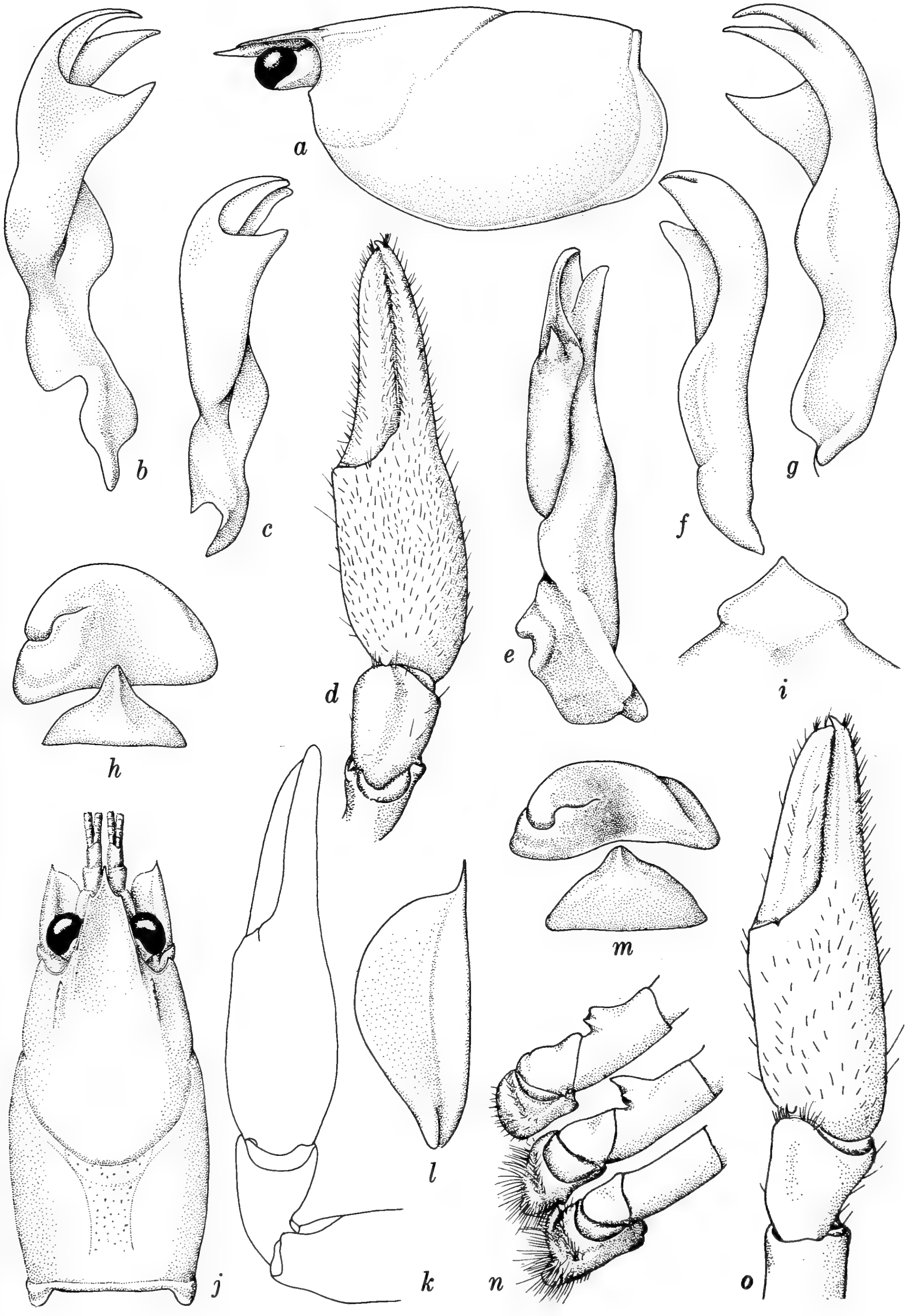
Fig. 2. *Cambarellus blacki* (all illustrations are of holotype except **c** and **f** of morphotype, and **h, m,** and **o** of allotype): **a,** Lateral view of carapace; **b, c,** Mesial view of first pleopod; **d, o,** Dorsal view of distal podomeres of cheliped; **e,** Caudal view of left first pleopod; **f, g,** Lateral view of first pleopod; **h,** Caudal view of annulus ventralis; **i,** Cephalic lobe of epistome; **j,** Dorsal view of carapace; **k,** Lateral view of distal podomeres of cheliped; **l,** Antennal scale; **m,** Caudoventral view of annulus ventralis; **n,** Proximal podomeres of second, third, and fourth pereiopods.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on distolateral surface of basis; ischium without spine; flagellum extending caudally to second abdominal tergum. Antennal scale (Fig. 2l) 2.5 times as long as broad, widest at about midlength; mesial margin of lamellar area evenly rounded; distolateral spine reaching midlength of ultimate podomere of antennular peduncle.

Third maxilliped extending cephalically slightly beyond tip of rostrum; mesial half of ischium with broad band of stiff simple setae, and single row of short, mostly plumose ones flanking ventromesial side of lateral costa; distolateral angle not produced, exopod reaching distal half of propodus.

Right chela (Fig. 2d, k) subovate in cross section, weakly depressed; surface, except for opposable margins of fingers, lacking tubercles and spines but bearing setiferous punctations and rows of mesial and lateral setal clusters on fingers. Opposable margins of both fingers with broad band of minute denticles, that of dactyl with conspicuous tubercle at approximately one-fifth length of finger from base.

Carpus of cheliped about 1.8 times as long as broad, studded with setiferous punctations and with broad longitudinal depression dorsally; neither it nor merus and ischium with spines or tubercles; sufflamen on ischium well developed, consisting of prominent lobe projecting proximally from postaxial proximal angle of podomere.

Hooks on ischia of second and third pereiopods (Fig. 2n) bituberculate, not overreaching corresponding basioschial articulation and neither opposed by tubercle on bases; proximal tubercle of hook on third pereiopod less conspicuous than that on second. Coxa of fourth pereiopod with prominent setiferous caudomesial and cephalomesial bosses, latter directed cephalolaterally; coxa of fifth pereiopod lacking setiferous caudomesial boss.

Sternum between second, third, and fourth pereiopods deep; lateral margins not strongly produced ventrally but bearing conspicuous row of plumose setae.

First pleopods (Fig. 2b, e, g) as described in ''Diagnosis.'' Both lobes of proximal podomere of uropod with prominent spine; distomedian spine on mesial ramus reaching distal margin of ramus.

Allotypic female.—Differing from holotypic male, other than in secondary sexual characters, in following respects: postorbital ridge ending cephalically in short spines; cervical spine present; caudoventral angles of third through fifth pleura of abdomen more rounded; chela (Fig. 2o) with opposable margin of fixed finger bearing tubercle one-third length of finger from base and single row, rather than band, of minute denticles; regenerated left cheliped with poorly developed sufflamen. See ''Measurements'' in Table 2.

Annulus ventralis and postannular sclerite (Fig. 2h, m) as described in ''Diagnosis.''

Morphotypic male, form II.—Differing from holotype in following respects: postorbital spine moderately well developed; suborbital angle sub-

Table 2.—Measurements (mm) of *Cambarellus blacki*.

	Holotype	Allotype	Morphotype
Carapace:			
Entire length	9.0	10.3	7.3
Postorbital length	6.9	7.5	5.2
Width	4.4	5.3	3.7
Height	4.3	5.3	3.4
Areola:			
Width	0.9	1.1	0.8
Length	2.7	2.9	2.0
Rostrum:			
Width	1.5	2.0	1.3
Length	2.4	2.9	2.1
Chela:			
Length, palm mesial margin	3.1	2.7	1.9
Palm width	2.0	1.9	1.4
Length, lateral margin	6.5	6.7	4.4
Dactyl length	3.0	3.5	2.2
Abdomen:			
Width	3.9	5.2	3.3
Length (approximate)	*	14.0	9.0

* Broken.

acute; tubercles and minute denticles on opposable margins of fingers of chela as in allotype; carpus of cheliped bearing ventrodistal spine, and merus exhibiting dorsal, ventral, and ventral distolateral spines; hooks on ischia of second and third pereiopods greatly reduced, both low, simple, and tuberculiform and flanked proximally by broad emargination; bosses on coxa of fourth pereiopod much reduced in size, cephalomesial one hardly recognizable as more than end of mesial longitudinal ridge on podomere. First pleopod (Fig. 2c, f) markedly similar to that of holotype but caudal process and central projection comparatively shorter, more robust, and contiguous almost to tip of latter; mesial process with shorter, more rounded distal section.

Size.—The largest specimen observed is the allotype, which has a carapace length of 10.3 (postorbital carapace length 7.5) mm. Corresponding lengths of the smallest and largest first form males are 9.0 (6.9) and 9.6 (7.2) mm.

Type-locality.—Small cypress pond at Oak Grove, Escambia County, Florida. The specimens were collected with a scrim dipnet pushed through grasses along the edge of the pond.

Disposition of types.—The holotypic male, form I, the allotypic female, and morphotypic male, form II, are deposited in the National Museum of Natural History, nos. 148901, 148902, and 148903, respectively, as are the paratypes consisting of 2♂I, 3♀, 11 juv. ♂, and 14 juv. ♀.

Range.—Known only from the type-locality.

Variations.—The most obvious variation is in the presence or absence of spines in various body regions; small cervical spines are present in only three of the adults but are evident in more of the juveniles; only three of the adults bear spines on the carpus and merus of the chelipeds, but most of the juvenile specimens exhibit such spines. Even though spines are consistently present on the marginal carinae of the rostrum and at the cephalic extremity of the postorbital ridges, they are decidedly longer in the juveniles than in adults; however, they are not uniformly small in the latter. In some juveniles and adults, the subrostral ridge may be seen in dorsal view from the caudal margin of the orbit to the marginal spine of the rostrum, but in most specimens they are not visible much beyond the level of the eye. Because of the dense setae on the distal part of the carpus and ventromesial surface of the merus of the cheliped, in some specimens the margin of the podomere is obscured and small spines or tubercles thereon might be overlooked; in at least one specimen, however, a small spine is present on the dorsal distomesial corner of the carpus and a small one on the ventral surface of the merus. Other variations are noted in the ''Diagnosis'' as well as in the descriptions of the allotype and morphotype. See ''Measurements'' in Table 2.

Relationships.—*Cambarellus blacki* has its closest affinities with *C. schmitti* Hobbs (1942:149) and *C. lesliei* Fitzpatrick and Laning (1976:138), and the single locality in which it has been found lies between the areas frequented by them. It differs from both in possessing a shorter rostrum with weaker marginal spines, decidedly smaller cervical spines that are often absent, and a more strongly arched first pleopod in the first form male. In *C. schmitti,* the terminal elements of the first pleopod of the first form male are disposed at angles no greater than 60 degrees to the shaft of the appendage; in *C. blacki,* the apices of the central projection and caudal process are directed at angles of about 90 degrees; furthermore, there is a much broader gap between the caudal and mesial processes in *C. blacki* than in the former. This crayfish differs further from *C. lesliei* in possessing bituberculate hooks on the ischia of the second and third pereiopods, whereas in the latter only simple hooks have been observed on the second pereiopod. In *C. lesliei,* the cephalomesial boss on the fourth pereiopod of the male is directed laterally; in *C. blacki,* it extends more nearly cephalically; also, the apical part of the mesial process of the first pleopod of the latter is bent somewhat distally rather than extending almost caudally from its base as in *C. lesliei.*

Etymology.—I take pleasure in naming this crayfish in honor of my friend and fellow student of crayfishes Joe B. Black whose contributions to our knowledge of many species occurring in the southern part of the United States have been invaluable.

Acknowledgments

I should like to thank Robert R. Miller and Michael L. Smith of the Museum of Zoology, University of Michigan, as well as those assisting them, for donating the specimens from Chihuahua to the Smithsonian, for field notes on the localities from which the crayfish were collected, and the latter for a color photograph of one of the specimens. I am also grateful to Lewis J. Marchand of Gainesville, Florida, for his assistance in obtaining the specimens from Florida. For their criticisms of the manuscript, I am indebted to Raymond B. Manning, Margaret A. Daniel, and C. W. Hart, Jr., of the Smithsonian Institution.

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93(1), 1980, pp. 208–215

ANTROMYSIS (*SURINAMYSIS*) *MERISTA*, A NEW FRESHWATER MYSID FROM VENEZUELA (CRUSTACEA: MYSIDACEA)

Thomas E. Bowman

Abstract.—Antromysis (*Surinamysis*) *merista,* a second species of the subgenus *Surinamysis,* is described from a gully adjacent to the Orinoco River near Barrancas, Venezuela. The species exhibits unusual sexual dimorphism: the ♂ antenna 1 has a long flagelliform process in addition to the 2 flagella; pereopod 6 has a multisegmented carpopropus in the ♂ but not in the ♀.

Only 3 species of freshwater mysids are known from South America, all members of the genus *Antromysis* and all known only from Surinam. These are *A.* (*Surinamysis*) *americana* (Tattersall, 1951), *A.* (*Parvimysis*) *almyra* (Brattegard, 1977), and *Antromysis* sp. Brattegard 1977, the latter not given a specific name because it was represented by only a single female. These 3 species were described by Brattegard (1977); the first 2 were assigned to *Diamysis* by Brattegard, but were transferred to *Antromysis* by Bowman (1977a).

The species described below was recorded in a checklist of South American freshwater mysids (Bowman, 1977b) as *Diamysis americana* Tattersall. While preparing a check list of tropical South American freshwater mysids (Bowman, in press), I reexamined the specimens and found that they are superficially very similar to Tattersall's species, but exhibit clear-cut differences in male secondary sexual characters that necessitate establishment of a new species.

Antromysis (*Surinamysis*) *merista,* new species
Figs. 1–4

Diamysis americana Tattersall.—Bowman, 1977b:149.

Material examined.—Venezuela, Monagas State, near Barrancas, wide shallow (maximum depth < 2 m) meandering gully, leg. Edward S. Deevey,

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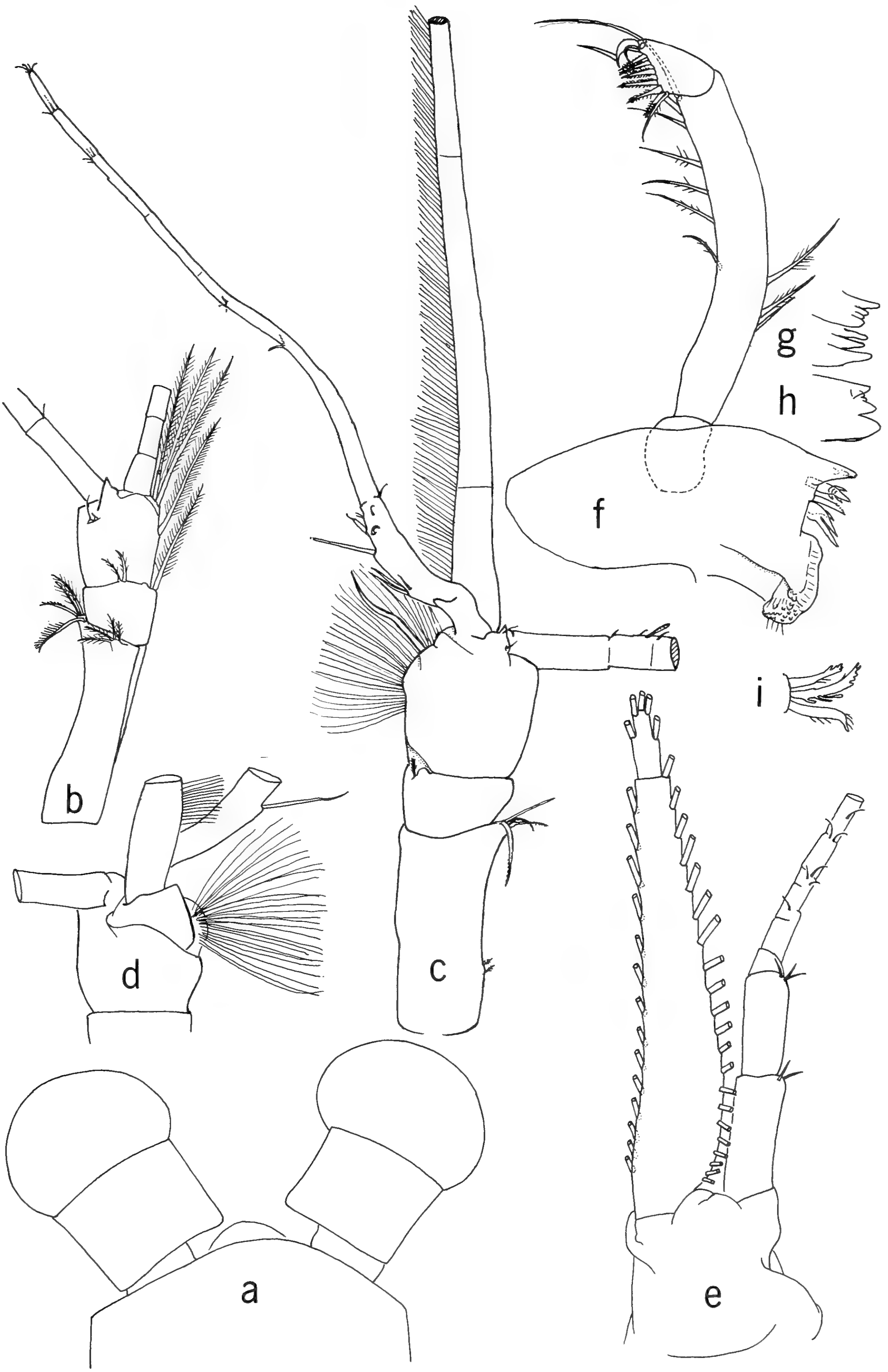
Fig. 1. *Antromysis* (*surinamysis*) *merista*: **a,** Rostrum and eyes, dorsal, ♂; **b,** Antenna 1, ♀ dorsal; **c,** Antenna 1, ♂, dorsal; **d,** Antenna 1, ♂, ventral; **e,** Antenna 2, ♀, dorsal; **f,** Right mandible, ♀; **g,** Incisor and lacinia, left mandible, ♀; **h,** Incisor, right mandible, ♀; **i,** Spine row, left mandible, ♀.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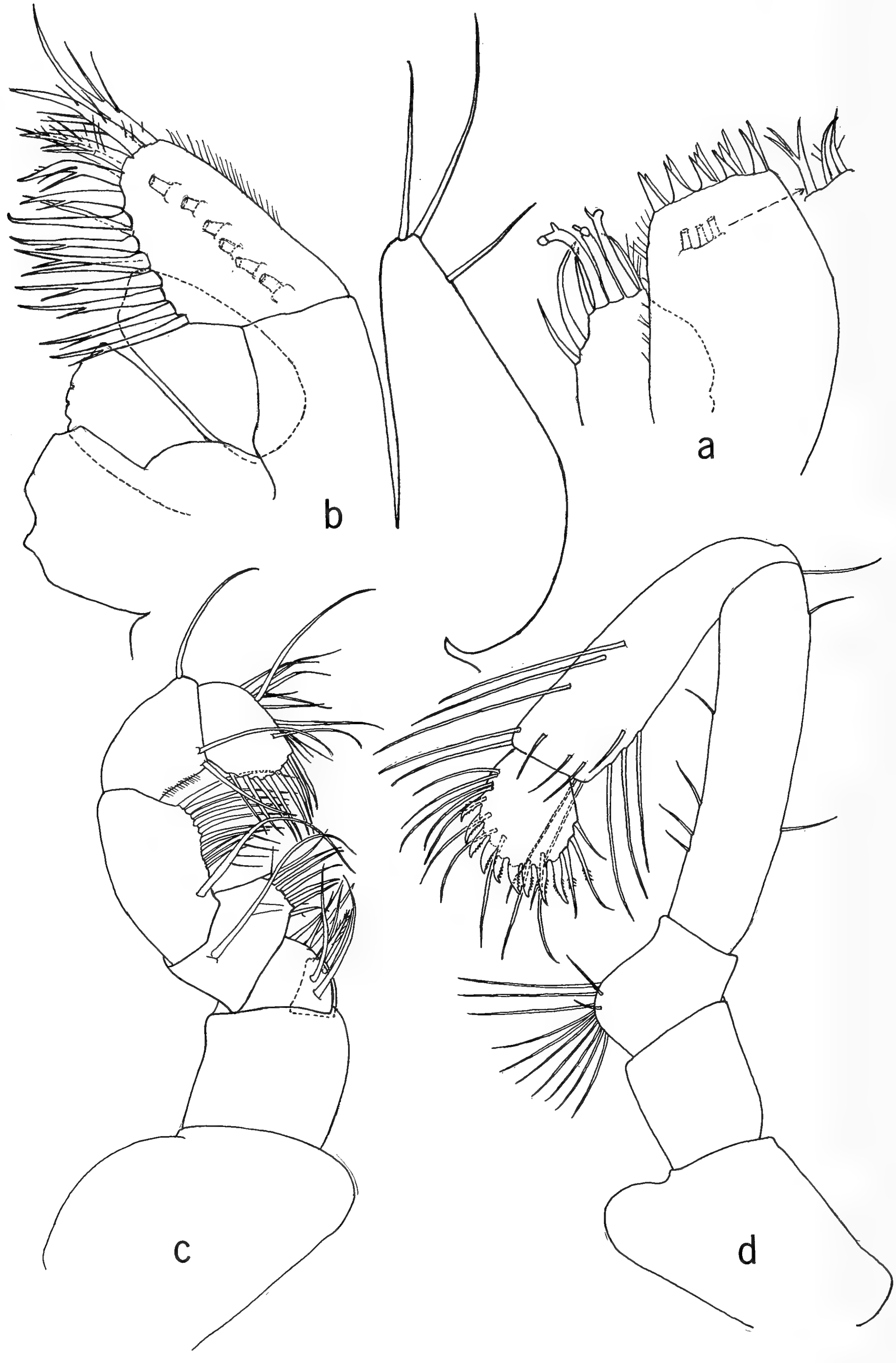

Fig. 2. *Antromysis* (*Surinamysis*) *merista*, ♂: **a,** Maxilla 1; **b,** Maxilla 2; **c,** Maxilliped; **d,** Pereopod 1.

Jr., and Georgiana B. Deevey, 26 November 1967: ♂ holotype (USNM 173131), 2♂ 8♀ paratypes (USNM 144056). At the time of collection the gully was not connected with the nearby Orinoco River, but obviously would connect when the river was in flood.

Etymology.—From the Greek "meristos" (divided), referring to the multisegmented carpopropus in ♂ pereopod 6.

Description.—Length of largest ♂ 7.2 mm, of ♂ holotype 6.7 mm, of largest ♀ 6.2 mm. Rostrum round-truncate, not covering base of eyestalk. Carapace emarginate posterodorsally, exposing last 2 pereonites. Cervical groove well developed. Eyes well developed; cornea occupying distal half, about 1.6× as wide as long, distinctly wider than eyestalk; eyestalk short, wider than long. Telson about 1.5× as long as width at base; lateral margins slightly concave, each armed along anterior $\frac{4}{5}$ with 6–8 subequal spines; each apical lobe with spine subequal to or longer than lateral spines; apical margin concave, depth of concavity about $\frac{1}{10}$ length of telson, concavity armed with 12–16 teeth. ♀ antenna 1, peduncle segment 1 about ⅓ longer than segments 2 and 3 combined, with groups of setae on anterolateral lobe and middorsal lobe; segment 3 with triangular middorsal lobe. ♂ antenna 1, peduncle segment 1 about as long as segments 2 and 3 combined, without middorsal lobe; ♂ lobe on segment 3 low, rounded, densely setose; in addition to usual 2 flagella, segment 3 bears dorsally a long, slender flagellum-like process obscurely segmented by a few incomplete sutures and sparsely armed with setae. Antenna 2 scale lanceolate, extending beyond antenna 1 peduncle, about 6× as long as wide; distal segment about $\frac{1}{7}$ length of whole scale, more than 2× as long as wide.

Right incisor with 3 large and 2 minute teeth; left incisor with 3 teeth, lacinia with 4 teeth. Spine rows each with 3 spines having different forms as illustrated. Maxilla 1 outer lobe with 12 terminal spines arranged in 5 rows and 3 subterminal surface setae; inner lobe with 7 terminal spines, 3 of them stouter and having rounded apex and subterminal twig. Maxilla 2, endopod 2-merous; segments subequal, distal segment with 15 marginal setae, both simple and bifurcate, and 6 surface setae; exopod reaching slightly beyond proximal endopod segment, with 3 distal setae. Maxilliped densely setose.

Pereopod 1 similar to that of *A.* (*S.*) *americana* as illustrated by Brattegard (1977, fig. 2G), but merus longer compared with carpopropus. Pereopods 2–3, ischium with proximal cluster of plumose setae; merus longer than ischium but shorter than 2-merous carpopropus, anterior margin with a few recurved spines; proximal carpopropus segment with several groups of slender spines having angular bend near midlength. Pereopod 4 sexually dimorphic; merus stouter in ♂; both merus and proximal carpopropus with many long marginal setae in ♂, with only a few scattered setae in ♀. Pereopod 6 with extraordinary sexual dimorphism; much longer in ♂ than in

Fig. 3. *Antromysis* (*Surinamysis*) *merista*: **a,** Pereopod 2, ♂; **b,** Same, suture between segments of carpopropus with distal carpal spines; **c,** Pereopod 4, ♀; **d,** Pereopod 4, ♂; **e,**

♀; ♀ carpopropus 2-merous; ♂ carpopropus 16-merous. Pereopod 7 with elongate merus, 1.5× length of ischium; distal margins of carpopropus segments with long setae.

♂ pleopod 4 like that of *A.* (*S.*) *americana,* but apparently with 1 more seta on exopod, and 3- rather than 2-merous exopod.

Uropod endopod about 2× length of telson and ¾ length of exopod, similar to that of *A.* (*S.*) *americana.*

Relationships.—The principal differences between *A.* (*S.*) *merista* and the only other species of the subgenus *Surinamysis, A.* (*S.*) *americana,* are given below in tabular form:

	americana	*merista*
Length of cornea	$^1/_3$ total eye	$^1/_2$ total eye
Telson	cleft $^1/_5$ length	emarginate $^1/_{10}$ length
Sexually dimorphic pereopods	pereopod 7	pereopods 4 & 6
♂ pleopod 4 exopod	2-merous	3-merous

Discussion.—The extraordinary sexual dimorphism in pereopod 6 requires comment. Dimorphism involving multisegmentation of a thoracic appendage in 1 sex but not in the other has not, to my knowledge, been observed in any other mysidacean, and I am not aware of its occurrence in any crustacean. My familiarity with Crustacea is far from adequate to state categorically that this condition does not occur elsewhere in the Crustacea. According to Hansen (1925), in the subfamily Mysinae, except the tribe Erythropini, the carpus and propus of pereopods 2–7 are fused into a carpopropus which is secondarily subdivided into a variable number of segments. The number of secondary segments increases with size, and may be greater in the posterior than in the anterior pereopods. Ii (1964) gives a maximum of 20 subsegments for *Neomysis rayii* (Murdoch), but the numbers are usually much fewer. Sexual differences unrelated to size have not been recorded, and the situation in pereopod 6 of *A.* (*S.*) *merista* appears to be unique.

The flagelliform process of the ♂ antenna 1 is most unusual, and no comparable structure has been reported from a New World mysidacean. Neither Tattersall (1951) nor Brattegard (1977) recorded such a process from *A.* (*S.*) *americana.* Dr. Brattegard kindly sent me some of his ♂ specimens from Surinam, all of which have a flagelliform process similar to that of *A.* (*S.*) *merista* but differing in details (compare Figs. 1c and 4d). In the genus

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Same, dactyl; **f,** Pereopod 6, ♀; **g,** Pereopod 6, ♂; **h,** Pereopod 7, ♂; **i,** Same, dactyl. *Antromysis* (*Surinamysis*) *americana*: **j,** Pereopod 6, ♂.

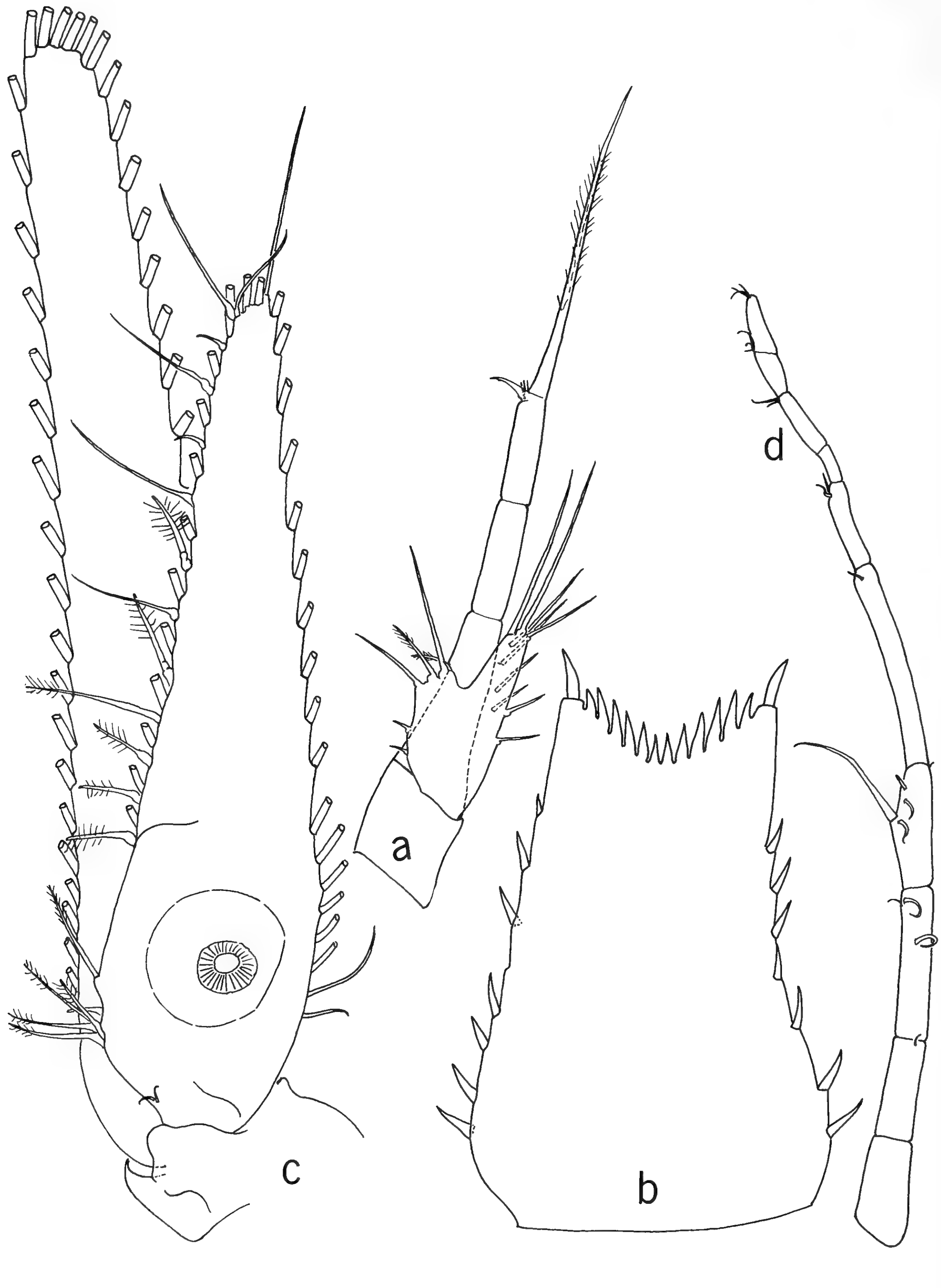

Fig. 4. *Antromysis* (*Surinamysis*) *merista*: **a,** Pleopod 4, ♂; **b,** Telson, ♀; **c,** Uropod, ♀. *Antromysis* (*Surinamysis*) *americana,* ♂; **d,** Antenna 1, flagelliform process.

Mesopodopsis Czerniavsky a similar process is present, consisting of a narrow long basal part armed distally with a single long slender seta. Four species are known, none from the New World, and none seems to be closely related to *Antromysis* (*Surinamysis*).

Acknowledgments

I am grateful to Drs. Georgiana B. Deevey and Edward S. Deevey for the gift of specimens of the new mysid, to Dr. Torleiv Brattegard for specimens of *A.* (*S.*) *americana,* and to Dr. Austin B. Williams for reviewing the manuscript.

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ARMADILLOGORGIA CYATHELLA AND *OPHIDIOGORGIA PARADOXA*, TWO NEW GENERA AND SPECIES OF PRIMNOID OCTOCORALS (COELENTERATA: ANTHOZOA) FROM SOUTH GEORGIA AND SOUTH ORKNEY ISLANDS

Frederick M. Bayer

Abstract.—*Armadillogorgia cyathella* and *Ophidiogorgia paradoxa*, two new genera and species of flagelliform primnoids with verticillate polyps, are described from South Georgia and South Orkney Islands. They are illustrated by scanning electron micrographs, photographs, and drawings, and are compared with species in the related genus *Primnoella*.

Investigations on the large number of octocoral specimens from several parts of the world added in recent years to the collections of the National Museum of Natural History, Smithsonian Institution, continue to reveal new taxa the importance of which merits publication in advance of comprehensive studies now in progress. Two of these are new genera and species of Primnoidae from the extreme South Atlantic and Weddell Sea allied to *Primnoella*, which demonstrate the morphological diversity in a family remarkable for the consistency of its taxonomic characters. They diverge in opposite directions from *Primnoella* species such as *P. magalhaenica* Studer, which approach most closely the generalized primnoid condition with 8 complete longitudinal rows of body scales, of which the topmost sclerite in each row is specialized as an opercular scale and more or less overreached by the next following scale in the row. Neither can be accommodated within the genus *Primnoella* as now understood.

One of the genera now described demonstrates the extreme development of structural specializations characteristic of the "Compressae" group of *Primnoella* species, in which the two abaxial rows of body scales alone cover the exposed side of the appressed polyps, and the lateral and adaxial rows are reduced in size and number of scales as in *P. australasiae* Gray as described and illustrated by Versluys (1906:52, fig. 55). The other genus, with its body scales in a layer several sclerites in thickness and not aligned in orderly longitudinal rows, appears to be an extreme modification of the "Convexae" group, the species of which have the exposed side of the polyps covered by 4 visible rows of scales (2 abaxial, 2 outer lateral) as in *P. antarctica* as described and illustrated by Kükenthal (1919:391, figs. 166–170). In the present case, new sclerites added between those of the original

8 rows disrupt the orderly arrangement. Moreover, in this genus, the polyps have a strong tendency to partial fusion into groups of two or three, a feature developed to the fullest in the genera *Callozostron* Wright and *Ainigmaptilon* Dean.

Armadillogorgia, gen. nov.

Diagnosis.—Dichotomously branched primnoids, axis stiff, brittle, calcified, without chambered core, holdfast spreading on solid substrate; polyps in whorls, closely appressed and adnate to stem, with 2 abaxial rows of numerous, closely fitting, narrow sclerites shaped like sickle blades set with the convex side outward and meeting at a zigzag suture line along the smoothly rounded middle of the abaxial side, forming a glossy, tight-fitting armor; lateral sclerites not in regular rows, not like the abaxials and not scalelike but similar to those of coenenchyme; no differentiated operculum, calicular aperture surrounded by small, imbricated, serrate scales. Coenenchyme thick, in 2 layers separated by solenia, inner layer filled with tuberculate, spheroidal or irregular grains, outer with tuberculate spheroids having a smooth, goblet-shaped or foliate process directed outward.

Type-species.—*Armadillogorgia cyathella,* sp. nov., here designated.

Distribution.—South Georgia.

Etymology.—The name alludes to the transverse abaxial sclerites of the polyps, which call to mind the band-like armor of the mammals called "armadillo"; Spanish, from Latin *armatus,* armed. Gender feminine.

Comparisons.—This genus is grossly similar to *Primnoella* but the verticillate polyps are adnate to the stem except for the oral region, the scales surrounding the aperture are numerous and not modified as an 8-parted operculum, and the abaxial body sclerites are so extremely modified that they have lost the scalelike form retained in even the most strongly modified species of *Primnoella.*

Armadillogorgia cyathella, sp. nov.
Figs. 1–5

Material.—Off South Georgia: 54°29′S, 39°22′W to 54°31′S, 39°19′W; 659–686 m. *Eltanin* cruise 22, sta. 1536, 8 February 1966. One colony.

Description.—The colony (Fig. 1) is sparsely branched in a dichotomous fashion, arising from a spreading holdfast devoid of polyps, attached to a dead scleractinian skeleton. The main trunk is stout, 9 mm in diameter exclusive of polyps, 16 mm in diameter including the whorls of tightly appressed polyps; whorls of polyps beginning immediately above the holdfast, the polyps of the first whorl rudimentary or vestigial, those of the next whorl well-developed. The first bifurcation of the axis occurs 7.5 cm above the holdfast, where the axis is broken and one branch lost. The other branch,

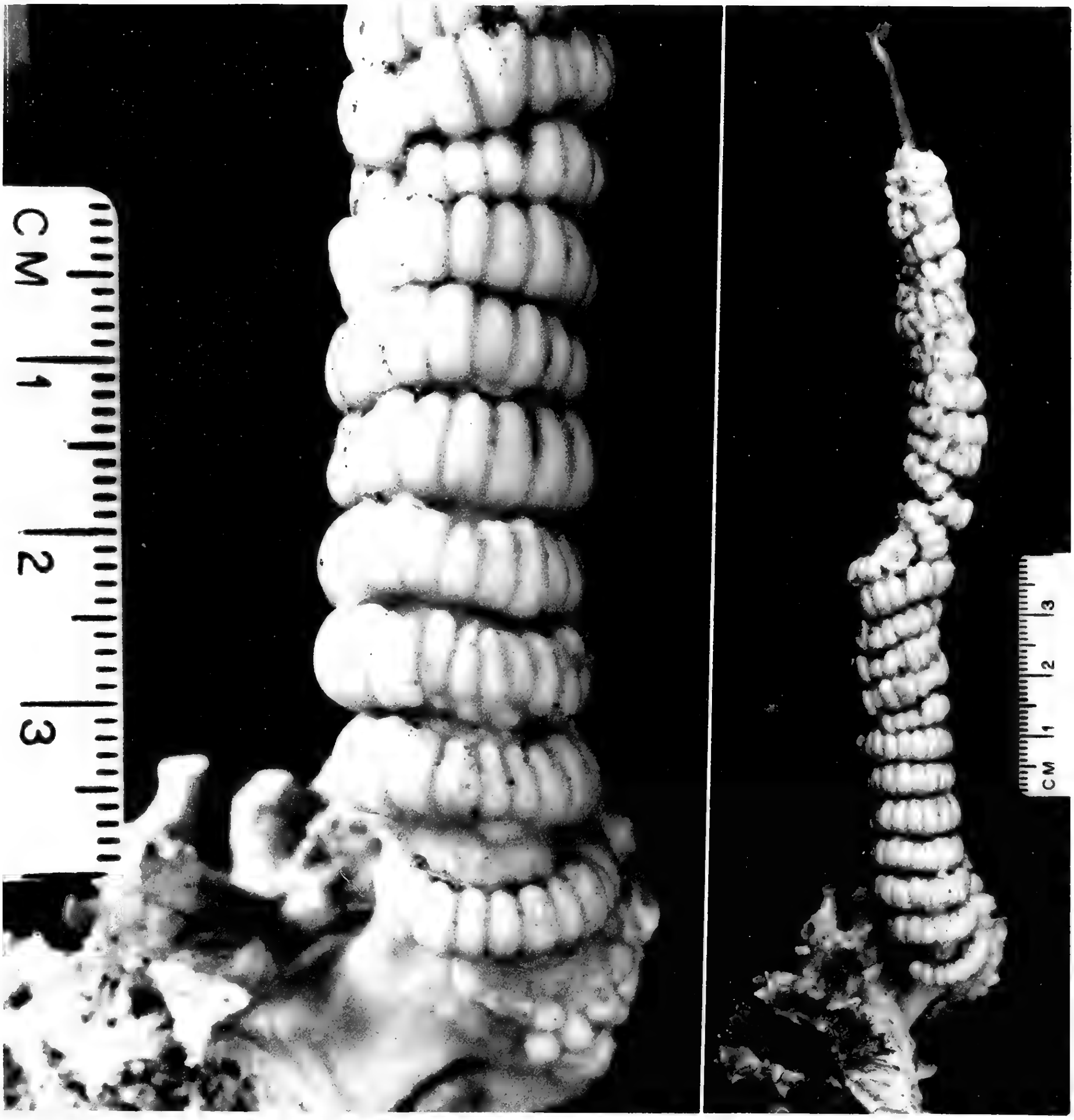

Fig. 1. *Armadillogorgia cyathella*. Holotype, USNM 58166.

detached from the main stem, is 8 cm long to the next bifurcation, where both branches were broken off and lost. Therefore, the height of the intact colony cannot be estimated, but the stoutness of the supporting axis and large size of the whorls would indicate a colony of substantial size, possibly a meter or more in height, with repeated bifurcations.

The whorls are composed of 15–20 polyps 4–7 mm tall, almost or quite touching the polyps of the next whorl above. Some of the whorls are obliquely set, and a few adjacent whorls join as a tight spiral. Seven whorls occur in 4 cm of axial length.

The abaxial surface of the polyps is covered by two rows of 40–55 tightly fitting sclerites meeting along a zigzag suture line, curved to fit the contour

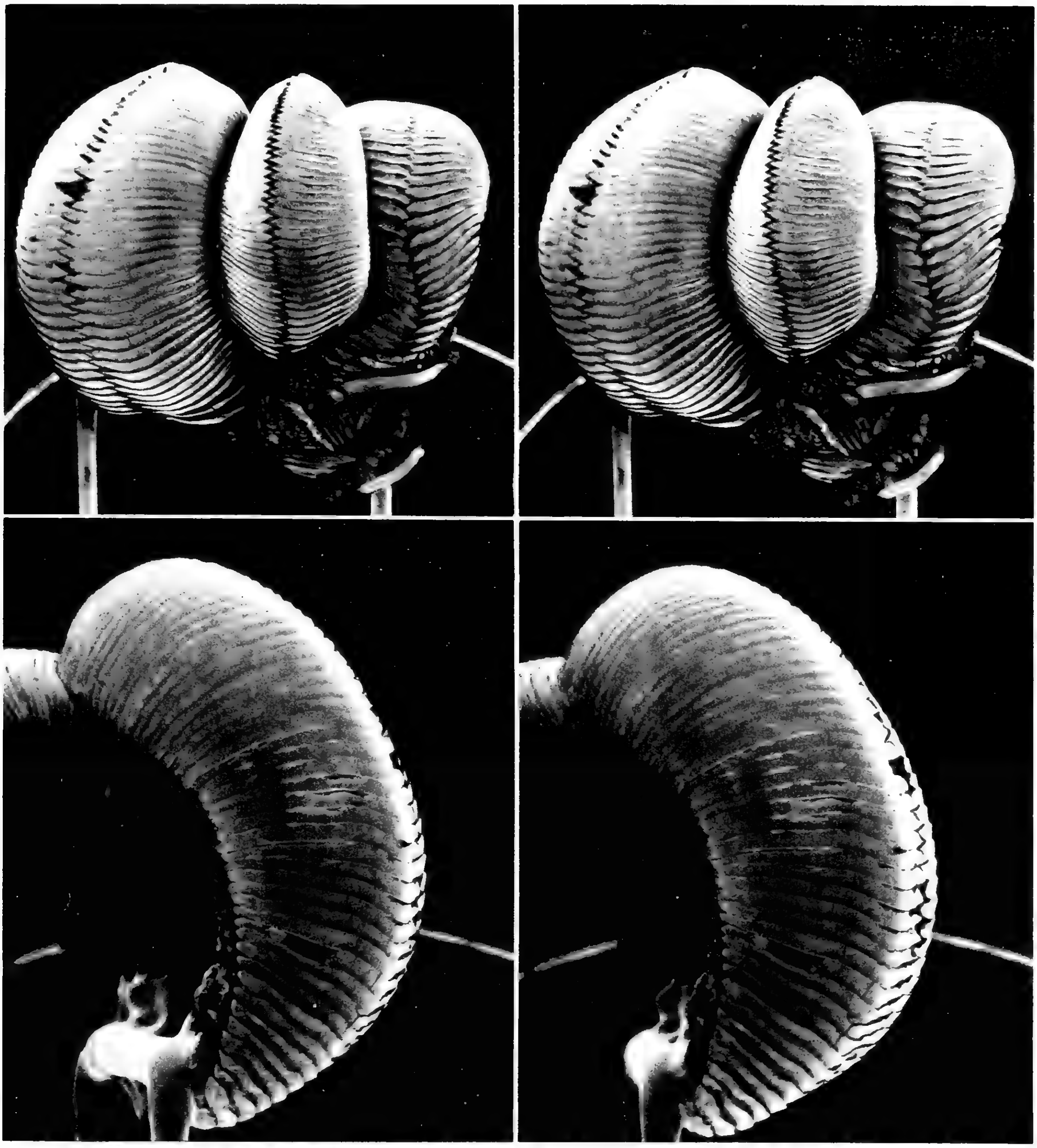

Fig. 2. *Armadillogorgia cyathella.* Holotype, USNM 58166: **Top,** three polyps in abaxial aspect, SEM, stereo pair, approximately ×8. **Bottom,** side view of left-hand polyp above, SEM, stereo pair, approximately ×13.

of the body wall (Fig. 2). The external face of the abaxial sclerites (Fig. 4a) is smooth and faintly concave, the two sides facing the adjacent sclerites above and below also slightly concave and smooth but sculptured near the adaxial end with a few inconspicuous radial wrinkles; a ridge of very complicated tubercles extends along the inner angle of the sclerite, serving to anchor it in the mesogloea of the abaxial body wall. Each side of the polyps has a longitudinal tract of closely packed sclerites consisting of a

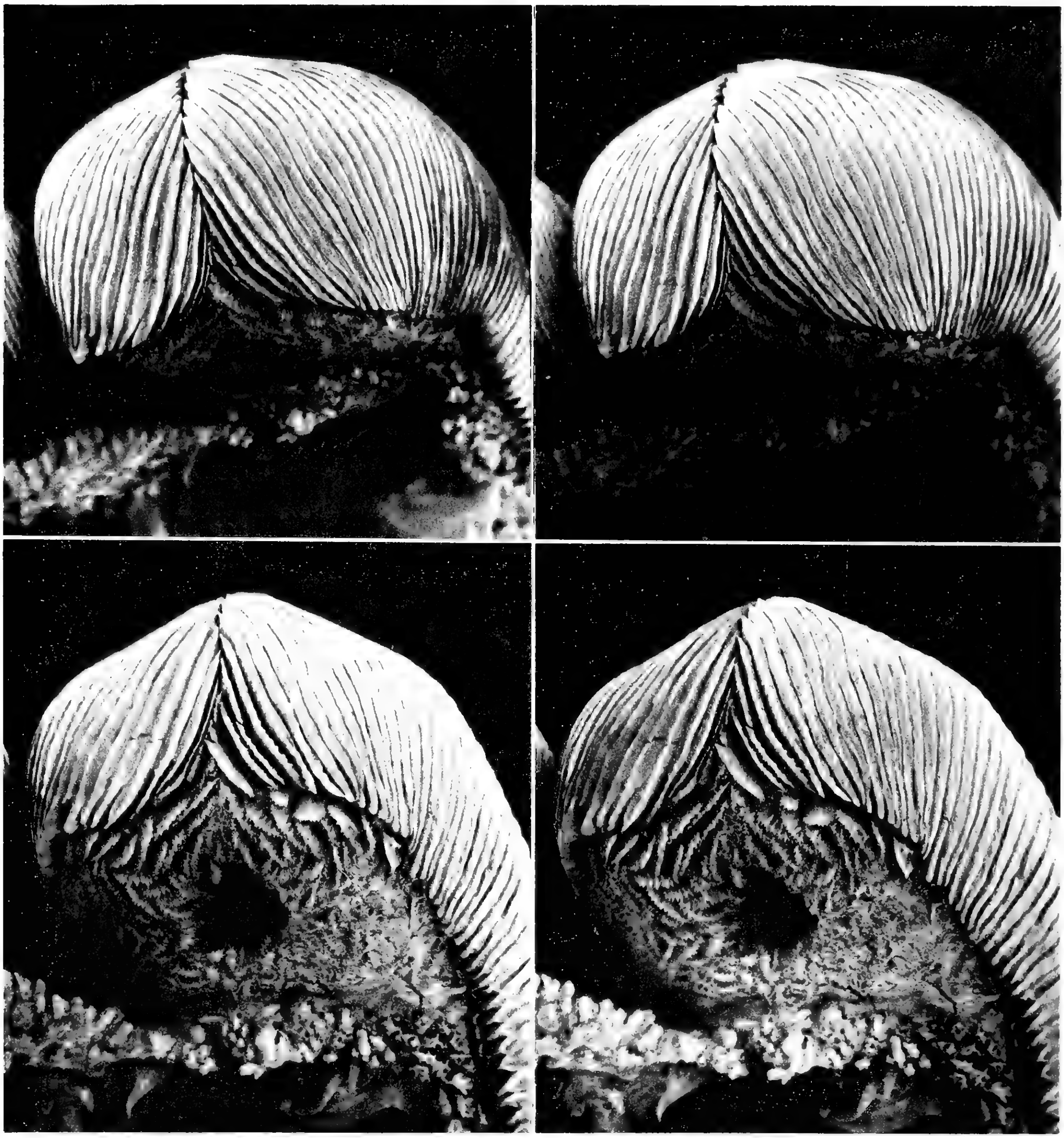

Fig. 3. *Armadillogorgia cyathella*. Holotype, USNM 58166: **Top,** apical view of left-hand polyp in Fig. 2, SEM, stereo pair, approximately ×21. **Bottom,** oral view of same, SEM, stereo pair, approximately ×23.

tuberculated base and a more or less expanded projecting leaf, representing the outer-lateral and inner-lateral scale rows and joining the adnate polyps to the adjacent coenenchyme (Fig. 4b). The distalmost body scales are not differentiated to form an operculum, those of the abaxial rows decreasing

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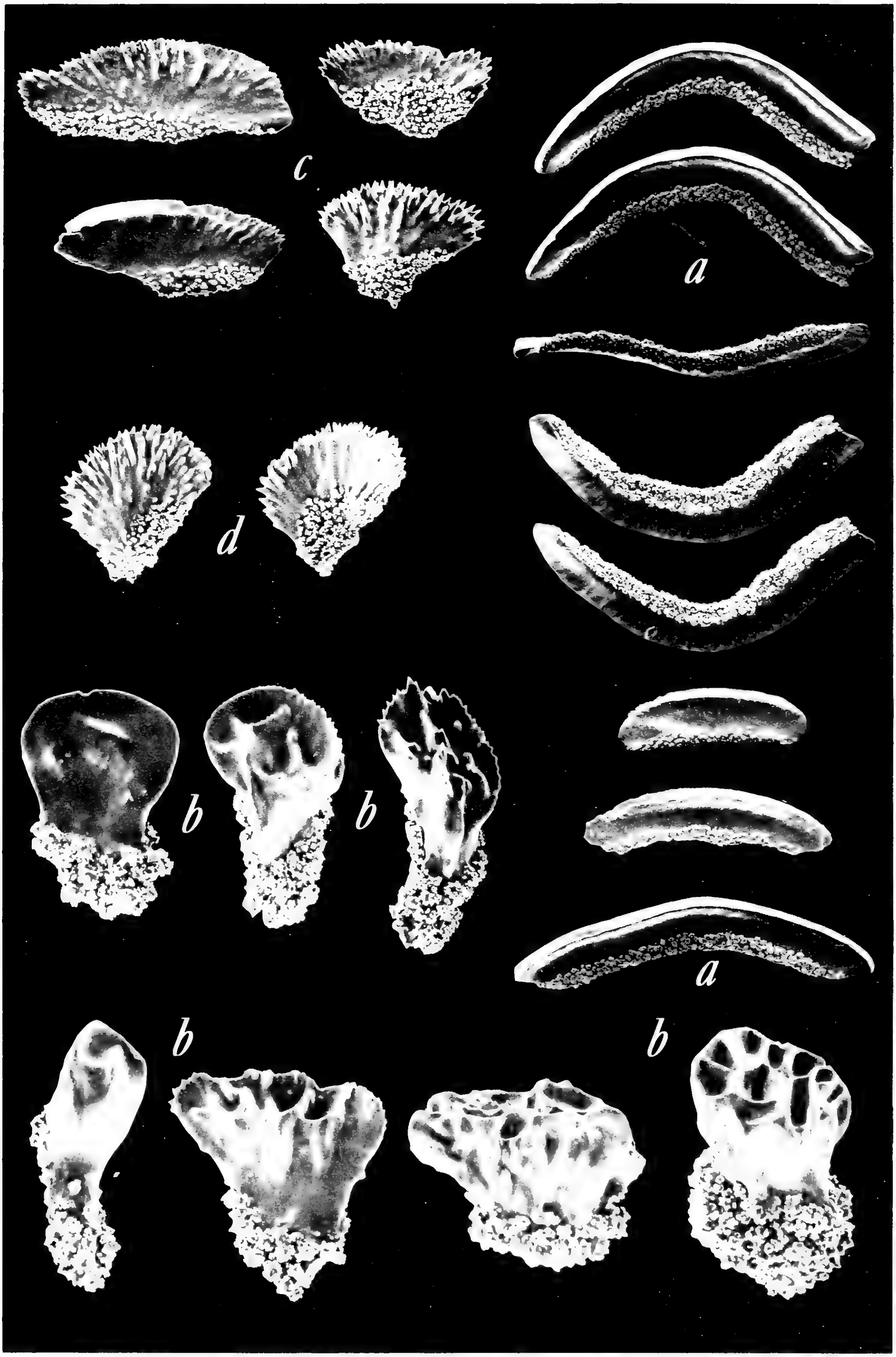
Fig. 4. *Armadillogorgia cyathella*. Holotype, USNM 58166: **a,** Abaxial sclerites, ×18; **b,** Coenenchymal sclerites from lateral margins of polyps, ×100; **c,** Circumoral and smaller abaxial sclerites, ×37.5; **d,** Circumoral sclerites, interior and exterior views, ×50.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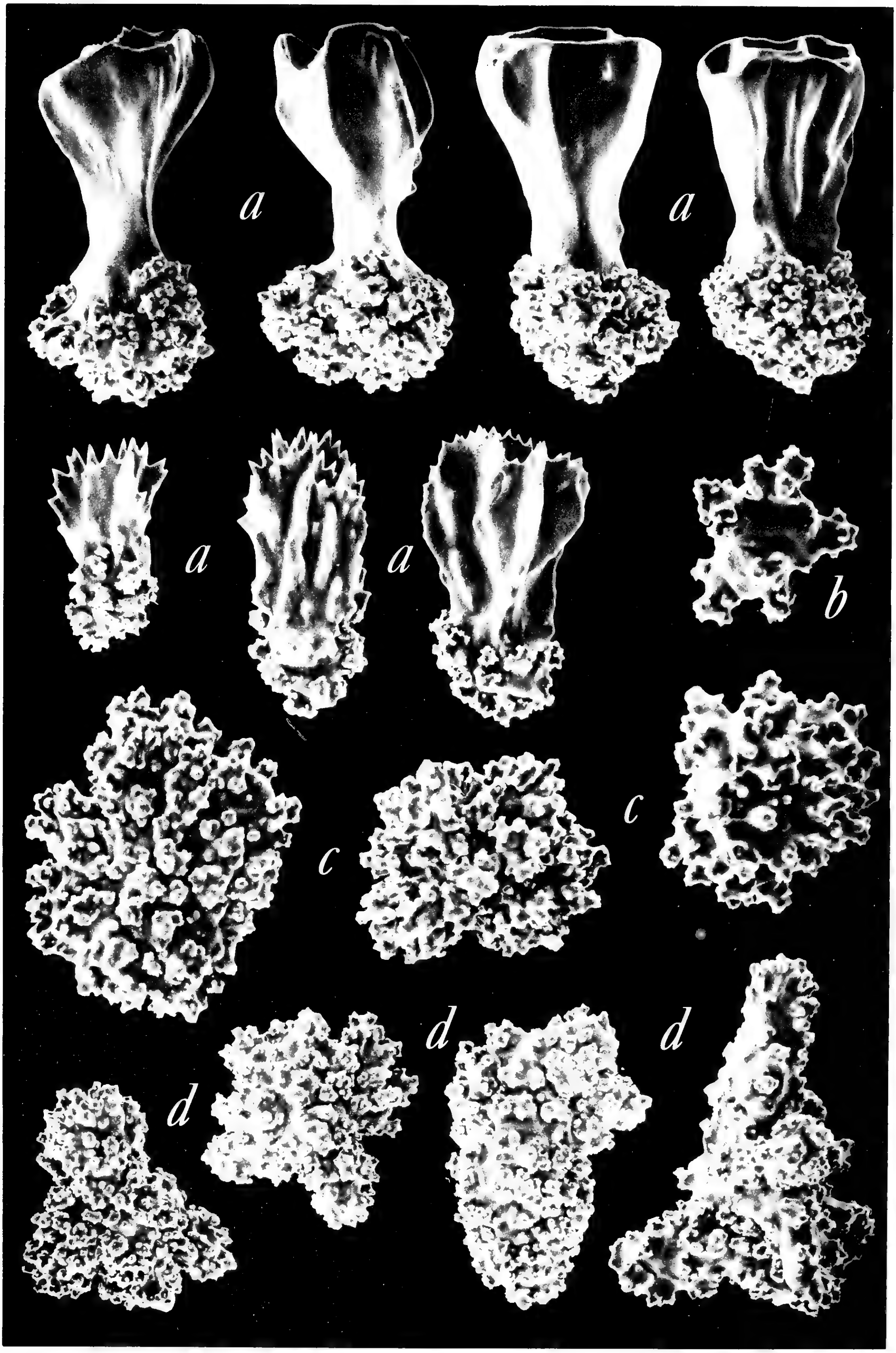
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in size and converging toward the inturned oral aperture (Fig. 3). The foliate processes of the distalmost lateral and adaxial sclerites overlap one another and are directed toward the oral aperture (Fig. 3, 4c, d). As the polyps are adnate to the coenenchyme except for the area immediately surrounding the calicular aperture, there is no adaxial wall.

The coenenchyme is thick, separated into two layers by a system of solenia. The outer layer is filled with sclerites having a spheroidal, tuberculated base and a projecting leaflike, laciniated or cupshaped outer process (Fig. 5a), together forming a dense pavement between the polyps. The inner layer of coenenchyme is filled with coarsely tuberculated grains (Fig. 5c, d) showing evidence of derivation from 6- and 8-radiate forms (Fig. 5b).

Holotype.—USNM 58166.

Etymology.—Latin *cyathus,* from Greek *kyathos,* a cup, + diminutive suffix, in allusion to the often cuplike coenenchymal sclerites. A noun in apposition.

Comparisons.—As illustrated by Thomson & Ritchie (1906:pl. 2, fig. 8), *Primnoella scotiae* from Burdwood Bank very closely resembles *Armadillogorgia cyathella,* but their description (1906:854) clearly indicates that the abaxial sclerites are broad scales of essentially primnoid form having the inner surface tuberculated and the outer surface tuberculated where covered by the adjacent scale but smooth (except for very fine wavy lines) where exposed. The abaxial rows are composed of 21–28 scales compared with more than 40 in *A. cyathella.* The calices, up to 3 mm long and 1 mm wide, are appressed but not adnate, as they are described as having adaxially "two small longitudinal rows along the edges, but the rest of the surface is covered with indistinct roundish scales irregularly disposed." The whorls are composed of fewer polyps (9–11) and are smaller in diameter (4 mm) than in *A. cyathella.* It is highly probable that *Primnoėlla compressa* Kükenthal, 1919, is a synonym of *P. scotiae,* and *P. philippii* Aurivillius, 1931, is very closely related. These, together with *P. biserialis* Wright and Studer and *P. delicatissima* Kükenthal form a distinctive "*biserialis* group" of species approaching, but much less modified than, *Armadillogorgia.*

Ophidiogorgia gen. nov.

Diagnosis.—Unbranched primnoids with polyps in regular whorls. Polyps tall, cylindrical, directed upward and appressed to coenenchyme but not

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Fig. 5. *Armadillogorgia cyathella.* Holotype, USNM 58166: **a,** Outer coenenchymal sclerites, ×168; **b,** Small inner coenenchymal sclerite, ×224; **c,** Larger inner coenenchymal sclerites, ×163; **d,** Largest inner coenenchymal sclerites, ×112.

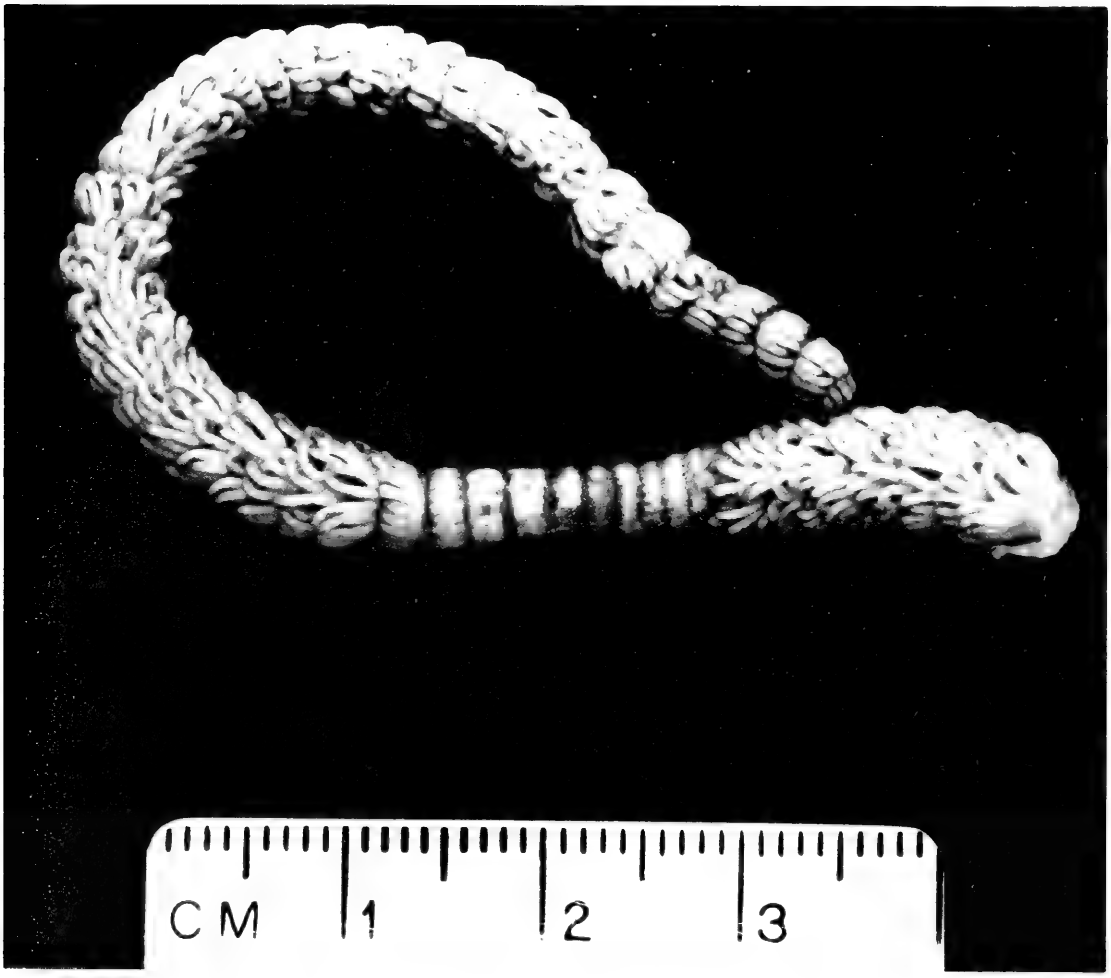

Fig. 6. *Ophidiogorgia paradoxa.* Holotype, USNM 58165.

adnate, covered abaxially and laterally with a multiple layer of circular platelets showing no trace of alignment in rows; adaxial side completely naked except for scales immediately surrounding the calicular aperture; scales folding inward around aperture but not differentiated as an operculum; tentacles without sclerites. Coenenchyme thick, outer layer filled with sclerites like those of polyps, inner layer containing stem canals separated by longitudinal tracts of tuberculate spheroids, mesogloea between inner and outer layers permeated by small solenia but lacking sclerites.

Type-species.—*Ophidiogorgia paradoxa,* sp. nov., here designated.

Distribution.—South Orkney Islands.

Etymology.—Greek *ophidion,* diminutive of *ophis,* serpent, + gorgia, in reference to the elongated, sinuous polyps. Gender feminine.

Remarks.—This genus is exceptional in several ways: (1) the absence of any indication of alignment of body sclerites in longitudinal rows in the fully developed polyps; (2) the tuberculate, pebble-like circular platelets scarcely

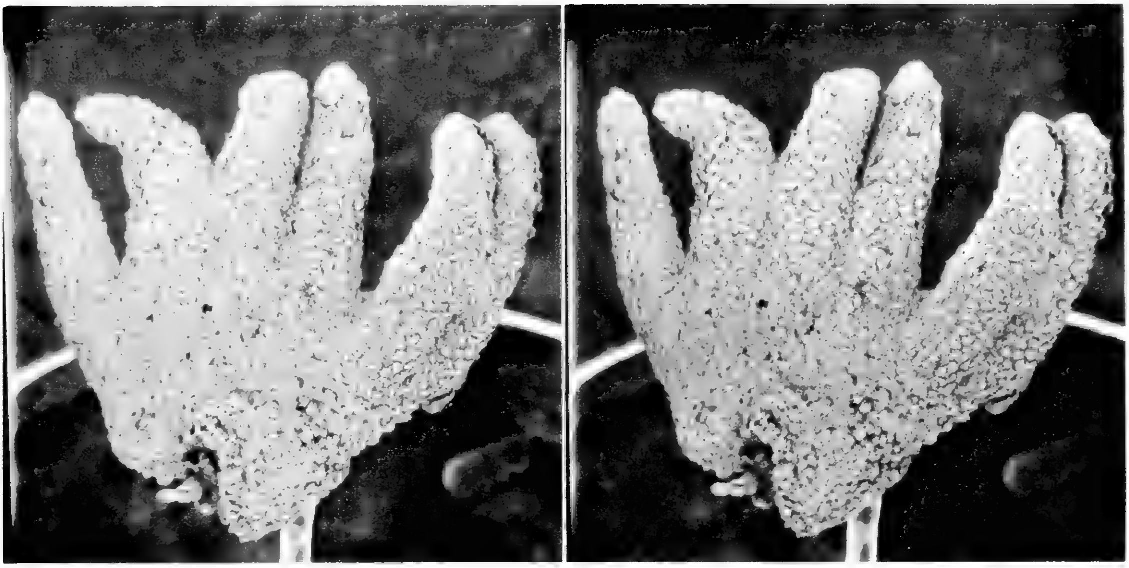

Fig. 7. *Ophidiogorgia paradoxa*. Holotype, USNM 58165: Six partially fused polyps in abaxial aspect, SEM, stereo pair, approximately ×14.

differentiated as scales and deployed in a multiple layer; and (3) lack of specialization of the distalmost scales as an operculum. It grossly resembles the genus *Primnoella* and probably is most closely related to it. The irregular arrangement of the sclerites in the fully developed polyps can be interpreted as a derived character, as is the case in *Primnoeides*, because the scales of the young polyps in intercalary whorls retain traces of orderly rows (Fig. 8), which quickly become disrupted by addition of new sclerites as growth proceeds. As the polyps of *Ophidiogorgia* are adaxially naked, the genus must have arisen from a *Primnoella*-like precursor that already had lost its adaxial sclerites.

Ophidiogorgia paradoxa, sp. nov.
Figs. 6–9

Material.—South Orkney Islands: 60°31′S, 45°53.7′W, 30 fathoms (55 m). *Eastwind* sta. 66-020, 8 February 1966; D. L. Pawson and D. F. Squires, coll. One colony lacking holdfast and axis.

Description.—The colony (Fig. 6) is whiplike, 115 mm long and 5 mm in diameter proximally, lacking holdfast and axis, which evidently were lost during collection. The polyps are cylindrical, narrow, about 3 mm tall and approximately 0.5 mm in diameter, set in whorls of 16–21 on low annular thickenings of coenenchyme and proximally fused together (Fig. 7) in groups of 2 or 3, rarely more, directed upward and appressed to the coenenchyme but not adnate to it; the tentacles are preserved more or less exsert and in most cases the oral region of the polyp is turned inward toward the coe-

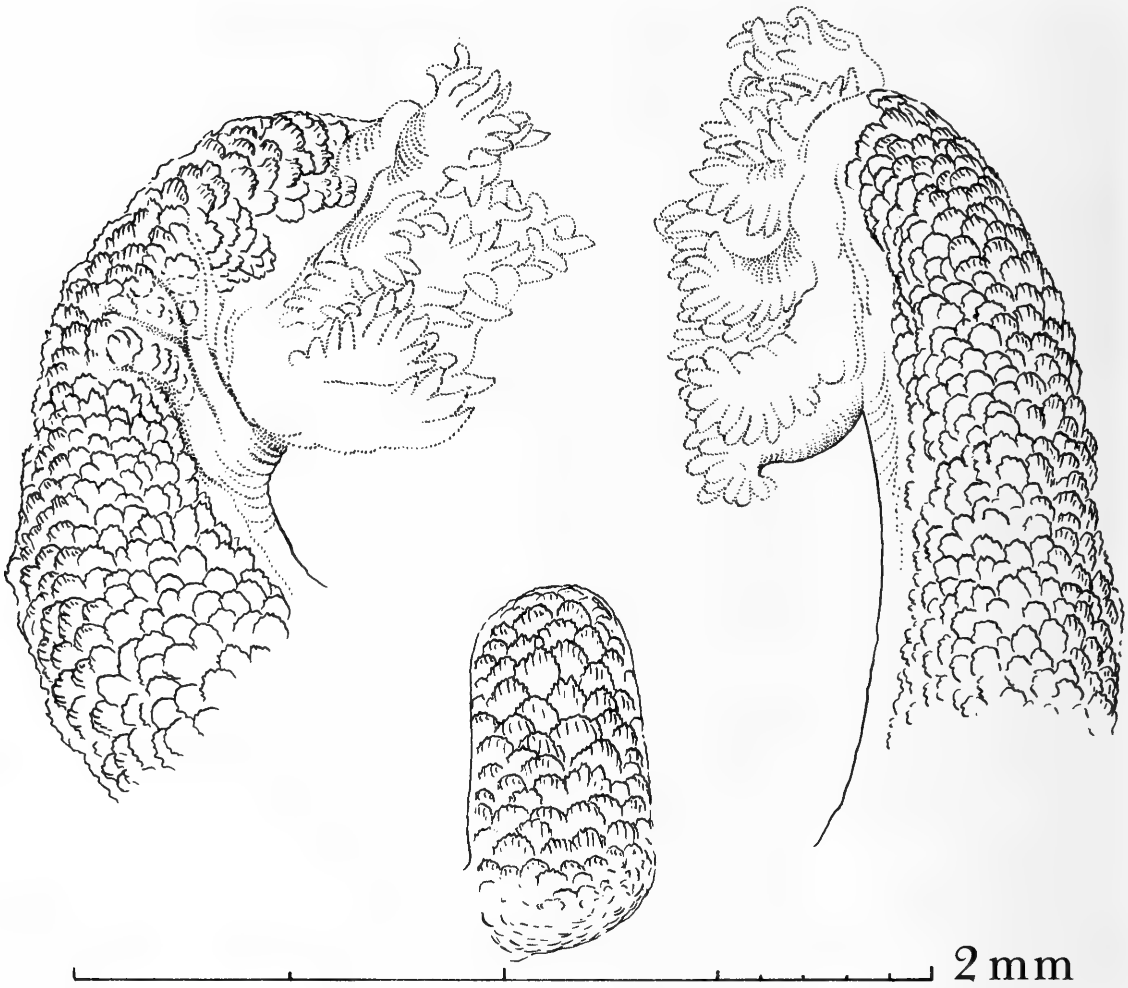

Fig. 8. *Ophidiogorgia paradoxa.* Holotype, USNM 58165: Lateral views of distal part of two fully developed polyps with tentacles preserved exsert, and abaxial view of immature polyp.

nenchyme (Fig. 8). About 5 whorls occur in 1 cm of axial length. Except for a narrow adaxial strip, the body of the fully developed polyps is filled with thick, roughly circular platelets having smooth, rounded, simple projections on the outer surface and compound tubercles on the inner surface (Fig. 9a), imbricating distad but not aligned in longitudinal rows and not confined to a layer one sclerite in thickness. The distal edge of the platelets, especially the larger ones, often has several pointed dentations, which may even project marginally as spines. The largest sclerites commonly develop an irregular, lumpy outer excrescence that gives them a pebble-like aspect. The distalmost sclerites are smaller but not different in shape from those of the proximal part of the body and are not differentiated as an operculum.

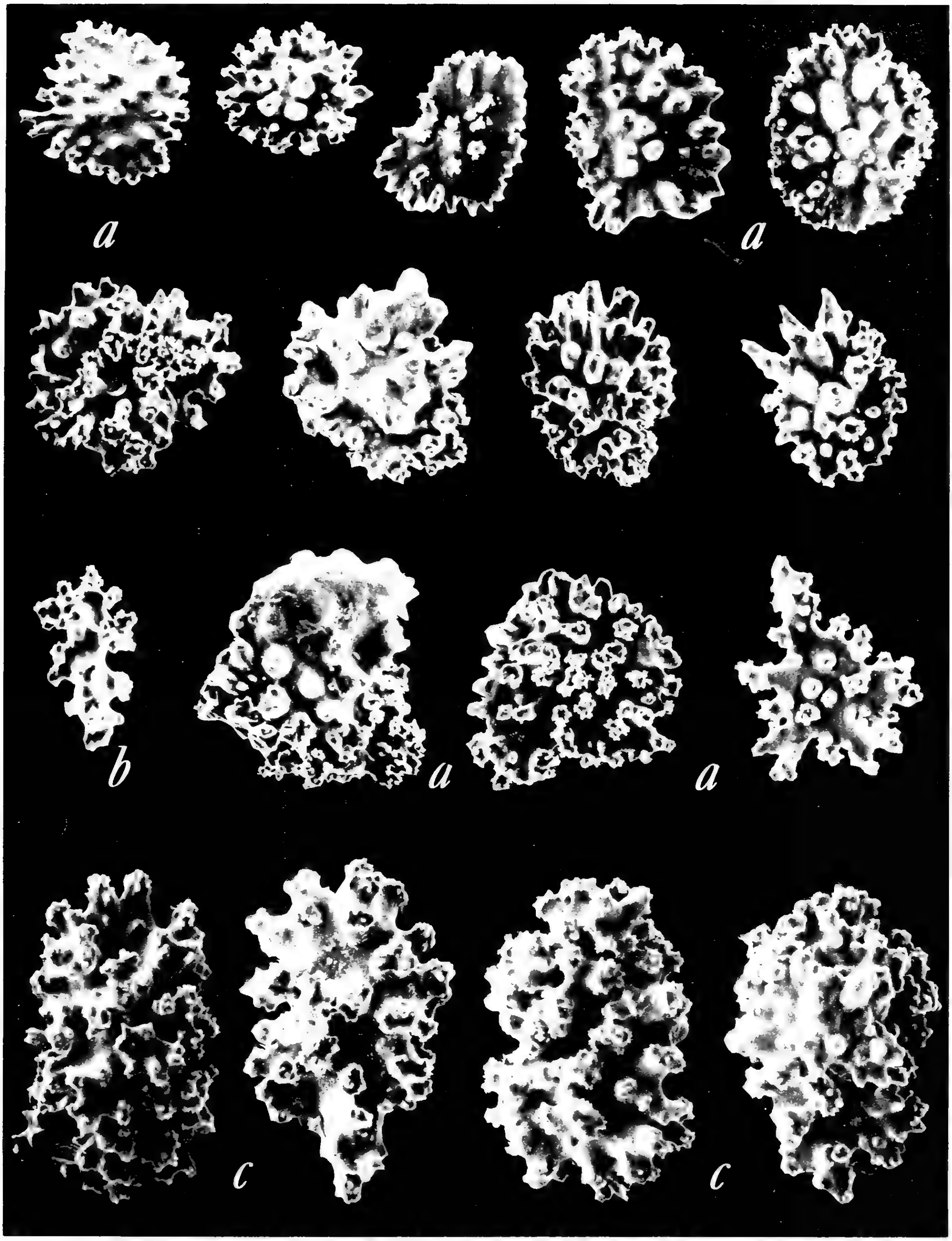

Fig. 9. *Ophidiogorgia paradoxa*. Holotype, USNM 58165: **a,** Sclerites of abaxial polyp walls, ×175; **b,** Inner coenenchymal sclerite, ×175; **c,** Inner coenenchymal sclerites, ×250.

The coenenchyme is thick, divided into two layers separated by mesogloea permeated by solenia. The outer layer contains sclerites like those of the polyps but often with a more irregular outer surface. The inner layer, containing the longitudinal stem canals, is filled with irregular bodies covered with compound tubercles (Fig. 9b, c).

In the proximal one-third of the colony, all of the polyps in nine whorls are atrophied and partly eroded away in a zone 15 mm long. This is probably the site of attachment of some epizoic organism such as a comatulid crinoid, many species of which commonly cling to gorgonaceans semipermanently, causing similar damage. If the causative organism was indeed collected along with the gorgonian, it was disassociated from its host during preservation, sorting and processing.

Holotype.—USNM 58165.

Etymology.—Latin, *paradoxus,* strange.

Comparison.—This species superficially resembles unbranched *Primnoella* colonies but differs from all described species by the irregular arrangement of its body scales. The form of the sclerites is also unlike that of *Primnoella* species, which is distinctly scalelike and externally smooth or nearly so.

Acknowledgments

I am grateful to Mr. Walter R. Brown, chief of the S.E.M. Laboratory of the Smithsonian Institution, who made the scanning electron micrographs, and to Mr. Michael Carpenter, who made the photographs for figures 1 and 6 and did all darkroom work for preparation of the figures. Drs. David L. Pawson and Thomas E. Bowman kindly read and criticized the manuscript.

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EIGHTEEN NEW SPECIES OF BRUCHIDAE, PRINCIPALLY FROM COSTA RICA, WITH HOST RECORDS AND DISTRIBUTIONAL NOTES (INSECTA: COLEOPTERA)

John M. Kingsolver

Abstract.—Diagnostic descriptions, illustrations of salient characters, geographic distribution, and host plants are given for the following new species: *Amblycerus epsilon, A. imperfectus, A. multiflocculus, A. pterocarpae, A. spondiae, A. vegai, Zabrotes chavesi, Merobruchus santarosae, M. boucheri, M. hastatus, M. paquetae, M. sonorensis, M. terani, Acanthoscelides hectori, A. johnsoni, A. megacornis, A. petalopygus,* and *A. triumfettae.*

Blackwelder's checklist (1946) of neotropical Coleoptera included only 9 species of Bruchidae from Costa Rica. Essentially no biological data were available for any of the Central American species at that time. In the last 15 years, however, largely through the intensive efforts of D. H. Janzen, University of Pennsylvania, Philadelphia, and his students, a prodigious amount of specimens and data has accumulated on the bruchids of Costa Rica, both in numbers of species represented, and in knowledge of life histories and host plant associations. The number of species now known from that country is 135, more than one-half of them undescribed when collected. Approximately 75% of these species have been reared from field collections of seeds, making this fauna one of the best known in the world for bruchids. Janzen's comprehensive studies on seed-seed predator interaction systems resulting from his collecting and rearing activities has stimulated a number of taxonomic papers on bruchids from Costa Rica including this paper.

The purpose of this paper is to describe for the first time 18 species of Bruchidae involved in Janzen's ecological studies.

Keys to species described in this paper are not provided because the genera represented are large, and all are being taxonomically revised at this time. Species herein included comprise only small parts of their respective genera.

Primary type-specimens are deposited in the United States National Museum of Natural History, Washington, D.C. (USNM). Paratypes of all species are deposited in USNM, in the C. D. Johnson Collection, Flagstaff, AZ, and in the Canadian National Collections, Ottawa, Ontario (CNCI).

Some paratypes are deposited in the British Museum (Natural History), London (BMNH), in the Muséum National d'Histoire Naturelle, Paris (MNHP), and in the American Museum of Natural History, New York (AMNH), and are indicated by the initials. The number of paratypes for each locality is listed in parenthesis after each block of data.

Three structural terms are introduced in this paper. *Cervical boss* is applied to a small, polished gibbosity on the anterolateral margin of the prothorax at the ventral extremity of the cervical sulcus. It usually forms the base for 1, 2, or 3 slender setae and is apparently the remnant of the anterolateral corner of the generalized pronotum of bruchids just as the cervical sulcus is probably the surviving portion of the sublateral sulcus. In the Pachymerinae, probably the most generalized of the bruchid subfamilies, 2 or 3 setae are located at the anterolateral corner of the pronotum on the sublateral carina. *Supraocular sulcus* is applied to the shallow furrow delimiting the dorsomedial margin of the compound eye in many bruchids. This sulcus may correspond to the ocular suture in more generalized insects, or it may be secondary. *Postmesocoxal sulcus* is applied to the furrow or groove delimiting the posterior rim of the mesocoxal cavity. In generalized bruchids (Pachymerinae, some Amblycerinae), this sulcus connects laterally with the parasutural sulcus of the metasternum.

Terminology for the male genitalia was proposed by Kingsolver (1970), and for the metatibia by Johnson and Kingsolver (1973).

Host plant names and authors, their family placement, and the names of associated Bruchidae are summarized in Table 1.

I am grateful to D. H. Janzen for the abundance of reared specimens and associated data; to C. D. Johnson for the loan of reared specimens and for critically reviewing the manuscript; and to Candy Feller and Mary Lou Cooley for many of the drawings.

AMBLYCERINAE

This subfamily is distinguished by the presence of movable spurs (calcaria) at the apex of the metatibia; mesepimeron and mesepisternum being of subequal size; and metacoxal face being broader than the metafemur.

Two genera are known from the Western Hemisphere—*Amblycerus* and *Zabrotes*. They can be differentiated by the presence of carinae on the metatibia in *Zabrotes* and their absence in *Amblycerus*.

Amblycerus Thunberg

Amblycerus Thunberg, 1815:121.

This is a large genus found only in continental Western Hemisphere with the exception of two species in the Galapagos Is. and one in the Marquesas Is., the latter likely an introduction.

Table 1.—Host Plants and Associated Bruchidae.

Host plant	Plant family	Bruchid species
Acacia angustissima (Mill.) Kuntze	Leguminosae	*Merobruchus terani*
Acacia berlandieri Benth.	Leguminosae	*Merobruchus terani*
Acacia collinsii Safford	Leguminosae	*Acanthoscelides petalopygus*
Acacia dolichostachya Blake	Leguminosae	*Merobruchus santarosae*
Acacia tenuifolia (L.) Willd.	Leguminosae	*Merobruchus terani*
Aeschynomene americana L.	Leguminosae	*Acanthoscelides megacornis*
Albizia adinocephala (Donn.-Smith) Britt. & Rose	Leguminosae	*Merobruchus sonorensis* *Merobruchus paquetae*
Albizia caribaea (Urb.) Britt. & Rose	Leguminosae	*Merobruchus sonorensis* *Merobruchus paquetae*
Albizia lebbek (L.) Benth.	Leguminosae	*Merobruchus sonorensis*
Albizia ortegae Britton & Rose	Leguminosae	*Merobruchus sonorensis*
Albizia sinaloensis Britton & Rose	Leguminosae	*Merobruchus sonorensis*
Albizia tomentosa (Micheli) Standl.	Leguminosae	*Merobruchus sonorensis*
Banisteriopsis cornifolia H.B.K. Robins.	Malpighiaceae	*Amblycerus multiflocculus*
Cassia emarginata L.	Leguminosae	*Amblycerus epsilon*
Cassia leptocarpa Benth.	Leguminosae	*Zabrotes chavesi*
Combretum farinosum H. B. K.	Combretaceae	*Amblycerus imperfectus*
Cordia alliodora (Ruiz. & Pav.) Cham. ex DC.	Boraginaceae	*Amblycerus vegai*
Cordia dodecandra DC.	Boraginaceae	*Amblycerus spondiae*
Heteropterys beechyana A. Juss.	Malpighiaceae	*Amblycerus multiflocculus*
Hippomane mancinella L.	Euphorbiaceae	*Amblycerus spondiae*
Lysiloma desmostachys Benth.	Leguminosae	*Merobruchus santarosae*
Lysiloma seemannii Britt. & Rose	Leguminosae	*Merobruchus sonorensis*
Macroptilium atropurpureum (DC.) Urb.	Leguminosae	*Acanthoscelides hectori*
Piptadenia flava (Spreng.) Benth.	Leguminosae	*Merobruchus hastatus*
Pithecellobium mangense (Jacq.) MacBride	Leguminosae	*Merobruchus boucheri*
Pithecellobium sonorae S. Wats.	Leguminosae	*Merobruchus sonorensis*
Pithecellobium undulatum (Britt. & Rose) Gentry	Leguminosae	*Merobruchus boucheri*
Prosopis juliflora (SW.) DC.	Leguminosae	*Amblycerus epsilon*
Pterocarpus rohrii Vahl	Leguminosae	*Amblycerus pterocarpae*
Rhynchosia minima (L.) DC.	Leguminosae	*Acanthoscelides hectori*
Spondias mombin L.	Anacardiaceae	*Amblycerus spondiae*
Spondias radlkoferi Donn.-Smith	Anacardiaceae	*Amblycerus spondiae*
Triumfetta lappula L.	Tiliaceae	*Acanthoscelides triumfettae* *Acanthoscelides johnsoni*
Ziziphus mexicana Rose	Rhamnaceae	*Amblycerus spondiae*

Whereas most bruchid genera are associated with the seeds of the Leguminosae, *Amblycerus* is found in seeds of a number of plant families, including Leguminosae.

Amblycerus epsilon, new species
Figs. 1, 30, 48, 60, 66, 67

Body length.—5.7–6.0 mm; width.—3.3–3.5 mm; pronotal length.—1.3–1.4 mm, width.—2.6–2.8 mm.

Color.—Integument dark red throughout except eyes piceous. Vestiture of yellowish gray slender hairs throughout; pronotum (Fig. 1) with three faint dorsal stripes of densely placed setae, i.e., an antescutellar stripe and two lateral curved stripes forming an approximation of the Greek letter *epsilon,* and an indistinct sublateral spot; elytra (Fig. 1) with similar stripes on sutural, third, fifth, seventh, and ninth intervals; disk of pronotum and elytra with minute bare spots marked by isolated slender setae; pygidium with narrow median stripe; venter of body with vestiture evenly distributed except for mesal one-third on metacoxal face.

Structure.—Body subelliptical, widest at basal one-third of elytra. Head turbiniform, eyes strongly protuberant laterally, coarsely faceted, ocular sinus about one-fourth length of eye; frons nearly flat, densely punctulate and setose, without frontal carina, frontoclypeal suture obtusely angulate; clypeus more coarsely punctate than frons, less densely setose; antenna (Fig. 48) long, reaching middle of metacoxa, subserrate from fourth segment, apical segment elliptical. Pronotum (Fig. 1) semicircular in dorsal aspect, basal margin bisinuate, disk convex, more strongly so in apical one-half, integument densely punctulate with a few coarser punctures in lateral areas; lateral carina somewhat obtuse, ventral submarginal channel extending about one-half distance from base to cervical boss, cervical sulcus fine, extending dorsad nearly to midline, cervical setae 3; prosternum short before coxae, intercoxal piece narrow, separating apices of procoxae. Scutellum (Fig. 60) short, scutiform. Elytra (Fig. 1) widest at basal one-third, lateral margins gently curved, bases sinuate, apices unevenly rounded; striae evident but not prominent, intervals of subequal width in basal three-fourths, of unequal widths in apical one-fourth, striae 4 and 5 and 6 and 7 conjoined apically; mesosternum short, linguiform; postmesocoxal sulci meeting mesally at obtuse angle, then extending laterally and connecting to parasutural sulci; vertical sulcus of metepisternum at obtuse angle with short parasutural sulcus. Abdomen with basal segment about as long as remaining 4 segments together; fifth segment slightly emarginate in male for reception of pygidial apex, truncate in female with slight transverse, subapical tumidity; pygidium nearly flat in both sexes. Male genitalia with median lobe (Fig. 66) about 3 times as long as wide; ventral valve broad at base, ogival to acute apex; dorsal valve more narrow at base than ventral valve, obtusely rounded apically; internal sac with paired irregular masses of blunt denticles and a pair of curved, rodlike sclerites basally, a large, subcylindrical, membranous sclerite mesally, and a pair of small, curved sclerites near apex; apical closure valve crescentic, attached to a pair of slender rods; lateral lobes (Fig. 67) short, Y-shaped; apical emargination rightangled. Pro- and mesolegs normal for genus; metacoxa reniform, densely punctulate and setose in lateral two-thirds with scattered larger punctures in lateral one-half; mesal one-third bare, polished, with dense cluster of punctures near insertion of trochanter; metafemur normal for genus; metatibia (Fig. 30) gradually widened to oblique apex, with row of fine punctures on dorsolateral face, apical margin microserrulate; lateral calcar slightly less than one-half length of metabasitarsus, mesal calcar four-fifths length of lateral calcar.

Holotype ♂.—COSTA RICA: Guanacaste Prov., Finca La Pacifica, 16 March 1971, D. H. Janzen (#632), in fruits of *Cassia emarginata*. (USNM Type #72379). Allotype ♀ and 23 paratypes, same data. Other paratypes.—COSTA RICA: Guanacaste Prov., 5 mi E Cãnas, 4 March 1972, D. H. Janzen (#VI-20-1972-I), in *Cassia emarginata* (88); Santa Rosa N.P., nr. El Naranjo, dry river bed, 15 March 1972, D. H. Janzen et al. (#VI-19-1972-XVIII), ex *Cassia emarginata* (6); 2 mi N Playa del Coco, 14 March 1971, D. H. Janzen (#615), in *Cassia emarginata* (45); Playa del Coco, 14 March 1971, D. H. Janzen (#618), in *Cassia emarginata* (23); Santa Rosa N. P., 6 March 1975, D. H. Janzen in *Prosopis juliflora*, (7); GUATEMALA: Barranquillo, 8 June 1920, F. H. B. Quarantine 36617, L. L. Spessard (#362a), ex "Vainillo" (*Cassia emarginata*) (6).

Amblycerus epsilon, n. sp., is closely related to and externally is indistinguishable from *A. martorelli* Bridwell; however, details of the armature of the internal sac (cf. fig. 1, p. 492, Kingsolver, 1970), especially the shape of the curved, rodlike sclerites and the median sclerite, as well as the relative shapes of the ventral and dorsal valves, are diagnostic. In addition, the apical emargination between the lateral lobes is relatively shallow in *A. epsilon*, whereas in *A. martorelli* it is deep and rounded.

Amblycerus martorelli breeds in seeds of *Prosopis juliflora* (SW.) DC. in the West Indies, and an undescribed species in this group in Venezuela also lives in *P. juliflora*.

The name *epsilon* refers to the markings on the pronotum.

Amblycerus imperfectus, new species
Figs. 2, 22, 31, 49, 61, 68, 69

Body length.—4.0–5.7 mm, width.—2.4–3.0 mm; pronotal length.—1.1–1.3 mm, width.—1.7–2.1 mm.

Color.—Integument dark red, eyes black, Vestiture of yellowish gray, brown, and golden aciculate hairs with yellowish brown and golden hairs forming faintly mottled pattern on elytra (Fig. 2) with brown hairs concentrated in small spots, pattern variable in development from that in Fig. 2 to nearly complete absence of dark spots, these sometimes faintly marked by golden spots; pronotum (Fig. 2) appearing slightly darker than elytra with somewhat variable, paired, sinuate, yellowish markings extending from base to apex and flanked by oval sublateral spots; legs and antennae uniformly red with yellowish vestiture; mesepisternum with 2 irregular, brown spots; abdominal sterna each with sublateral brown spot, sometimes with incomplete row of spots mesad of sublateral spots; pygidium with pattern as in Fig. 22 in more intensely marked specimens varying to unicolorous.

Structure.—Body subelliptical, widest at basal one-third of elytra. Head turbiniform, eyes moderately convex, protruding laterally, ocular sinus shallow; frons evenly, finely punctulate, convex, lacking frontal carina; clypeus finely, evenly punctulate except apical margin granulose; labrum finely punctate basally; postocular fringe narrow, postocular furrow moderately deep; antenna (Fig. 49) reaching middle of metepisternum, subserrate from fourth segment, eleventh subelliptical. Pronotum (Fig. 1) nearly semicircular, somewhat narrowed apically, basal margin bisinuate, disk transversely, evenly arcuate, basal lobe slightly depressed, sublateral carina traceable in middle of basal margin, along entire lateral margin, and connecting with cervical sulcus which extends dorsad nearly to middle of pronotum; cervical boss bisetose, posterior angle of pronotum with 1 seta; pleural area deeply concave, sublateral sulcus parallel to lateral carina; prosternum flat, constricted at middle, slightly expanded apically, face with nearly impunctate lateral ridges. Scutellum as in Fig. 61. Elytra (Fig. 1) 1.4 times as long as wide, apices evenly rounded, lateral margins arcuate; striae narrow, deep, regular in course, 4 and 5 conjoined at apical one-fourth, 6 and 7 conjoined near apex of elytron, intervals of subequal width; mesosternum semicircular, slightly channeled longitudinally; postmesocoxal sulci meeting on midline at right angle, extending laterally to join parasutural sulci, the latter extending nearly to posterior margin of metasternum. Abdomen with first sternum equal in length to remaining sterna together, terminal sternum slightly emarginate in male, evenly arcuate in female; pygidium (Fig. 22) transversely flat, slightly arcuate in lateral aspect, surface evenly punctulate. Male genitalia with median lobe (Fig. 61) 4 times as long as wide, ventral valve ogival with apex acute, dorsal valve arched, less acute than ventral valve, armature of internal sac consisting of large, paired, externally serrate, flat sclerites near base, a complex of elongate, flat, tapered blades and smaller bladelike spines, and a wishbone-shaped sclerite with serrate stem, a patch of fine spicules near apex, closure valve semicircular with paired rods attached; lateral lobes (Fig. 68) fused basally, lobes divergent, emargination between them shallow. Pro- and mesolegs not modified; metacoxae reniform, slightly concave, densely punctulate and setose except for subtriangular polished area in mesal one-half, lateral one-half sparsely foveolate, circular cluster of punctures near trochanteral insertion; metafemur normal for genus; metatibia (Fig. 31) with lateral calcar one-half as long as metabasitarsus, mesal calcar two-thirds as long as lateral calcar; metabasitarsus elongate, curved, nearly as long as metatibia.

Holotype ♂.—COSTA RICA. Guanacaste Prov.: Santa Rosa (N.P.), beach area, 15 March 1972, D. H. Janzen et al. (#VI-19-1972-XII), ex seeds of *Combretum farinosum* (USNM Type #76374). Allotype ♀ and 41 paratypes, same data. Other paratypes.—Santa Rosa (N.P.), road to El Naranjo, 9 March 1972, D. H. Janzen et al. (#VI-20-1972-XXVIII), *Combretum farinosum* (2); Santa Rosa (N.P.), road to Casona, 20 April 1976, D. H. Janzen, *Combretum farinosum* (1).

This species is closely related to *A. perfectus* (Sharp) described from Tehuantepec, Mexico, that has been collected in Costa Rica in the same reared lots with *A. imperfectus,* new species. These two can be distinguished with certainty only by examination of the male genitalia. The color pattern in *A. perfectus* is usually more intensely brown but the range of variation overlaps that of *A. imperfectus.* Differences in the male genitalia to separate *A. perfectus* are: dorsal valve rounded apically, not acute; internal sac with basal sclerites more slender and less strongly serrate; blade-like sclerites in middle of sac longer and with serrate margins; wishbone sclerite more semicircular; spines surrounding complex smaller.

The name refers to the imperfectly developed color pattern as compared to that of *A. perfectus.*

Amblycerus multiflocculus, new species

Figs. 3, 23, 32, 62, 70, 71

Body length.—4.0–6.0 mm, width.—2.6–3.9 mm; pronotal length.—2.25–2.75 mm, width.—2.0–3.0 mm.

Color.—Integument dark red throughout except eyes black. Vestiture of gray, white, brown, and golden aciculate hairs; pronotum (Fig. 3) with mostly white hairs but with scattered vague patches of mostly golden hairs, 4 intensely white spots in slightly arcuate, transverse median row, 1 spot each side midway between transverse line and apical margin, the 6 spots forming 2 triangles; elytra (Fig. 3) with intermixed golden and gray hairs on intervals with very narrow stripe of gray hairs on either side of each stria, pattern of small, intensely white tufts as follows: third interval with 8–10 tufts, fifth with 6–7 tufts, seventh with 5–6 tufts, ninth with 7–8 tufts, eleventh with 4 or 5 vague white patches in basal one-half; pygidium (Fig. 23) unevenly covered with white hairs, punctures showing through vestiture, median line sometimes marked by narrow line of white hairs; venter of body evenly covered with intermixed golden and gray hairs but with golden sheen; abdominal sterna with lateral row of whitish spots.

Structure.—Body elliptical, widest at middle of elytra. Head turbiniform; eyes strongly protuberant laterally, coarsely faceted, ocular sinus shallow; frons finely, densely punctulate, faintly carinate medially; clypeus slightly wider than long, more coarsely punctulate than frons; labrum impunctate except for transverse row of setiferous punctures; antenna subserrate, long, reaching metacoxa. Pronotum (Fig. 3) trapezoidal, mostly convex but flattened in basal one-half; basal margin bisinuate with fine submarginal carina in middle one-third; lateral margin of disk with fine carina nearly concealed by vestiture, continuous with fine apical carina, the latter obsolete in middle one-fourth; disk punctulate, middle one-third with scattered coarser punctures, these much denser in lateral areas of disk, surface nearly concealed by dense vestiture; cervical boss bisetose, occasionally with 3 setae; pleural region deeply concave, limited dorsally by prominent submarginal sulcus. Prosternum Y-shaped, short before coxae, intercoxal piece narrow, somewhat arched, slightly expanded apically, the apex articulating against mesosternal lobe. Scutellum (Fig. 62) about 1.6 times as long as wide, slightly attenuate, rounded apically, bisulcate. Elytra (Fig. 3) about 1.3 times as long as wide, striae moderately deeply impressed; intervals convex, imbricate-punctate; elytral apices evenly rounded; disk subdepressed medially to about apical one-third; sutural interval prominent in apical one-half. Mesosternum linguiform, medially sulcate; postmesocoxal sulci continuous across midline, connected laterally with parasutural sulci which extend posteriorly to metacoxal margin; metepisternal sulcus deep anteriorly, angulate, ending posteriorly in elongate, polished boss; metepisternum with several prominent foveolae. Abdomen with first sternum about as long as remaining sterna together; posterior margin of fifth sternum truncate in male, arcuate in female; pygidium (Fig. 23) subtriangular, lateral margins arcuate, apex truncate. Male genitalia with median lobe (Fig. 70) slender, about 4.5 times as long as wide; ventral valve subtriangular with lateral margins incurvate, base broad, apex acute; armature of internal sac consisting of a pair of thin plates near base each bearing dense cluster of acute spines, a pair of small, falcate and serrate blades, a median C-shaped blade with 2 cusps, and a pair of angular, spiny sclerites; apex of sac lined with rows of fine spicules; closure valve crescentic with paired, slender rods attached; lateral lobes (Fig. 71) short, expanded apically, apical margin shallowly emarginate. Pro- and mesolegs not modified; metacoxal face reniform, densely clothed except in basal one-fourth, lateral one-half with about 40 small foveolae, proximal polished area with about 16 rounded, small punctures; metafemur short, stout; metatibia (Fig. 32) short, with prominent row of punctures on dorsolateral face, lateral calcar about 0.6 as long as metabasitarsus, mesal calcar about 0.6 as long as lateral calcar, both calcaria slightly curved laterad.

Holotype ♂.—COSTA RICA. Guanacaste Prov.: Santa Rosa N. P., dry river bed, 15 March 1972, D. H. Janzen (#VI-19-1972-V), reared from *Heteropterys beechyana,* (USNM Type #76383). Allotype ♀ and 8 paratypes, same data. Other paratypes.—COSTA RICA. Guanacaste Prov.: Santa Rosa N. P., 10 February 1978, Liesner (#5268), reared from *Banisteriopsis cornifolia* (14). PANAMA. Chiriqui Prov.: Cerro Punta, 8,000 ft., 18–24 July 1961, J. M. Campbell (2). EL SALVADOR. San Salvador: Tonocatepeque, 20 June 1958, L. J. Bottimer (Coll. #102j) (1). MEXICO. Oaxaca: 24 mi N Matias Romero, 24 June 1969, Bright and Campbell (1).

This species is most closely related to *Amblycerus geminatus* (Sharp). The latter is relatively smaller, has fewer and larger flocculent white spots on the pronotum and elytra, and is distinctly different in details of the male internal sac armature. In *A. geminatus,* the apex of the ventral valve is more sharply acute, the apex of the dorsal valve is arched with arcuate lateral margins, the spiny, paired sclerites near the base of the sac are more arcuate, the wishbone sclerite is narrower with cusps relatively longer, and the median sclerites are serrate rather than spiny. The terminal margin of the lateral lobes is truncate rather than emarginate.

The specific name is derived from the white flocculent spots.

Amblycerus pterocarpae, new species

Figs. 4, 33, 50, 63, 72, 73

Body length.—5.9–7.6 mm, width.—4.0–4.9 mm; pronotal length.—2.4–2.6 mm, width.—3.5–3.7 mm.

Color.—Integument reddish brown on anterior part of clypeus, pronotal disk and flanks, elytra, abdomen, and 3 terminal segments of each tarsus; dark red on metatibial calcaria and sometimes on apex of metafemur and of metatibia; piceous to black on head and antenna, venter of thoracic segments, legs except tarsal segments mentioned above. Vestiture evenly distributed over entire body, that on reddish parts yellowish red, that on piceous parts silvery gray.

Structure.—Body elliptical (Fig. 4), depressed above, widest at basal one-third of elytra. Head subtriangular, eyes protuberant, moderately coarsely faceted; frons slightly convex, densely, finely punctulate, lacking frontal carina but with short, impunctate line immediately above fronto-clypeal suture; clypeus densely punctate, coarser than on frons, apical margin granulate; vestiture on head densely set except for labrum and paired elliptical bare spots at level of dorsal margins of eyes; antenna (Fig. 50) long, slender, subserrate from fourth segment. Pronotum (Fig. 4) trapezoidal, lateral margins moderately arcuate, apex truncate, disk convex except depressed and canaliculate on basal lobe, disk punctulate over entire surface and with small, shallow rounded foveolae evenly distributed except in median one-fourth; lateral margin entire, delimited by dorsal and ventral submarginal sulci, dorsal sulcus connected to cervical sulcus, the latter fine, shallow; cervical boss with 3 setiform punctures; prosternum Y-shaped, precoxal length about equal to width of intercoxal piece, the latter flat, slightly constricted between procoxal apices with apex bluntly angulate. Scutellum (Fig. 6) elongate, two times as long as wide, tridenticulate apically. Elytra (Fig. 4) one-third longer than wide, disk depressed around scutellum and slightly depressed longitudinally between fifth intervals; strial punctures shallow, rounded, striae scarcely impressed basally but with channeling more evident in apical two-thirds; intervals subequal in width, flat, striae 4 and 5 conjoined at apical one-fourth; elytral apices subtruncate; mesosternum linguiform, depressed medially for reception of prosternal apex; conjoined postmesocoxal sulci slightly arcuate on midline; vertical metepisternal sulcus at right angles to parasutural sulcus, the latter extending caudad to small fusiform, polished boss at posterior margin of metepisternum. Abdomen with first ventral segment slightly shorter than remaining segments together, fifth segment slightly emarginate in male, evenly arcuate in female; pygidium semicircular in male, subtriangular and apically truncate or slightly emarginate in female. Male genitalia with median lobe (Fig. 72) three and one-half times as long as wide; ventral valve acute apically, lateral margins incurvate, base broad; dorsal valve with margin arcuate; internal sac with two pairs of hollow, thin-walled, denticulate sclerites, anterior pair flanking wishbone-shaped sclerite; apical transfer valve circular with two slender rods attached; lateral lobes (Fig. 73) expanded apically, setose, apical margin with paired angulate lobes separated by angulate median emargination. Pro- and mesolegs normal for genus; metacoxal face densely setose in lateral four-fifths, bare and polished in mesal one-fifth with cluster of punctures near insertion of trochanter; middle of anterior border with narrow, transverse, polished ridge; metafemur normal for genus; metatibia (Fig. 33) lacking dorsolateral row of punctures; lateral calcar one-half length of metabasitarsus, mesal calcar one-half length of lateral calcar.

Holotype ♂.—COSTA RICA. Guanacaste Prov.: Santa Rosa N. P., Rio Caldera, 8 May 1976, D. H. Janzen (#310359), coll. ex seeds of *Pterocarpus rohrii* (USNM Type #76375). Allotype ♀ and 83 paratypes, same data. Other paratypes.—Guanacaste Prov.: Santa Rosa N.P.; Rio Caldera, 15 May 1978, *Pterocarpus rohrii,* D. H. Janzen, coll. (1); (Limon Prov.), Hamburg Farm, Reventazon, Ebene Limon, 17 July 1931, at light, F. Nevermann, coll. (1). The colloquial name of *Pterocarpus rohrii* Vahl. is "Sangre Drago."

Amblycerus pterocarpae appears to be closely related to *A. pollens* (Sharp) and *A. tachigaliae* Kingsolver in color and body form, and the male genitalia support this relationship to a degree. All three species are uniformly reddish yellow to reddish brown dorsally with the sternal thoracic segments piceous to black. In *A. pterocarpae* and *tachigaliae* the abdomen is red, whereas in *A. pollens* the abdomen is the same color as the thoracic sterna. *A. pollens* alone possesses a stridulatory file on the metepisternum scraped by a blunt tooth on the metafemur.

Amblycerus pterocarpae and *A. tachigaliae* can be distinguished by the following (characters of *tachigaliae* in parentheses): Scutellum narrow, twice as long as wide (broad, nearly quadrate); lateral calcar one-half length of metabasitarsus (three-fourths length of basitarsus); frons only slightly convex (frons strongly convex); cervical sulcus evenly arcuate at ventral end (sulcus strongly hooked ventrally); apex of prosternum more than one-half as wide as mesosternum (one-third as wide); armature of internal sac, Fig. 72 (see fig. 2, p. 151, Kingsolver, 1976).

The fruit of *Pterocarpus* is a wafer-like samara with a centrally placed seed. *Amblycerus pterocarpae* is the only known bruchid to develop in seeds of this genus. Eggs are deposted on the fruit after they have fallen from the tree.

The host of *A. tachigaliae* is *Tachigalia versicolor* Standley and Williams, a tall tree found in tropical Central America. Its fruit is a large (25–30 cm), elongate samara with a centrally placed seed upon which *A. tachigaliae* oviposits after the samara falls to the ground.

In the original description of *A. tachigaliae* (Kingsolver, 1976), the specific name was spelled both as *tachygaliae* and as *tachigaliae*. The latter spelling was intended since the name of the host is *Tachigalia*.

Amblycerus spondiae, new species
Figs. 5, 34, 64, 74, 75, 76, 77

Body length.—4.4–5.9 mm, width.—2.5–3.5 mm; pronotal length.—1.1–1.3 mm, width.—1.8–2.3 mm.

Color.—Integument deep red to piceous throughout except tarsi reddish brown. Vestiture of very fine yellowish hairs evenly distributed over body except condensed into narrow stripes on elytra intervals, those on intervals 3, 5, 7, and 9 more prominent especially in apical one-half (Fig. 5); vestiture partly concealing surface sculpture; pronotum with fine median stripe and vaguely condensed patches of hairs; pygidium with narrow median stripe of vestiture.

Structure.—Body oblong-ovate, widest at middle of elytra. Head subtriangular; eyes strongly protuberant laterally; frons convex, finely punctate with scattered coarser punctures, densely setose except for two round, denuded spots at level of dorsal margins of eyes; clypeus densely, coarsely punctate; postocular lobe narrow, sparsely setose. Pronotum (Fig. 5) semicircular in dorsal aspect, widest at base; disk convex, more strongly so apically; basal lobe shallow, vaguely sulcate; integument evenly, densely punctate, each puncture rounded and setiferous; basal margin densely fringed with hairs; lateral carina obtuse, finely sulcate ventrally, extending anteriorly to cervical boss, boss with 3 setiferous punctures, cervical sulcus short, extending dorsad about one-half distance of midline; pleural area deeply concave; prosternum T-shaped, short before coxae, intercoxal piece narrow, arched, slightly constricted in middle. Scutellum (Fig. 64) elongate, twice as long as wide, trilobed and bisulcate apically. Elytra (Fig. 5) together one-third longer than wide; striae prominent, narrow, deep, regular in course with strial punctures closely set, each bearing a short, thin seta, vestitural hairs of two types, one short, aciculate, the other long, slender; mesosternum short, linguiform. Metasternum finely punctate; metepisternum with prominent vertical sulcus connecting mesally at obtuse angle with parasutural sulcus, terminating caudally in shining, narrow, curved boss; postmesocoxal sulci meeting medially behind angulate ridge, connecting laterally with parasutural sulcus on metasternum and extending to its caudal margin. First abdominal segment equal in length to remaining four together; caudal margin of fifth segment in male distinctly emarginate; in female truncate; pygidium subtriangular, truncate apically; disk densely, finely foveolate, each foveola the base of a slender, black hair; intervals with densely set, yellowish, aciculate hairs; median line marked with narrow stripe of yellowish hairs. Male genitalia with median lobe (Fig. 72) about 4 times as long as wide; ventral valve broad, ogival, with apex acute; dorsal valve elongate, obtusely rounded apically; internal sac armed with paired, thornlike sclerites near base, an elongate, wishbone-shaped sclerite, and paired, complex, elongate sclerites with serrate ridges at middle of sac; transfer valve at end of sac semicircular with paired, slender rods attached; lateral lobes (Fig. 73) narrow basally, abruptly expanded apically, lobes setose, terminal margin angulately emarginate. Pro- and mesolegs normal for genus; metacoxal face densely setose in lateral three-fourths with scattered large punctures nearly hidden by vestiture; polished area near trochanteral insertion with dense cluster of about 15 punctures; metafemur normal for genus; metatibia (Fig. 34) with lateral calcar one-half as long as metabasitarsus, mesal calcar about one-half as long as lateral calcar.

Holotype ♂.—COSTA RICA. Guanacaste Prov.: Taboga, 16 km SW Cañas, hillside, 17 November 1971, *Spondias mombin* or *radlkoferi,* Bag 3, R. Carroll (USNM Type #76377). Allotype ♀ and 144 paratypes, same data. Other paratypes.—Guanacaste Prov.: Palo Verde, OTS, COMELCO A, 17 November 1971, R. Carroll, *Spondias mombin* or *radlkoferi,* Bag 2, (93); Finca La Pacifica, 6 km N Cañas, emerg. 29 December 1972, R. Carroll, *Spondias mombin or radlkoferi,* Bag 1, (9); 4 mi. N Bagaces, 17 November 1971, R. Carroll, *Spondias mombin* or *radlkoferi,* Bag 4, (29); same data but 15 November 1971, Code 019 (21); Santa Rosa N.P., Playa Naranjo, ca. 15

July 1974, D. H. Janzen, reared from endocarps *Hippomane mancinella* L. (33); Finca La Pacifica, 5–6 March 1973, D. R. Whitehead, dry leaf litter, riparian forest (1); Santa Rosa N.P., nr. Choros Salina Windsor, 24 February 1973, D. H. Janzen, *Hippomane mancinella,* (2); Taboga, 30 June 1968, C. D. Johnson (1); San Jose Prov.: La Caja b. San Jose, October 30 (no year), F. Nevermann (3); Curridabat bei San Jose, 15 May 1932, F. Nevermann, on leaf (1); Alajuela Prov., Surrubres (no date) (3). PANAMA. Alajuelo, 17 April 1911, August Busck (1). EL SALVADOR. San Salvador, 9 June 1958, L. J. Bottimer coll. 101h (1); Santa Tecla, 5 June 1958, L. J. Bottimer coll. 101z (1); Vol. Conchagua, 27–29 May 1958, Cartwright and Bottimer coll. 101n and o (2). GUATEMALA. Salama, 29 July 1947, 3,000 ft., C. & P. Vaurie, (1) (AMNH); Amatitlan, 24 August 1947, 4,000 ft., C. & P. Vaurie (3) (AMNH); Rabinal, 2 August 1947, 3,000 ft., C. & P. Vaurie (1) (AMNH); 8 km W San Vicente Pacaya, Esq., 14 May 1966, 4,500 ft., J. M. Campbell, beating (1); 34 km N El Rancho, El Pro., 22 June 1966, 2,000 ft., J. M. Campbell (1). MEXICO. Chiapas: 2 mi N Simojovel, 9 June 1969, J. M. Campbell (6); Cd. Cuauhtémoc, 5 June 1969, J. M. Campbell, (3); Ocosingo, 1 June 1969, Bright and Campbell (1); 12 mi N Tuxtla Gutierrez, 7 June 1969, J. M. Campbell (4); 12 mi N Tuxtla Gutierrez, 7 June 1969, J. M. Campbell (4); Cintalapa, intercepted U.S. Plant Quarantine, Laredo, TX, 13 April 1951, in seed *Cordia dodecandra* (2); Guerrero: Rio Balsas (no date), Wickham (1); Jalisco (state): intercepted U.S. Plant Quarantine, El Paso, TX, 15 November 1976, in fruits *Ziziphus mexicanus* (8).

Amblycerus spondiae, named from one of its host genera, is most closely related to *A. alternatus* (Pic) and *A. lineolatus* (Motschulsky), differing consistently in the shape of the paired sclerites near the base of the internal sac of the male genitalia. In *A. spondiae,* these are thorn-like (Fig. 72); in *A. alternatus,* they are contiguous basally, divergent, rounded, and granulate apically; and in *A. lineolatus* they are fleshy with thorn-like spines attached apically. Both *A. alternatus* and *lineolatus* are distinctly striped on elytral intervals 3, 5, 7, and sometimes 9, and in addition to a median stripe, the pronotum is striped contiguous to and in line with elytral stripes 3 and 5.

The host plants of *A. spondiae* fall into 4 plant families—*Spondias mombin* L. and *radlkoferi* Donn.-Smith belong to the Anacardiaceae, *Hippomane mancinella* L. to the Euphorbiaceae, *Cordia dodecandra* DC. to the Boraginaceae, and *Ziziphus mexicana* Rose to the Rhamnaceae. This is the first recorded species of bruchid to have four plant families in its host list.

Oviposition by *A. spondiae* is apparently on fruits or endocarps on the ground. Adults have been observed on clumps of *Spondias* endocarps that had passed through the alimentary tract of monkeys, and on endocarps of *Hippomane* from which the fleshy exocarp had sloughed off. Eggs were observed on fruits of *Ziziphus dodecandra.*

Amblycerus vegai, new species

Figs. 6, 35, 51, 65, 78, 79

Body length.—2.5–3.1 mm, width.—1.4–1.8 mm; pronotal length.—0.7–0.9 mm, width.—1.1–1.3 mm.

Color.—Integument reddish yellow throughout except eyes black. Vestiture of silvery gray and reddish brown slender hairs in distinct mottled pattern on elytra (Fig. 6), condensed silvery gray spot at base of fifth and occasionally third interval, mottling less evident on pronotum; head, venter of body, and appendages with evenly distributed silvery hairs; pygidium with ovate, median spot of brown hairs flanked by silvery patches, brown spot sometimes divided by narrow line of silvery hairs.

Structure.—Body subelliptical, widest at basal one-third of elytra, dorsal profile arcuate. Head subtriangular; eyes large, strongly protuberant laterally, coarsely faceted, ocular sinus one-fifth length of eye; postocular fringe absent; frons nearly flat, frontal carina absent, surface of frons and clypeus punctulate; antenna (Fig. 51) slender, reaching caudal margin of metepisternum, subserrate from fourth segment. Pronotum (Fig. 6) trapezoidal, lateral margins gently arcuate, apex truncate; disk evenly convex, without depressions or elevations, surface finely, densely punctulate with scattered coarser punctures in lateral areas; lateral margin bluntly carinate, submarginal sulcus present beneath carina only, dorsal submarginal sulcus absent; cervical sulcus and cervical boss absent, the latter represented by two setiferous punctures; prosternum before coxae very short, intercoxal piece narrow, slightly expanded apically. Scutellum subtriangular (Fig. 65). Elytra (Fig. 6) 1.4 times as long as wide; disk slightly depressed around scutellum, otherwise evenly convex; striae shallow, narrow, punctures scarcely evident, intervals flat, uniform in width except fourth narrowed basally, fourth, fifth, and sixth narrowed apically; apices of elytra arcuate; mesosternum triangular, slightly concave medially; postmesocoxal sulci meeting medially at obtuse angle, sulci meeting parasutural sulcus of metasternum; metepisternal vertical sulcus arcuate at its juncture with parasutural sulcus. Abdomen with first sternum slightly longer than remaining four together in male, slightly shorter in female; pygidium subtriangular, rounded apically, slightly convex, finely, evenly punctulate. Male genitalia with median lobe (Fig. 78) about 5 times as long as wide; ventral valve ogival, acute apically; dorsal valve subtriangular, rounded apically; armature of internal sac consisting of saddle-shaped sclerite near base of sac, an elongate, wishbone-shaped sclerite and paired, elongate, clavate sclerites each with cluster of spines, paired, serrate, bladelike sclerites, and paired, hollow, triangular, thin-walled sclerites articulated with apices of fork of wishbone, apex of sac with circular transfer valve with two appended, slender rods; lateral lobes (Fig. 79) expanded apically, setose, apical margin shallowly emarginate.

Holotype ♂.—COSTA RICA. Guanacaste Prov.: Finca La Pacifica, Cañas, 9 April 1971, in seeds of *Cordia alliodora,* Janzen #688 (USNM Type #76376). Allotype ♀ and 6 paratypes, same data. Other paratypes.—COSTA RICA. Guanacaste Prov.: Santa Rosa, 15 March 1972, D. H. Janzen et al. (#VI-20-1972-VIII), *Cordia alliodora,* dry hillside (10); Finca La Pacifica, 26 March 1976, D. H. Janzen, in flowers of *Enterolobium* (13). EL SALVADOR. Vol. Conchagua, 27–29 May 1958, Depto de La Union, L. J. Bottimer cl. #101o (39).

This species is most closely related to *Amblycerus caymanensis* Kingsolver described from the West Indies. It differs in the following details (*caymanensis* in parentheses): Average body length 2.8 mm (3.5 mm); saddle-shaped sclerite in internal sac of male genitalia with basal projection bent ventrad and arms broad and thin (basal projection dorsal and arms slender); paired bladelike sclerites broad with serrations fine (sclerites slender with serrations coarse); lateral lobes with apical margin incurvate (margin subtruncate with median incision).

Cordia alliodora (Ruiz and Pav.) Cham. ex DC. (Boraginaceae) is widespread in subtropical and tropical New World, and its fruits are hosts for several closely related species of *Amblycerus*.

Amblycerus vegai, new species, is named for Gerado Vega, who has contributed much to field studies by D. H. Janzen in Costa Rica.

Zabrotes Horn

Zabrotes Horn, 1885:156.

Zabrotes is known, with one exception, only from the Western Hemisphere. One species, *Z. subfasciatus* (Boheman), attacks seeds of *Phaseolus* spp. and has spread through commerce to Africa and Asia. Host associations of species of *Zabrotes* are so far known only to be with leguminous seeds.

Zabrotes chavesi, new species

Figs. 7, 8, 36, 52, 80, 81

Body length.—1.9–2.0 mm, width.—1.1–1.3 mm; pronotal length.—0.5–0.6 mm, width.—0.6–0.7 mm.

Color.—Integument black in both sexes except antennal segments 1 and 2 reddish brown. Vestiture of male (Fig. 7) of brown and gray slender hairs in following pattern: Head with sparse gray hairs; pronotum with broad, median, brown stripe bisected by gray cruciate mark, lateral one-third of disk predominantly gray enclosing brownish spot, basal and lateral margins with continuous, narrow, brown band; scutellum gray; elytra predominantly brown with intervals 3 and 5 gray, occasionally with gray spot at base of interval 7, narrow transverse gray band extending from middle of interval 3 to interval 9; pygidium with about equal proportions of brown and gray hairs with median brown stripe bisected by narrow, gray stripe, lateral one-third each side mostly gray but with lateral, brown spot; venter of body mostly gray with brown spot in lateral one-half of metacoxal face, in lateral one-fourth of first abdominal sternum, a few scattered brown hairs laterally on telescoped sterna 2 to 4, and large spot on sternum 5; appendages gray. Variation in male: transverse bars on elytra are sometimes indistinct. Vestiture of female (Fig. 8) mostly dark brown dorsally with gray pattern, mostly gray beneath; head gray; pronotum with large, cordate median area brown with small, median gray spot, flanks with large, diffuse, gray spot, basal lobe with gray marginal stripe; scutellum gray, elytra largely dark brown, fifth interval with intermittent gray stripe reaching from base to midpoint of elytra, there joining irregular, transverse gray band spanning intervals 3 to 9, narrow band of golden brown hairs on anterior and posterior margins of transverse band; pygidium mostly brown with narrow, median gray stripe and broad, transverse basal gray band; venter of body with evenly distributed mostly gray hairs except all but extreme distal end of metacoxal face brown, and brown spots laterally on abdominal sterna.

Structure.—Body short, broadly ovate; head in repose strongly opisthognathous concealing procoxae. Head turbiniform, eyes strongly protuberant, subtriangular, nearly flat anteriorly; ocular sinus deep, nearly bisecting eye; frons with faint vertical carina; frontoclypeal suture faint; frons and clypeus densely punctulate; labrum sparsely punctulate; antenna (Fig. 52) long, reaching hind coxa, subserrate from fifth segment, not sexually dimorphic. Pronotum (Figs. 7, 8) broad, base strongly bisinuate, lateral margins strongly arcuate, apex briefly truncate; disk finely punctulate medially, more coarsely punctate laterally; vestiture posteriad of transverse bar of cruciate mark directed at 60° toward midline; in lateral aspect, lateral margin carinate, arcuate, meeting vertical supracoxal carina behind eye, then extending to anterior margin; margin dorsad of lateral carina with two setiferous punctures set in distinct depression; prosternum much reduced, depressed, triangular, concealed by head in repose, procoxae connate. Scutellum (Fig. 7) small, equilaterally triangular. Elytra (Figs. 7, 8) together broader than long, lateral margins arcuate, apices separately, evenly rounded; striae narrow, shallow, strial punctures fine, setiferous, intervals finely imbricate, sparsely punctate; intervals nearly equidistant basally, but 3, 5, and 7 narrowed apically, all striae free apically; mesosternum linguiform, rounded apically; postmesocoxal sulci meeting at a right angle mesally, reaching metasternal-mesepisternal suture laterally. Abdomen short, first ventral segment longer than remaining four together; second, third, and fourth strongly telescoped, fifth emarginate in both sexes, more deeply so in male; pygidium convex, finely, densely punctate. Male genitalia with median lobe (Fig. 80) short, cucullus broad; ventral valve triangular, lateral margins nearly straight; dorsal valve spatulate, slightly longer than ventral valve; base of internal sac with curved, thickened margins, middle of sac with 2 curved, acute spines, apex of sac armed with fine denticles; lateral lobes (Fig. 81) straplike basally, with fleshy, setiferous lobes apically. Pro- and mesolegs not modified; metacoxal face reniform, nearly flat, densely punctulate with a few faintly depressed foveolae, and densely setose in lateral three-fifths, remainder polished, slightly depressed, and with cluster of coarse punctures near insertion of trochanteral condyle; metafemur somewhat falcate, dorsal margin perceptibly curved in basal one-half, arcuate in apical one-half, ventral margin sinuate and carinate externally, channeled on ventral face for reception of tibia; metatibia (Fig. 36) gradually widened from base to obliquely truncate apex, lateral face with 2 distinct carinae, mesal face with 1 carina, apex with two short, unequal calcaria on ventral margin, apical margin finely serrate.

Holotype ♂.—COSTA RICA. Guanacaste Prov.: Santa Rosa N. Park, 12 March 1976, D. H. Janzen, ex seeds of *Cassia leptocarpa* (USNM Type #76374). Allotype ♀ and 5 paratypes, same data. Other paratypes.—San Jose Prov.: La Casa s. San Jose, July 1932, Schmidt, leg., Nevermann Coll. (4). EL SALVADOR. San Salvador, 14 June 1958, L. J. Bottimer Coll. No. 101H (1); S C Porrillo, 5 June 1958, Depto San Vicente, L. J. Bottimer Coll. No. 102A (1). MEXICO. Jalisco: Chapingo, 15 August 1949, L. J. Bottimer Coll. No. 125T (1). Guerrero: km 383 Acapulco Rd., 28 July 1934, C. C. Plummer, coll., Bottimer No. 70B (1). Sinaloa: Mazatlan, 10 May 1961, Howden and Martin (1). Michoacan: Apatzingan, 28 March 1970, USDA Plant Quarantine, Laredo No. 818 (1).

Zabrotes chavesi, new species, belongs to a group of species with a dense cluster of punctures on the hind coxa near the trochanteral condylic insertion. Included in this group are *Z. cruciger* Horn, *spectabilis* Horn, *planifrons* Horn, *interstitialis* (Chevrolat), and *arenarius* Wolcott. The male genitalia in this group, however, indicate that diversity exists, and that the group may not be natural. Only *Z. interstitialis* has previously been illustrated (Kingsolver, 1970:204) but genitalia of all of the above species have been examined and were found to be distinctive.

Zabrotes chavesi is the only species in the group with a spatulate apex on the dorsal valve in the male genitalia. *Zabrotes planifrons, Z. interstitialis,* and *Z. arenarius* have no distinguishable pattern in either sex, and this effectively separates them from *Z. chavesi.* Both *Z. cruciger* and *Z. spectabilis* have strongly contrasting patterns of pronotum, elytra, and pygidium in both sexes and can be distinguished from female *Z. chavesi* by the strongly contrasting white triangular mark at the base of the pronotum as well as the genital character mentioned above.

This species is named for Franklin Chaves, Park Director of Santa Rosa National Park in northwestern Costa Rica.

BRUCHINAE

This subfamily is the largest in the Bruchidae, and much study is needed toward a reclassification of the genera, especially on a world basis. Thirty-four genera are now assigned to this subfamily.

Merobruchus Bridwell

Merobruchus Bridwell, 1946:54.

Merobruchus is a medium-sized genus found only in the Western Hemisphere, and is known so far to breed only in leguminous plant seeds. It is related to the *Gibbobruchus-Caryedes* complex of genera but also shows some affinity with some species now placed in *Acanthoscelides* (*s. lat.*). The limits of the genus have not been satisfactorily circumscribed, but a taxonomic study of North American species is now underway.

Characters that tentatively can be used to recognize species belonging to *Merobruchus* are: metafemur swollen, pecten with 1 long and 2 or 3 shorter denticles, metatibia arcuate basally to fit ventral margin of metafemur, head short, base of elytra with low gibbosity from which third and fourth striae arise, male genitalia with ventral valve broad, internal sac usually with at least a wishbone-shaped sclerite.

Merobruchus santarosae, new species
Figs. 9, 10, 11, 24a, 24b, 37, 82, 83

Body length.—3.1–4.2 mm, width.—1.9–2.1 mm; pronotal length.—0.9–1.3 mm, width.—1.3–1.4 mm.

Color.—Integument deep red above with piceous spots on elytra; venter of body usually somewhat darker especially on thoracic sterna; eyes black; antenna reddish yellow with segments 8–10 piceous; pro- and mesolegs reddish yellow, metalegs usually dark red. Vestiture of yellowish gray and dark brown, slender, recumbent hairs, brown hairs only on piceous integumental spots on elytra and occasionally on pronotum; elytral disk usually with large brown lateral spot and numerous smaller spots (Figs. 9, 10, 11); pronotal disk occasionally with broad, dark stripe but usually concolorous; pygidium (Fig. 24a) of female with distinct, median, yellowish stripe, this less distinct in male (Fig. 24b).

Structure.—Body ovate, widest at basal one-third of elytra. Head short, subtriangular; eyes protuberant laterally, convex, ocular sinus about one-half length of eye; postocular fringe narrow; supraocular sulcus short, shallow, bottom of sulcus with tuberculate, setiferous punctures; vertex finely punctulate, punctures on frons and clypeus somewhat coarser and denser, those on frons tending to be strigose, frontal carina prominent, strigose, impunctate, connected dorsally to transverse depression between vertex and frons; labrum vaguely punctulate; antenna gradually clavate from third segment, segments 8–10 wider than long, segment 11 elliptical. Pronotum (Fig. 10) campaniform, lateral margins nearly straight in dorsal aspect, disk strongly convex except depressed subbasally near posterior angles, basal lobe shallowly canaliculate medially, surface punctulate-imbricate with scattered umbilicate, setiferous punctures; lateral carina ridge-like extending from posterior angle nearly to procoxal cavity; cervical sulcus short, deep; cervical boss bisetose; prosternum T-shaped, moderately short before procoxae, intercoxal piece sharply triangular, barely separating coxae apically. Scutellum short, broader than long, shallowly emarginate and bidentate apically. Elytra (Fig. 10) together slightly longer than broad; disk slightly depressed medially between fifth intervals; striae regular in course, narrow, nearly concealed by vestiture, stria 2 arising behind scutellum, 3 and 4 arising from denticles set on low gibbosity, 5 and 6 from subbasal denticles in slight depression, all striae ending free apically; intervals of subequal width, surface imbricate-punctate; mesosternum triangular, truncate apically; postmesocoxal sulci meeting medially at right angle, angulate behind coxae. Abdomen with first sternum equal in length to remaining 4 together, fifth sternum of male with deep, broad emargination, lateral margins of emargination slightly raised, last sternum of female with deep, narrow emargination, lateral margins prominent, angulate; pygidium (24a and b) subtriangular, lateral margins arcuate, disk convex, finely punctulate. Male genitalia with median lobe (Fig. 82) about 4 times as long as wide; ventral valve broad, quadrate, apical margin slightly emarginate; dorsal valve absent; internal sac with fine denticles in basal one-half, a short wishbone-shaped median sclerite, and paired, flattened, thornlike sclerites in apical one-half; closure valve crescentic; lateral lobes (Fig. 83) short, deeply cleft, spatulate apically. Pro- and mesolegs not modified; metacoxal face reniform, densely punctate except narrow, bare, transverse strip near anterior border; metafemur and metatibia as in Fig. 37, pecten with 1 long and 3 short denticles; metatibia with lateral, lateroventral, ventral, and dorsomedial carinae distinct and complete; mucro short, length about one-half width of tibia at apex.

Holotype ♂.—COSTA RICA. Guanacaste Prov.: Santa Rosa N.P., rd. to El Naranjo, 9 March 1972, D. H. Janzen et al. (#VI-20-1972-XXXI), *Lysiloma* sp. (USNM Type #72820). Allotype ♀ and 269 paratypes, same data. Other paratypes.—Same data as type except (#VI-19-1972-II) (6); Santa Rosa N.P., 12 March 1976, D. H. Janzen (#10355, 10356, 10357), *Lysiloma desmostachys* (295); Santa Rosa N.P., 9 March 1973, D. H. Janzen (3). MEXICO. San Luis Potosi: El Salto de Agua, 28–30 July 1960, H. Howden

(1); Puebla (state), 11 January 1965, USDA Plant Quarantine interception, El Paso 64581, in "palo amarillo" (6); Sonora: Yecora, 7,000′, 20–22 May 1961, Gibson et al. (1); Guerrero: 13 mi N Chilpancingo, 25 August 1958, H. Howden (1).

This species is most closely related to *M. sonorensis,* new species, and the differences are discussed under that species. The color pattern of *M. santarosae* resembles that of the darker forms of *M. paquetae,* new species, but the white pygidial triangle and male genitalia are distinctive.

The specific name is taken from the type-locality.

Merobruchus boucheri, new species
Figs. 12, 25, 38, 53, 84, 85.

Body length.—3.2–3.7 mm, width.—1.5–2.2 mm; pronotal length.—0.8–1.3 mm, width.—1.1–1.5 mm.

Color.—Integument yellowish red to piceous. Vestiture of yellowish gray and dark brown slender hairs with scattered coppery hairs of elytra in pattern shown in Fig. 12; head densely setose except middle of frons and clypeus; pronotum (Fig. 12) with broad, dark, median stripe, lateral areas yellowish with vestiture dense concealing sculpture; elytra with dark brown hairs on piceous spots, yellowish gray and coppery spots on lightly colored areas; pygidium with basal triangular spot yellowish (Fig. 25), median and lateral spots brown with median spot and lateral areas yellowish; venter of body yellowish; pro- and mesolegs yellowish red, metalegs dark red; antennae (Fig. 53) yellowish except segments 7, 8, and 9 dark brown.

Structure.—Body ovate, widest at middle one-third of elytra. Head turbiniform; eyes moderately protruding, ocular sinus one-half length of eye; supraocular sulcus sharply limited, bottom of sulcus with setiferous tubercles; postocular fringe narrow; vertex finely variolate, each variole with centrally placed hair; frons more deeply variolate tending to be costulate; frontal carine obtuse, impunctate; clypeus bimodally punctate, granulate apically; antenna (Fig. 53) reaching posterior angle of pronotum, subserrate and gradually clavate from fifth segment, segments 6 to 10 wider than long, eleventh subelliptical. Pronotum campaniform (Fig. 12), in dorsal aspect, lateral margins incurved, apex rounded, disk strongly convex with basal lobe briefly canaliculate, basal margin slightly depressed laterad of basal lobe, basal one-half of disk with short, obtuse longitudinal ridges posterolaterally; surface of disk densely variolate, each variole with a centrally placed hair; in lateral areas, varioles less dense, indistinctly defined, concealed by dense vestiture, intervals finely punctate; lateral carina present only briefly in middle of margin, concealed by dense vestiture; cervical boss bisetose; cervical sulcus short, concealed by vestiture; prosternum T-shaped, acutely triangular between coxae, incised apically but separating coxae. Scutellum quadrate, deeply incised and bidentate apically. Elytra (Fig. 12) together slightly longer than wide, disk subdepressed medially, convex laterally; striae regular in course, intervals 3, 5, and 7 slightly wider than 2, 4, and 6; striae shallow, narrow, with strial punctures close-set, stria 2 arising basally in deep, basal pit with fine anterior ridge, striae 3 and 4 arising basally in prominent denticles set on low gibbosity, all striae free apically except 4 and 5 approximate or conjoined; mesosternum subtriangular, apex rounded; postcoxal sulci angulate. Abdomen with first sternum longer than remaining sterna together; fifth sternum in both sexes with deep, angulate notch, that of female deeper than that of male, lateral margins of notch in male obtusely rounded, those in female with caudoventrally directed, minutely serrate lobes, each with prominent tuft of yellowish setae; pygidium slightly convex, disk minutely punctate. Male genitalia with median lobe (Fig. 84) elongate, cucullus broad, apex slightly expanded; ventral valve arcuate, nearly as broad basally as apex of median lobe; dorsal valve absent, replaced by membranous lobe extending slightly beyond apex of ventral valve; armature of internal sac consisting of dense rows of denticles in basal one-half, a quadrate median plate with projecting thornlike spine, a pair of subapical spines set in cluster of fine denticles, and an apical cluster of close-set, rounded denticles; apical closure valve circular; lateral lobes (Fig. 85) each narrow but expanded apically, strongly bowed, the cleft between them deep. Pro- and mesolegs not modified; metacoxal face slightly convex, densely punctate except for polished, transverse area near anterior margin; metaleg as in Fig. 38, pecten with 1 long and 3 short denticles; metatibia arcuate, lateral, lateroventral, ventral, and dorsomedial carinae distinct and complete, mucro shorter than width of tibia at apex, corona with 3 or 4 fine denticles.

Holotype ♂.—COSTA RICA. Guanacaste Prov.: 2 mi E Bagaces, 23 February 1972, D. H. Janzen (#VI-20-1972-XXXXIV), in seeds *Pithecellobium mangense* (USNM Type #72819). Allotype ♀ and 161 paratypes, same data. Other paratypes.—COSTA RICA. Guanacaste Prov.: Santa Rosa N. P., nature trail, 15 March 1972, D. H. Janzen (#IV-19-1972-XV), in seeds *Pithecellobium mangense* (324); Santa Rosa N. P., nature trail, 10 March 1976, D. H. Janzen, in seeds of *Pithecellobium mangense* (78); 6 km SE Bagaces, 23 February 1973, R. Carroll (8). HONDURAS. Aguan Valley, Culuco, March 1979, G. V. Manley, in seeds of *Pithecellobium* prob. *mangense* (2); Comayagua, 2 February 1979, G. V. Manley, ex seeds *Pithecellobium* prob. *mangense* (2); Coyoles, 16 February 1978, G. V. Manley, ex seeds *Pithecellobium* prob. *mangense* (1); same data except 15 March (14). PANAMA. Canal Zone, Ft. Clayton, 30 March 1964, L. J. Bottimer, (#121Q), ex seeds of *Acacia*? (20); Canal Zone, March 1920, H. L. Lyon (Bottimer #56k) (2). MEXICO. (all collected by C. D. Johnson) Sonora: 13 mi NW Alamos, 23 December 1976 (CDJ #165-76) and 4 mi NW Alamos, 23 December 1976

(CDJ #175-76), both in *Pithecellobium undulatum* (16); 5 mi W Alamos, 23 December 1976 (CDJ #186-76), in *Pithecellobium undulatum* (22); 6 mi W Alamos, 27 December 1977 (CDJ #168-77), in *Pithecellobium undulatum* (50); 2 mi E Alamos, 29 December 1977 (CDJ #189-77), in *Pithecellobium undulatum* (12). Sinaloa: 38 mi S Culiacan, 25 February 1973 (CDJ #196-73), in *Pithecellobium* aff. *mangense* (4). Nayarit: 2 mi NW Acaponeta, 10 March 1973 (CDJ #482-73)(90).

Among the described species, *Merobruchus boucheri,* new species, is most closely related to *M. solitarius* (Sharp), but its nearest relatives are yet to be described. The distinctive broad, median stripe of the pronotum combined with the pygidial pattern and the male genital characters will easily separate this species.

Except for the host label "*Acacia*" on the Panamanian specimen, this species is apparently restricted to *Pithecellobium mangense* (Jacq.) MacBride and *P. undulatum* (Britt. & Rose) Gentry, the latter apparently replacing *P. mangense* as the host plant in northern Mexico.

This species is named for Douglas Boucher, who showed D. H. Janzen the seed crop that contained the first collection of this bruchid.

Merobruchus hastatus, new species
Figs. 13, 26, 39, 86, 87

Body length.—3.25–3.75 mm, width.—2.0–2.7 mm; pronotal length.—1.9–2.0 mm, width.—1.4–1.5 mm.

Color.—Integument reddish to piceous; eyes black; prolegs, metatibia, and usually apex of metafemur reddish yellow; antenna with basal 7 and eleventh segments reddish yellow, segments 8–10 piceous to black. Vestiture of grayish yellow and dark brown slender hairs above, silvery gray beneath, dark brown hairs generally placed on piceous spots of pronotum, elytra, and pygidium in pattern shown in Figs. 13 and 26.

Structure.—Body ovate, widest at basal one-third of elytra. Head turbiniform; eyes strongly protuberant laterally, slightly convex anteriorly, ocular sinus about one-half length of eye, supraocular sulcus short, bottom of sulcus with minute, setiferous, tuberculate punctures, postocular fringe narrow; vertex punctulate-reticulate, punctures crowded, intervals narrow, ridge-like, frons more coarsely punctate, frontal carina prominent, minutely strigulate, frontal region separated from vertex by prominent, transverse depression above level of eyes; clypeus punctate-reticulate with apex finely granulose; antenna short, scarcely reaching humerus, clavate from fourth segment, apical segments strongly transverse, eleventh subelliptical. Pronotum (Fig. 13) campaniform, lateral margins incurvate, basal margin strongly bisinuate, disk convex except subdepressed near basal angles and briefly sulcate on basal lobe, surface with irregularly placed, umbilicate foveolae, each with long seta in middle of depression; intervals punctulate, lateral carina effaced except for short section in middle of lateral margin; cervical sulcus short, deep, nearly hidden by vestiture; cervical boss bisetose; prosternum T-shaped, apex acutely triangular, procoxae connate apically. Scutellum quadrate, slightly wider than long, emarginate and bidentate apically. Elytra (Fig. 13) together slightly longer than wide, striae prominent, deep, narrow, regular in course; first stria arising behind scutellum, second, fifth, and sixth arising basally, third and fourth arising from subbasal denticles set on low gibbosity, strial punctures 1 to 2 diameters apart; intervals 3, 5, and 7 slightly wider than 2, 4, and 6, all intervals finely strigose-punctulate, all striae free apically except 4 and 5 sometimes conjoined; mesosternum triangular, linguiform, postmesocoxal sulci arcuate but not angulate behind coxae, not meeting on midline. Abdomen with first sternum slightly longer than remaining four together, fifth sternum deeply, broadly emarginate in male, with small angulate notch with raised margins in female; pygidium subtriangular, lateral margins gently arcuate, convex, apex in male strongly reflexed, disk densely punctulate, intervals granulose, color pattern as in Fig. 26, piceous areas somewhat variable in shape. Male genitalia with median lobe (Fig. 86) moderately slender, 4 times as long as wide; ventral valve subquadrate, truncate apically; internal sac with elongate mass of fine denticles in basal one-half, a pair of large thornlike sclerites, a large, median, thornlike or wishbone-shaped sclerite, and another pair of thornlike sclerites in middle, and large mass of very fine spicules in apical portion; closure valve circular; lateral lobes (Fig. 87) broad, expanded toward midline at apices, cleft between lobes about two-thirds their length. Pro- and mesolegs not modified, metacoxal face densely punctulate except for polished, bare, transverse area near anterior margin; metafemur (Fig. 39) rather strongly incrassate, pecten with 1 long denticle followed by 3 shorter denticles; metatibia (Fig. 39) arcuate basally, straight and slightly expanded apically; lateral, lateroventral, ventral, and dorsomedial carinae distinct and complete; mucro short, its length about one-third width of tibia at apex, lateral denticle prominent, coronal denticles 4.

Holotype ♂.—COSTA RICA. Guanacaste Prov.: Santa Rosa N. P., 12 March 1976, D. H. Janzen (#10357), ex seeds of ?*Piptadenia flava* (USNM Type #72821). Allotype ♀ and 44 paratypes, same data.

This species is most closely related to *M. paquetae,* new species, among the described species. It differs in the form of the pygidial markings (cf. Figs. 26 and 27), in the color pattern of the elytra (cf. Figs. 13 and 14), and in the form of the ventral valve and of the internal sac armature (cf. Figs. 86 and 88).

The specific name is derived from the triangular pygidial spot.

Merobruchus paquetae, new species
Figs. 14, 27, 40, 88, 89

Body length.—2.0–3.1 mm, width.—1.1–1.9 mm; pronotal length.—0.6–1.0 mm, width.—0.9–1.4 mm.

Color.—Integument dark red to piceous; pro- and mesolegs and antenna reddish yellow, in darker forms with segments 8–10 piceous; eyes black; metafemur mostly piceous with dorsal one-third dark red; pronotum with broad median stripe darker than lateral areas; elytra with lateral margins usually clouded with piceous, sometimes with a lateromedian, dark, rounded spot similar to that of *M. acaciae,* new species (Fig. 11); pygidium usually with paired, median, irregular dark areas showing through vestiture, more prominent in darker specimens. Vestiture of yellowish gray, silvery gray, white, and dark brown slender hairs in pattern in Figs. 14 and 27, dark brown hairs restricted to piceous areas; scutellum white; basal triangle and median diamond-shaped mark on pygidium (Fig. 27) of yellowish gray to white with paired, darker, integumental areas encroaching; venter of body with evenly distributed silvery gray hairs.

Structure.—Body ovate, widest at basal one-fourth of elytra. Head short, turbiniform, eyes strongly convex and protuberant laterally, ocular sinus about two-thirds length of eye, supraocular sulcus short, shallow, with bottom of sulcus set with minute, setiferous tubercles, postocular fringe narrow; vertex densely punctulate, frons more coarsely punctulate, frons and vertex separated by transverse depression, frontal carina ridge-like, impunctate; clypeus densely punctate-reticulate; antenna gradually clavate, reaching humerus, subserrate from fifth segment, 7–10 wider than long, 11 elliptical. Pronotum (Fig. 14) campaniform, lateral margins perceptibly sinuate, basal margin sinuate with basal lobe rectangular; disk strongly convex except for subbasal depressions near posterior angles, and for subbasal median sulcus; surface closely, minutely foveolate, each foveola circular, umbilicate, and setose; lateral carina prominent, arcuate, extending from posterior angle nearly to procoxal cavity; cervical sulcus deep, narrow; cervical boss bisetose; prosternum T-shaped, apex acute, short, barely separating procoxal apices. Scutellum quadrate, deeply emarginate apically, bidentate. Elytra (Fig. 14) together slightly longer than wide, depressed in postscutellar area; striae narrow, shallow, distinct, slightly sinuate, first stria arising at scutellar depression, second arising from basal pit with anterior carina, third and fourth arising from individual denticles on slight basal elevation, fifth and sixth strongly convergent basally, arising from individual denticles which have a common base set in a subbasal depression, all striae free apically except 4 and 5 sometimes conjoined; intervals 3, 5, 7, and 9 slightly wider than 2, 4, 6, and 8; mesosternum triangular, lingulate apically; postmesocoxal sulci not meeting on midline, obtusely angulate behind coxae.

Abdomen with first sternum about 1.5 times as long as remaining sterna together; fifth sternum in male broadly, deeply emarginate, nearly divided; emargination in female shallow but with lateral margins of emargination slightly flared; pygidium (Fig. 27) subtriangular, lateral margins arcuate, apex bluntly rounded, more strongly reflexed in male, disk convex, surface minutely punctulate. Male genitalia with median lobe (Fig. 88) nearly 4 times as long as wide; ventral valve with apical margin arched in ventral aspect; internal sac with armature consisting of clusters of fine denticles basally, a pair of larger denticles near base, a wishbone-shaped sclerite and 2 large thornlike sclerites in middle of sac, apex of sac lined with small, rounded and acute denticles and fine spicules; closure valve circular; lateral lobes (Fig. 89) short, broad, the cleft between them about two-thirds their length. Pro- and mesolegs not modified; metacoxal face reniform, densely punctulate except for elongate polished area near anterior border; metafemur (Fig. 40) moderately incrassate, dorsal margin arcuate, ventral margin sinuate near apex, pecten consisting of 1 long denticle followed by 2 or 3 shorter denticles; metatibia (Fig. 40) strongly arcuate in basal one-half with lateral, lateroventral, ventral, and dorsomedial carinae complete, distinct; mucro short, acute, length about one-half width of tibia at apex, lateral denticle short, coronal denticles 3 or 4.

Holotype ♂.—COSTA RICA. Guanacaste Prov.: 1 mi W Tilaran, 4 March 1972, D. H. Janzen et al. (#VI-20-1972-XII), *Lysiloma* sp. (USNM Type #72823). Allotype ♀ and 55 paratypes, same data. Other paratypes.—COSTA RICA. Guanacaste Prov.: Santa Rosa N. P., beach area, 15 March 1972, D. H. Janzen (#VI-19-1972-VII), *Lysiloma* sp. (2); Santa Rosa N. P., 3 March 1978, D. H. Janzen (#10970), *Albizia adinocephala* (32); Santa Rosa N. P., monument hill, 25 February 1977, D. H. Janzen, *Albizia adinocephala* (27); Santa Rosa N. P., rd to El Naranjo, 9 March 1972, D. H. Janzen (#VI-19-1972-II), *Lysiloma* sp. (2); Finca La Pacifica, Cañas, 19 March 1974, D. H. Janzen (#1974-51), reared from *Lysiloma* sp. (3); La Pacifica, Tenorio Rd., 7 March 1976, *Albizia caribaea* (95); Rio Cañas, Cañas, 7 March 1975; D. H. Janzen, *Lysiloma* sp. (68); Bagaces, COMELCO, great swamp, 13 March 1971, D. H. Janzen (#606), *Albizia caribaea* (3). NICARAGUA. Granada, Divia, 1 July 1963, L. J. Bottimer (coll. #114o) (1). PANAMA. Canal Zone: Gamboa, 16 March 1964, L. J. Bottimer (#120u) (1). COLOMBIA. Magdalena: Rio Frio, Darlington (4); Antioquia; Sopetran, 750 m, 15 March 1974, J. Escobar, in seeds *Pseudosamanea* sp. (21). VENEZUELA. Merida; Merida, 19 May 1978, in Saman (1). Surinam, USDA Plant Quarantine intercep. N.Y. 9521, 17 April 1979, *Mimosa* sp. (4). BRAZIL. Rio de Janeiro; Paqueta Is., June 1954, N. L. H. Krauss (1); Seropedica, Univ. Rural km 47, October 1958, J. Hercio (1). Mato Grosso: Rosario Oeste, October 1963, M. Alvarenga (1); Corumba, Acc. No. 2966, lowlands, March (8).

The generally darker lateral margins of the elytra, approximate fifth and sixth strial bases, and contrasting dark areas on the pygidium are characteristic in combination, but the arched ventral valve, paired basal denticles, wishbone and thornlike sclerites in the male genitalia are definitive. Because of the somewhat variable color pattern and possible confusion in external characters with *M. santarosae,* especially in the darker forms, male genitalia should always be examined.

Stator limbatus (Horn) and *Merobruchus sonorensis,* new species, have been reared in company with *M. paquetae* in the same lots of *Lysiloma* sp. and *Albizia adinocephala.*

This species is named for the Paqueta Is. locality.

Merobruchus sonorensis, new species

Figs. 15, 28, 41, 90, 91

Body length.—2.9–3.5 mm, width.—1.6–2.0 mm; pronotal length.—0.9–1.2 mm, width.—1.2–1.4 mm.

Color.—Integument mostly dark red with some piceous clouding on head, pronotum, and pygidium, eyes black, antenna yellowish red with segments 8, 9, and 10 piceous, pro- and mesolegs yellowish red; vestiture of yellowish gray, dark brown, and white slender hairs; vestiture on head, pronotum, and venter of body yellowish gray, midline of pronotum with narrow, condensed stripe of hairs in most specimens (Fig. 15); scutellum white; elytra yellowish gray except dark brown hairs on dark integumental spots; pygidium (Fig. 28) mostly yellowish gray but with dark brown on piceous integument; basal triangle and median spot white.

Structure.—Body ovate, widest at basal one-third of elytra. Head short, turbiniform; eyes strongly convex, protuberant laterally, ocular sinus about two-thirds length of eye, supraocular sulcus short, shallow, its bottom with row of tuberculate, setiferous punctures; postocular fringe very narrow; vertex densely punctulate, frons more coarsely punctulate, frons and vertex separated by shallow, transverse depression above eye level, frontal carina ridgelike, impunctate, minutely strigulate; clypeus punctate-reticulate with apical margin granulose; antenna short, reaching posterior angle of pronotum, gradually clavate from fourth segment, segments 6–10 strongly transverse, eleventh elliptical. Pronotum (Fig. 15) campaniform, lateral margins vaguely sinuate, basal margin sinuate, basal lobe transverse, arcuate; disk convex except subdepressed subbasally near lateral angles, basal lobe shallowly sulcate; surface minutely, irregularly foveolate, each foveola circular, umbilicate, and setose; lateral carina arcuate, extending from posterior angle one-half distance to procoxal cavity; cervical sulcus deep, narrow, short, nearly hidden by vestiture, cervical boss bisetose; prosternum T-shaped, apex acutely triangular, barely separating apices of procoxae. Scutellum quadrate, bilobate. Elytra (Fig. 15) slightly longer than wide, subdepressed medially; striae narrow, lightly impressed, regular in course, not laterally deflected basally, first stria arising behind scutellum, second from basal pit with marginal carina, third and fourth from subbasal denticles set on low gibbosity, fifth and sixth from small basal denticles; all striae free apically except fourth and fifth sometimes conjoined apically; strial punctures close-set, separated by a diameter; intervals of subequal width, sometimes with second and fourth perceptibly wider, transversely strigose and sparsely punctate; mesosternum triangular, apex lingulate; postmesocoxal sulci sharply angulate behind coxae. Abdomen with first sternum 1.5 times as long as remaining sterna together in male, 1.25 times in female; fifth sternum broadly, deeply emarginate in male, angulately emarginate in female with angles slightly flared ventrad; pygidium (Fig. 28) subtriangular, briefly truncate apically, apex more reflexed in male, lateral margins arcuate, disk convex, minutely foveolate, with white pubescent spots essentially alike in both sexes. Male genitalia with median lobe (Fig. 90) about 4 times as long as wide, ventral valve subquadrate, apical margin slightly emarginate; internal sac lined with fine denticles in basal one-third, middle one-half with wishbone-shaped sclerite and a pair of broad-based, thornlike sclerites, apical area with a patch of fine spicules, closure valve circular; lateral lobes (Fig. 91) short, rather broad, slightly expanded toward midline at apices, cleft between lobes about two-thirds their length. Pro- and mesolegs not modified; metacoxal face reniform, densely punctulate except for semicircular polished area near anterior margin; metafemur (Fig. 41) moderately incrassate, dorsal margin strongly arcuate, ventral margin moderately arcuate, sinuate apically, pecten with 1 long denticle followed by 2 or 3 shorter denticles; metatibia (Fig. 41) strongly arcuate basally, nearly straight in apical three-fourths, lateral, lateroventral, ventral and dorsomedial carinae complete, prominent, mucro short, its length about one-third width of tibia at apex, lateral denticle short, coronal denticles 4.

Holotype ♂.—COSTA RICA. Guanacaste Prov.: Santa Rosa National Park, Central Barranca, 6 March 1975, D. H. Janzen, reared from seeds of *Lysiloma seemannii* (USNM Type #72822). Allotype ♀ and 1,200 paratypes, same data. Other paratypes.—COSTA RICA. Guanacaste Prov.: Cañas, La Pacifica, 18 April 1974, D. H. Janzen, reared from *Albizia adinocephala* (20); La Pacifica, Tenorio Rd., 7 March 1976, D. H. Janzen, *Albizia caribaea* (37); nr. Cañas, 100 m Rio Sandillal Bridge, 3 March 1972, D. H. Janzen et al. (#VI-20-1972-III), *Lysiloma* sp. (50); 8 km NE Cañas, 4 March 1972, D. H. Janzen et al. (#VI-20-1972-XVII), *Lysiloma* sp. (4); Rio Cañas nr. Cañas, 3 March 1972, D. H. Janzen (#VI-20-1972-XXXXIII), *Albizia* sp. (37); Cañas, Rio Cañas, 7 March 1975, D. H. Janzen, *Lysiloma* sp. (250); Santa Rosa N. P., beach area, 15 March 1972, D. H. Janzen et al. (#VI-19-1972-VII), *Lysiloma* sp. (24); same data except (#VI-19-1972-XI)

(31); Santa Rosa N. P., top of hill, 3 March 1977, D. H. Janzen, *Albizia adinocephala* #2 (45); Santa Rosa N. P., monument hill, 25 February 1977, D. H. Janzen, *Albizia adinocephala* (125); Santa Rosa N.P., 3 March 1978, D. H. Janzen (#10970), *Albizia adinocephala* (31); 1 mi W Tilaran, 4 March 1972, D. H. Janzen et al. (#VI-20-1972-XII), *Lysiloma* sp. (4); nr. Bagaces, COMELCO Area B, 9 March 1976, D. H. Janzen, *Lysiloma seemanii* (40). MEXICO. Sonora: Chinobampo, Rio Mayo, 10 January 1937, H. S. Gentry (#2980), *Albizia sinajoensis* (1); San Carlos Bay, Gulf Calif., 9 July 1921, E. C. VanDyke (1); Alamos, 23 February 1963, P. H. Arnaud, Jr. (1). Sinaloa: Culiacan, 25 October–18 November 1891, E. Palmer (#1774), *Pithecellobium sonorae* (1); Los Mochis, 9 October 1938; G. Frey (1); 26 mi N Pericos, 13 August 1960, P. H. Arnaud, Jr. et al. (1). Nayarit: La Palma, 1923, J. G. Ortega (#90), *Albizia ortegae* (1 abdomen only). Guererro: Acapulco, 4-1-1963, in *Albizia lebbek* (1). Chiapas: Tuxtla Gutz., 27 December 1949, F. Miranda (#5870), *Albizia tomentosa* (1): Berriozabal, 18 December 1949, F. Miranda (#5868), *Albizia tomentosa* (1); 2 mi S Simojovel, 5 July 1969, Campbell and Bright (1). COLOMBIA. Magdalena: Rio Frio (no date), Darlington (9).

This species appears to be most closely related to *M. santarosae,* new species, in the armature of the male internal sac, but the divided pygidial spot (cf. Figs. 24 and 28) and the elytral pattern (cf. Figs. 9, 10, 11, and 15) serve to separate the species; however the male genitalia should be examined for positive identification.

The name *sonorensis* is taken from Sonora State from where the species was first determined to be new. Sonora is apparently the northern limit of its geographical distribution. Costa Rica was selected as the type-locality because of its more nearly central location in the range.

This species has been found with *M. paquetae,* new species, and *Stator limbatus* (Horn) in *Albizia adinocephala* and *Lysiloma seemannii.*

Merobruchus terani, new species

Figs. 16, 29, 42, 92, 93

Body length.—3.6–4.4 mm, width.—2.1–2.5 mm; pronotal length.—1.1–1.5 mm, width.—1.5–1.9 mm.

Color.—Integument deep red to piceous; pro- and mesolegs and basal 5 or 6 and terminal antennal segments reddish yellow. Vestiture of light orange, cinerous, and dark brown recumbent hairs; head, pronotum, and pygidium light orange; elytra (Fig. 16) with light orange, cinerous, and brown, with broad, transverse band and basal spots orange, apical one-third mottled with orange, brown, and cinerous hairs intermixed; scutellum orange; body beneath with mostly cinerous with orange on mesepimeron, and orange spots on mesepisternum and laterally on fourth and fifth abdominal segments; pygidium with densely set orange vestiture, dark areas (Fig. 29) often with brown hair but usually bare; legs cinerous with apices of pro- and mesotibia and tarsal pads yellowish.

Structure.—Body ovate, broadest at middle of elytra. Head short, subtriangular; eyes protuberant laterally, ocular sinus about one-half length of eye, postocular lobe narrow, setose; vertex finely, densely punctate, punctures on clypeus, frons, and lateral mandibular face somewhat coarser, deeper, and closer together, sometimes merging, each puncture with slender hair arising from its center; frontal carina well-marked but not sharply ridged, expanded into T-shape dorsally, impunctate but finely strigulate; ventral sulcus of head terminating dorsally in a deep postocular pit; supraocular sulcus shallow, bottom of sulcus tuberculate, each tubercle bearing a short, slender seta; antenna reaching posterior angle of pronotum, strongly clavate, segments 1 through 4 slender, 5 through 10 eccentric, 11 subtriangular. Pronotum (Fig. 16) subcampaniform, convex, subdepressed basally, posterolateral corners of disk strongly depressed, depressions delimited anteriorly by obtuse, oblique ridges, basal lobe shallowly sulcate, disk densely foveolate, each foveola round, flat-bottomed, and bearing a single seta in its center, foveolae generally crowded, separated by less than a diameter, sometimes coalescing; lateral carina extending from posterolateral corner about two-thirds distance to procoxal insertion, cervical sulcus extending dorsad from bisetose cervical boss to level of dorsal margin of eye; prosternum T-shaped, acutely triangular between bases of procoxae, apex acute narrowly separating coxal apices. Scutellum quadrate, deeply emarginate and bidentate apically. Elytra together (Fig. 16) as long as wide, lateral margins subparallel in middle one-half; striae regular in course, intervals of uniform width, strial punctures round, flat-bottomed near base of elytra, gradually decreasing in size toward apex, each puncture bearing a seta on its anterior margin, strial sulci shallow basally, deepening toward apex, intervals finely imbricate, stria 1 arising from scutellar depression, 2, 5, and 6 from deep, basal pits, 3 and 4 from prominent, basal, bidentate gibbosity, all striae free apically; mesosternum with intercoxal strap truncate apically; postmesocoxal sulci not meeting on midline, angulate behind coxae. Metasternum finely variolate. Abdomen with first sternum longer than remaining segments together, fifth ventral in both sexes deeply emarginate for reception of apex of pygidium, that of male with lateral margin of notch evenly carinate but not prominent, that of female with lateral margin prominently and angulately carinate; pygidium (Fig. 29) of male slightly reflexed and somewhat truncate apically; of female vertical and rounded apically, disk of pygidium finely, obscurely variolate. Male genitalia with median lobe (Fig. 92) broad apically, cucullus emarginate basally, ventral valve broad, arcuate; armature of internal sac consisting of single wishbone-shaped sclerite, apex of sac with large patch of fine denticles; lateral lobes (Fig. 93) long, bowed, cleft to two-thirds their length. Pro- and mesolegs normal for genus; metacoxal face reniform, densely punctate except for elongate, polished area near anterior border; metaleg as in Fig. 42.

Holotype ♂.—COSTA RICA. Guanacaste Prov.: Santa Rosa (N.P.), 15 March 1972, D. H. Janzen, in seeds *Acacia tenuifolia* (USNM Type #72818). Allotype ♀ and 19 paratypes, same data. Other paratypes.—COSTA RICA. Santa Rosa N. P., 12 March 1976, D. H. Janzen, in seeds *Acacia tenuifolia* (24); Santa Rosa N.P., 10 March 1976, D. H. Janzen, in seeds *Acacia tenuifolia* (18); Santa Rosa N.P., 12 May 1976, D. H. Janzen (#10347), in seeds *Acacia tenuifolia* (1); Santa Rosa N.P., 18 January 1977, D. H. Janzen, in seeds *Acacia tenuifolia* (18); Finca La Pacifica, 7 March 1976, D. H. Janzen (#10317), in seeds *Acacia tenuifolia* (13); La Pacifica, 2 February 1973, D. H. Janzen (#VI-20-1972-XXXXVIII), in seeds *Acacia tenuifolia* (15); Cañas (La Pacifica), 13 March 1973, P. Opler, in seeds *Acacia tenuifolia* (1); Taboga, 26 February 1973, R. Carroll (#VI-20-1972-XXXVIII), in seeds *Acacia tenuifolia* (1). HONDURAS. Coyoles, 21 June 1978, G. V. Manley (1). MEXICO. Sonora: Alamos, 7 April 1966, M. W. Neilson (2). Nuevo Leon: 3 mi NW Linares, 20 June 1964, C. D. Johnson, reared from seeds *Acacia berlandieri* (1); Monterrey, Chipinque Mesa, 24–26 July 1960, H. F. Howden (1). Jalisco: 56 mi S Puerto Vallarta, 9 March 1973, C. D. Johnson (446-73), *Acacia* sp. (28). Puebla: Tehuacan, 30 June 1954, D. G. Kissinger (1). Guerrero: 18 mi N Chilpan, 26 August 1958, H. F. Howden (1); between Iguala and Chilpancingo, January 1945, N. L. H. Krauss, ex legume seeds (2); Acapulco (no date), Chittenden (19). Oaxaca: 14 mi W Niltepec, 7 July 1971, Clark et al. (1); 75 mi SE Oaxaca, 2,500′, 6 July 1968, C. D. Johnson (#225-68), reared from seeds *Acacia angustissima,* emerged 15 August 1968 (1).

This species is most closely related to *M. lineaticollis* (Sharp), the latter easily recognized by the dark red body with narrow, intensely white median line of the pronotum and pygidium, and longer arms on the wishbone sclerite in the male genitalia.

I name this species for my good friend and colleague, Arturo Terán, of Tucumán, Argentina.

Acanthoscelides Schilsky

Acanthoscelides Schilsky, 1905:C, No. 95.

Acanthoscelides is a large, varied genus as presently understood with many forms quite unlike the type-species, *A. obtectus* (Say). C. D. Johnson has underway an extensive study of the North American species. Because of the diversity of forms, a generic diagnosis is impractical now. The five species herein characterized are tentatively placed in *Acanthoscelides* until the investigations mentioned above determine their true relationships.

Acanthoscelides hectori, new species
Figs. 17, 43, 54, 94, 95

Body length.—2.50–2.75 mm, width.—1.50–1.75 mm; pronotal length.—1.25–1.30 mm, width.—1.60–1.75 mm.

Color.—Integument reddish to black with head, pronotum, pro- and mesolegs, apical one-half or more of metafemur, all of metatibia and tarsi, and pygidium reddish, elytra, eyes, meso- and metathorax black, abdominal sterna variable, apical one-half of each antennal segment piceous. Vestiture of mostly gray, short, slender hairs with darker spots of pattern (Fig. 17) bronze; pronotum with vague cruciate mark in middle, pygidium with indistinct median stripe.

Structure.—Body subelliptical, widest behind elytral humeri. Head turbiniform, eyes protuberant laterally, convex, ocular sinus about one-half length of eye, supraocular sulcus short, shallow, bottom of sulcus with setiferous tubercles, postocular lobe narrow but distinct; vertex densely punctulate, setose, frons more coarsely punctate, frontal carina prominent, extending dorsally to transverse depression between upper limits of eyes; basal two-thirds of clypeus punctate, apical portion minutely strigulate; antennae (Fig. 54) reaching middle of metepisternum, subserrate from fifth segment, terminal segment elliptical. Pronotum (Fig. 17) campaniform, lateral margins moderately arcuate, base subtruncate except for semicircular basal lobe, disk nearly evenly convex, briefly canaliculate on basal lobe, surface of disk minutely foveolate, nearly concealed by vestiture; lateral carina represented by low ridge extending from posterior angle about one-half distance to procoxal cavity; cervical sulcus short, deep, partly concealed by vestiture; cervical boss bisetose; prosternum T-shaped, acutely triangular between coxae, not separating coxal apices. Scutellum quadrate, densely pubescent, apex emarginate and bidentate. Elytra (Fig. 17) together as long as wide, evenly convex, striae distinct, narrow, strial punctures close-set, striae regular in course except occasionally some striae slightly sinuate in middle, striae 2, 5, and 6 arising from small basal pits, 3 and 4 each with small basal denticle, all striae free apically except 5 and 6 conjoined; intervals 3 and 5 slightly wider in middle than others; mesosternum subtriangular, apex lingulate; postmesocoxal sulci meeting medially at obtuse angle, laterally following contour of mesocoxal cavities. Abdomen with first sternum slightly longer than remaining sterna together, fifth sternum deeply, broadly emarginate for reception of apex of pygidium in male, slightly emarginate in female; pygidium convex in both sexes, apex more strongly reflexed in male; disk finely, densely foveolate. Male genitalia with median lobe (Fig. 94) slender, 5 times as long as wide; ventral valve short, broad, ogival to obtuse apex; dorsal valve absent; armature of internal sac with dense, linear cluster of fine spicules near apical orifice, a large, compressed, helmet-shaped sclerite in basal one-half, a slender spine and several fine spicules in middle, 2 clusters of fine spicules near apex; closure valve circular; lateral lobes (Fig. 95) long, slender, slightly expanded in apical one-third, apices acute. Pro- and mesolegs not modified; metacoxal face reniform, densely, finely punctulate except for bare transverse area near anterior margin; metafemur (Fig. 43) moderately incrassate, dorsal margin evenly arcuate, ventral margin straight except slightly sinuate near apex, pecten with 1 long denticle followed by 2 smaller denticles; metatibia (Fig. 43) arcuate in basal one-third, straight and perceptibly expanded apically, lateral, ventral, and dorsomedial carinae distinct and complete, lateroventral carina obsolete toward apex, mucro slender, acute, slightly shorter than apical width, coronal denticles 5.

Holotype ♂.—COSTA RICA. Guanacaste Prov.: Taboga, 16 km SW Cañas, 16 March 1972, D. H. Janzen et al. (#VI-20-1972-XXII) (USNM Type #76384). Allotype ♀ and 36 paratypes, same data. Other paratypes.—COSTA RICA. Guanacaste Prov.: 1.6 mi W Hwy. 21, Comunidad, 14 March 1971, D. H. Janzen (624), in seeds of herbaceous legume (8); La Pacifica, 19 March 1974, D. H. Janzen (#1974-10), reared from *Calpogonium caeruleum* (21); Puntarenas Prov.: Barranca Site, 6 mi NW turnoff to Puntarenas on Pan-American Hwy., 11 March 1971, D. H. Janzen (1): MEXICO. Tabasco: Teapa, Feb. and Mar. (1908), Godman Salvin 1908-146, H.H.S. (3). EL SALVADOR. intercepted USDA Plant Quarantine, Washington, D.C. #315, in *Macroptilium atropurpureum* (5). PANAMA. Canal Zone: Paraiso (no date), Schwarz, ex pods *Rhynchosia,* (19); Paraiso, 6 April 1911, E. A. Schwarz, ex pods *Rhynchosia minima* (3).

As is indicated in the discussion of *A. triumfettae,* new species, this species is one of numerous small *Acanthoscelides* that do not at present seem to belong to any of the characterized groups nor appear to be closely related to any of the described species. The ogival ventral valve and the helmet-shaped sclerite in the internal sac are distinctive, and the combination of integumental colors may be helpful in relating *hectori* to other species when *Acanthoscelides* is treated.

Acanthoscelides hectori, new species, is named for Hector Luis Arriola, the Park Ranger for Santa Rosa National Park, who has been invaluable in assisting D. H. Janzen in ecological studies in the Park.

Acanthoscelides johnsoni, new species
Figs. 18, 44, 55, 96, 97

Body length.—1.50–2.25 mm, width.—0.90–1.25 mm; pronotal length.—0.60–0.75 mm, width.—0.75–1.00 mm.

Color.—Integument black except pro- and mesolegs, apical one-half to one-third of metafemur in most females, and basal 4 segments of antenna in both sexes reddish (some males may have reddish infusion on metafemoral apex; basal one-half of mesofemur in some specimens piceous). Vestiture evenly distributed (Fig. 18), silvery gray with bronzy sheen above, ashy gray beneath; distinct pattern usually lacking, faint median stripe of close-set hairs on pronotum and on pygidium or pygidium with only a basal triangular spot, some specimens with faint striping on elytra. Scutellum gray.

Structure.—Body ovate, widest at basal one-third of elytra. Head short, turbiniform, eyes moderately protuberant laterally, not strongly convex anteriorly, ocular sinus deep, only 3 or 4 rows of facets on dorsal rim of eyes, supraocular sulcus shallow, reaching vertical axis of eye, sulcus minutely tuberculate-setose, postocular fringe narrow; vertex and frons punctulate-granulate, sparsely setose, frontal carina represented by impunctate median costa; clypeus coarsely punctulate; antenna of male (Fig. 55) long, reaching posterior margin of metacoxa, serrate from fifth segment, segments 5–10 as long as wide, eleventh elongate-elliptical; antenna of female reaching middle of metepisternum, subserrate from fifth segment, segments 5–10 wider than long, eleventh elliptical. Pronotum (Fig. 18) campaniform, lateral margins moderately arcuate, sinuate at basal angles, basal margin bisinuate, basal lobe semicircular, briefly canaliculate, disk strongly, evenly convex except slightly depressed basally near posterior angles, surface of disk finely foveolate, nearly concealed by vestiture; lateral carina arcuate, obtuse, about one-half length of pronotum; cervical sulcus short, deep, ventrally delimiting bisetose cervical boss; prosternum short before coxae, acutely triangular, procoxae connate apically. Scutellum quadrate, slightly longer than wide, emarginate and bidentate apically. Elytra (Fig. 18) together wider than long, margins moderately arcuate, disk convex, slightly depressed along suture; striae distinct, narrow, deep, regular in course, first and second striae arising from basal pits, third, fourth, fifth, and sixth each with minute denticle basally, all free apically except conjoined fifth and sixth; intervals imbricate, sparsely foveolate, unequal in width, with third, fifth, and seventh wider than others; mesosternum lingulate; postmesocoxal sulci not meeting medially, distinct, laterally following contour of coxal cavities. Abdomen with first sternum about as long as remaining sterna together, male with long, slender, golden hairs in middle of first sternum, fifth sternum of male deeply, broadly emarginate, of female evenly arcuate on posterior margin; pygidium triangular, convex, apex of male slightly reflexed, of female vertical at apex but slightly longitudinally swollen, disk in both sexes minutely foveolate. Male genitalia with median lobe (Fig. 96) elongate, slender, about 7 times as long as wide; ventral valve ovate, ogival apically, with base set in circular cavity at apex of lobe; armature of internal sac consisting of fine spicules lining apical orifice; middle of sac with, in succession, a cluster of minute, transverse denticles, a group of large, thornlike denticles, a group of minute denticles, and a small patch of fine spicules near apex; closure valve not evident; lateral lobes (Fig. 97) elongate, strongly, eccentrically expanded at apices, cleft between lobes about one-half their length. Pro- and mesolegs not modified; metacoxal face reniform, minutely punctulate over all but anterior margin; metafemur (Fig. 44) not strongly incrassate, elongate-elliptical, pecten with 1 long denticle followed by 2 minute denticles; metatibia (Fig. 44) nearly straight with lateral, ventral, and dorsomedial carinae distinct and complete, lateroventral carina indistinct or absent, mucro short, length less than one-half apical width of tibia, coronal denticles 5, subequal in size.

Holotype ♂.—COSTA RICA. Guanacaste Prov.: 2 mi W Tilaran, 4 March 1972, D. H. Janzen et al. (#VI-20-1972-XIII), in *Triumfetta lappula* (USNM Type #76382). Allotype ♀ and 7 paratypes, same data. Other paratypes.—Costa Rica. Alajuela Prov.: 4 km SE San Ramon, 10 March 1971, D. H. Janzen (#534) in seeds of *Triumfetta lappula* (15).

This species superficially resembles *A. megacornis,* new species, but the male genitalia indicate that the two are not closely related. It does not appear to be closely related to any of the described species in the Western Hemisphere. The uniformly distributed vestiture, short mucro, elongated male antennae, and details of male genitalia are definitive.

It should be noted that the 2 collections of this species also yielded specimens of *Acanthoscelides triumfettae,* new species, but the two species are not closely related.

I am pleased to name this species for my colleague and good friend, C. D. Johnson, who has made many significant contributions to the knowledge of New World Bruchidae.

Acanthoscelides megacornis, new species
Figs. 19, 45, 56, 57, 98, 99

Body length.—1.6–1.8 mm, width.—1.0–1.1 mm; pronotal length.—0.6–0.7 mm, width.—0.7–0.8 mm.

Color.—Integument black except pro- and mesolegs and antennal segments 1–3 or 1–4 partly or completely reddish. Vestiture evenly distributed over entire body; greenish gray, short, slender hairs above except scutellum white, silvery gray beneath, pygidium with faint, gray median line.

Structure.—Body ovate, widest at basal one-third of elytra. Head turbiniform, eyes protuberant laterally, somewhat flattened anteriorly, ocular sinus deep leaving only 3 or 4 rows of facets on dorsal rim of eye, supraocular sulcus extending dorsolaterally to connect with postocular sulcus, bottom of supraocular sulcus with minute, setiferous tubercles, median margin of sulcus bordered by fine carina, postocular fringe narrow; vertex and frons punctulate, frons with prominent median tubercle (?frontal carina), setae of vertex directed toward dorsal margin of tubercle; clypeus slightly more coarsely punctulate than frons; antenna dimorphic, in male (Fig. 56) reaching posterior margin of metacoxa, strongly serrate from third segment, segments 4–10 each broadly triangular, eleventh segment elliptical; in female, antenna (Fig. 57) reaching middle of metepisternum, subserrate from fifth segment, segments 5–10 subtriangular, eleventh elliptical. Pronotum (Fig. 19) campaniform, lateral margins moderately sinuate, base subtruncate, basal lobe semicircular, disk evenly convex, briefly canaliculate on basal lobe and lightly depressed near posterior angle, surface minutely foveolate, foveolae distributed unevenly, sometimes coalescing, sometimes separated as much as 2 or more diameters; lateral carina represented by obtuse ridge extending from posterior angle to tumidity dorsad of procoxal cavity; cervical sulcus distinct, deep, delimiting at its ventral end the bisetose cervical boss; prosternum acutely triangular, short before procoxae, apex not separating coxal apices. Scutellum quadrate, emarginate apically, minutely bidentate. Elytra (Fig. 19) together slightly longer than wide, subquadrate, lateral margins evenly arcuate, disk evenly convex except subdepressed in basal one-third between third intervals, striae deep, distinct, regular in course, strial punctures barely evident, first stria arising near apex of scutellum, second in a deep basal pit sometimes with a blunt denticle on anterior rim, third and fourth each in a subbasal, rather prominent denticle, fifth and sixth arising from basal margin, fifth and sixth usually conjoined apically, fourth and seventh occasionally conjoined, remaining striae free apically; intervals of subequal width, minutely imbricate, each with 4 or 5 irregular rows of hairs; mesosternum subtriangular, apex slightly constricted, truncate; postmesocoxal sulci meeting medially at obtuse angle, strongly impressed behind coxae. Abdomen with first sternum about twice length of remaining sterna together, fifth sternum deeply, broadly emarginate for reception of pygidium, evenly arcuate, evenly convex, disk faintly punctulate. Male genitalia with median lobe (Fig. 98) elongate, about 7 times as long as wide; ventral valve equilaterally triangular, lateral margins slightly arcuate; armature of internal sac consisting of elongate patch of fine spicules near apical orifice, middle one-half of sac lined with minute, blunt denticles, apical one-fourth of sac with rows of small, thornlike denticles; closure valve minute, circular; lateral lobes (Fig. 99) slender basally, suddenly clavate apically, cleft between them deep. Pro- and mesolegs not modified; metacoxal face reniform, finely, densely foveolate except along anterior margin; metafemur (Fig. 45) moderately incrassate, pecten with 1 long denticle and 2 increasingly smaller denticles; metatibia (Fig. 45) with base strongly arcuate, apical four-fifths straight, with lateral carina barely traceable, lateroventral carina obsolete apically, ventral carina distinct, dorsomedial absent, mucro minute, shorter than the 4 or 5 denticles in corona.

Holotype ♂.—COSTA RICA. Guanacaste Prov.: Santa Rosa N.P., 31 December 1975, D. H. Janzen (#JHJ 341), in *Aeschynomene americana* (USNM Type #76385). Allotype ♀ and 1,200 paratypes, same data. Other paratypes.—COSTA RICA. Guanacaste Prov.: Finca Taboga, 6 mi SW Cañas, 9 February 1967, D. H. Janzen, sweeping riparian forest understory at night (2); San Mateo, Hiquito, Pablo Schild (1). MEXICO. Jalisco: Guadalajara, Crawford, Carn. Mus. acc. 3901 (1); Morelos; Cuernavaca, December 1944 and November 1966, N. L. H. Krauss (3); Cuernavaca, Fenyes Coll. (1); Pte. de Ixtla, Wickham (1); Veracruz: Cotaxtla, 28 October 1961, Krauss (1); Boca del Rio, November 1960 (4); Cordoba, 22 November 1963, N. L. H. Krauss (1). GUATEMALA. USDA Plant Quarantine interceptions, all in dried chrysanthemum heads at Houston, #644, 9 March 1972 (1), #632, 9 March 1972 (1), #667, 20 March 1972 (1), #698, 7 April 1972 (1). HONDURAS. Ocotepeque, 12 April 1979, G. V. Manley, cloud forest at pass (32); Tegucigalpa, 20 February 1918, 9 February 1915, 15 October 1917 (20). EL SALVADOR: Monte Cristo, 7–9 May 1958, O. L. Cartwright (3). NICARAGUA. Madriz, 8 July 1957, D. R. Lauck (1); Chinandega (no date) Baker Coll. (8); Managua (no date) Baker Coll. (3).

The relationships of this species are as yet obscure. It does not appear to be closely related to any of the described species, although it superficially resembles *Acanthoscelides johnsoni,* new species; however, the male genitalia are distinctly different in the two species. Distinctive characters for *A. megacornis,* new species, include the elongated, strongly serrate male antenna, uniform coloration, tuberculate frons, small mucro, and details of the male genitalia.

The name *megacornis* is derived from *mega* (Gr.—large), and *cornu* (Gr.—horn) referring to the long antenna.

Acanthoscelides petalopygus, new species

Figs. 20, 46, 58, 100, 101

Body length.—3.2–3.9 mm, width.—2.0–2.5 mm; pronotal length.—0.9–1.2 mm, width.—1.5–1.9 mm.

Color.—Integument evenly dark red throughout except eyes black. Vestiture of evenly distributed, short, slender gray hairs with golden sheen; pronotum (Fig. 20) with narrow median strip of close-set hairs; elytra with denuded, reddish brown, quadrate spots at basal one-third and apical three-fifths of third elytral interval, at middle of seventh and of ninth intervals; pygidium with short, basal, triangular spot, its apex extending as a narrow median stripe to apex of pygidium, round spot of close-set hairs midway between median line and lateral border.

Structure.—Body subelliptical, widest at middle of elytra. Head turbiniform, eyes large, convex, protuberant laterally, ocular sinus about one-half length of eye, supraocular sulcus short, crescentic, bottom of sulcus with setiferous tubercles, postocular fringe narrow; frons and vertex densely, finely punctate, frontal carina lacking; clypeus punctate basally, transversely striolate apically; labrum bare except for basal row of setiferous punctures, middle of apical margin with low gibbosity; antenna (Fig. 58) moderately long, reaching middle of metepisternum, subserrate from fourth segment, segments 5–10 transverse, each slightly wider than long, eleventh elliptical. Pronotum (Fig. 20) broadly triangular, lateral margins arcuate, basal margin truncate except for rectangular basal lobe; disk evenly convex except for brief, median, subbasal sulcus; surface of disk densely foveolate, intervals minutely punctulate; lateral carina present as an obtuse ridge extending from posterior angle two-thirds distance to procoxal cavity; cervical sulcus short, fine; cervical boss bisetose; prosternum Y-shaped, acutely triangular apically, intercoxal piece vertical, thin, separating procoxae apically. Scutellum broader than long, apically emarginate and bidentate. Elytra (Fig. 20) together slightly longer than wide, subdepressed between sixth intervals; striae regular in course, shallow, punctures evident, striae 1 arising in scutellar depression, 2 and 5 each in deep basal pit with carinate border, 3 and 4 in smooth, basal gibbosity; intervals 3, 5, and 7 slightly wider than 2, 4, and 6, surface finely imbricate; mesosternum subtriangular, rounded apically, disk imbricate; postmesocoxal sulci meeting medially at obtuse angle, parallel to margin of coxal cavities. Abdomen with first sternum as long as remaining four together; fifth sternum in male slightly emarginate, evenly arcuate in female; pygidium broad, flat in basal one-half, convex in apical one-half in male, evenly convex in female. Male genitalia with median lobe (Fig. 100) about 4 times as long as wide, flattened; ventral valve short, broad, subtruncate apically; dorsal valve a membranous lobe as long as apex of ventral valve; apical orifice flanked by large, spatulate plates, middle of sac lined with minute spines, apex trilobed, lateral sacs lined with fine spicules; closure valve circular; lateral lobes (Fig. 101) divergent, the cleft between deep, rounded, each lobe broad, spatulate. Pro- and mesolegs not modified; metacoxal face reniform, with densely placed, fine, setiferous punctures except elongate, transverse area near anterior border bare, polished; metafemur (Fig. 46) moderately incrassate, lateral ventral margin with strong sinuation subapically, mesal ventral margin with 1 large denticle and 2 shorter denticles, one or both denticles on posterior slope of large denticle; metatibia (Fig. 46) moderately arcuate basally, expanded apically, with lateral, lateroventral, ventral, and dorsomedial carinae complete and distinct, mucro short, acute, coronal denticles 4.

Holotype ♂.—COSTA RICA. Guanacaste Prov.: Santa Rosa (N.P.), nature trail, 15 March 1972, D. H. Janzen et al. (#VI-19-1972-XIX), *Acacia collinsii* (USNM Type #76380). Allotype ♀ and 20 paratypes, same data. Other paratypes.—Santa Rosa N.P., salt pan pasture, 12 March 1976, D. H. Janzen, *Acacia collinsii* (3).

Acanthoscelides petalopygus, new species, does not belong to any of the species groups characterized in Johnson (1970), Slobodchikoff and Johnson (1973), or Kingsolver (1980). It appears to be most closely related to *A. gregorioi* (Pic) described from Brazil, and perhaps more distantly related to *A. mexicanus* (Sharp) and *A. lapsanae* (Motschulsky) from Mexico and Central America.

The specific name is derived from *petalos* (Gr.—broad) and *pygus* (Gr.—rump).

Acanthoscelides triumfettae, new species
Figs. 21, 47, 59, 102, 103

Body length.—1.50–1.75 mm, width.—0.9–1.2 mm; pronotal length.—0.5–0.7 mm, width.—0.7–0.9 mm.

Color.—Integument of pronotum, elytra, abdomen, legs and antennae light red with spots of pronotum and elytra dark red (Fig. 21), head and venter of thorax piceous, head sometimes red with piceous clouding, metafemur sometimes dusky basally, antennal segments often partly piceous. Vestiture of yellowish, white, and dark brown slender hairs, pronotum (Fig. 21) with cruciate pattern medially; elytra (Fig. 21) with brown vestiture on dark red spots, light red integument covered with yellowish hairs, third interval with elongate spot of densely placed hairs; pygidium densely setose, yellowish with narrow median line of close-set hairs.

Structure.—Body ovate, widest at middle of elytra. Head turbiniform, eyes convex, laterally protuberant, ocular sinus about one-half length of eye, supraocular sulcus shallow, setiferous, postocular fringe narrow, vertex and frons finely punctulate, densely setose, hairs oriented toward dorsal end of indistinct frontal carina; clypeal punctation coarser than that of frons; antenna of male (Fig. 59) reaching metacoxal margin, of female reaching humerus, subserrate in both sexes from fourth segment, eleventh segment elliptical. Pronotum (Fig. 21) campaniform, briefly canaliculate on basal lobe, basal margin truncate except for semicircular basal lobe; surface finely foveolate, densely setose; lateral carina absent; cervical sulcus short, deep; cervical boss bisetose; prosternum short, triangular, intercoxal piece not separating procoxal apices. Scutellum slightly longer than wide, emarginate and bidentate apically. Elytra (Fig. 21) together slightly longer than wide, convex, widest at middle; striae prominent, regular in course, strial punctures separated by a diameter, stria 1 arising in scutellar depression, 2–6 arising basally each with a minute denticle on basal margin, all striae ending free apically except 5 and 6 abbreviated and conjoined; mesosternum triangular, apex bluntly rounded; postmesocoxal sulci meeting medially at acute angle, parallel to margin of coxal cavity laterally. Abdomen with first sternum 1.5 times as long as remaining sterna together; fifth sternum deeply emarginate in male, evenly arcuate in female; pygidium subtriangular, disk evenly convex, densely, finely punctulate, punctures concealed by vestiture. Male genitalia with median lobe (Fig. 102) slender, 8 times as long as wide, ventral valve triangular, short, subacute, dorsal valve lacking; internal sac in basal one-half lined with fine denticles, middle of sac with patch of fine spicules, apical portion of sac with long, slender spines and patch of slender spicules; closure valve oval; lateral lobes (Fig. 103) long, slender, uniform in width, cleft between lobes deep. Pro- and mesolegs not modified; metacoxal face reniform, finely punctulate-reticulate except for elongate, transverse bare area near anterior border; metafemur (Fig. 47) with dorsal margin arcuate, ventral margin slightly sinuate, pecten composed of 1 short denticle about as long as basal width of tibia followed by 2 minute denticles; metatibia (Fig. 47) gradually expanded from arcuate base, lateral, ventral, and dorsomedial carinae distinct and complete, lateroventral carina abbreviated apically; mucro short, acute, its length about one-half width of apex of tibia, corona with 4 or 5 minute denticles.

Holotype ♂.—COSTA RICA. Guanacaste Prov.: 2 mi W Tilaran, 4 March 1972, D. H. Janzen et al. (#VI-20-1972-XIII), in *Triumfetta lappula* (USNM Type #76381). Allotype ♀ and 123 paratypes, same data. Other paratypes.—COSTA RICA. Guanacaste Prov.: Santa Rosa N.P., nature trail, 15 March 1972, D. H. Janzen et al. (#VI-19-1972-XXII), *Triumfetta lappula* (40); 5 mi N La Cruz, 11 March 1976, D. H. Janzen, *Triumfetta lappula* (61); Santa Rosa N.P., humid forest, 10 March 1976, D. H. Janzen, *Triumfetta lappula* (98); Alajuela Prov.: 4 km SE Ramon, 10 March 1971, D. H. Janzen (#534), *Triumfetta lappula* (8).

This species is not closely related in male genital characters to any of the described species in this large, composite genus; however, the slender median lobe with its pattern of denticles and spicules, and the large, thornlike spine (Fig. 102) in the internal sac as well as the slender lateral lobes (Fig. 103) are diagnostic. Externally, the color pattern resembles any number of small, brownish *Acanthoscelides*. It must remain for the first revisor of the genus to place this species in its proper relationship.

Two of the collections of *A. triumfettae,* new species, also yielded *A. johnsoni,* new species, but the two species do not appear to be closely related.

The specific name is derived from the generic name of the host plant.

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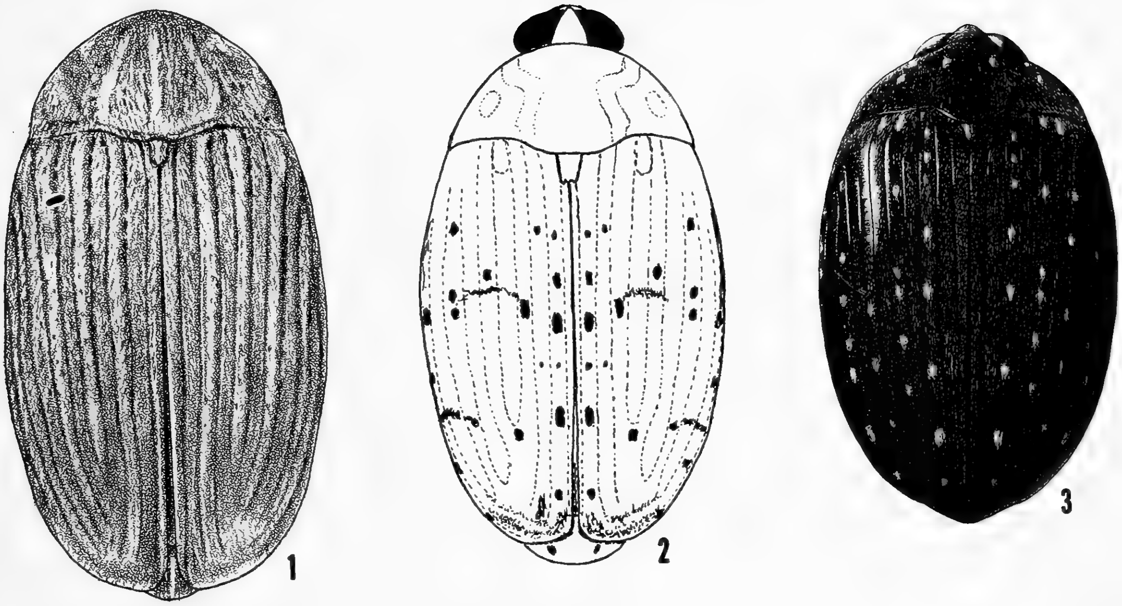
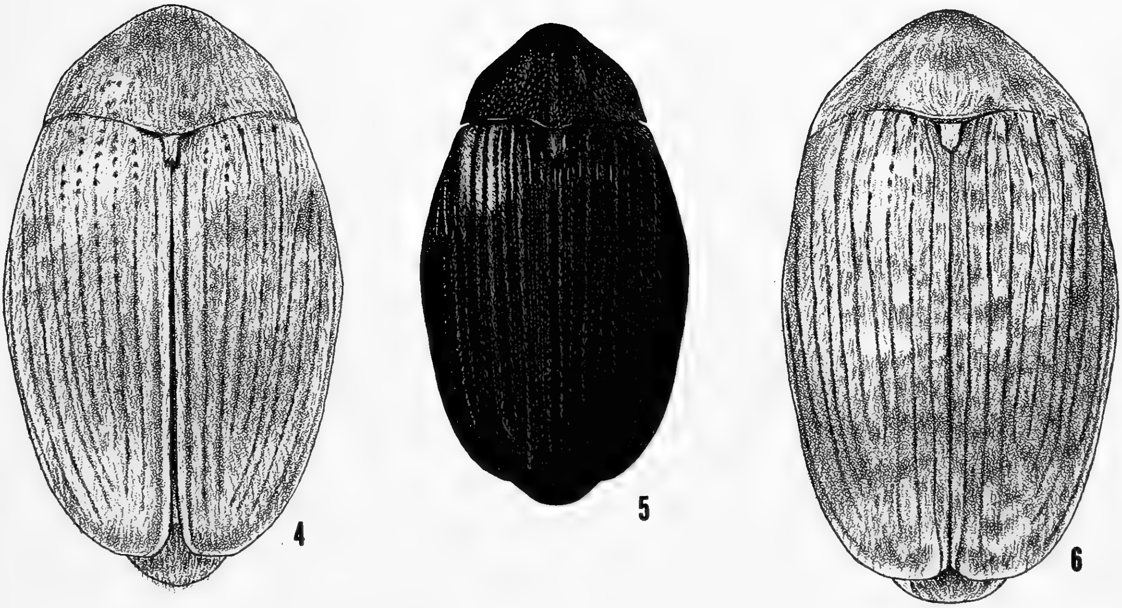
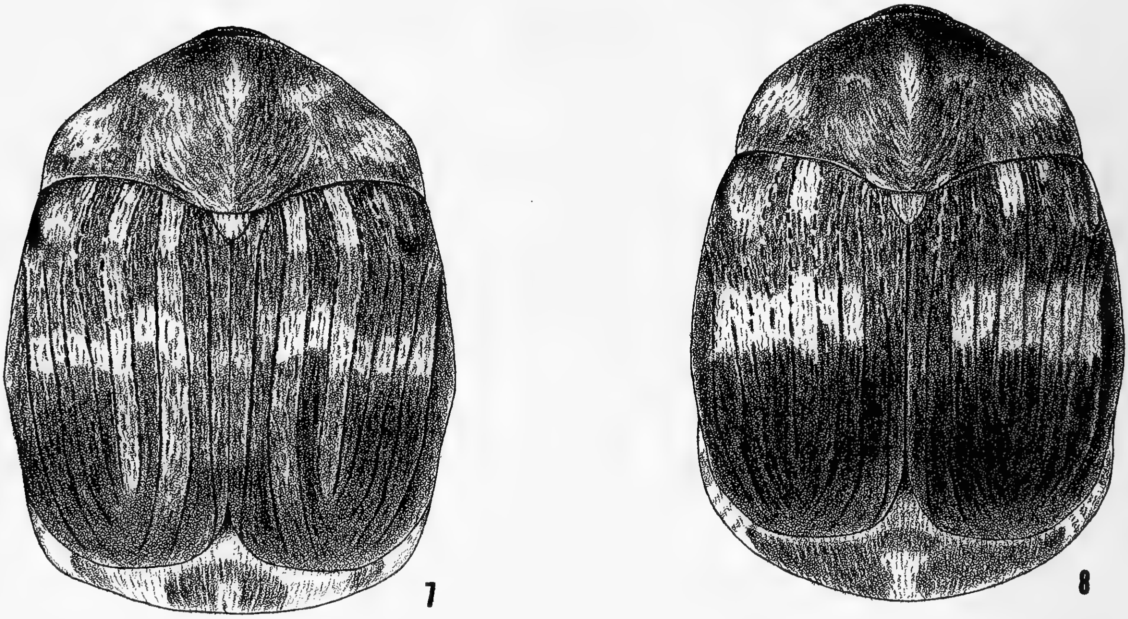


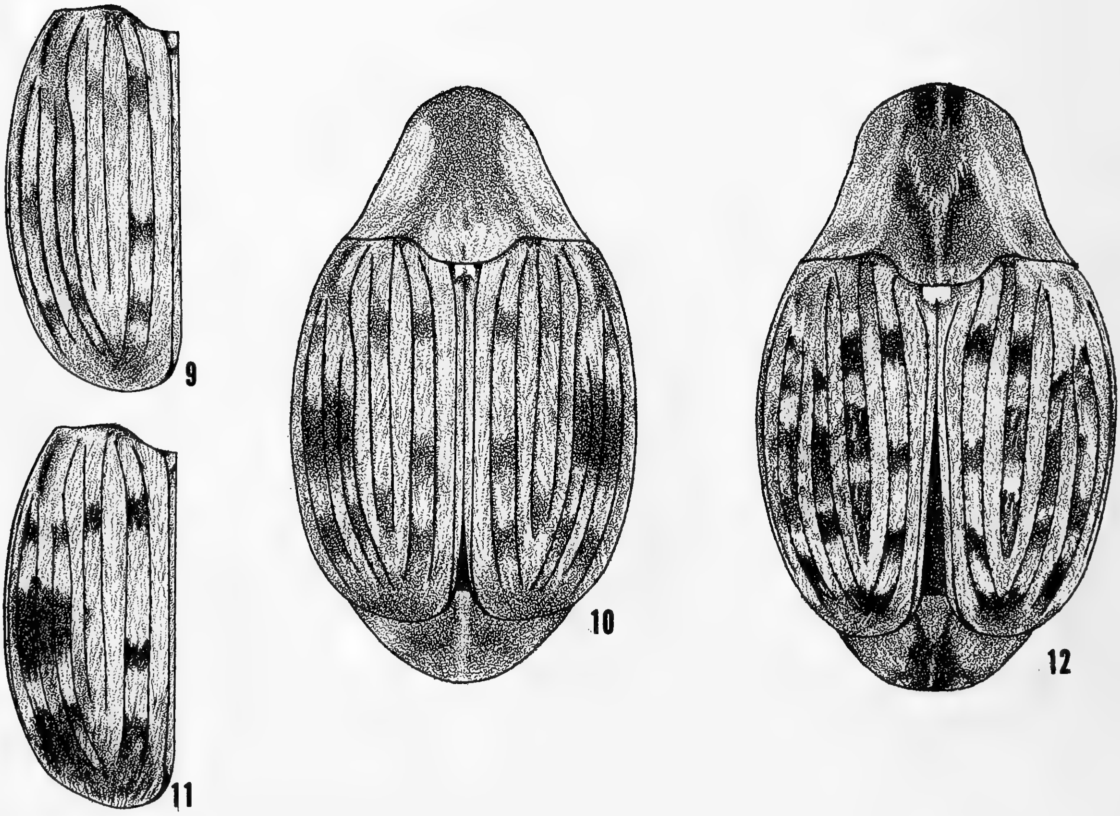
Figs. 1–3. *Amblycerus* spp., dorsal habitus: 1, *A. epsilon*; 2, *A. imperfectus,* 3, *A. multiflocculus*.



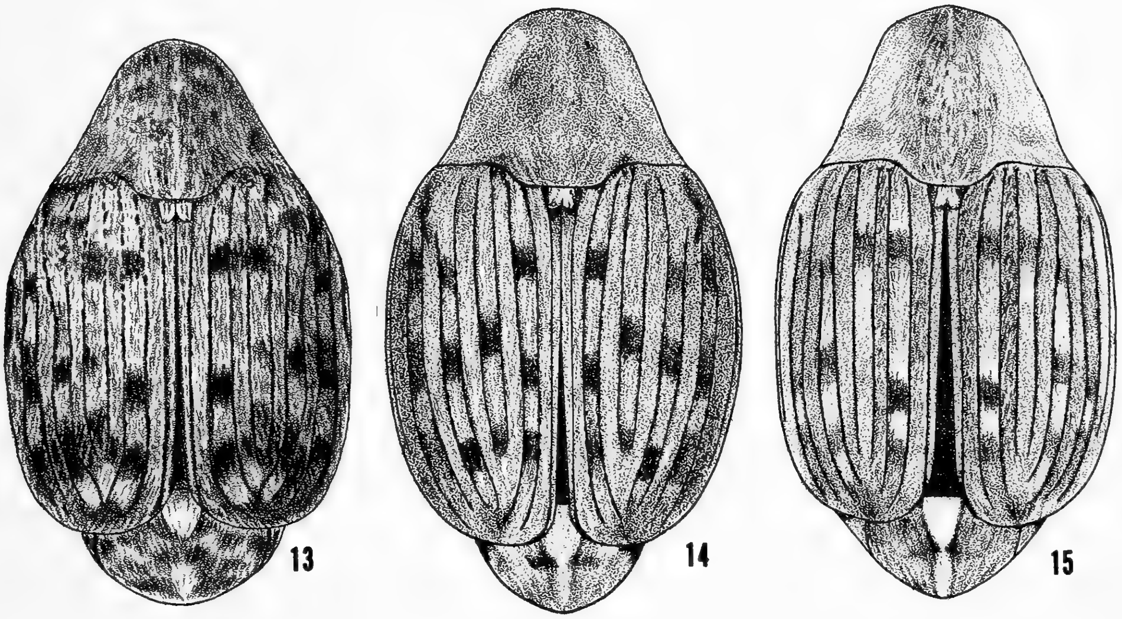
Figs. 4–6. *Amblycerus* spp., dorsal habitus: 4, *A. pterocarpae*; 5, *A. spondiae*; 6, *A. vegai*.



Figs. 7–8. *Zabrotes chavesi,* dorsal habitus; 7, Male; 8, Female.



Figs. 9–12. *Merobruchus* spp., dorsal habitus: 9, 10, 11, *M. santarosae*; 12, *M. boucheri.*



Figs. 13–15. *Merobruchus* spp., dorsal habitus: 13, *M. hastatus*; 14, *M. paquetae*; 15, *M. sonorensis*.

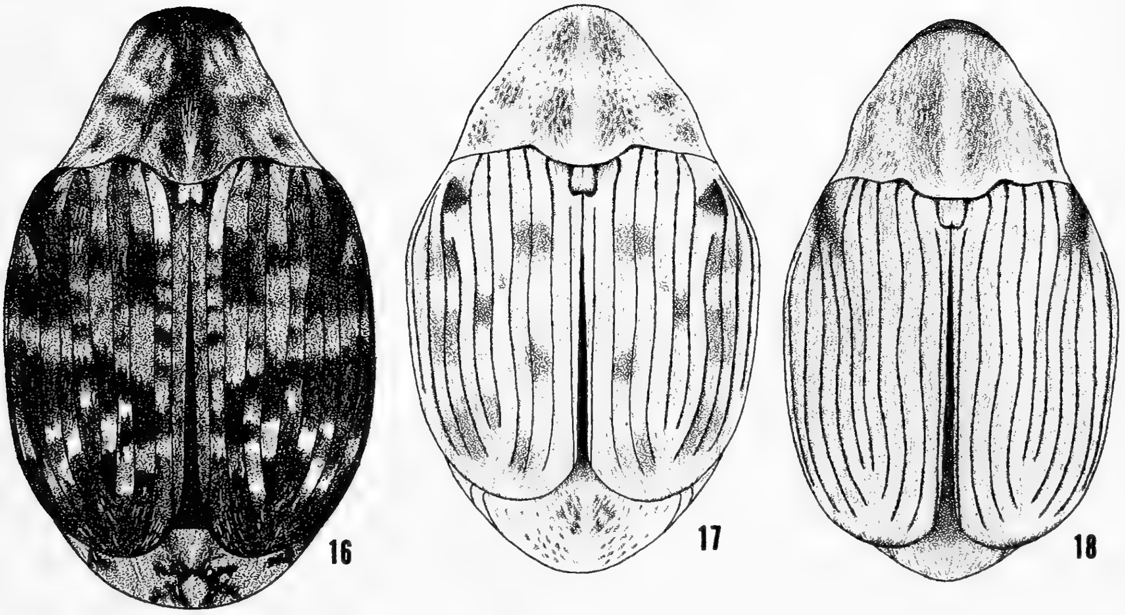
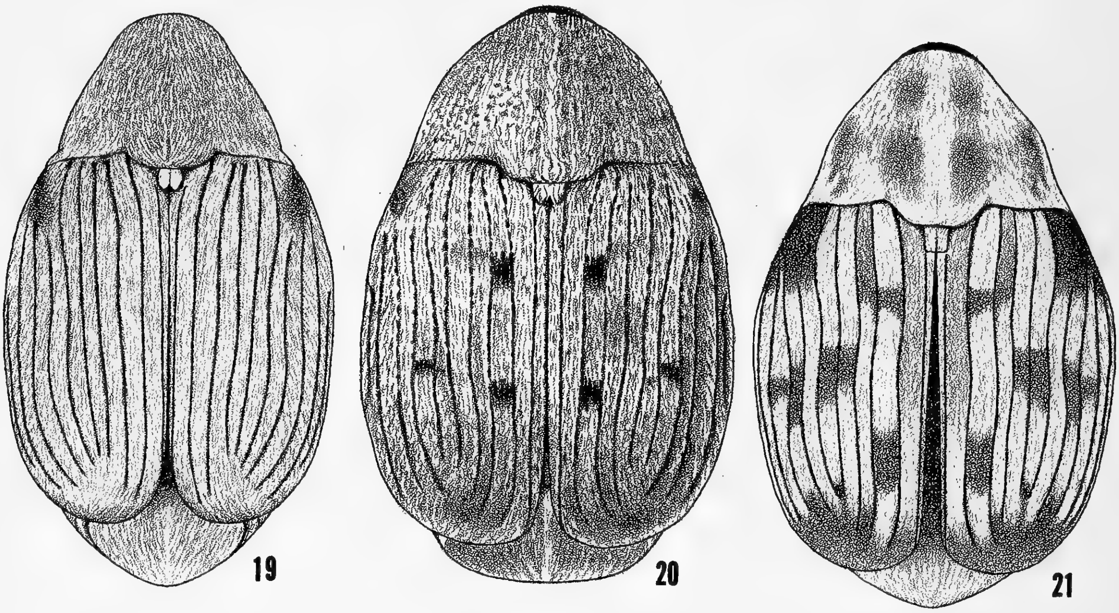
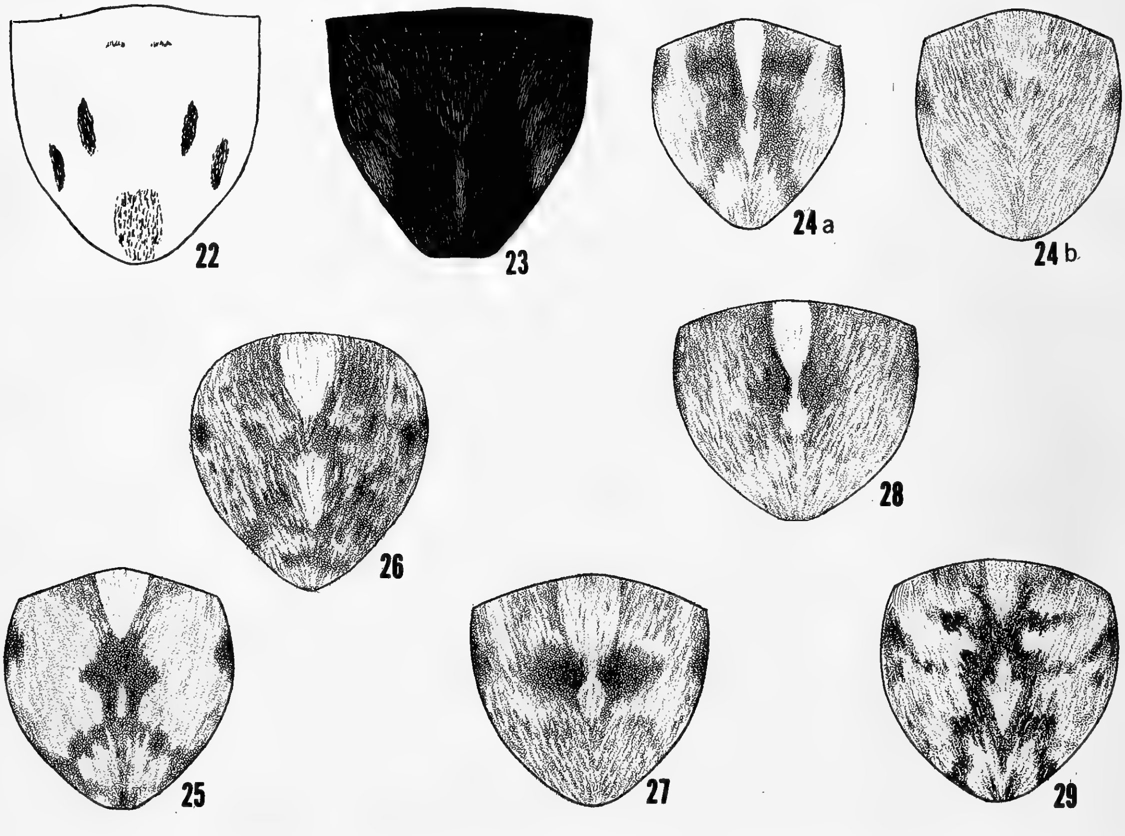


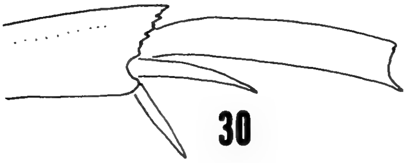
Fig. 16. *Merobruchus terani*, dorsal habitus; Figs. 17–18, *Acanthoscelides* spp., dorsal habitus: 17, *A. hectori*; 18, *A. johnsoni*.



Figs. 19–21. *Acanthoscelides* spp., dorsal habitus: 19, *A. megacornis*; 20, *A. petalopygus*; 21, *A. triumfettae*.



Figs. 22–29. Pygidia: 22, *Amblycerus imperfectus*; 23, *A. multiflocculus*; 24a, *Merobruchus santarosae*, female; 24b, Same, male; 25, *M. boucheri*; 26, *M. hastatus*; 27, *M. paquetae*; 28, *M. sonorensis*; 29, *M. terani*.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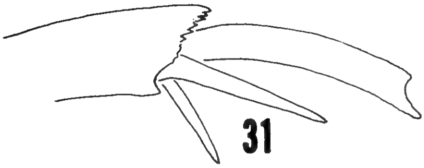
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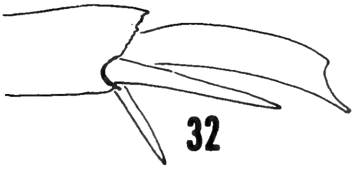
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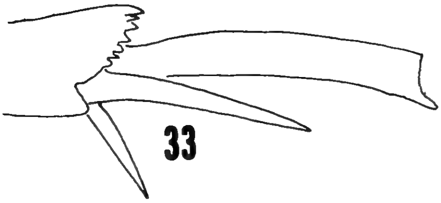
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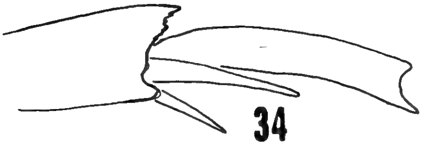
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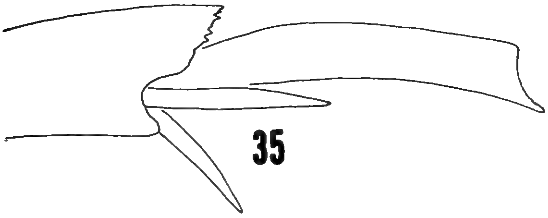
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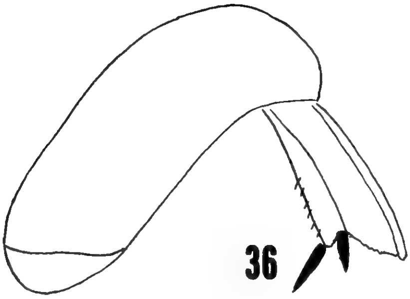
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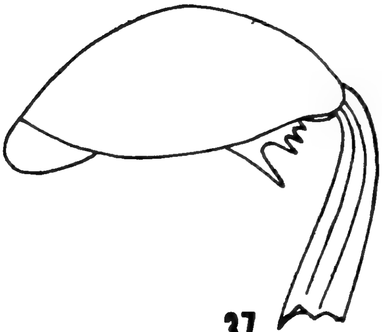
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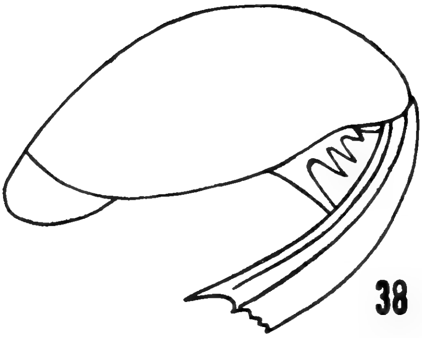
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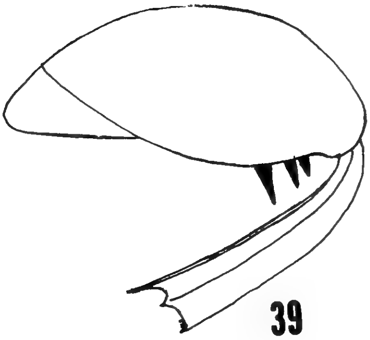
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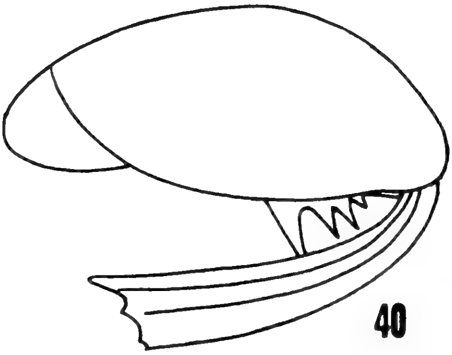
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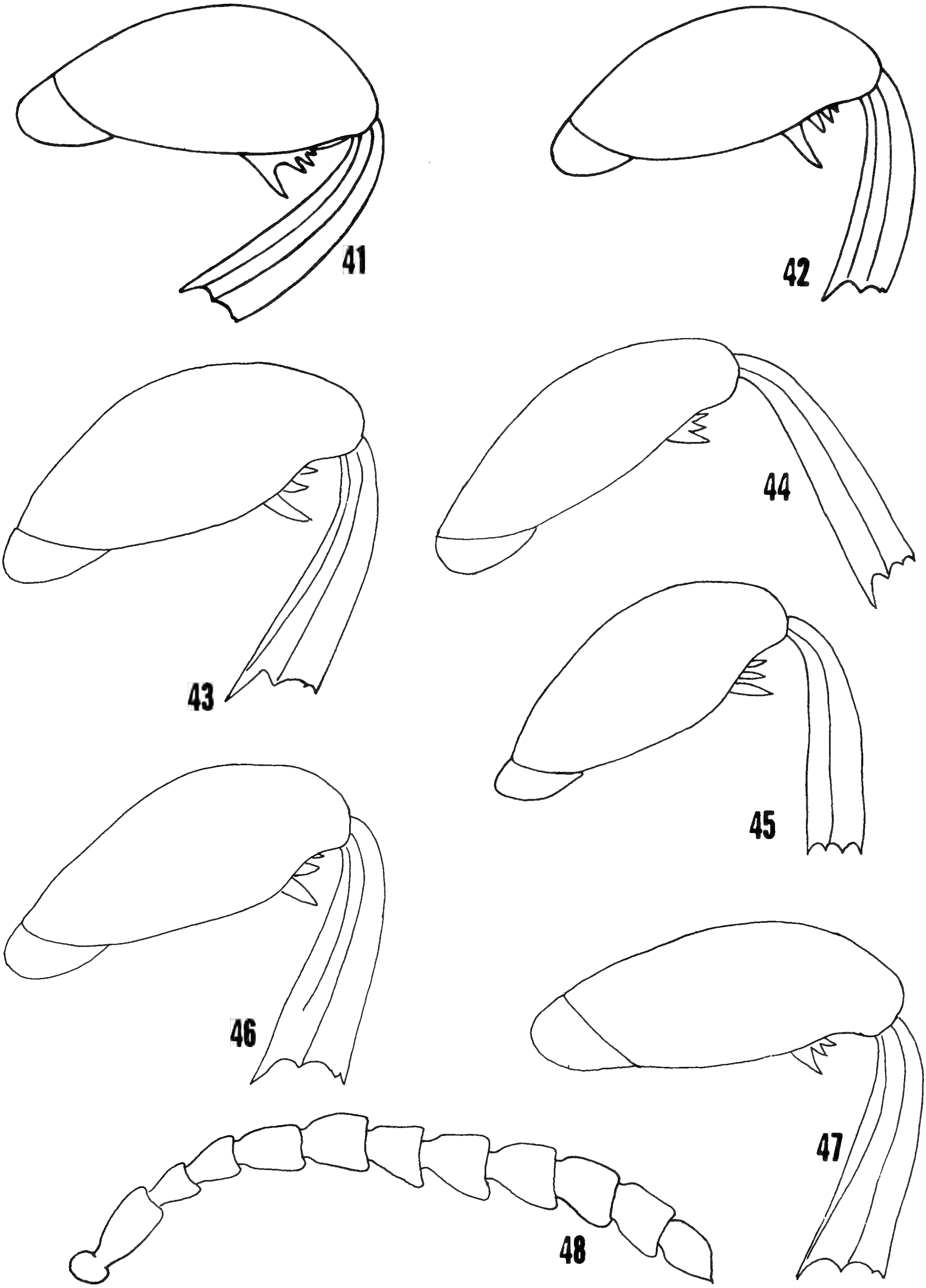
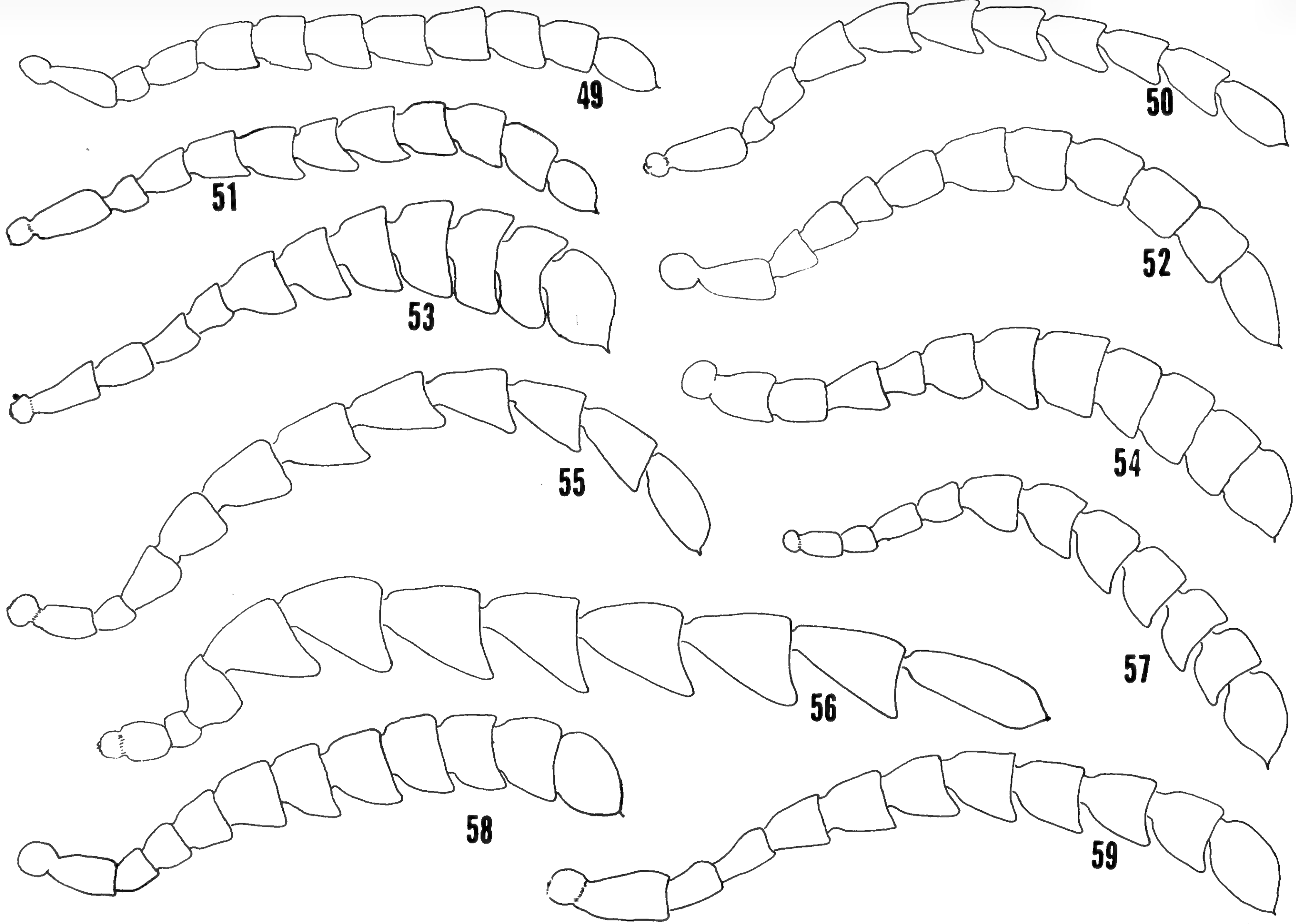
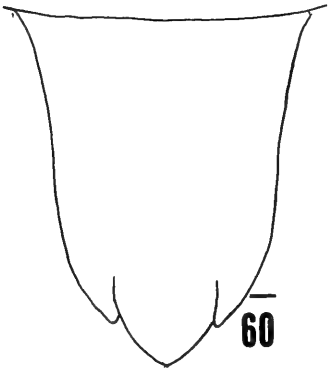
Figs. 30–35. *Amblycerus* spp. apex of metatibia: 30, *A. epsilon*; 31, A. *imperfectus*; 32, *A. multiflocculus*; 33, *A. pterocarpae*; 33, *A pterocarpae*; 34, *A. spondiae*; 35, *A. vegai*. Fig. 36, *Zabrotes chavesi,* metaleg. Figs. 37–40, *Merobruchus* spp., metaleg: 37, *M. santarosae*; 38, *M. boucheri*; 39, *M. hastatus*; 40, *M. paquetae*.



Figs. 41–47. Metaleg: *Merobruchus* spp.; 41, *M. sonorensis*; 42, *M. terani*. *Acanthoscelides* spp., metalegs: 43, *A. hectori*; 44, *A. johnsoni*; 45, *A. megacornis*; 46, *A. petalopygus*; 47, *A. triumfettae*. Fig. 48, *Amblycerus epsilon,* antenna.



Figs. 49–59. Antenna: *Amblycerus* spp.; 49, *A. imperfectus* 50, *A. pterocarpae*; 51, *A. vegai*. Fig. 52, *Zabrotes chavesi*. *Merobruchus* spp.; 53, *M. boucheri*. *Acanthoscelides* spp., 54, *A. hectori*; 55, *A. johnsoni*; 56, *A. megacornis*, male; 57, Same, female; 58, *A. petalopygus*; 59, *A. triumfettae*, male.



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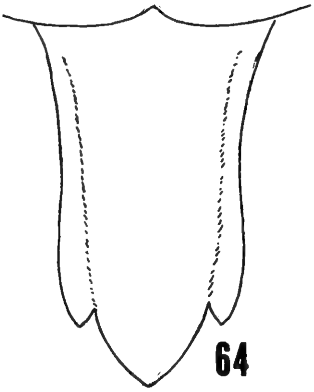

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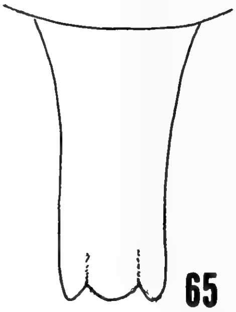

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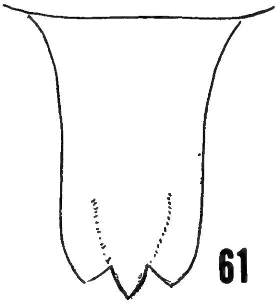

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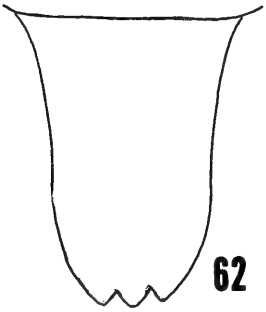

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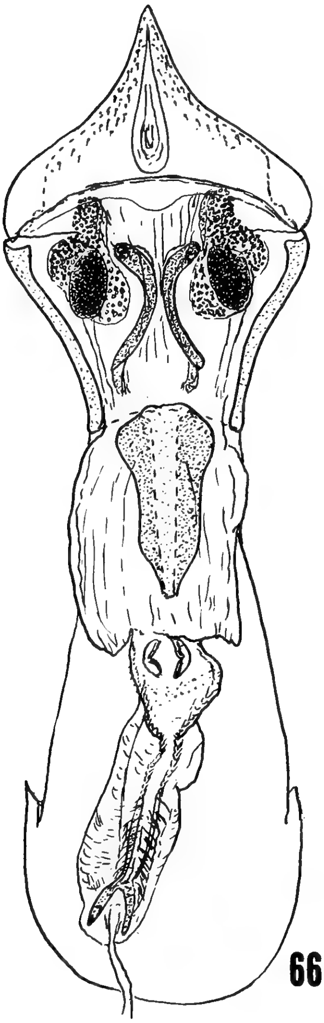

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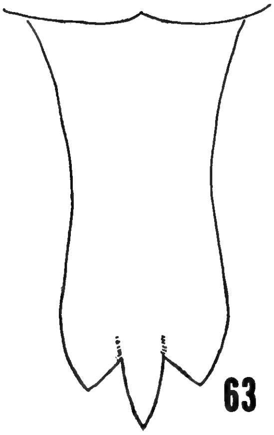

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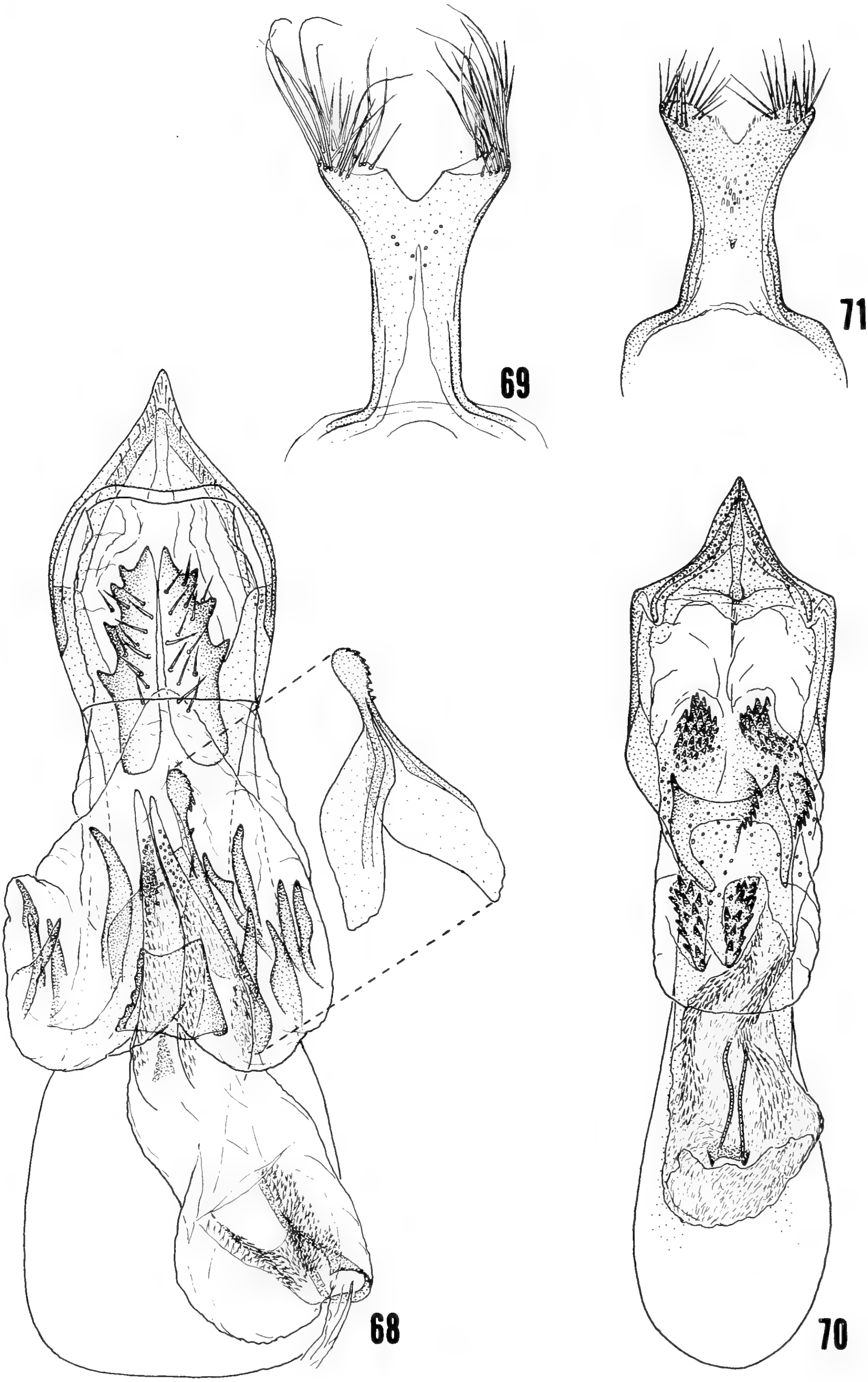
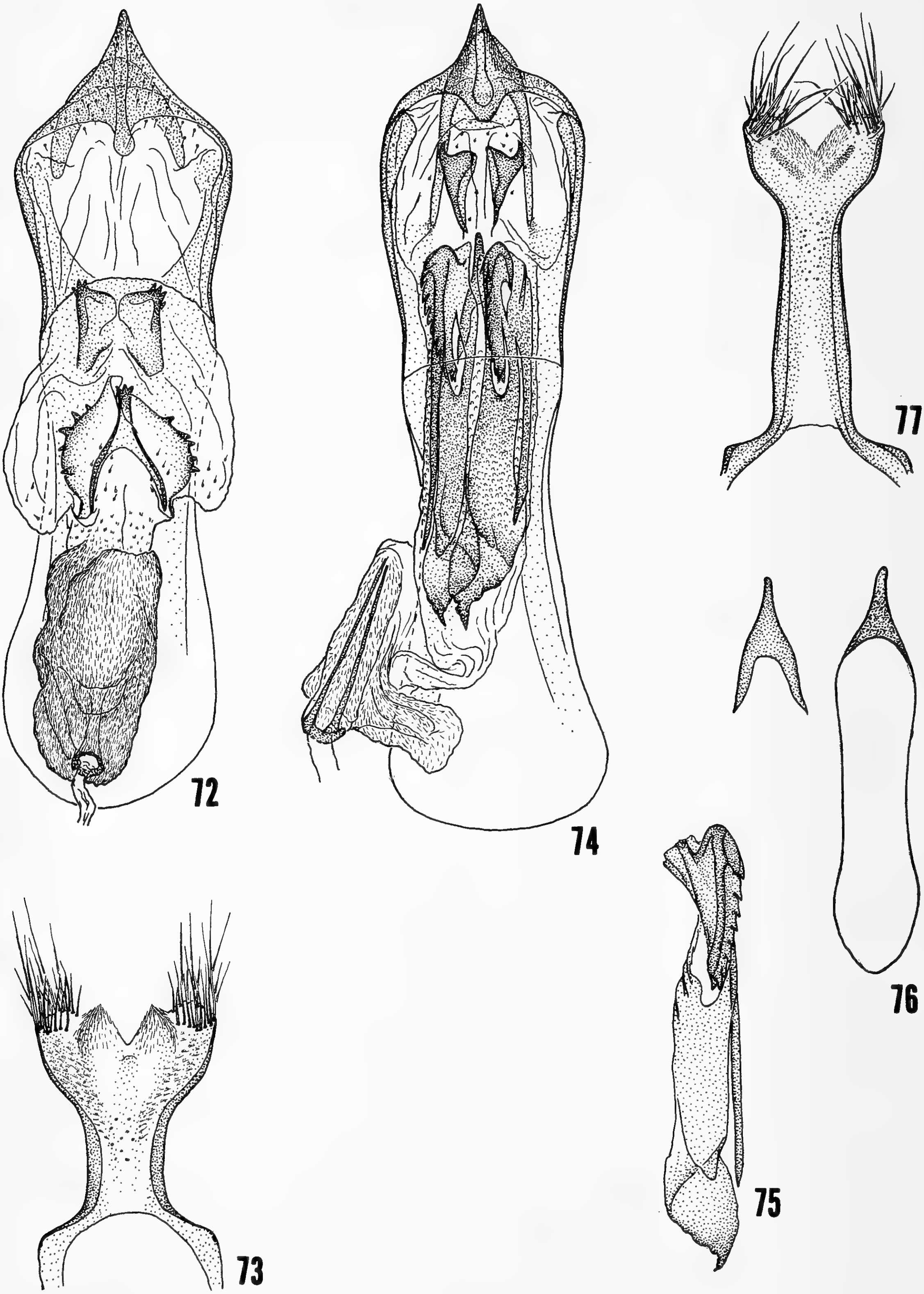
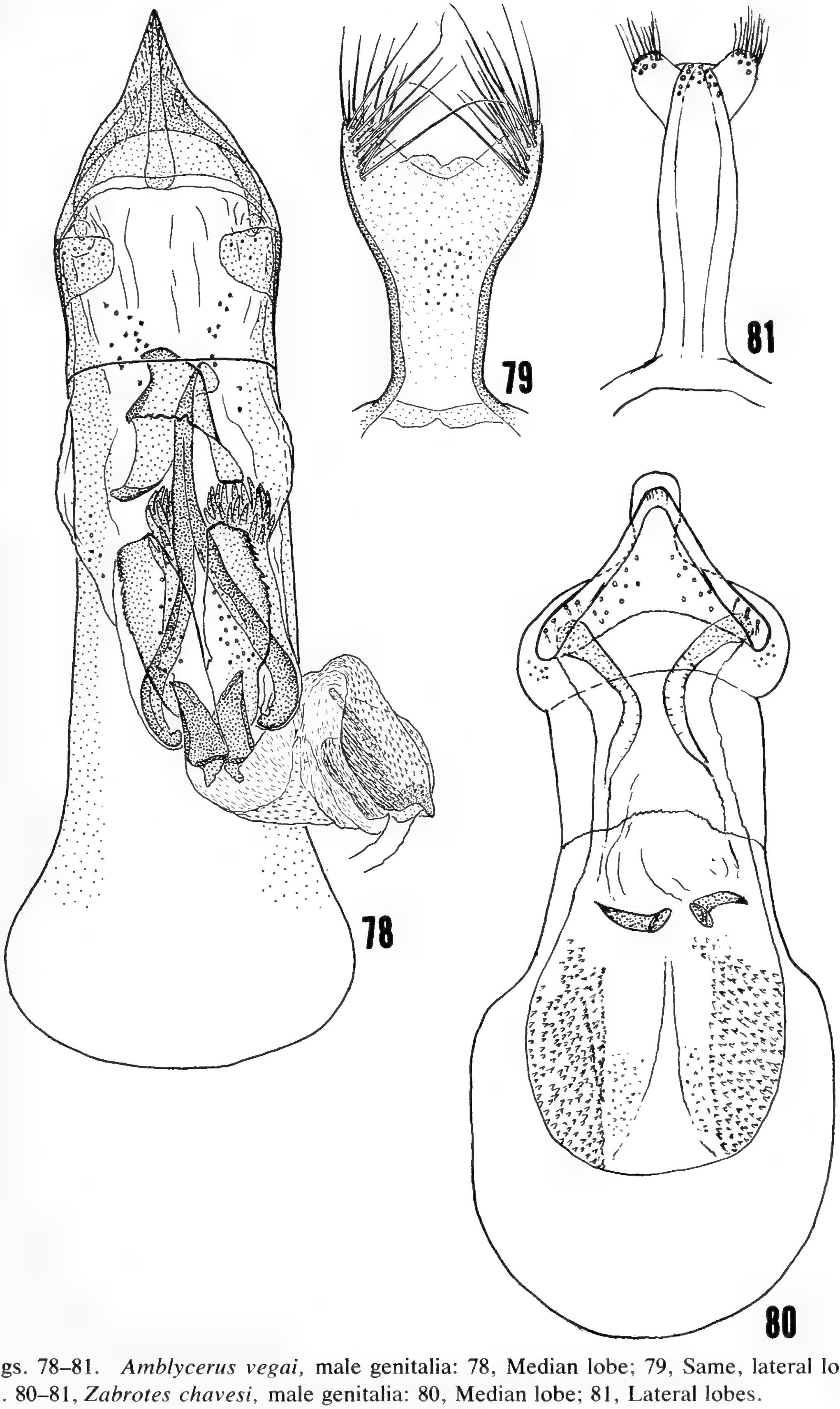
Figs. 60–65. *Amblycerus* spp., scutella: 60, *A. epsilon*; 61, *A. imperfectus*; 62, *A. multiflocculus*; 63, *A. pterocarpae*; 64, *A. spondiae*; 65, *A. vegaii*. Figs. 66–67, *Amblycerus epsilon*, male genitalia: 66, Median lobe; 67, Lateral lobes.



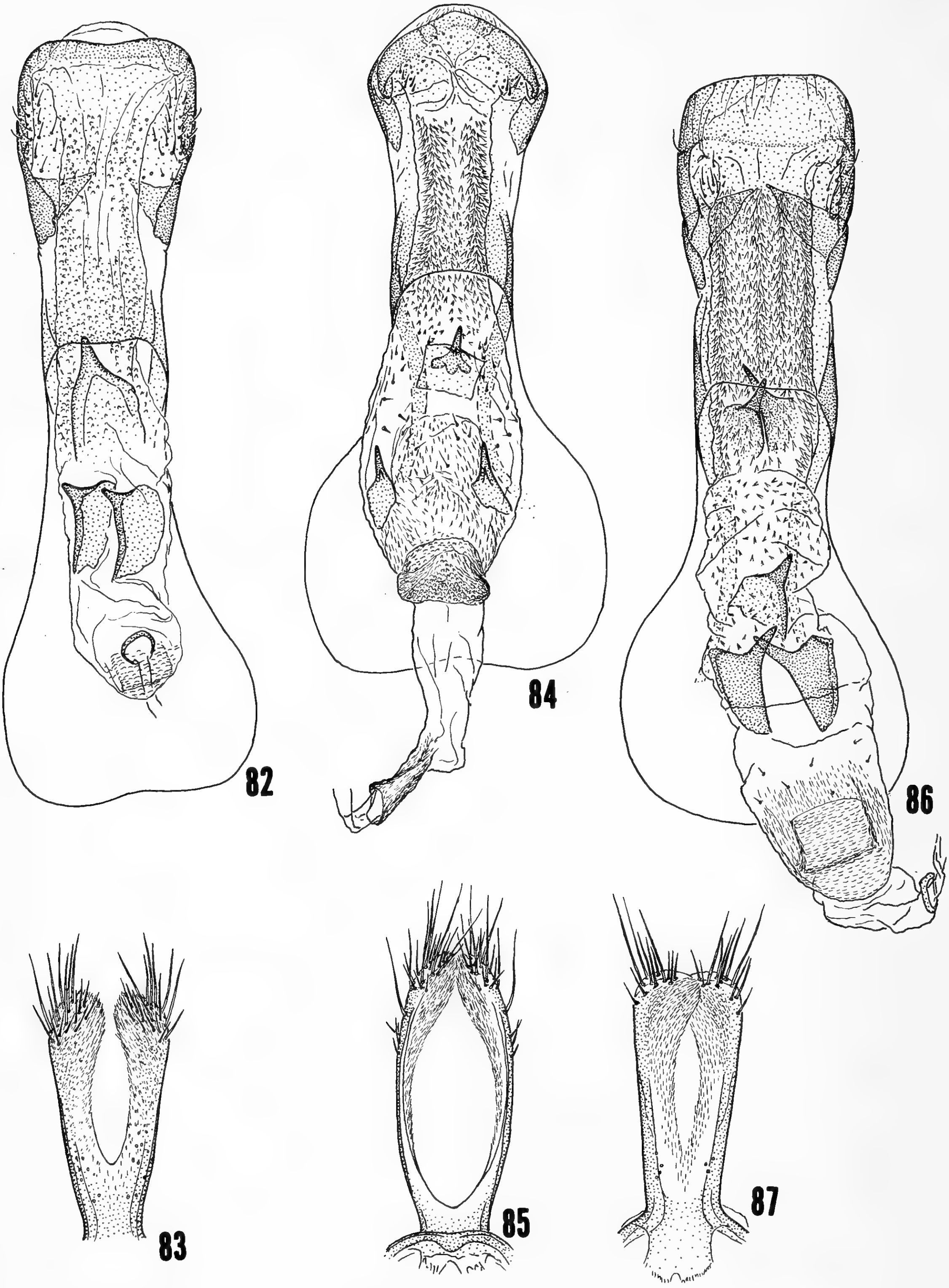
Figs. 68–71. *Amblycerus* spp., male genitalia: 68, *A. imperfectus,* median lobe; 69, Same, lateral lobes; 70, *A. multiflocculus,* median lobe; 71, Same, lateral lobes.



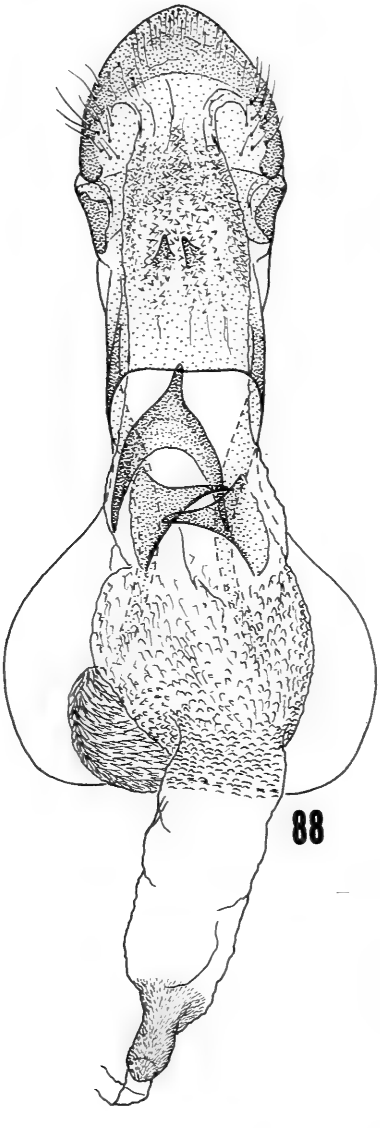
Figs. 72–77. *Amblycerus* spp., male genitalia: 72, *A. pterocarpae*, median lobe; 73, Same, lateral lobes; 74, *A. spondiae*, median lobe; 75, Same, sclerite of internal sac, dorsal aspect; 76, Same, wishbone sclerite, ventral and dorsal aspects; 77, Same, lateral lobes.



Figs. 78–81. *Amblycerus vegai,* male genitalia: 78, Median lobe; 79, Same, lateral lobes. Figs. 80–81, *Zabrotes chavesi,* male genitalia: 80, Median lobe; 81, Lateral lobes.



Figs. 82–87. *Merobruchus* spp., male genitalia: 82, *M. santarosae,* median lobe; 83, Same, lateral lobes; 84, *M. boucheri,* median lobe; 85, Same, lateral lobes; 86, *M. hastatus,* median lobes; 87, Same, lateral lobes.



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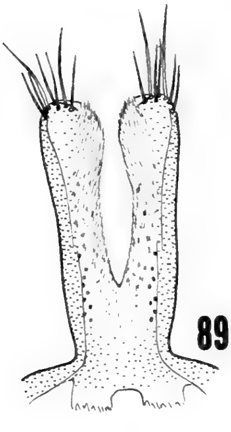

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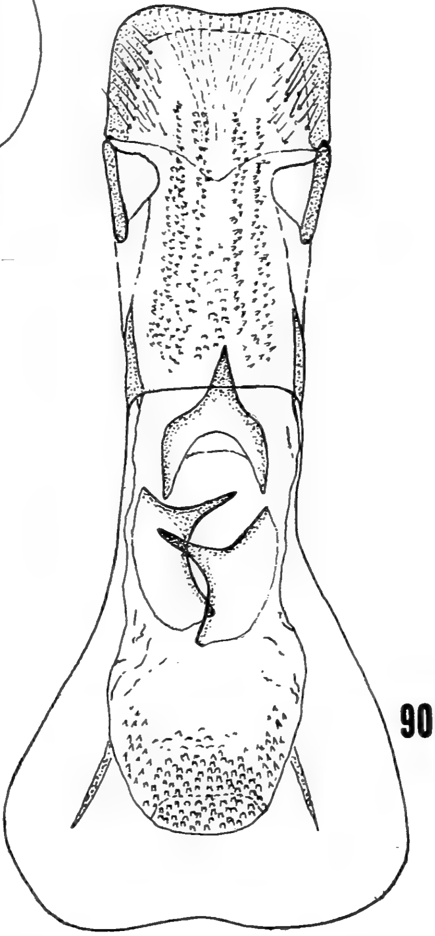

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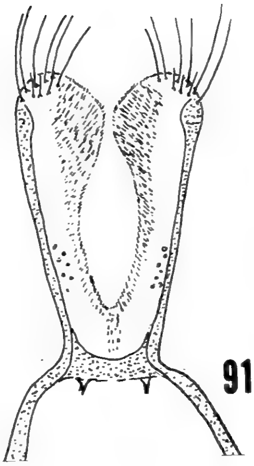

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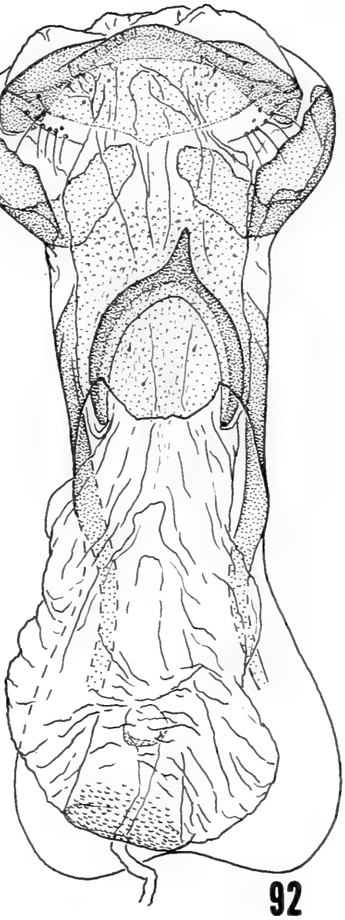

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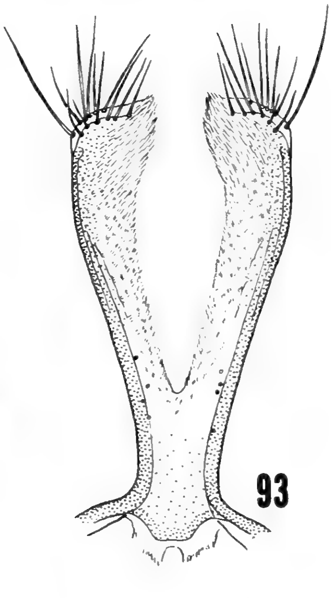

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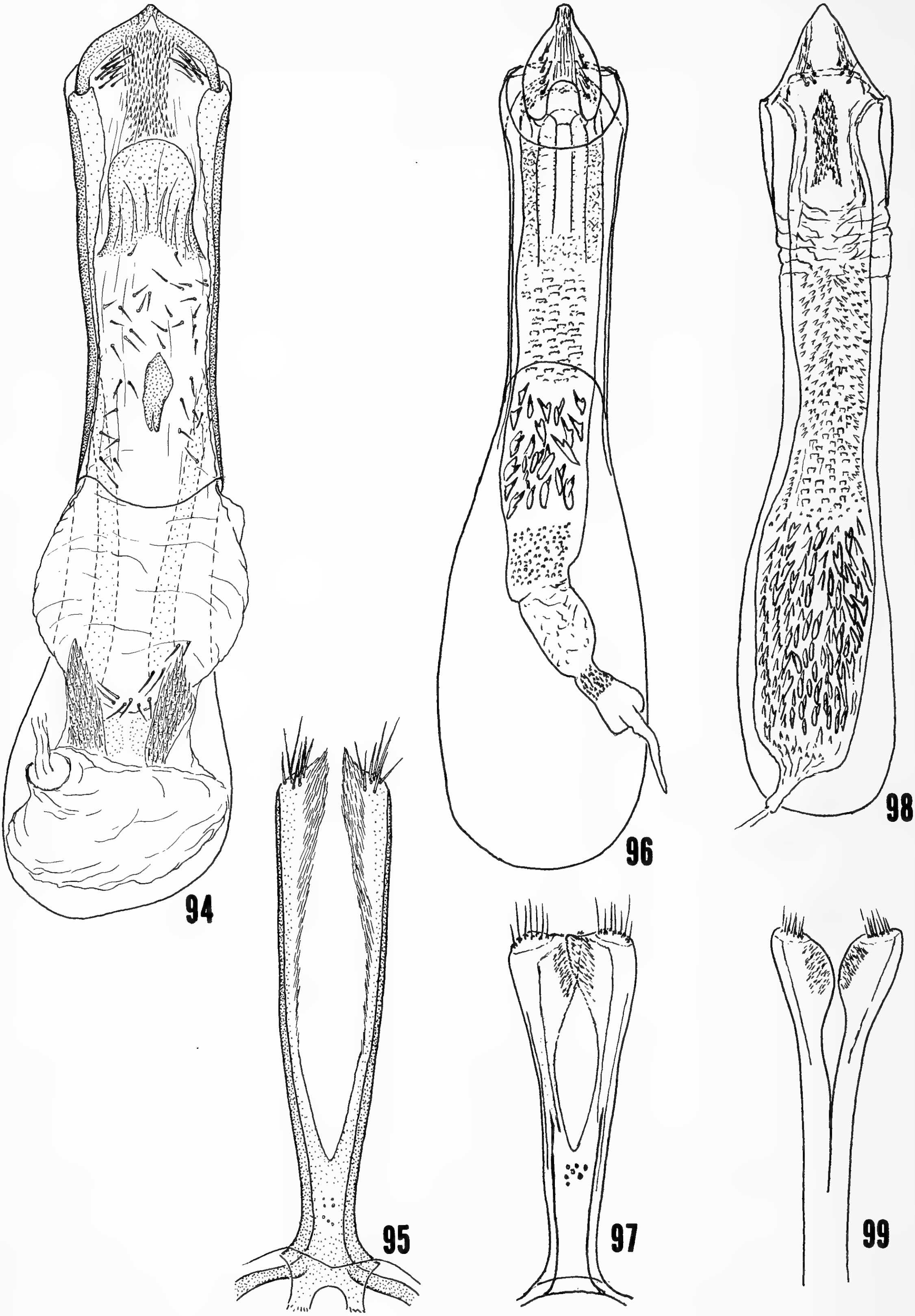

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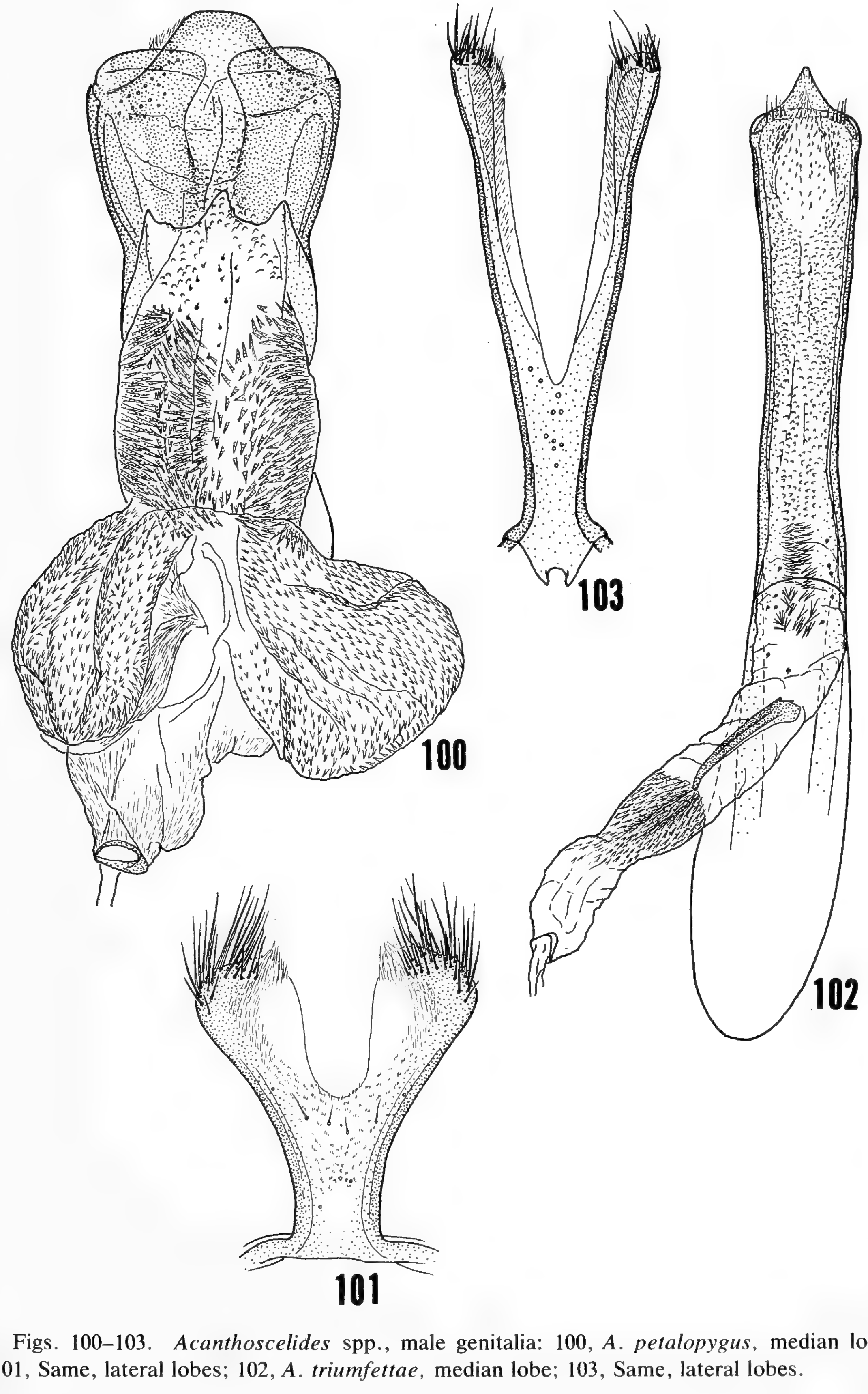

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MARINE ALGAE FROM SAN SALVADOR ISLAND, BAHAMAS

Harold G. Marshall

Abstract.—Eighty-nine marine algal species are reported from the coastal areas of San Salvador, Bahamas. The flora represents an assemblage similar to species found in other Bahamian islands, Bermuda, and the tropical coastal area of the southeastern United States.

The island of San Salvador is located along the western margin of the north Atlantic (24°04′N Lat., 74°35′W Long.) and is a part of the Bahamian archipelago (Fig. 1). The island is oval-shaped, approximately 190 km^2 in size, with an interior that contains numerous saline ponds and lakes and an offshore perimeter interspaced with coral reefs. The island's inland lakes and ponds are about 72% of its total area. These are basically shallow waters less than 2 meters deep, have salinities up to 52‰, and are bordered by extensive growths of mangroves. At Sandy Hook is the entrance of a lone, finger-like extension from the southeastern end of the island that brings tidal waters, confined in Pigeon Creek, within the island's interior. The island's long axis lies north to south with the largest coral reef development along its northwestern, northern, and eastern sides. An assortment of narrow, sandy beaches and rocky beaches form the shoreline.

The land mass of the island and its population are small compared to many other populated Bahamian islands. Only modest development has taken place over the last century. Of note historically, the island is recognized as the site of Columbus' first landing in the New World. However, results of modern-day shipping have left a more direct impact on the sand and rocky beaches of this island. Located directly south and southwest of shipping lanes and current systems, the island's beaches have received an increasing amount of oil products associated with tankers and other large vessels. The intertidal zone shows evidence of various sized tar balls, oil globules, and tar-like substances brought in with the tides. In some of the northern areas of the island, the rocks are covered extensively with these products throughout the intertidal and supralittoral zones. To a much lesser degree, portions of the shallow, infralittoral regions also are affected. In these areas, the "tar" patches have excluded algae and reduced animal populations.

Eighty-nine species were noted during this study. Collections of algal specimens on this island were made during the months of January and Feb-

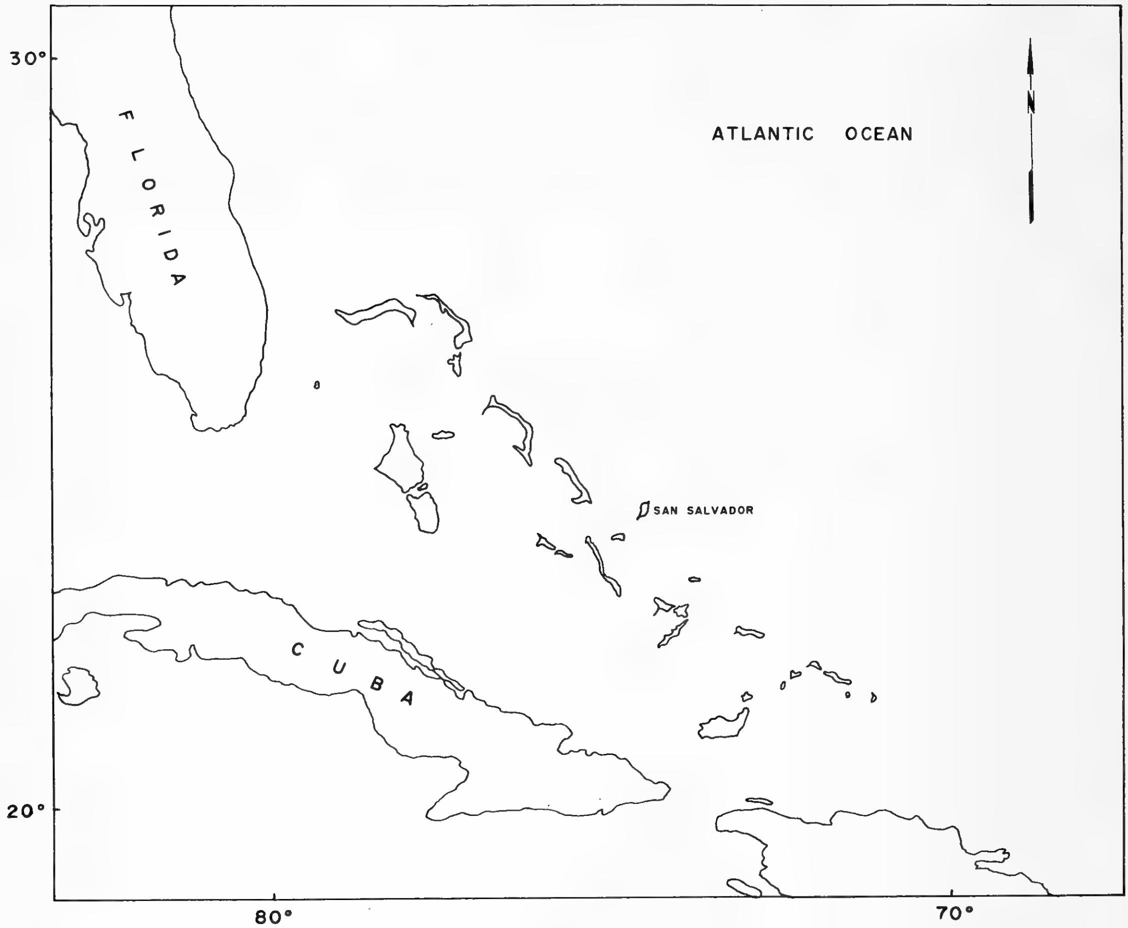

Fig. 1. Location of San Salvador Island (scale 1:3,322,500).

ruary from 1975 through 1978. The collections were mostly based on random visits to sites around the entire island, but did not include deep water dredging. Also not included are many of the coralline Melobeseae, the myxophyceans, and numerous epiphytic species. The following is a preliminary list of the most representative macroalgal forms for the island. Species from the inland, saline lakes will be added in future reports. The algal species are similar to those reported on other tropical coasts within the western north Atlantic (Howe, 1920, 1945; Taylor, 1928, among others), e.g. other Bahamian islands, southeastern Florida, and Bermuda. This is evident in the marine algae found within the sublittoral zone extending from the shoreline to the outer reef margin and among the more quiet waters of sheltered coves. Where island cliffs and rocks are exposed to tidal action along the coasts, algal zonation patterns may be found among the pitted and weathered rocks. The lower intertidal zone has various assemblages of algae that vary with the degree of wave protection and turbulence. An example would be *Cladophora fuliginosa* and *Wrangelia argus* on the more exposed surfaces, with *Cladophora fascicularis, Dictyopteris justii* and *Stypopodium zonale*

Table 1.—Location of algae identified from San Salvador Island, Bahamas. Zones: Supralittoral (SL); upper intertidal (UT); lower intertidal (LT); infralittoral (IL).

	Zones			
	SL	UT	LT	IL
CHLOROPHYCEAE				
Cladophorales				
Cladophora crispula Vickers				X
Cladophora fascicularis (Mertens) Kutzing			X	X
Cladophora fuliginosa Kutzing			X	X
Siphonocladiales				
Acetabularia crenulata Lamouroux				X
Anadyomene stellata (Wulfen) C. Agardh			X	X
Batophora oerstedi J. Agardh				X
Batophora oerstedi v. *occidentalis* (Harvey) Howe				X
Chamaedoris peniculum (Ellis & Solander) Kuntze				X
Cladophoropsis membranacea (C. Agardh) Børgesen			X	X
Cympolia barbata (Linnaeus) Lamouroux				X
Dasycladus vermicularis (Scopoli) Krasser			X	X
Dictyosphaeria cavernosa (Forsskal) Børgesen			X	X
Halicystis osterhoutii L. R. & A. H. Blinks				X
Neomeris annulata Dickie				X
Neomeris cokeri Howe				X
Neomeris mucosa Howe			X	X
Valonia macrophysa Kutzing				X
Valonia ventricosa J. Agardh				X
Siphonales				
Avrainvillea longicaulis (Kutzing) Murray & Boodle			X	X
Avrainvillea nigricans Decaisne				X
Codium isthmocladum Vickers				X
Codium taylori Silva				X
Caulerpa cupressoides (West) C. Agardh				X
Caulerpa mexicana (Sonder) J. Agardh				X
Caulerpa paspaloides v. *compressa* (Weber-van Bosse) Howe				X
Caulerpa prolifera (Forsskal) Lamouroux				X
Caulerpa racemosa (Forsskal) J. Agardh				X
Caulerpa sertularioides (Gmelin) Howe				X
Caulerpa verticillata J. Agardh				X
Halimeda incrassata (Ellis) Lamouroux				X
Halimeda lacrimosa Howe				X
Halimeda monile (Ellis & Solander) Lamouroux				X
Halimeda opuntia (Linnaeus) Lamouroux				X
Halimeda tuna (Ellis & Solander) Lamouroux				X
Penicillus capitatus Lamarck				X
Penicillus dumetosus (Lamouroux) Blainville				X
Penicillus pyriformis A. & E. S. Gepp				X
Rhipilia tomentosa Kutzing				X
Rhipocephalus oblongus (Decaisne) Kutzing				X

Table 1.—Continued.

	Zones			
	SL	UT	LT	IL
Rhipocephalus phoenix (Ellis & Solander) Kutzing				X
Udotea cyathiformis Decaisne				X
Udotea flabellum (Ellis & Solander) Lamouroux				X
Udotea spinulosa Howe				X
Udotea sublittoralis Taylor				X
PHAEOPHYCEAE				
Ectocarpales				
Ectocarpus elachistaeformis Heydrich				X
Dictyotales				
Dictyopteris justii Lamouroux			X	X
Dictyota cervicornis Kutzing				X
Dictyota dentata Lamouroux				X
Dictyota dichotoma Lamouroux				X
Dictyota divaricata (Hudson) Lamouroux				X
Padina sanctae-crucis Børgesen				X
Padina vickersiae Hoyt				X
Pocockiella variegata (Lamouroux) Papenfuss				X
Stypopodium zonale (Lamouroux) Papenfuss			X	X
Chordariales				
Elachistea minutissima Taylor				X
Punctariales				
Colpomenia sinuosa (Roth) Derbes and Solier			X	X
Fucales				
Sargassum filipendula C. Agardh				X
Sargassum fluitans Børgesen		(Pelagic)		
Sargassum natans (Linnaeus) J. Meyen		(Pelagic)		
Sargassum platycarpum Montagne			X	
Sargassum pteropleuron Grunow				X
Turbinaria tricostata Barton			X	X
Turbinaria turbinata (Linnaeus) Kuntze			X	X
RHODOPHYCEAE				
Cryptonemiales				
Amphiroa fragilissima (Linnaeus) Lamouroux				X
Corallina subulata Ellis & Solander				X
Fosliella chamaedoris (Foslie & Howe) Howe				X
Fosliella farinosa (Lamouroux) Howe				X
Gigartinales				
Agardhiella tenera (J. Agardh) Schmitz				X
Gracilaria cervicornis (Turner) J. Agardh				X
Gracilaria foliifera (Forsskal) Børgesen				X
Gracilaria verrucosa (Hudson) Papenfuss				X
Hypnea musciformis (Wulfen) Lamouroux				X

Table 1.—Continued.

	Zones			
	SL	UT	LT	IL
Rhodymeniales				
Botryocladia occidentalis (Børgesen) Kylin				X
Ceramiales				
Acanthophora spicifera (Vahl) B,rgesen			X	X
Bostrychia montagnei Harvey			X	X
Bostrychia tenella (Vahl) J. Agardh	X	X	X	
Bryothamnion triquetrum (Gmelin) Howe			X	X
Caloglossa leprieurii (Montagne) J. Agardh			X	
Centroceras clavulatum (C. Agardh) Montagne				X
Ceramium subtile J. Agardh				X
Digenia simplex (Wulfen) C. Agardh			X	X
Laurencia obtusa (Hudson) Lamouroux				X
Laurencia papillosa (Forsskal) Greville			X	X
Polysiphonia denudata (Dillwyn) Kutzing				X
Polysiphonia howei Hollenberg		X	X	
Polysiphonia subtilissima Montagne				X
Spermothamnion gorgoneum (Montagne) Bornet				X
Spyridia aculeata v. *hypneoides* J. Agardh			X	X
Wrangelia argus Montagne			X	X
Wrangelia penicillata C. Agardh				X

found in protected areas. In the upper intertidal zone *Bostrychia tenella* becomes the prominent species with the scattered presence of *Polysiphonia howei* also noted.

Bostrychia tenella extends into the lower margin of the supralittoral zone where it develops primarily within pockets and areas where desiccation is reduced. This area is also occupied by myxophyceans which are the dominant forms in the supralittoral zone.

Pelagic algal forms were common to the shallow water area and washed up on the local beaches. These included *Sargassum fluitans, S. natans, Turbinaria tricostata,* and *T. turbinata.*

Acknowledgment

Special acknowledgment is extended to Donald Gerace, Director of the College Center for the Finger Lakes, Bahama campus, for his assistance and use of the laboratory facilities on San Salvador Island that were made available during my collection trips. Prepared specimens of the algae are available in the herbarium collections at the San Salvador laboratory.

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Department of Biological Sciences, Old Dominion University, Norfolk, Virginia 23508.

PROC. BIOL. SOC. WASH.
93(2), 1980, pp. 291–298

GILA BORAXOBIUS, A NEW SPECIES OF CYPRINID FISH FROM SOUTHEASTERN OREGON WITH A COMPARISON TO *G. ALVORDENSIS* HUBBS AND MILLER

Jack E. Williams and Carl E. Bond

Abstract.—*Gila boraxobius,* a new cyprinid fish, is described from a small spring-fed lake in the Alvord Basin of southeastern Oregon. This dwarf species of *Gila* is characterized by a large head with dorsal surface slightly concave in profile, large eyes, slender caudal peduncle, and reduced lateral line. *Gila boraxobius* is most closely allied to *G. alvordensis* Hubbs and Miller, with which it is compared. The restricted habitat of *G. boraxobius* is threatened by drilling associated with geothermal energy exploration.

Fishes of the genus *Gila* Baird and Girard form a diverse assemblage of western North American cyprinids. Fifteen species and numerous subspecies of the genus currently are recognized. Many of these taxa have been described from allopatric populations in the Great Basin. The species described herein inhabits a small spring-fed lake, Borax Lake (T37S, R33E, Sec. 14), in the Alvord Basin of the Great Basin province. Snyder et al. (1964) reported that during Pleistocene times a lake of over 1,200 km^2 at its maximum extent was present in the Alvord Basin. As pluvial lakes, such as Lake Alvord, dried, fishes became isolated in remaining springs and creeks of the basins (Hubbs et al., 1974). Eleven allopatric populations of fishes of the genus *Gila* inhabit waters of the Alvord Basin of Oregon and Nevada. One of the 11 populations, from Trout Creek in Oregon, was named *G. alvordensis* by Hubbs and Miller (1972). In their diagnosis of *G. alvordensis,* Hubbs and Miller included the *Gila* from Borax Lake, although they reported it as "usually greatly dwarfed" in comparison to the Trout Creek *Gila*. Further investigation of the Borax Lake *Gila* demonstrated that this fish is separable from the Trout Creek *Gila* at the specific level.

Drilling associated with geothermal energy exploration threatens the Borax Lake *Gila* through possible interference with the hot springs that supply water to the lake. The Unique Wildlife Ecosystem Program of the U.S. Fish and Wildlife Service regards the Borax Lake area as the second most important and unique ecosystem in Oregon (Bruce Boccard pers. comm.). Because of restricted habitat and threats from geothermal exploration, the new species has been proposed for the federal threatened and endangered species list and is currently on the protected list of the Oregon Department

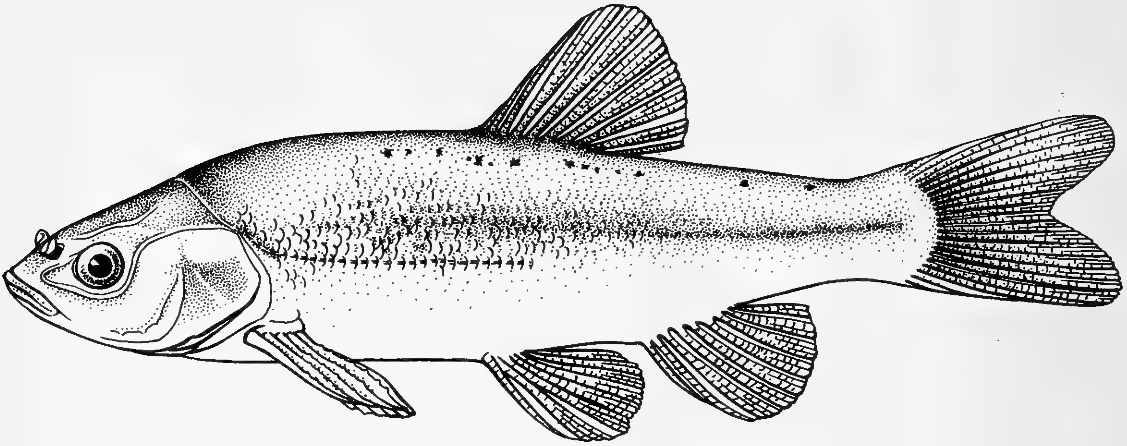

Fig. 1. Holotype of *Gila boraxobius,* UMMZ 203329, a tuberculate male 50.6 mm SL.

of Fish and Wildlife. The species is listed as threatened by the Endangered Species Committee of the American Fisheries Society (Deacon et al., 1979).

Materials and methods.—Thirty specimens each of *Gila* from Borax Lake and Trout Creek were examined to determine their morphometry and meristics. Counts and measurements followed the methods of Hubbs and Lagler (1958). In enumerating vertebrae from radiographs, the methods of Hubbs et al. (1974:90) were followed; the hypural plate was counted as one vertebra and the Weberian apparatus as four. In some specimens, the identification of the transitional vertebra between precaudal and caudal vertebrae was difficult and may have caused some inaccuracy. Measurements were made to the nearest 0.1 mm with precision dial calipers. In order to reduce the effects of allometry no specimens less than 40 mm SL were measured. Dyes and magnification were employed on counts involving scales and lateral line pores. Counts or measurements of *Gila alvordensis* refer to specimens from Trout Creek. Results reported in this study are based on preserved specimens from the Oregon State University Collection of Fishes (OS). Type material was deposited at Oregon State University and the University of Michigan Museum of Zoology (UMMZ).

Gila boraxobius, new species
Borax Lake Chub
Fig. 1

Siphateles sp. Hubbs and Miller, 1948 (zoogeography).

Gila alvordensis Hubbs and Miller, 1972 (diagnosis of *G. alvordensis* included "usually greatly dwarfed [form] in Borax Lake"). Bond, 1974 (rare status).

Holotype.—Tuberculate male, UMMZ 203329, 50.6 mm SL; collected by

Table 1.—Measurements, in thousandths of standard length, of 30 specimens each of *Gila boraxobius* and *G. alvordensis*.

	Gila boraxobius			*Gila alvordensis*		
Measurement	Range	Mean	SD	Range	Mean	SD
Standard length, mm	41.7–90.4	48.9	9.1	47.4–119.5	64.8	22.1
Predorsal length	549–600	570.5	12.0	506–581	557.4	15.0
Greatest body depth	214–331	243.8	21.5	239–269	251.6	8.3
Greatest body width	144–197	157.8	29.5	128–191	160.8	14.8
Anal to caudal length	289–333	312.0	12.6	298–345	320.4	11.3
Head length	280–357	318.1	14.4	252–287	270.0	9.1
Head depth	173–208	194.3	7.5	169–189	177.1	5.3
Head width	159–201	179.4	11.1	140–172	158.9	9.5
Orbit length	48–79	64.3	6.4	37–59	49.9	5.7
Snout length	78–105	90.4	6.2	66–86	73.1	5.2
Snout to nostril length	50–70	58.4	5.3	42–61	50.1	5.5
Length of upper jaw	73–104	85.4	5.9	68–90	77.1	4.4
Mandible length	81–110	97.6	6.3	75–95	84.3	5.2
Least bony interorbital width	70–91	82.4	4.6	78–104	90.5	5.6
Least caudal peduncle depth	92–122	107.9	6.7	110–138	123.9	7.0
Longest gill raker	6–24	9.6	4.1	9–16	12.3	2.1

K. Howe and party from Borax Lake, Harney County, Oregon, 5 August 1977.

Paratopotypes.—All collected from Borax Lake, Harney County, Oregon. UMMZ 203330, 114 specimens (14.3–68.3 mm SL); OS 4137, 12 (34.1–90.4); OS 4138, 182 (25.8–61.8).

Diagnosis.—*Gila boraxobius* is most closely allied to *G. alvordensis*. These species differ from other species of *Gila* in possessing the following combination of characters: uniserial pharyngeal teeth, radii in all fields of the scale, and typically seven dorsal and anal fin rays. A comparison of proportional measurements, in thousandths of SL, between *G. boraxobius* and *G. alvordensis* illustrates many interspecific differences (Table 1). The head of *G. boraxobius* is longer, wider and deeper than that of *G. alvordensis*. *Gila boraxobius* possesses a larger eye than does *G. alvordensis*. Orbit length of *G. boraxobius* is greater than snout to nostril length, but equal to or less than this in *G. alvordensis*. *Gila boraxobius* possesses a longer snout than does *G. alvordensis*. The length of the jaw in *G. boraxobius* is greater than in *G. alvordensis*. The caudal peduncle of *G. boraxobius* is quite slender in comparison to *alvordensis*. In profile, the dorsal surface of the head of *boraxobius* is concave, rather than convex as in *alvordensis*. The lateral line is reduced in *G. boraxobius,* but complete in *G. alvordensis*; lateral line pore counts averaged 13.2 (range 2–43) for 30 specimens from Borax Lake and 44.2 (30–66) in 30 specimens of *G. alvor-*

Table 2.—Sexual dimorphism of fin lengths, expressed in thousandths of SL, in *Gila boraxobius*. Ranges are given with means in parentheses.

Measurement	4 males	28 females
Depressed dorsal fin	220–243 (229.5)	174–213 (190.8)
Depressed anal fin	192–217 (204.0)	156–182 (170.4)
Left pectoral fin	223–233 (227.8)	162–197 (183.5)
Left pelvic fin	149–192 (172.3)	129–154 (140.5)

densis. The modal number of pectoral fin rays is 13 in *G. boraxobius*, and 14 or 15 in *G. alvordensis*.

Description.—*Gila boraxobius* is a dwarf species of *Gila*. Adult specimens are typically 33–50 mm SL. Of several hundred specimens from Borax Lake in the Oregon State University collection, only four fish are longer than 60 mm SL. These four specimens are all female, including individuals of 61.8, 68.3, 90.4, and 92.7 mm SL. The largest male collected was 50.6 mm SL (holotype). Males as small as 28.6 mm SL are highly tuberculate. Mature eggs were found in females as small as 31.8 mm SL. The head of *G. boraxobius* is large with the dorsal surface prominently concave in profile. The jaw is long; the mouth is quite oblique, rising to opposite the lower one-half of the eye. The eyes are large. The caudal peduncle is noticeably slender.

The anterior margin of the rather small dorsal fin is slightly rounded and the posterior margin is slightly convex. There are two rudimentary dorsal fin rays, the largest of which is approximately one-half the length of the first principal ray. The anterior margin of the anal fin is rounded and the posterior margin is slightly convex. When the dorsal and anal fins are depressed, the branches of the third principal ray are typically the longest. The posterior tips of the slightly forked caudal fin are rounded. All fins are proportionately larger in males than in females (Table 2). *Gila boraxobius* typically has 7

Table 3.—Frequency distribution of fin ray counts in *Gila boraxobius* and *G. alvordensis*.

	Dorsal rays				Anal rays			Left pelvic rays			
	6	7	8	Mean	7	8	Mean	7	8	9	Mean
Gila boraxobius	1	27	2	7.0	21	9	7.3	2	25	3	8.0
Gila alvordensis		25	5	7.2	28	2	7.1	4	25	1	7.9

	Left pectoral rays					Caudal rays				
	12	13	14	15	Mean	17	18	19	20	Mean
Gila boraxobius	4	16	6	4	13.3	2	5	23		18.7
Gila alvordensis	1	6	13	10	14.1		4	24	2	18.9

Table 4.—Frequency distribution of selected characters in *Gila boraxobius* and *G. alvordensis*.

	Gill rakers										
	13	14	15	16	17	18	19	20	21	22	Mean
Gila boraxobius	1	1	7	2	2	1	1	1			15.9
Gila alvordensis						5		5	4	2	19.9

	Caudal peduncle circumference scales												
	26	27	28	29	30	31	32	33	34	35	36	37	Mean
Gila boraxobius	1	3	3	8	6	4	2	2			1		29.8
Gila alvordensis				2	6	4	7	3	4	2	1	1	32.1

	Precaudal vertebrae					Caudal vertebrae					Total vertebrae				
	18	19	20	21	Mean	16	17	18	19	Mean	36	37	38	39	Mean
Gila boraxobius	9	16	5		18.9		3	14	13	18.3	3	18	9		37.2
Gila alvordensis		8	19	3	19.8	1	9	17	3	17.7		13	16	1	37.6

dorsal and anal fin rays, 8 pelvic rays, 13 pectoral rays, and 19 caudal rays (Table 3).

Gila boraxobius has fine, deeply embedded scales. Caudal peduncle scale counts averaged 29.8 (Table 4). Radii are well developed in all fields of the scale.

The lateral line in *G. boraxobius* is reduced. Twenty-seven of 30 fish examined had lateral line pores restricted to near the head; three possessed a moderately or well developed lateral line. The lateral line configuration of *G. boraxobius,* based on the specimens with this structure developed, originates at the dorsal margin of the opercle, descends at approximately a 30° angle to below the horizontal skeletogenous septum, then parallels the septum and continues posteriorly to a point just anterior to the midpoint of the dorsal fin base. At a point even with the midpoint of the dorsal fin base, the lateral line rises until it intercepts the horizontal septum slightly past the base of the dorsal fin. No specimens exhibited lateral line development on the caudal peduncle.

Pharyngeal teeth of *G. boraxobius* are uniserial and well hooked. Teeth are typically 5-4, occasionally 4-4. The tips of all teeth except the uppermost are hooked at a right angle or greater. The fourth and fifth teeth are usually hooked at greater than right angles. Grinding surfaces are weakly developed and occupy approximately one-third the length of the tooth. The lower limb of the arch is constricted below the last tooth and then expanded so that it appears nearly spatulate and then tapers to a blunt point. The upper limb shield is moderately expanded.

Gill rakers on the first arch averaged 15.9 for 16 specimens (Table 4). Gill rakers are short, especially on the lower limb where they appear as mere bumps.

The intestine is of the simple sigmoid configuration. Intestinal length typically equals 80–90% of standard length. Peritoneum color is variable, but usually numerous black speckles result in a dark appearance.

Modal numbers of vertebrae are: precaudal, 19; caudal, 18 or 19; total vertebrae, 37 (Table 4).

Color.—Live specimens of *Gila boraxobius* are moderately dark, olive green on the dorsal surface of the head and body with a dark line extending along the length of the dorsal midline. Lateral surfaces are mostly silver with numerous small melanophores from the dorsal midline over approximately the upper three-quarters of the body. The sides of the body display a purple iridescence. The ventral surface is silver. The fins are colorless except for many melanophores along the rays of the dorsal and caudal fins and the first four rays of the pectoral fins. Occasional specimens possess melanophores along the anal fin rays. In preservative, some specimens display an uneven row of large melanophores, not usually visible in life, along each side of the dorsal midline.

Sex ratio and sexual dimorphism.—Fewer males than females were present in collections of *G. boraxobius* made during summer months. In a sample of 90 individuals greater than 39.0 mm SL collected in August, 24.4% were male and 75.6% were females. However, collections made during spring, autumn, and winter showed nearly equal numbers of adults of both sexes. Males are easily distinguished from females by the relative length of their fins, all of which are longer than those of females (Table 2). The pelvic fins of males reach to or past the origin of the anal fin; in females, the pelvic fins usually do not reach the anus. Nuptial tubercles are found only on males longer than 28 mm SL and are restricted to the body and paired fins. Numerous very small tubercles are present along the entire length of the body, more noticeably on the anterior one-half. On the moderately twisted pectoral fins, tubercles occur on the dorsal surfaces of the first seven or eight (occasionally nine) rays. The outermost rays are moderately thickened. Tubercles are borne along most of the length of the first six rays. They are strongest on outermost rays and smaller, blunter and fewer on inner rays. Each tubercle is restricted to a single ray segment, where it arises from a rounded base to form a strong prominent apex. Tubercles present on the pelvic fins are considerably smaller, blunter and fewer than those on the pectoral fins.

Relationships.—Sixteen species are now recognized in the genus *Gila*. *Gila boraxobius* is allied most closely to *G. alvordensis* Hubbs and Miller of which it is considered to be a dwarf relative. Hubbs and Miller (1972) referred *G. alvordensis* to the subgenus *Siphateles* but noted that several characters of *G. alvordensis* are distinct from the diverse *G. bicolor* complex, which otherwise constitutes the subgenus. *Gila boraxobius* shares those characters with *G. alvordensis*. *Gila alvordensis* and *G. boraxobius* possess finer, more deeply embedded scales than does *G. bicolor*. Radii are well developed in all fields of the scales in *G. boraxobius* and *G. alvordensis,* whereas the radii are restricted to the posterior field in *G. bicolor*. Typically, seven dorsal and anal fin rays are present in *G. boraxobius* and *G. alvordensis*. *Gila bicolor* has eight or more rays in the dorsal and anal fins. Decisions on subgeneric classification of these species must await completion of a systematic study of the *Gila* inhabiting the Alvord and adjacent basins.

Distribution and habitat.—*Gila boraxobius* is restricted to Borax (=Hot) Lake, outflows in the immediate vicinity of the lake, and two small adjacent pools. No other species of fish inhabits these waters. *Gila boraxobius* is occasionally found in Lower Borax Lake, an artificial lake fed from outflow waters of Borax Lake. Lower Borax Lake usually dries during the summer and never harbors a viable population of *G. boraxobius*. Borax Lake is a relatively shallow and very clear 4.1-ha natural lake that receives water from several thermal springs. These springs issue from a fault into the lake at 35–40°C, and lake temperatures vary from approximately 17 to 35°C depending on season, weather, and distance from the spring sources. *Gila boraxobius* avoids water with a temperature above approximately 34°C. The water of the lake is slightly alkaline (pH near 7.3). Mariner et al. (1974) reported sodium to be the major cation while bicarbonate, sulfate, and chloride (listed in decreasing abundance) were the principal anions in Borax Lake. Specific conductance of the water is 2,410. A complete chemical composition of Borax Lake water can be found in Mariner et al. (1974, 1975). The lake is situated on salts that have been deposited by the lake waters resulting in increased elevation of the lake. By this process, which apparently has been proceeding for hundreds or thousands of years, the elevation of Borax Lake is now 10 m higher than the surrounding land.

Material examined.—*Gila boraxobius* collected from Borax Lake, Harney County, Oregon (in addition to the type material), as follows: OS 4105, 84 specimens; OS 4106, 11; OS 5498, 21. *Gila alvordensis* collected from Trout Creek, Harney County, Oregon, as follows: OS 2778, 62 specimens; OS 5511, 4; OS 6311, 10.

Etymology.—The specific epithet *boraxobius* is derived from borax and *βιος* (bios), life, referring to the life of the species in the borate waters of Borax Lake.

Acknowledgments

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A NEW SPECIES OF *CONUS* FROM SOUTHEASTERN FLORIDA (MOLLUSCA: GASTROPODA)

Edward J. Petuch

Abstract.—A new species of *Conus* from southeastern Florida, *Conus flamingo,* is described. The preferred habitat of the new species is given and comparisons are made to the closely related species *Conus amphiurgus* Dall, 1889, and *C. flavescens* Sowerby, 1834.

As recently as 1971, a new gastropod, *Conus patae,* was described by R. T. Abbott as coming from offshore of southeastern Florida. It seemed remarkable that such a distinctive American species could have remained undescribed until such a late date. Since the description of *Conus patae,* dredging trips undertaken by several amateur malacologists along the south coast of Florida have brought to light yet another new species of *Conus.* This addition to the Florida mollusk fauna is described here.

Abbreviations: USNM—United States National Museum Collection (now National Museum of Natural History); UMML—Invertebrate Museum Collection of the Rosenstiel School of Marine and Atmospheric Science, University of Miami.

Family—Conidae
Genus—*Conus* Linnaeus, 1758
Conus flamingo, new species
Fig. 1

Material examined.—*Holotype*—Length 19.4 mm, width 9.5 mm, 45.7 m depth off Dania, Broward County, Florida, Oct. 1975, USNM 780663. *Paratypes*—Length 18.4 mm, 30.5 m depth off Dania, USNM 773413; length 16.8 mm, 121.9 m depth off Palm Beach, Florida, July 1977, USNM 781994; length 20 mm, 45.7 m depth off Dania, Oct. 1975, USNM 780664; length 14 mm, UMML 8174.

Shell description.—15–20 mm adult shell length, elongate with elevated spire; shoulder smooth with sharply raised edge; body whorl smooth, silky, with faintly raised cords near anterior end; spire whorls smooth; color bright cherry red to reddish-orange with varying amounts of white patterning—ranging from scattered, crescent-shaped white patches around mid-body (as in holotype) to large white zig-zags running entire length of shell; spire red with regularly-spaced white patches that extend over shoulder angle onto

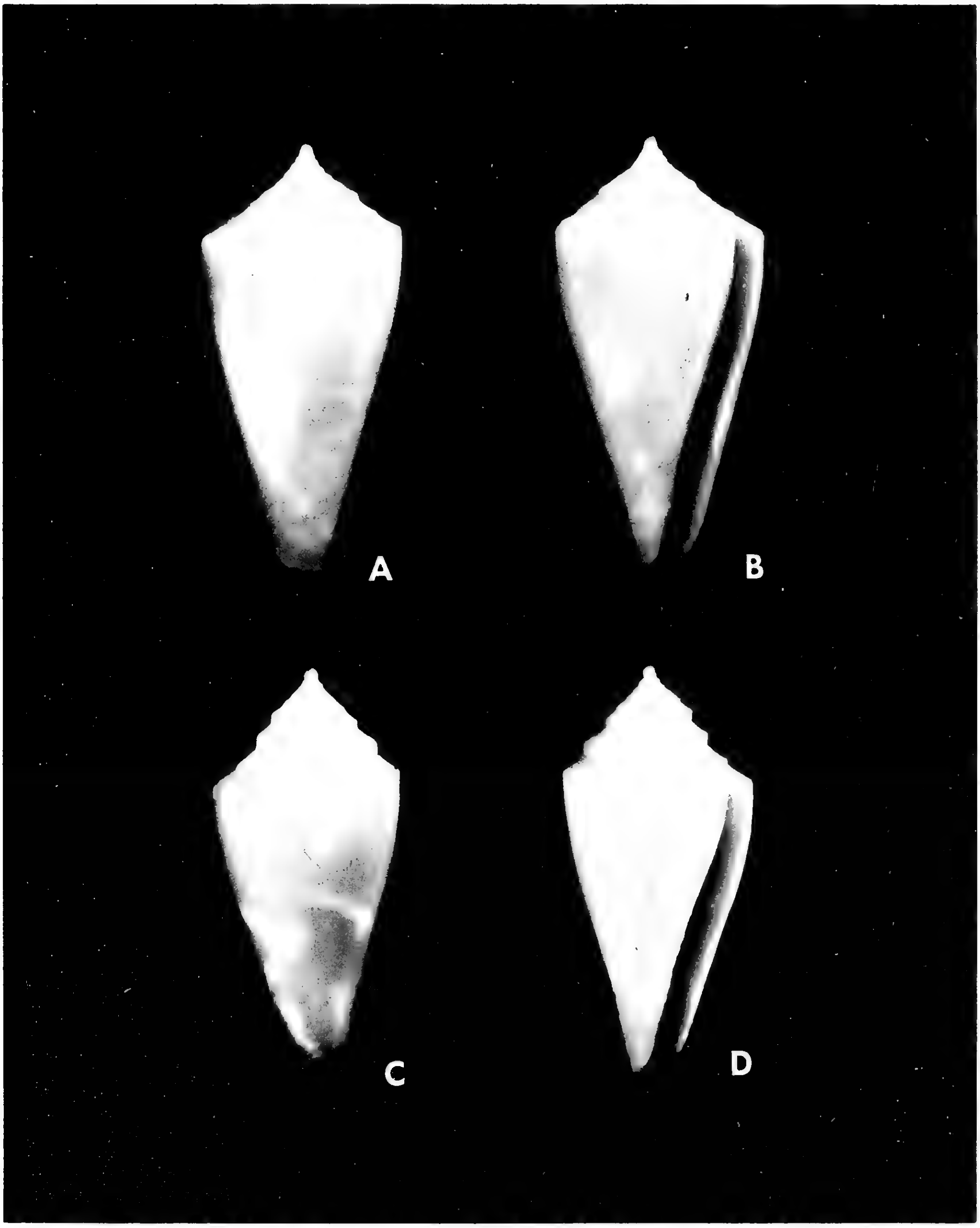

Fig. 1. *Conus flamingo*: **A,** Dorsal aspect of holotype; **B**, Ventral aspect of holotype; **C**, Dorsal aspect of paratype length 18.4 mm; **D,** Ventral aspect of same specimen.

body whorl; interior of aperture red; protoconch very large, protracted, mamillate; periostracum thin, yellowish, translucent.

Description of animal.—Body and siphon color uniform pale amber; eyes black; operculum tiny, oval.

Type-locality.—45.7 m depth off Dania, Broward County, Florida.

Distribution.—At present known from 45.7–121.9 m depth, from Palm Beach to Dania, Florida.

Ecology.—The new species prefers sand and shell gravel-rubble bottoms at depths of 45.7–121.9 m. Other gastropods found with the new species include: *Conus amphiurgus* Dall, 1889 (+*Conus juliae* Clench, 1942) (Walls, 1979, p. 91), *Scaphella junonia* (Lamarck, 1804), *Scaphella gouldiana* (Dall, 1887), *Mitra antillensis* Dall, 1889, *Mitra straminea* A. Adams, 1853, *Murex bellegladensis* E. H. Vokes, 1963, *Chicoreus mergus* E. H. Vokes, 1974, *Phyllonotus oculatus* (Reeve, 1845), *Distorsio mcgintyi* Emerson and Puffer, 1953, *Polystira tellea* (Dall, 1889), *Callistoma psyche* Dall, 1889, and *Antillophos candei* (d'Orbigny, 1842).

Etymology.—Named for the tropical bird (flamingo, *Phoenicopterus* sp.) whose plumage coloration closely approximates the rather startling and characteristic shell color of the new species. The name is proposed as a noun.

Remarks.—Only two other Florida cones could possibly be confused with *Conus flamingo*; these are *C. amphiurgus* and *C. flavescens* Sowerby, 1834. Young specimens of *C. amphiurgus* (Clench, 1942, p. 26 as *C. juliae*; Walls, 1979, p. 89, bottom 2 figures), though often bright red like *C. flamingo,* always have rows of dark-colored dots around the body whorl (Abbott, 1974, no. 2782), a character totally lacking in the new species at any age. *Conus amphiurgus* has a wider shoulder, lacks the mamillate protoconch of *C. flamingo,* and has a larger adult shell length (av. 50 mm). *Conus flavescens* has a mammillate protoconch like the new species (Clench, 1942:23), but the protoconch is larger and more exerted. The coloring of *C. flavescens* is always in shades of yellow, pale brown, pale orange, or white, and often with a pattern of brown dots, dashes, and flammules. This type of color pattern is quite different from the solid bright red color and white crescents and zig-zags of *C. flamingo.* The colors of the living animals also help in separating the 3 species: *Conus flavescens* has a white animal, *C. amphiurgus* a bright orange-red animal, and *C. flamingo* an amber-colored animal.

Conus flamingo is the newest member of a species complex comprising *C. amphiurgus, C. flavescens, C. caribbaeus* Clench, 1942, *C. attenuatus* Reeve, 1844(+*C. ustickei* Miller *in* Usticke, 1959 Walls, 1979:147), and *C. daucus* Hwass, 1792. In Florida, the new species is sympatric only with *C. amphiurgus*. *Conus attenuatus, C. caribbaeus, C. flavescens* and *C. daucus* are often found together in shallow water back reef areas; some, like *C. daucus* and *C. flavescens,* are occasionally found in only a few centimeters of water near *Thalassia* beds. *Conus flamingo* and *C. amphiurgus,* on the other hand, are known to occur only offshore in fairly deep water.

Lozet and Petron (1977, no. 191a) illustrate in color a specimen of *C. flamingo,* but misidentify it as a variety of "*C. juliae*." *Conus drezi* S. E. Hoerle, 1976 (Hoerle, 1976, plate 5, figs. 1a–1c), of the middle Miocene Shoal River Formation, Florida, is the earliest known member of the above-mentioned species complex and may possibly be the direct ancestor.

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This is a scientific contribution from the Rosenstiel School of Marine and Atmospheric Science, University of Miami.

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DITYLENCHUS INTERMEDIUS (DE MAN) FILIPJEV (NEMATODA: ANGUINIDAE) AND *BASIRIA HIBERNA*, N. SP. (NEMATODA: PSILENCHIDAE) FROM TENNESSEE

E. C. Bernard

Abstract.—*Ditylenchus intermedius* (de Man) Filipjev from Tennessee is described from two collections, one from soil and the other from rotted wood. They differ from previously described specimens in having a broader, more anterior median bulb and bursa covering only one-quarter the male tail. *Basiria hiberna,* n. sp. is described from soil under turf. It is separated from other *Basiria* spp. with clavate or rounded tails by more anterior vulva, offset spermatheca, and dorsal gland orifice 4–5.5 μm from the stylet base. *Basiria similis* (Thorne and Malek) and *Basiria ritteri* (Baqri and Jairajpuri) are proposed as new combinations. A key is given for *Basiria* spp. with rounded or clavate tails.

During examination of soil and rotted wood for preparation of a comprehensive list of Tennessee nematodes, two interesting species were recovered, one differing in several characters from previous descriptions, the other undescribed. These species, in the families Anguinidae and Psilenchidae, respectively, are described below. Specimens were killed and fixed in hot 4% formalin and processed to glycerin by Seinhorst's (1959) rapid method.

Ditylenchus intermedius (de Man) Filipjev
Figs. 1–8, Table 1

Two collections of specimens resembling published descriptions of this species were made, one from grass-covered soil in Hamilton County, and one from rotted wood in Union County. Measurements and ratios for both collections are given in Table 1. Morphologically the populations are quite similar, but the Hamilton County specimens are much larger, with a proportionately shorter tail. Illustrations for this species were made from the Union County specimens; the following description also is based largely on the Union County material.

Females.—Body slightly curved ventrally when heat-relaxed, slightly tapered anteriorly, more posteriorly (Fig. 1). Cuticle finely striated (striae 0.8 μm wide in esophageal region (Fig. 2)). Lateral field a slightly raised band,

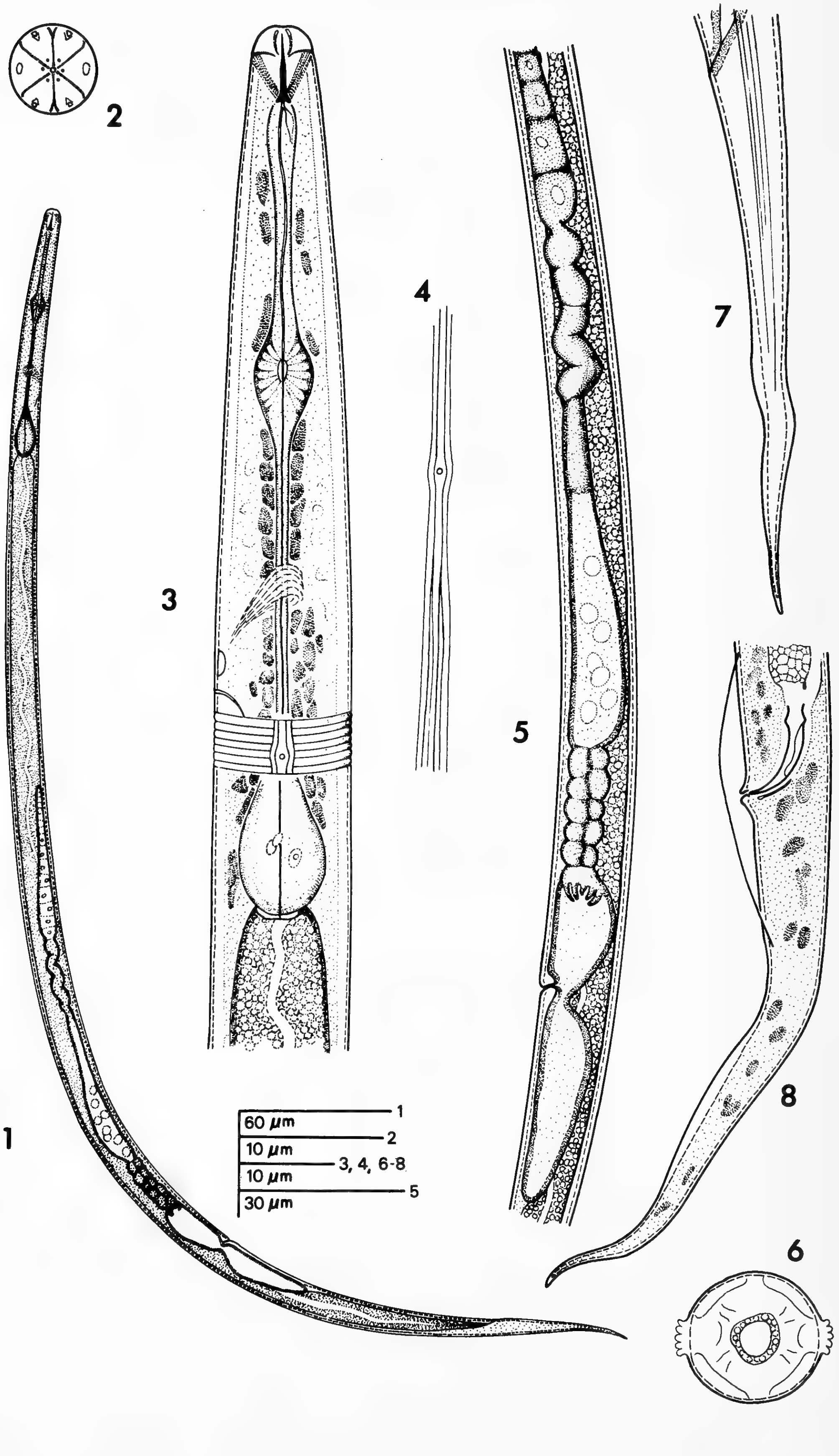
2
4
7
3
5
8
1
60 μm 1
10 μm 2
10 μm 3, 4, 6-8
30 μm 5
6

Table 1.—Measurements and ratios for two Tennessee collections of *Ditylenchus intermedius* (de Man) Filipjev.

	Union County			Hamilton County		
	Females (n = 6)			Females (n = 5)		
	Mean	Range	Male	Mean	Range	Male
Length (μm)	614	501–701	595	1078	956–1152	830
a	52.6	50.3–57.2	46.1	46.7	44.2–51.2	46.1
b	6.7	5.7–7.3	6.6	7.1	6.7–7.7	6.0
c	9.3	8.6–9.9	9.9	12.4	11.3–13.2	11.1
G1 (%)	26	21–30	—	40	34–44	—
G2 (%)	4.5	3.0–6.0	—	4.5	3.9–5.1	—
V (%)	72	71–74	—	81	75–85	—
T (%)	—	—	64	—	—	38
MB (%)	37.9	36.1–39.4	38.6	39	38.3–40.2	37.0
T/ABT	8.1	7.5–8.6	7.0	5.4	4.6–5.9	5.0
Spicule length (μm)	—	—	17.7	—	—	17.7
Gubernaculum length (μm)	—	—	3.9	—	—	4.8

consisting at midbody of 6 fine but distinct lines (Fig. 6), about one-third greatest body width; 4 lateral lines at deirid level, becoming 6 immediately posteriorly (Fig. 4). Phasmids not seen.

Stomal orifice surrounded by 6 minute papillae (Fig. 2); head divided into 6 sectors; each of 2 subdorsal and 2 subventral sectors with cephalic papillae near the periphery; amphids small, oval, and near periphery, possibly extending slightly onto side of head. Lip region rounded-truncate, devoid of annulation.

Stylet short and slender, length 7.0–7.5 μm in Union County collection, 8.6–9.3 μm in Hamilton County collection; knobs small and sloping posteriorly (Fig. 3). Ovate median bulb in anterior half of esophagus (Table 1, MB); valve small. Nerve ring near middle of isthmus. Basal bulb elongate-pyriform, cardia obscure. Excretory pore slightly anterior to basal bulb. Cephalids and hemizonion not seen; hemizonid large, about 2 annules anterior to excretory pore. Deirids at anterior of basal bulb, somewhat more posterior than excretory pore.

Female gonad prodelphic, outstretched, about one-quarter of body length (Fig. 1). Oocytes in single file; spermatheca long, continuous, containing

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Figs. 1–8. *Ditylenchus intermedius*. 1, Entire lateral view, female; 2, *En face* view, female; 3, Anterior region; 4, Lateral field near deirid; 5, Female reproductive system; 6, Cross-section near midbody; 7, Female tail; 8, Male tail.

large, ovate spermatozoa (Fig. 5). Junction of quadricolumella and uterus with several digitate processes extending posteriorly. Vagina anteriorly inclined; vulval flaps absent. Length of post-vulval sac more than twice maximum body width. Anus distinct. Length of tail 4.6–8.6 times anal body width (Table 1:T/ABT), sometimes irregularly bent with cuticular thickenings dorsally or ventrally (Fig. 7). Lateral field extending onto posterior half of tail. Terminus finely rounded.

Male.—Similar in most respects to females. Spicules curved, moderately cephalated; gubernaculum slender, simple, slightly thickened distally (Fig. 8). Bursa adanal, covering only about one-fourth the tail. Tail bent, cuticle thickened ventro-medially, very finely rounded terminally.

Localities.—Five females, 1 male, in soil under turf, Chattanooga, Hamilton County, Tennessee, December, 1977; and 6 females, 1 male, in saturated, rotted heartwood of a log attacked by a white-rot fungus, Big Ridge State Park, Union County, Tennessee, 20 May, 1978.

Discussion.—Most of the morphological characters of these specimens agree with those given by de Man (1880, 1884) and Goodey (1933). Among the differences in the present material are the slightly larger, more anterior median bulb, smaller bursa, and slightly different spicule shape. Between the two Tennessee populations, differences occur in body length, relative tail-length, and position of the vulva. The Hamilton County material further differs from the original description (de Man, 1880) in having a slightly more slender body and a shorter tail, while the Union County specimens differ from the original description in being much shorter. However, Goodey's (1933) concept of the species includes both groups. The differences mentioned are not large enough to warrant taxonomic distinctions.

Elmiligy (1971) described a species, *Basiroides nortoni,* which Bello and Geraert (1972) transferred to *Ditylenchus.* The latter authors considered *D. nortoni* to be very close to, or identical with, *D. intermedius.* The main difference between *D. nortoni* and the specimens here considered *D. intermedius* is in the lateral field; *D. nortoni* has four incisures, while Tennessee *D. intermedius* have six. Neither de Man (1880, 1884), nor Goodey (1933) described this character. Goodey (1963) speculated that *D. intermedius* was an aggregate species consisting of several similar forms. The variation among habitats (soil and rotted wood) suggests at least ecological differences.

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Figs. 9–19. *Basiria hiberna*: 9, Entire lateral views, female and male; 10, Various amphid apertures; 11, Anterior end, surface view; 12, *En face* view, female; 13, View just below surface of head; 14, Anterior region; 15, Female reproductive system; 16, Cross-section near midbody; 17, Male tail; 18, Surface views of bursal region and tail tip; 19, Female tails.

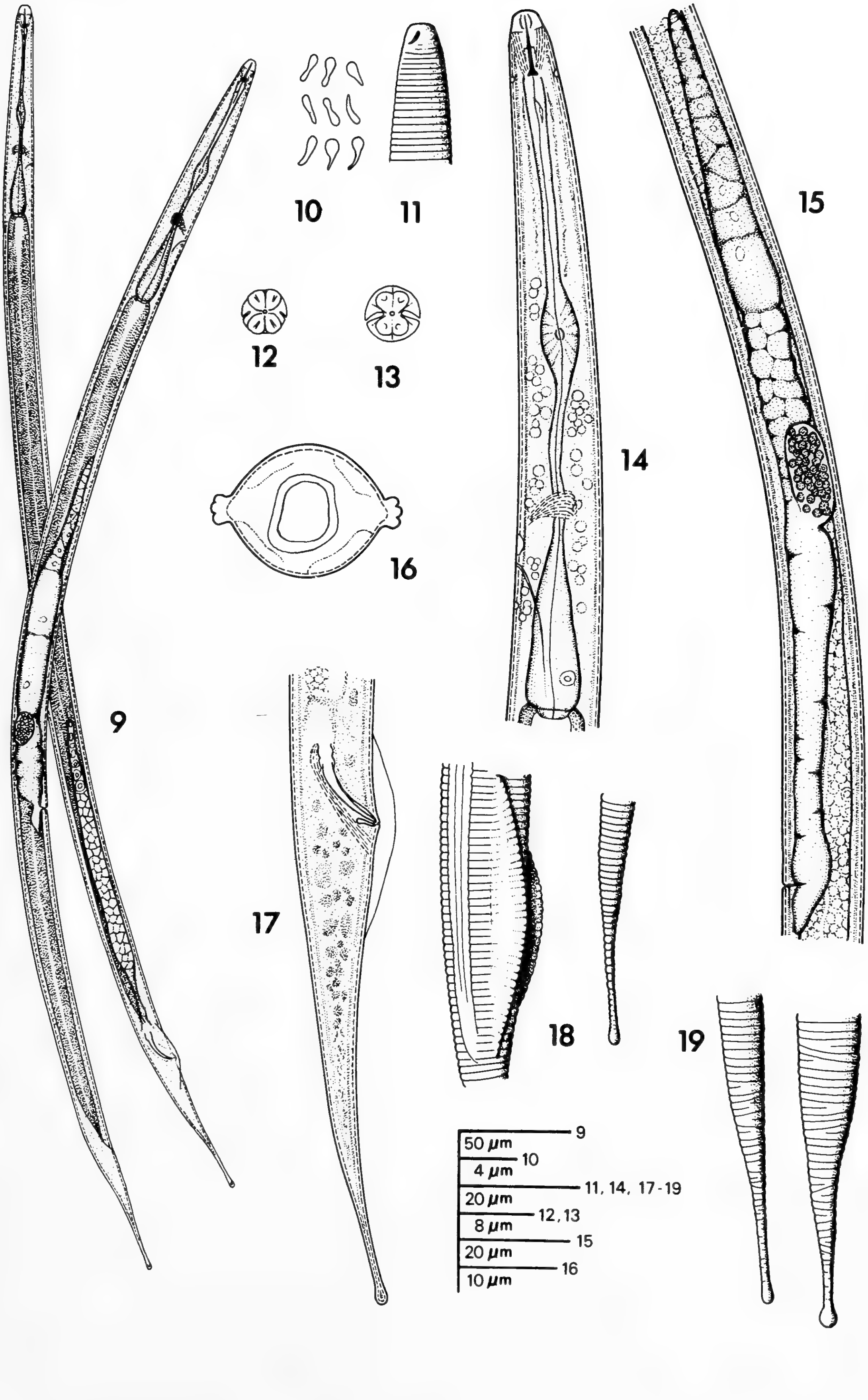
9
10
11
12
13
14
15
16
17
18
19
50 µm 9
4 µm 10
20 µm 11, 14, 17-19
8 µm 12, 13
20 µm 15
10 µm 16

Table 2.—Measurements and ratios for *Basiria hiberna,* n. sp.

	Holo- type ♀	Allo- type ♂	Paratype ♀♀ (n = 16)			Paratype ♂♂ (n = 3)	
			Mean	Range	SD	Mean	Range
Length (μm)	540	537	559	541–640	28.9	530	514–554
a	44.1	52.6	41.6	34.7–49.5	4.5	38.0	34.4–42.8
b	19.2	20.5	19.9	16.9–22.0	1.0	20.4	16.9–23.1
c	11.1	11.0	11.2	9.7–12.4	0.87	12.0	11.0–12.8
G1 (%)	29.3	—	—	18.5–33.8	4.1	—	—
V (%)	61.2	—	61.3	56–64	2.4	—	—
T (%)	—	28.6	—	—	—	24.2	17.9–30.5
MB (%)	50.7	53.1	48.1	42.7–53.8	2.8	45.7	42.0–51.0
T/ABT	7.0	7.0	6.3	5.0–7.0	0.57	6.0	5.6–6.3
Spicule length (μm)	—	15.0	—	—	—	12.6	11.6–14.3
Gubernaculum length (μm)	—	2.2	—	—	—	—	—

Basiria hiberna, new species
Figs. 9–19; Table 2

Measurements and ratios are given in Table 2. Measurements in the text are means, with ranges given in parentheses.

Females.—Body straight to ventrally curved when heat-relaxed, tapering slightly anteriorly; tail slender, elongate-conoid, with clavate or capitate terminus (Fig. 19). Cuticle rather finely striated, striations about 1.3 μm in width, becoming slightly wider and irregular on tail. Lateral field a strongly raised band (Fig. 16), appearing as 4 lateral incisures about one-fourth the body width. Phasmids not seen.

En face view (Fig. 12) showing 4 large subdorsal and subventral lips, each with a single cephalic papilla, lips appearing to coalesce just below surface (Fig. 13). Amphid apertures on sides of head, oblique, and extending as narrow pockets well into lip region; apertures of various shapes, but always about 2 μm long (Fig. 10). Lip region in profile a rounded trapezoid, wider than high, without transverse or longitudinal striae (Fig. 11).

Stylet 11.0 μm (10.1–11.6) in length (11.0 μm in holotype); knobs flange-like, sloping posteriorly (Fig. 14). Dorsal gland orifice 4.7 μm (4.1–5.4) from stylet knobs (4.8 μm in holotype). Median bulb elongate-oval, valve reduced in size (Fig. 14); median bulb at midpoint, or somewhat anterior to midpoint, of esophagus (Table 2: MB). Nerve ring surrounding esophagus in posterior region of isthmus. Basal bulb elongate; cardia small. Excretory pore at level of anterior end of basal bulb. Cephalids easily seen, at level of stylet knobs; hemizonid large, just anterior to excretory pore; hemizonion behind excretory pore. Deirids not seen.

Female gonad (Figs. 9, 15) outstretched, about 25% of body length. Oocytes mostly in single file; distinct oviduct present (Fig. 15). Spermatheca offset, variable in size from short to long oval; spermatozoa round. Uterus variable in length. Vulva at about 60% of body length (Table 1). Vagina slightly inclined anteriorly. Post-vulval sac less than one body-width. Length of tail 5–7 times body width at level of anus (Table 1: T/ABT), usually clavate, occasionally capitate (Fig. 19).

Males.—Similar in most respects to females (Fig. 9). Stylet 10.2–11.1 μm in length (10.2 μm in allotype). Dorsal gland orifice 4.8–4.9 μm from stylet knobs (4.8 μm in allotype). Nerve rings slightly more anterior, hemizonid not as distinct. Gonad occupying about 20–30% of body length. Spicules (Fig. 17) ventrally curved, doubly cephalated, with small, ventro-distal velum. Gubernaculum tiny, slightly enlarged proximally. Bursa weakly developed, adanal (Fig. 18), not associated with lateral field. Tail similar to that of female.

Types and locality.—Holotype female (T-309t), 16 female paratypes and 3 male paratypes (T-2390p, T-2391p), collected 8 December 1977, and allotype male (T-310t), collected 26 May, 1978, all in soil under turf near Third Creek on the University of Tennessee Agricultural Campus, Knoxville, Knox County, Tennessee. All type-specimens are deposited in the U.S.D.A. Nematode Collection, Beltsville, Maryland.

Diagnosis.—*Basiria hiberna,* n. sp. is separated from all other *Basiria* spp. with clavate or broadly rounded tails by the more anterior position of the vulva and the offset spermatheca.

The following key will serve to separate the known species of *Basiria* with clavate or broadly rounded tails.

1. Dorsal esophageal gland orifice 2–3 μm from stylet base 2
– Dorsal gland orifice more than 4 μm from stylet base 3
2. Excretory pore at anterior of basal bulb, just posterior of hemizonid; stylet length 11–13 μm .... *B. tumida* (Colbran) Geraert
– Excretory pore at middle of basal bulb, 2–4 annules behind hemizonid; stylet length 9–10 μm .. *B. ritteri* (Baqri and Jairajpuri) n. comb.
3. Stylet knobs strongly reduced .... *B. obscura* Szczziegel
– Stylet knobs of normal appearance 4
4. Lateral field with 2 incisures ... *B. similis* (Thorne and Malek) n. comb.
– Lateral field with 4 incisures 5
5. Spermatheca offset; V = 56–64%; dorsal gland orifice less than 6 μm from stylet knobs .... *B. hiberna* n. sp.
– Spermatheca continuous; V = 64–66%; dorsal gland orifice 6–7 μm from stylet knobs .... *B. incita* Szczziegel

Basiria similis (Thorne and Malek) n. comb. (=*Clavilenchus similis* Thorne and Malek, 1968) and *Basiria ritteri* (Baqri and Jairajpuri) n. comb. (=*Tylenchus* (*Clavilenchus*) *ritteri* Baqri and Jairajpuri, 1969) are hereby proposed, following the generic concept of *Basiria* Siddiqi as defined by Geraert (1968).

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FIRST RECORDS OF THE MACULATED FLOUNDER *BOTHUS MACULIFERUS* (POEY) FROM THE CARIBBEAN COAST OF CENTRAL AMERICA

M. P. Weinstein, K. L. Heck, Jr., and R. W. Davis

Abstract.—Five individuals of the maculated flounder, *Bothus maculiferus* (Poey) were collected from seagrass habitats in the vicinity of Colon, Republic of Panama. These specimens represent the first records of *B. maculiferus* from the Caribbean coast of Central America. Morphological characteristics of the specimens, habitat data and other ecological features of area of capture are described.

Weinstein and Heck (1977, 1979) and Heck (1977, 1979) previously described the seagrass fauna in the vicinity of Colon, Republic of Panama. Fishes and invertebrates were collected during a monthly sampling program (August 1974 to July 1975) with a 4.9-m otter trawl (6.5-mm mesh liner) at four seagrass stations. During this survey, five specimens of the maculated flounder, *Bothus maculiferus* (Poey), were collected which represent the first records of this species from the Caribbean coast of Central America. Here we describe morphological characteristics of these specimens and habitat data along with other ecological features of the area where this little known species was captured. All specimens from our work are in the Florida State University (FSU) fish collection.

Study sites.—The study sites in our survey were chosen to represent different conditions in which the seagrass habitat occurs in open subtidal waters (i.e., not on back reefs). Water depth at the sites was approximately 1–2 m depending on tidal condition, and the areas were never exposed at low tide. The two stations at which *B. maculiferus* was collected were separated by about 5 km.

At Station 1, the vegetation was primarily composed of thick growths of *Thalassia testudinum* and *Halimeda opuntia*. Less abundant plants were *Syringodium filiforme, Pencillus capitatus,* and *Udotea flabellum*. The sediment was mostly fine mud, derived from deposition by a nearby small stream and from runoff from a mangrove swamp lining the shore. Water was most turbid here and the site was relatively protected from wave shock by a patch reef.

Well developed coral growths surrounded Station 4, which was located on the leeward side of two small islands. *Thalassia testudinum* was the dominant plant, although there were some small patches of *Syringodium* *filiforme*. Calcareous green algae were relatively scarce and sediments were coarse, consisting of calcareous sands and some coral fragments. Wave shock was low during the dry season.

Catalogued material.—FSU 25479, 1 specimen, 65 mm SL; captured at Station 4 in October 1974, approximately 6.5 km NE Colon at Bahia Las Minas. FSU 25964, 2 specimens, 118 and 119 mm SL, taken in a single collection at Station 4 in December 1974. FSU 26536, 26538, 2 specimens, 139 and 64 mm SL, collected in December 1974 at Station 1, approximately 6.4 km NE Colon at Bahia Las Minas.

Diagnosis.—Body depth as a percentage of SL ranged from 56–59%; eye diameter to head length exceeded 23% only slightly in the 64-mm specimen from Station 1. In all individuals, the anterior edge of the upper eye was located above the midpoint of the lower eye, and a notch in the dorsal profile was absent. Dorsal fin ray counts 94–97; anal rays 72–74, gill rakers (lower limb) 6–8; the specimen with six on the ocular side had 7 rakers on the blind side as did the individual with 8 on ocular side. All specimens had well developed eye tentacles, especially the largest. Color varied from light to dark brown, with two dark blotches along the lateral line. One individual had very distinct circular body rings comprised of individual spots (Böhlke and Chaplin, 1968); others had similar, but less distinct, ring patterns.

Discussion.—Salinities on capture dates were 36‰ at Station 4 in October, and 24 and 22‰ at Stations 1 and 4, respectively, in December. *Bothus maculiferus* was not collected during the height of the dry season, possibly because of intense wave activity and associated turbulence in the littoral zone. Numbers of individuals of all species collected at the stations where *B. maculiferus* was present were generally much reduced during the dry season (Weinstein and Heck, 1979).

Stomachs of our specimens contained several fishes (*Monacanthus* sp., unidentified remains), portunid crabs, penaeid shrimp and stomatopod remains, suggesting that *B. maculiferus* is an active predator on the grass flats.

Previous accounts of this species (Gutherz, 1967; Böhlke and Chaplin, 1968, Almeida, 1973) list the range of *B. maculiferus* from the Bahamas and Cuba south to Curacao and the eastern shore of Brazil. Our specimens extend the range of this species to the Western Caribbean coast of Central Americas as far north as Panama.

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A COMPARISON OF *PSEUDOBAICALASELLUS* AND *CAECIDOTEA*, WITH A DESCRIPTION OF *CAECIDOTEA BOWMANI*, N. SP. (CRUSTACEA: ISOPODA: ASELLIDAE)

Julian J. Lewis

Abstract.—The Appalachian genus *Pseudobaicalasellus* is analyzed and found to be a synonym of *Caecidotea*. A new subterranean species, *C. bowmani,* is described with a redescription of *C. holsingeri,* along with notes on *C. vandeli*. An analysis of the affinities of the asellid *cannulus* group shows certain *Caecidotea* spp. from Arkansas and southern Mexico to be morphologically similar to the Appalachian species.

Bresson (1955) described 3 new species of asellids collected in the Appalachian Valley and Ridge Province of Virginia and West Virginia: *Asellus vandeli, A. simonini* and *A. henroti*. Bresson placed these species in the subgenus *Baicalasellus* primarily because of the unusual morphology of the male second pleopod, which resembled species inhabiting Lake Baikal, in the Soviet Union, more than North American species.

Steeves (1965) named the *cannulus* group to receive additional species morphologically similar to those described by Bresson (1955) and eventually placed 8 species in it (Steeves, 1969). A diagnosis of the *cannulus* group was not published and the assignment of species is open to further interpretation. In this paper the *cannulus* group is considered to consist of 10 species: *Caecidotea bowmani, C. cannulus, C. circulus, C. henroti, C. holsingeri, C. incurva, C. nortoni, C. scyphus, C. simonini* and *C. vandeli.*

Henry and Magniez (1970) pointed out the morphological, zoogeographical and ecological differences between the Lake Baikal and Appalachian asellids and erected the genus *Pseudobaicalasellus* to accept Bresson's (1955) 3 species.

Holsinger and Steeves (1971) assigned the ill defined *cannulus* group to *Pseudobaicalasellus,* but chose to retain the genus *Asellus* until taxonomic problems concerning the group could be resolved. Fleming (1973) followed Holsinger and Steeves (1971) and synonymized *Pseudobaicalasellus* and *Conasellus* (=*Caecidotea*) with *Asellus*. Bowman (1975) rejected Fleming's (1973) synonymy of *Conasellus* with *Asellus* but did not comment on the status of *Pseudobaicalasellus*.

Table 1 lists characters considered by Henry and Magniez (1970) in the diagnosis of *Pseudobaicalasellus,* plus others of taxonomic value. Data for

Table 1.—Comparison of diagnostic characters of *Pseudobaicalasellus* and *Caecidotea.*

Character	*Pseudobaicalasellus*	*Caecidotea*
Maxilla 1:		
—inner lobe apical setae	5	5
—outer lobe apical setae	11–13	10–13
Maxilliped oostegite	membranous, setose	membranous, setose
Pereopod 1 sexual dimorphism	absent	present or absent
Pereopod 4 specialization	male more robust than female	male more robust than female
Male pleopod 1:		
—retinaculae	2–7	0–7
—distal margin	rounded or subtriangular	rounded, flattened or subtriangular
Mandibles:		
—palp segment 3	plumose setae	plumose setae
—incisors/lacinia mobilis	4-cuspate	4-cuspate
Male pleopod 2:		
Endopod:		
—basal apophysis	present or absent	present or absent
—basal spur	slightly produced	slightly produced
—labial spur	absent	absent
—torsion	present	present or absent
—tip processes	single or multiple	single or multiple
Exopod:		
—posterior catch lobe	slightly produced	slightly produced
Female pleopod 2	subtriangular	subtriangular
Pleopod 3 suture	transverse	transverse
Pleopod 4	exopod larger than endopod	exopod larger than endopod
Uropods:		
—endopod vs. exopod	endopod longer or about equal	endopod longer or about equal
—sexual dimorphism	slight	present or absent
—length	short or elongate	short or elongate

this table came from Bowman (1967, 1974, 1975), Bresson (1955), Lewis and Bowman (1977), Mackin and Hubricht (1940), Steeves (1963a, 1963b, 1965, 1966), Steeves and Holsinger (1968), and Williams (1970). It is apparent that there is considerable overlap in the morphology of *Caecidotea* and *Pseudobaicalasellus*. Similarities of the male pereopod 1, pleopod 1 and pleopod 2 of species assigned to *Pseudobaicalasellus* suggest a monophyletic group deserving a separate genus, but as additional species have been described the morphological differences between the 2 genera have disappeared. Considering this, I believe that Holsinger and Steeves (1971) were justified in their conservative approach to *Pseudobaicalasellus*. I place *Pseudobaicalasellus* as a synonym of *Caecidotea*, and follow Bowman (1975) in considering *Caecidotea* and *Asellus* to be distinct genera.

Caecidotea bowmani, new species

Figs. 1–3, 4h

Material examined.—VIRGINIA, Rockbridge Co., drain tile next to trail in park at Natural Bridge, collected by Julian J. Lewis and Teresa M. Everitt, 20 May 1977, 6 males and 12 females. The holotype 8.8 mm male (USNM 172995) and 17 paratypes (USNM 172811–172813, 172996) are deposited in the National Museum of Natural History, Smithsonian Instution.

Description.—Eyeless, unpigmented. Longest male 12.0 mm, longest female 8.5 mm; body slender, linear, about 6.4× as long as wide; coxae visible in dorsal view. Margins of head, body and telson moderately setose. Head about 1.8× as wide as long; anterior margin concave, without rostrum; postmandibular lobes rather prominent, broadly produced. Telson about 1.5× as long as wide, sides subparallel, caudomedial lobe moderately well defined.

Antenna 1 reaching middle of last segment of antenna 2 peduncle; flagellum variable, of about 8–11 segments, last 5 (8.5 mm female) to 7 (11.0 mm male) segments each bearing esthete, each esthete appearing 3-segmented. Antenna 2 reaching pereonite 6; last segment of peduncle about 1.5× length of preceding segment; flagellum variable, 46 (11.0 mm male) to 58 (8.5 mm female) segments.

Mandibles with 4-cuspate incisors and lacinia mobilis; spine row with 11 plumose spines in left mandible, 16 in right mandible; palp bearing plumose setae on distal segments. Maxilla 1, apex of outer lobe with 13 robust spines and 2 subterminal setae; inner lobe with 5 robust, plumose setae. Maxilliped with 5–6 retinaculae; oostegite well developed in female, with numerous marginal setae.

Male pereopod 1 propus about 2.2× as long as wide, lacking processes; palm straight proximally, bearing 3 robust spines, slightly concave distally; dactyl flexor margin bearing about 5–6 spines. Female pereopod 1 similar to male, sexual dimorphism lacking. Pereopod 4 more robust in male than female, sexual dimorphism pronounced, flexor margin of dactyl bearing 2 spines.

Male pleopod 1 longer than pleopod 2; protopod about 0.75× as wide as long, with 3 retinaculae on right, 4 on left. Exopod subtriangular, about 0.4× as wide as long, lateral margin broadly convex, with many moderately long setae. Male pleopod 2 exopod, proximal segment with 3–4 lateral, 0–1 mesial plumose setae, distal segment laterally convex, mesially concave,

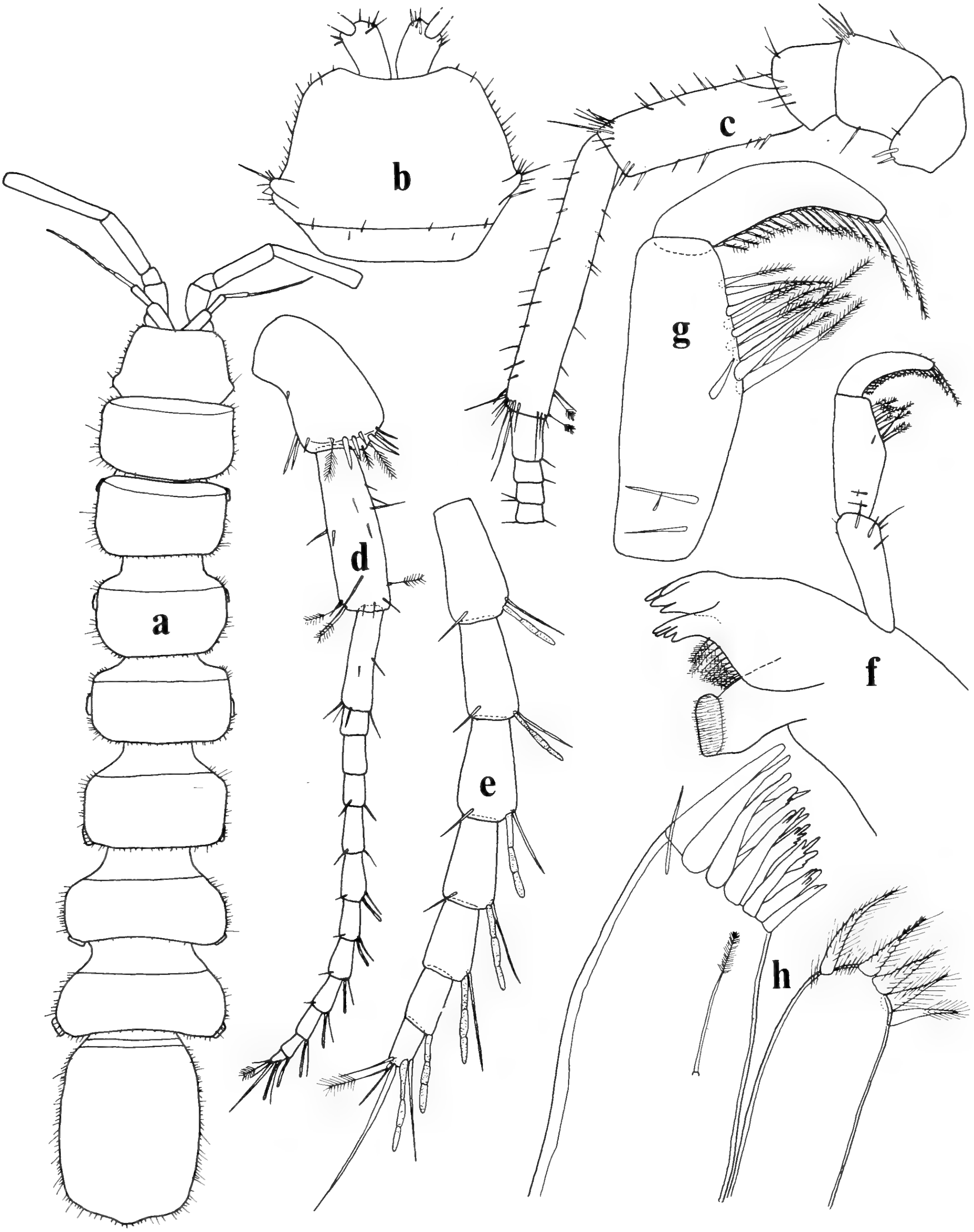

Fig. 1. *Caecidotea bowmani*, ♂: **a,** Habitus, dorsal; **b**, Head, dorsal; **c**, Antenna 2 peduncle; **d**, Antenna 1; **e,** Antenna 1, distal segments; **f**, Left mandible; **g**, Same, distal segments of palp; **h**, Maxilla 1.

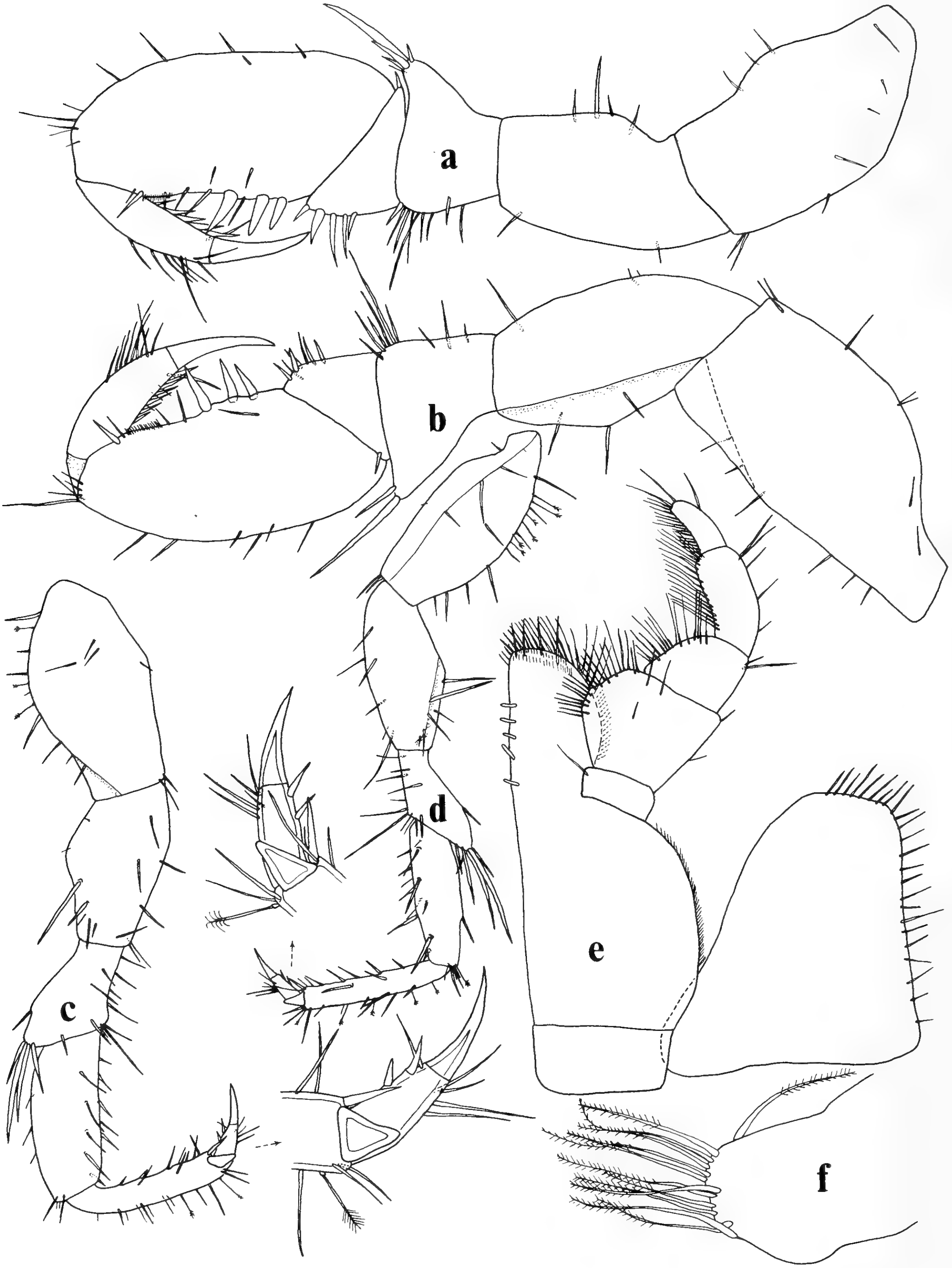

Fig. 2. *Caecidotea bowmani*: **a**, Pereopod 1, ♂; **b**, Pereopod 1, ♀; **c**, Pereopod 4, ♂; **d**, Pereopod 4, ♀; **e**, Maxilliped, ♂; **f**, Oostegite of ♀ maxilliped.

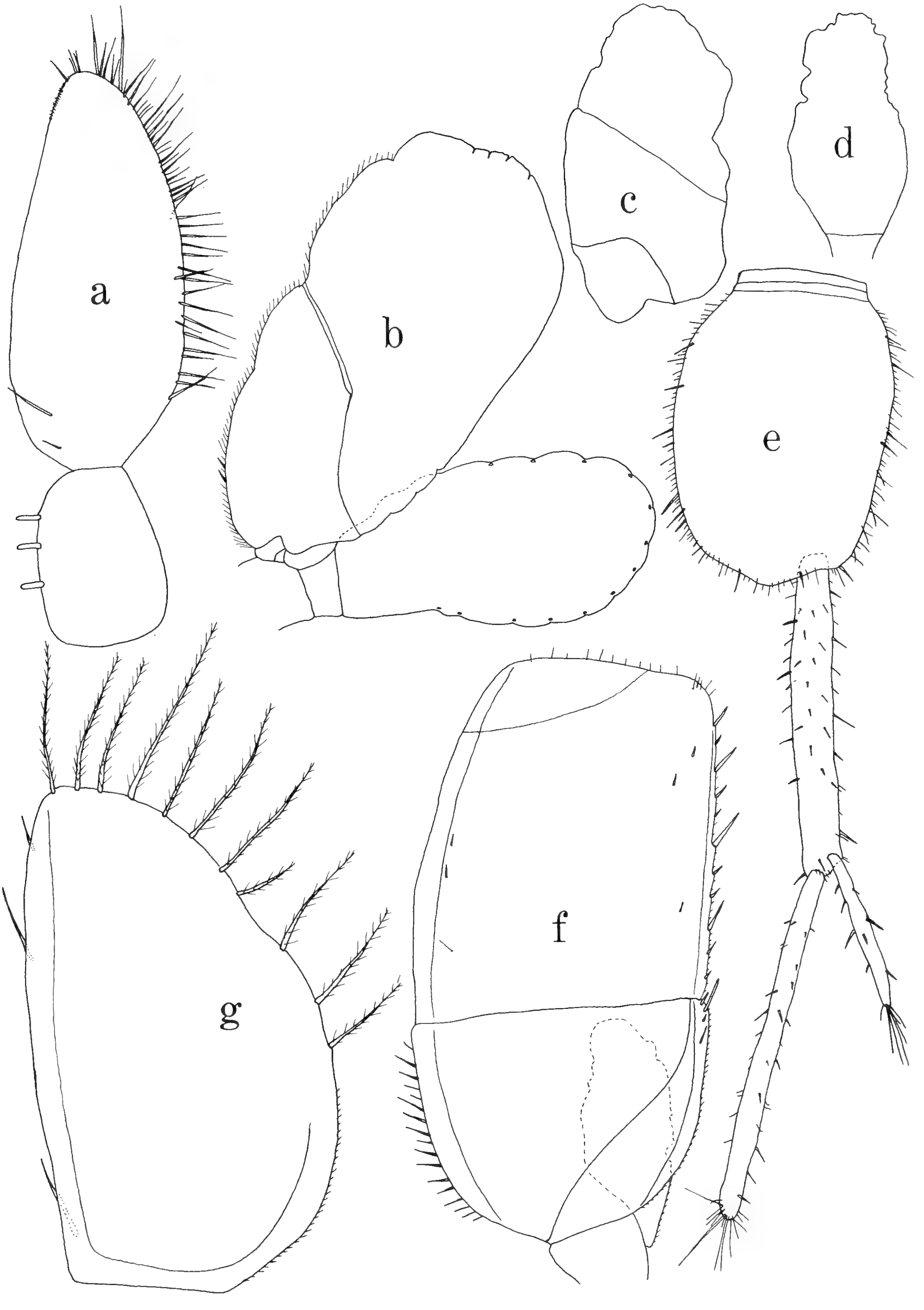

Fig. 3. *Caecidotea bowmani*: a–f, ♂: **a**, Pleopod 1; **b**, Pleopod 4; **c, d,** Pleopod 5, exopod and endopod; **e,** Pleotelson and uropod; **f**, Pleopod 3. **g**, Pleopod 2, ♀.

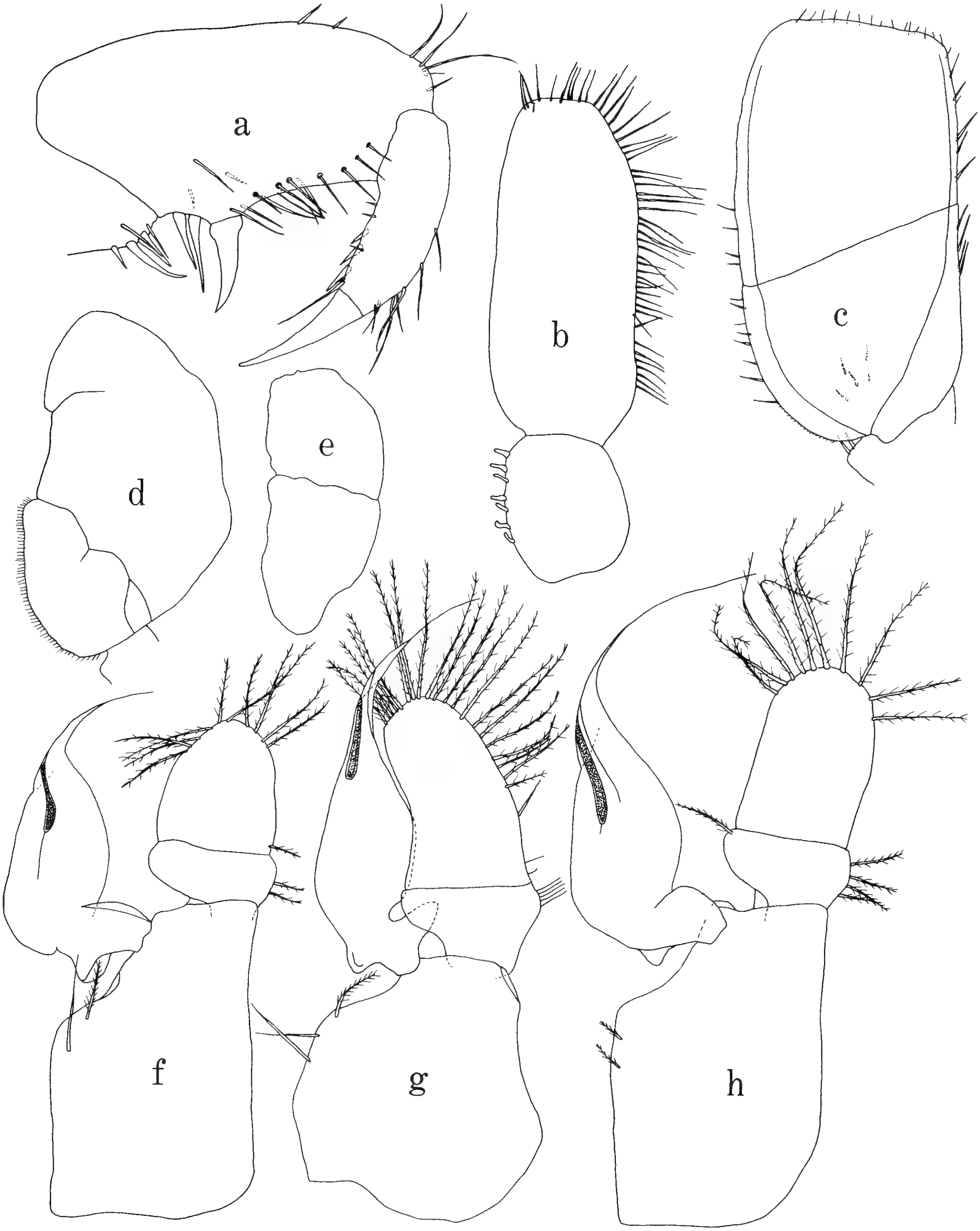

Fig. 4. *Caecidotea holsingeri*, ♂: **a,** Pereopod 1; **b,** Pleopod 1; **c**, Pleopod 3; **d**, Pleopod 4, exopod; **e**, Pleopod 5, exopod; **g**, Pleopod 2. *Caecidotea vandeli*: **f**, Pleopod 2, ♂. *Caecidotea bowmani*: **h**, Pleopod 2, ♂.

apically broadly rounded, bearing 10–13 long, plumose setae; endopod with broadly rounded basal apophysis, tip of endopod a single process tapering to a thread extending in an arc for about 0.4× the entire endopod; entire endopod appears twisted. Female pleopod 2 triangular, lateral margin with slgith concavity, bearing about 11 plumose setae. Male pleopod 3 exopod about 2× as long as wide; distal segment about 1.5 times as long as proximal segment; marginal setae not plumose. Pleopod 4 fleshy, bearing numerous setules and single false suture; pleopod 5 fleshy, lacking setules.

Male uropod slender and elongate, endopod about 1.2, exopod about 0.5× as long as protopod.

Etymology.—It is a pleasure to name this new species after Dr. Thomas E. Bowman, Curator of Crustacea, National Museum of Natural History.

Habitat.—*Caecidotea bowmani* is known only from the type-locality, a small drain tile next to a tourist trail leading through a privately owned park called Natural Bridge of Virginia. The drain is obscured by soil which has slumped from the hillside in which it is placed. In this area the Cambrian aged Conococheague Formation (primarily limestone and dolomite) is exposed, but the tile appears to lie above this bedrock in a mixture of soil and hillside rubble. Water from the drain runs a few meters into Cedar Creek and eventually enters the James River.

Caecidotea bowmani was collected from the undersides of leaves in the company of an undescribed species of the subterranean amphipod genus *Stygobromus*.

Relationships.—The male pleopod 2 endopods of *C. bowmani, C. vandeli, C. simonini, C. holsingeri, C. cannulus* and *C. chiapas* all terminate in an elongate cannula. The endopods of *C. bowmani* and *C. vandeli* are nearly identical, but these 2 species can be separated by the following characteristics: (1) the average body length of *C. bowmani* is about twice that of *C. vandeli*; (2) the male pleopod 1 is subtriangular in *C. bowmani,* suboval in *C. vandeli*; (3) the male pleopod 2 exopod distal segment is longer and more linear in *C. bowmani*; (4) the male pleopod 3 of *C. bowmani* lacks distal plumose setae present in *C. vandeli*; and (5) the uropods of *C. bowmani* are longer than the pleotelson, while those of *C. vandeli* are less than 0.5× the length of the pleotelson.

The cannulas of *C. bowmani, C. holsingeri* and *C. cannulus* taper to a fine thread, but the endopods are otherwise dissimilar. *Caecidotea holsingeri* possesses a pronounced basal apophysis not exhibited by other members of the *cannulus* group. The body of the endopod is widened near the midlength in *C. cannulus,* in contrast to the slender endopods of *C. bowmani* and *C. holsingeri.* In *C. simonini* and *C. chiapas* the cannula is elongate but does not terminate in a threadlike structure.

The male first pleopod has a suboval or subtriangular distal segment bearing distal and lateral setae in all 10 members of the *cannulus* group. The pereopod 1 propus palmar margin lacks processes in these 10 species, along with *C. adenta, C. richardsonae, C. tomalensis, C. occidentalis* and some other *Caecidotea*. Sexual dimorphism is poorly described in most asellids, but is lacking in the pereopod 1 of *C. bowmani, C. holsingeri* and *C. packardi*. The sexual dimorphism of pereopod 4 in *C. bowmani* is common within the genus.

Caecidotea holsingeri (Steeves)

Fig. 4a–e, g

Asellus holsingeri Steeves, 1963a:462–465, figs. 1–5; 1965:84; 1966:395, 397, fig. 7; 1969:56–58, 61.—Steeves and Holsinger, 1968:81.—Culver, 1971: 173, 175–177, 179–181, 183–184, tables 1, 4, fig. 2.—Holsinger and Steeves, 1971:193–195, fig. 6.—Fleming, 1972:253; 1973:286–291, 295–296, fig. 1. tables 1–6.—Culver, Holsinger and Baroody, 1974:691, table 1.—Rutherford and Handley, 1976:43, 45, table 1.—Culver, 1976:946, 948, 951, 954, table 1. Holsinger, Baroody and Culver, 1976:24–26, 59.

Asellus sensu lato *holsingeri* Steeves.—Holsinger, 1978:8.

Conasellus holsingeri (Steeves).—Henry and Magniez, 1970:356.

Material examined.—WEST VIRGINIA: Greenbriar Co., Organ Cave (type-locality), 27 Aug. 1978, 5 males, 1 female. Bransford Cave, 26 Aug. 1978, 2 males, 6 females (3 ovigerous, 3.2, 3.4, 3.5 mm). Monroe Co., Rock Camp Cave, 25 Aug. 1978, 1 male. Pocahontas Co., Linwood Cave, 29 Aug. 1978, 4 males, 19 females (15 ovigerous, 5.5–7.9 mm). Martha's Cave, 1 Sept. 1978, 4 males, 5 females (1 ovigerous, 3.5 mm). Randolph Co., Alpena #1 Cave, 29 Aug. 1978, 1 male, 9 females. All of these specimens were collected by D. Culver and T. Ehlinger.

Description of topotypic material.—Eyeless, unpigmented. Largest individual 9.8 mm; body slender, linear, about 5.2× as long as wide, coxae visible in dorsal view. Margins of head, pereonites and telson moderately setose. Head about 1.8× as wide as long; anterior margin concave, postmandibular lobes moderately produced. Telson about 1.3× as long as wide, sides subparallel, caudomedial lobe somewhat produced, broadly rounded.

Antenna 1 barely reaching last segment of antenna 2 peduncle, flagellum of 5–7 segments, bearing 2–5 esthetes, varying with size of specimen. Antenna 2 reaching to about pereonite 6, last segment of peduncle about 1.3× length preceding segment, flagellum of about 36 segments (9.8 mm male).

Mandibles with 4 cuspate incisors and lacinia mobilis, (except 9.8 mm male with 5 cuspate left incisor) setae rows with 13 plumose setae in left mandible, 12 plumose setae in right mandible. Maxilla 1, apex of outer lobe with 13 spines and 1 subterminal seta, inner lobe with 5 apical plumose setae. Maxilliped with 4–6 retinaculae.

Pereopod 1, sexual dimorphism absent, propus about 2.1× as long as wide, palm very slightly concave, processes absent, 1 large spine proximally. Dactyl flexor margin with about 3 stout spines. Pereopod 4 of male moderately setose and spinose, dactyl with 1 small mesial spine. Female pereopod 4 missing in Organ Cave specimen, in 7.8 mm ovigerous female from Linwood Cave, pereopod 4 much less robust than male, spine on dactyl absent.

Pleopod 1 larger than pleopod 2, protopod about 0.5 length exopod, with 7–8 retinaculae; exopod about 0.4× as wide as long, non-plumose setae along lateral and apical margins. Pleopod 2, protopod with 2 mesial non-plumose setae, exopod, proximal segment with 5 non-plumose setae; distal segment, mesial margin concave, about 20 long plumose setae on distal and lateral margins, 3 shorter, non-plumose setae proximal laterally. Endopod, basal apophysis distinct; tip terminating in single process tapering to a fine, elongate thread, some torsion apparent.

Pleopods 3, 4, and 5 as figured. Uropod (9.8 mm male) 3.2 mm long, protopod and endopod spatulate, endopod about 1.4, exopod about 0.8× as long as protopod.

Distribution.—*Caecidotea holsingeri* is known from the extreme western portion of Maryland through eastern West Virginia (Steeves, 1969) and a Bath Co., Virginia locality (Holsinger and Steeves, 1971). Fleming (1972) and Holsinger, Baroody and Culver (1976) listed a total of 27 cave localities within this range.

Variation.—*Caecidotea holsingeri* was known by a single specimen when described (Steeves, 1963a) and additional specimens have revealed some variation. Steeve's 8-mm specimen was apparently immature, since the uropod figured was not as elongate or spatulate as a larger 9.8 mm male. Holsinger, Baroody and Culver (1976) report a length of 12 mm for this species.

The distinct basal apophysis was fastened around the proximal segment of the exopod in several specimens (Fig. 4g). In this way the convex lateral surface of the endopod is even with the concave mesial surface of the exopod, forming a continuous surface. This presumably aids in sperm transfer in some manner.

The endopod tip was shown by Steeves (1963a) with a small apical flange, but this feature was not present in the majority of specimens examined. The male pereopod 1 bears a spine on the palmar margin which varies from small and seta-like to large, robust and distally curved. At least one specimen had a large spine on one gnathopod and a small seta on the other.

Caecidotea vandeli (Bresson)

Fig. 4f

Asellus vandeli Bresson, 1955:69–75, figs. 49–61.—Vandel, 1965:277.—Henry and Magniez, 1968:2.—Steeves, 1969:53, 56–58.—Cole and Minckley, 1972:322.—Fleming, 1972:253; 1973:286, 289–291, 295–296, fig. 1, tables 4–6.

Pseudobaicalasellus vandeli (Bresson).—Henry and Magniez, 1970:357.

Material examined.—VIRGINIA: Montgomery Co., Slusser's Chapel Cave, 21 April 1968, collected by J. Holsinger, R. Whittemore (USNM 327628), 3 males (5.9–6.7 mm), 6 females (6.8–7.6 mm).

Distribution.—The type-locality of *C. vandeli* is Erhardt's Cave, Montgomery Co., Virginia (Bresson, 1955). Steeves (1969) visited there without success in collecting additional specimens, but listed a second locality in the same county, Slusser's Chapel Cave. Douglas (1964) and Holsinger (1975) gave locations and descriptions of these caves. Fleming (1972) reported an additional cave locality in Montgomery Co., plus individual collections from Bath, Botetourt and Giles counties.

Comments.—Steeves (1969) believed that the cannula had been broken in the male used by Bresson (1955) since specimens from Slusser's Chapel Cave had a cannula much longer than originally figured. I have redrawn this structure as it appears undamaged (Fig. 4f).

Affinities of the cannulus group.—In 7 additional species the male pleopod 2 possesses the single elongate, tapering terminal process and torsion of the endopod characteristic of the *cannulus* group: *C. chiapas* Bowman (1975); *C. pasquinii* Argano (1972); *C. montana* (Mackin and Hubricht, 1938); *C. oculata* Mackin and Hubricht (1940); and *C. zullini, C. vomeroi* and *C. mitchelli* Argano (1977). Of these 7 species, *C. montana* and *C. oculata* are epigean species occurring in the Ouchita Province, although *C. oculata* is associated with groundwater (springs) in some collections (Mackin and Hubricht, 1940). *C. chiapas, C. pasquinii, C. zullini, C. vomeroi* and *C. mitchelli,* all members of the *chiapas* group (Argano, 1977), are phreatobites or troglobites occurring in Mexico. Three other species, *C. laticaudata, C. foxi* and *C. dimorpha* possess rather elongate cannulas, but in these species the cannula is associated with auxiliary processes (lateral, mesial or caudal) and exhibits no evidence of torsion.

Members of the *cannulus* group also lack processes on the gnathopod palm and possess setae along both the convex distal and lateral margins of the male pleopod 1 exopod. Of the seven species listed above in which the male pleopod 2 is of the type found in *cannulus* group species, all have processes along the gnathopod palm. The lateral margin of the pleopod 1 exopod is convex only in *C. montana* and *C. vomeroi,* concave in *C. chiapas, C. pasquinii, C. oculata, C. mitchelli* and *C. zullini.* All of these 7 species differ further from the *cannulus* group species in having elongate setae, usually plumose, along the distal margin only, with short spines or setae along the lateral margin.

Williams (1970) and Steeves (1966) placed emphasis on the morphology of the male pleopod 2 endopod tip in evaluating phylogenetic relationships, although Williams included other morphological aspects.

If monophyletic groups could be determined by endopod tip morphology alone, the 17 species assemblage consisting of the *cannulus* group (10 species), *chiapas* group (5 species), *C. oculata,* and *C. montana* might be considered phylogenetically related due to the similarity of the endopod tips of these species. However, a phylogenetic group based on, e.g., the morphology of the gnathopod, would yield very different results than one based on endopod morphology. When the interrelationships of these morphological characters are better understood, it may be possible to designate subgenera within the genus *Caecidotea.*

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My special thanks go to Dr. Thomas E. Bowman for repeatedly reading the MS, checking the drawings, making specimens available from the U.S. National Museum collections, and allowing me the use of his facilities at the museum.

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TWO NEW SPECIES OF EARLESS FROGS ALLIED TO *ELEUTHERODACTYLUS SURDUS* (LEPTODACTYLIDAE) FROM THE PACIFIC SLOPES OF THE ECUADORIAN ANDES

John D. Lynch

Abstract.—Two new species are described from cloud forests in western Ecuador. *Eleutherodactylus surdus* is redescribed and the purported Colombian subspecies is accorded specific status. The relationships among the five species of the *surdus* assembly are reviewed.

Eleutherodactylus surdus was named by Boulenger (1882) on the basis of one specimen from the Andes of western Ecuador and another from "South America." The species was redisovered in high cloud forests in Imbabura and Pichincha provinces, Ecuador, in 1967 and 1968 and briefly mentioned by Lynch (1970) who compared it with two species he thought allied. Cochran and Goin (1970) named *Eleutherodactylus surdus cabrerai* from the northern reaches of the Cordillera Central in Colombia. Lynch (1979) compared *E. surdus* to *E. baryecuus* from the eastern slope of the Andes in Ecuador. Lynch and Duellman (1980) considered *E. baryecuus* and *E. surdus* the only named members of the *surdus* assembly of the *unistrigatus* group of *Eleutherodactylus*.

Fieldwork by William E. Duellman in 1975 and additional surveys by me in 1977 and 1978 revealed the presence of two other species on the western slopes of the Andes in Ecuador. One of these species was considered an undescribed trans-Andean representative of the *pugnax* assembly of the *unistrigatus* group by Lynch and Duellman (1980).

Eleutherodactylus baryecuus Lynch, *E. pugnax* Lynch, and *E. surdus* (Boulenger) (but not *E. surdus cabrerai* Cochran and Goin) are distinctive in lacking ears (tympanum, plectrum, and *cavum tympanicum*). Both of the new species described below lack ears as well. Ear loss has occurred elsewhere among *Eleutherodactylus* (e.g., *E. anotis* Walker and Test, *E. colodactylus* Lynch, *E. ruidus* Lynch) but is tentatively considered evidence of relationship among *E. baryecuus, E. pugnax, E. surdus,* and two new species. Discovery of the new species requires that *E. surdus* be redescribed.

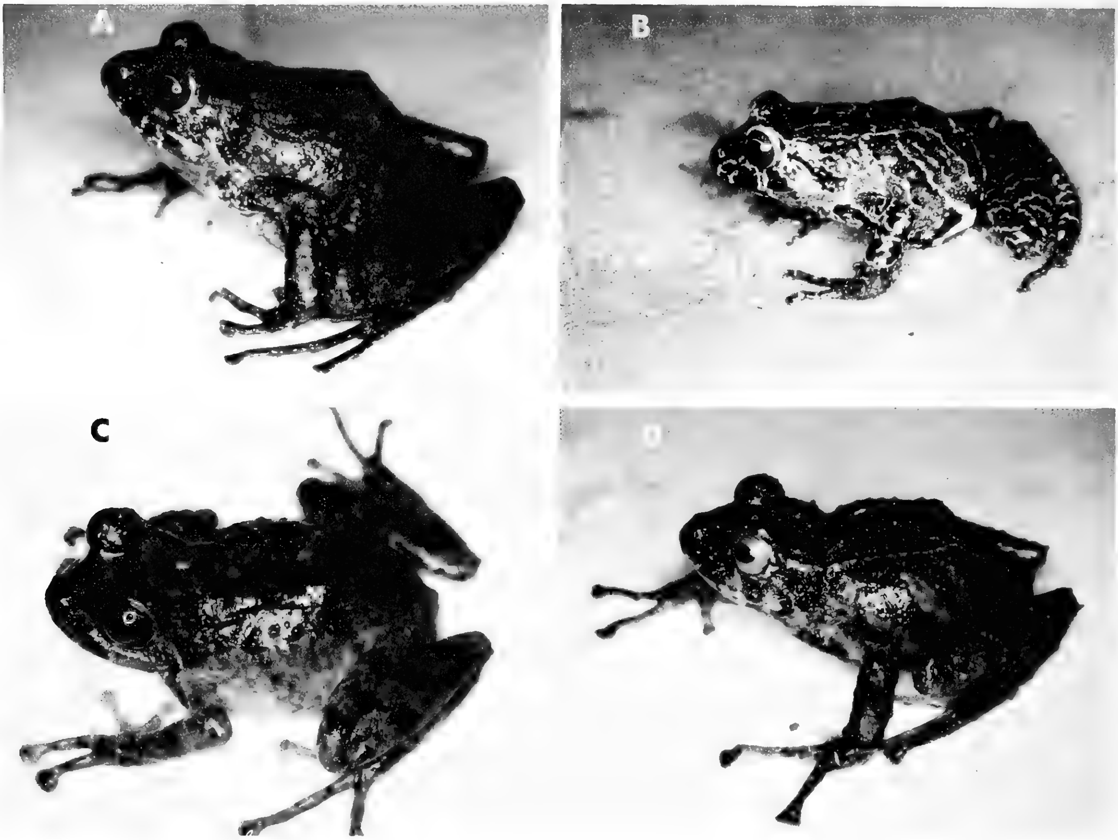

Fig. 1.—Pacific versant species of the *surdus* assembly of *Eleutherodactylus*. (**A**) *E. surdus*, female, 48.3 mm SVL, KU 179000; (**B**) *E. surdus*, ca. 30–40 mm SVL, not preserved, from Los Alpes; (**C**) *E. duellmani*, female, 44.6 mm SVL, KU 179252; (**D**) *E. sobetes*, female (holotype), 41.3 mm SVL, 179389.

Materials and Methods

Measurements were taken as described by Lynch and Duellman (1980); unless stated otherwise, data refer to adults. Maturity in males was assumed if the testes were enlarged and in females if convoluted oviducts or enlarged eggs were present. The following abbreviations are used: SVL (snout–vent length), HW (head width), IOD (interorbital distance), and E–N (eye to nostril distance). Statements given in the diagnoses are not repeated in the descriptions unless a qualification is required. All specimens are deposited at the University of Kansas Museum of Natural History (KU). The abbreviations AMNH and BM(NH) refer to American Museum of Natural History and to British Museum (Natural History), respectively.

Status of Colombian Populations

Cochran and Goin's (1970:401) casual remark that *Eleutherodactylus surdus cabrerai* is obviously related to the Ecuadorian *E. surdus* requires correction. Their description and illustrations of *cabrerai* adequately contradict their assertion of close relationship. *Eleutherodactylus cabrerai,* new combination, differs from *E. surdus* in having a fully developed ear concealed beneath the skin, in having pustular skin on the dorsum, in lacking cranial crests, and in having small, widely separated vomerine odontophores. Four males (AMNH 14012, 14014–15, 14026) are 18.0–28.6 mm SVL and lack vocal slits. Two gravid females (AMNH 14008, 14011) are 35.3–37.1 mm SVL.

Eleutherodactylus surdus (Boulenger)
Fig. 1A–B

Hylodes surdus Boulenger, 1882:212, pl. 14. fig. 3. [Cotypes.—BM(NH) 60.6.16.106 (reregistered as 1947.2.17.25) and 71.4.16.46 (reregistered as 1947.2.17.26), former from W Ecuador (Fraser) and latter from South America].

[*Eleutherodactylus surdus*] *surdus*: Cochran and Goin, 1970:339–401.

Diagnosis.—1) skin of dorsum smooth (some warts on upper flanks), that of venter areolate; dorsolateral folds absent or very feebly developed; 2) tympanum absent; 3) snout ovoid to subacuminate in dorsal view, round in profile; snout short, E–N < eye length; canthus rostralis sharp; 4) cranial crests present; 5) vomerine odontophores massive, oval in outline; 6) males lacking vocal sac and slits; no nuptial pad in males; 7) first finger shorter than second; broad discs on all fingers; pads on II–IV; 8) fingers with narrow, keel-like lateral fringes; 9) ulnar tubercles not evident; 10) knee, heel, and tarsus lacking tubercles; 11) outer metatarsal tubercle indistinct, $^1/_5$ size of oval inner; supernumerary plantar tubercles at bases of toes; 12) toes with thick lateral fringes, not webbed; discs and pads like those of fingers except smaller; 13) gray above with indefinite brown markings on dorsum; facial markings prominent; venter cream with brown marbling, throat nearly uniform brown; posterior surfaces of thighs brown with white spots; groin brown with vertical cream bars; underside of shank boldly barred; 14) adults moderate-sized, SVL of males 24.5–36.9 mm ($\bar{x}$ = 31.1 ± 1.2 [± 2 standard errors], N = 34), of females 40.4–50.5 ($\bar{x}$ = 45.1 ± 1.5, N = 13).

Eleutherodactylus surdus differs from most other species of the genus in the absence of the ear but is similar in size and habitus to *E. baryecuus* and the two species described below. Both of the new species have warty skin on the dorsum and each has distinct dorsolateral folds. Each has more fleshy lateral fringes on the fingers. *Eleutherodactylus baryecuus* has a more rounded snout, distinct brown markings on the dorsum, and lacks lateral fringes or keels on the fingers.

Description.—Head narrower than to as wide as body, much wider than

Table 1.—Proportions (as percentages) of some frogs of the *surdus* assembly of *Eleutherodactylus*. First line gives range, second gives mean ± 2 standard errors and N (in parentheses).

	Tibia/SVL	HW/SVL	Eyelid/IOD	E–N/eye
E. duellmani ♂	48.9–58.8 54.6 ± 1.0 (32)	35.4–41.1 37.8 ± 0.6 (32)	78.8–129.6 102.3 ± 4.3 (32)	59.0–79.5 69.6 ± 1.9 (32)
E. duellmani ♀	47.8–59.9 54.2 ± 1.5 (17)	35.7–41.1 38.7 ± 0.6 (17)	81.6–126.2 105.7 ± 4.9 (17)	61.5–80.2 70.3 ± 2.5 (17)
E. sobetes ♀ (2)	56.0–57.3	40.3–41.4	80.0–108.7	84.1–88.2
E. surdus ♂	53.0–61.4 58.0 ± 0.9 (34)	33.6–40.3 37.9 ± 0.6 (34)	68.8–108.6 87.4 ± 4.4 (28)	70.8–83.3 76.9 ± 2.6 (11)
E. surdus ♀	53.4–62.6 58.1 ± 1.5 (13)	35.4–39.5 37.3 ± 0.6 (13)	75.0–100.0 81.6 ± 4.4 (13)	73.2–81.5 78.1 ± 2.9 (5)

long; snout ovoid to subacuminate (smaller individuals) in dorsal view; nostrils small, weakly protuberant, directed dorsolaterally; loreal region weakly concave, sloping abruptly to lips; lips not flared; interorbital region furrowed, broader than upper eyelid; no tubercles on upper eyelid; supratympanic fold distinct, ending above forearm; subconical postrictal tubercles anterior to end of supratympanic fold; choanae relatively small, not concealed by palatal shelf of maxillary arch when roof of mouth is viewed from directly above; vomerine odontophores median and posterior to choanae, oval (rarely faintly triangular) in outline, large, separated on midline by distance equal to an odontophore breadth, each 3 times size of a choana, bearing 5–6 teeth in a clump or indefinite transverse row; tongue longer than wide, its posterior border not notched, posterior ⅓ not adherent to floor of mouth; males lack vocal slits; in many preserved males the loose skin on the throat suggests the presence of vocal sacs but none was found.

Skin of dorsal surfaces smooth except for some roughening (fine ridges) on lower back; flanks becoming areolate ventrally with scattered small warts on upper flanks; throat smooth; discoidal folds distinct; anal opening not extended in sheath; no anal warts.

Ulnar tubercles not evident except for small antebrachial; palmar tubercle bifid, twice as large as oval thenar tubercle; supernumerary palmar tubercles pale, indefinite, flattened; subarticular tubercles low, round; discs broader than long; tip of thumb scarcely wider than digit; fingers III–IV bearing broad, apically rounded pads, about twice as wide as digit below pad, that on II smaller; all fingers long; thumb of breeding males not swollen nor bearing nuptial pad.

Tubercles normally absent on tarsus but in some individuals a faint row of smaller outer tarsal tubercles and an indistinct tubercle just proximal to the inner metatarsal tubercle are evident; inner metatarsal tubercle twice as long as wide; plantar surface bearing supernumerary tubercles at bases of toes II–IV; subarticular tubercles longer than wide, moderately elevated; toes bearing prominent, thick lateral fringes coalescing at toe bases; toes not webbed; pads of toes bear broad discs, apically rounded; heels of flexed hind legs overlap; heel of adpressed hind leg reaches to anterior edge of eye or nostril.

Coloration.—Dark gray to gray-brown above with indistinct brown to nearly black markings (interorbital bar, scapular and sacral chevrons); canthal-supratympanic stripe and labial bars black edged with white; limb bars indistinct; anal triangle rarely evident; throat brown with white flecks along jaw; venter cream, heavily marbled with brown; undersides of thighs brown with cream spots; underside of shank and top of tarsus cream, barred with black; anterior surfaces of thighs and groin cream with broad vertical black bars; posterior surfaces of thighs dark brown with white spots (smaller than thumb pad).

In life, *E. surdus* is light to dark brown (sometimes with a greenish to reddish-orange wash) with darker brown markings. The side of the head and flanks have a suffusion of yellow. The throat is heavily pigmented with brown; the venter is dirty white and heavily reticulated and spotted with black or dark brown. The groin and concealed surfaces of the limbs are dirty white with brown markings (or brown with dirty white spots and bars). The iris is reddish-brown with black flecks. Some individuals have yellow flecks on the dorsal surfaces.

Variation.—In small individuals a dorsal color pattern is usually evident (see Boulenger, 1882:pl. 14, fig. 3) but the pattern is essentially obliterated in adults. Variability in proportions is summarized in Table 1.

Natural history.—In 1967 and 1968, *E. surdus* was abundant along the roadcuts at 'Los Alpes,' a construction site on the Aloag-Tandapi road. The forests extended virtually to the roadside and the newly exposed rock walls were continuously dripping water. By 1977, this site had dried appreciably and the forests were cut back well away from the road. Casual search did not yield specimens of *E. surdus*.

At La Delicia (Otavalo–Apuela road), *E. surdus* was found at night perched on moss-covered banks along the edge of the road or on dirt banks along streams. The forests still occur near the road. *Eleutherodactylus surdus* was not found along heavily wooded forest streams (where *E. duellmani* was encountered).

Reproductively active animals (enlarged eggs/swollen testes) were found in January, March, June, and July.

Distribution.—Known only from upper cloud forests (2,500–2,700 m) in western Ecuador. ECUADOR, *Prov. Imbabura*: La Delicia, 2,700 m, KU 130888–90, 179000–16. *Prov. Pichincha*: Los Alpes, 2,500 m, KU 111385–94, 117584–617.

Eleutherodactylus duellmani, new species
Fig. 1C

Holotype.—KU 179325, an adult male, one of a series collected at the waterfall on the Quebrada Zapadores, 5 km ESE Chiriboga, Provincia Pichincha, Ecuador, 1,920 m, on 9 July 1977 by John D. Lynch.

Paratypes.—KU 165913–21, 179316–24, 179326–37, from the Quebrada Zapadores (between bridge and first waterfall).

Diagnosis.—1) skin of dorsum and flanks bearing many small flat warts, that of venter areolate; dorsolateral folds reaching sacrum; 2) tympanum absent; 3) snout ovoid in dorsal view, rounded to truncate in profile; snout short, E–N < eye length; canthus rostralis moderately sharp; 4) interorbital region furrowed; 5) vomerine odontophores large, subtriangular in outline; 6) males lacking vocal sac and slits; males with small, indistinct, nuptial pad on thumb; 7) first finger shorter than second; broad discs on all fingers; pads on II–IV; 8) fingers with lateral fringes; 9) ulnar tubercles not distinct; 10) small tubercles on heel and outer tarsus; large tubercle on inner edge of tarsus; 11) outer metatarsal tubercle not always evident, inner oval, at least 8 times size of outer; few supernumerary plantar tubercles, indistinct; 12) toes with lateral fringes, webbing (not enclosing basal subarticular tubercles), broad discs, large pads; 13) brown above with diffuse brown markings; venter gray to cream with diffuse cream spots or brown reticulation; 14) adults moderate-sized, SVL of males 24.9–36.0 mm ($\bar{x} = 31.2 \pm 1.2$, N = 32), of females 36.6–45.8 ($\bar{x} = 41.8 \pm 1.3$, N = 17).

Eleutherodactylus duellmani is most similar to *E. baryecuus* Lynch, *E. pugnax* Lynch, *E. surdus* (Boulenger), and *E. sobetes* (described below) but differs from *E. baryecuus* and *E. surdus* in having warty (not smooth) skin on the dorsum and in having short dorsolateral folds. It differs from *E. pugnax* in having only basal webbing of the toes and in lacking an inner tarsal fold. From *E. sobetes, E. duellmani* differs in lacking fleshy canthal ridges, in having an incomplete dorsolateral fold, and in having more numerous flat warts on the dorsum. The iris is brown in *E. duellmani* and orange in *E. sobetes*.

Description.—Head narrower than (large females) to as wide as body, much wider than long; snout ovoid in dorsal view (intermediate between subacuminate and round); nostrils minute, not or only slightly protuberant, directed dorsolaterally; canthus rostralis evident but rounded and concave; loreal region concave, sloping abruptly to lips; lips not flared; tubercles on upper eyelid, none especially prominent; supratympanic fold obscured by subconical to conical warts; large conical postrictal tubercles; choanae relatively small, round, not concealed by palatal shelf of maxillary arch; vomerine odontophores massive, each 3–4 times size of a choana, lying medial and posterior to choanae, roughly triangular in outline, bearing transverse row of 4–6 small teeth, odontophores separated on midline by distance equal to odontophore width; tongue longer than wide, its posterior border not notched, posterior 1/5 not adherent to floor of mouth.

Skin of dorsal surface beset with many warts, those toward head separated, those caudad more nearly juxtaposed; tubercles form dorsolateral folds; similar tubercles on limbs and flanks; anal opening not extended in sheath; skin of throat areolate; discoidal folds ill-defined, lying anteriad to groin.

Ulnar tubercles not distinct from tubercles on dorsal and lateral surface of forearm; palmar tubercle bifid, about size of elongate thenar tubercle; supernumerary palmar tubercles low, distinct, smaller than subarticular tubercles which are elevated, broader than long, weakly bifid; thumb lacking pad or pad only slightly dilated; pads on II–IV broadly dilated (largest on III and IV), round apically on I–II, weakly emarginate on III–IV; males lacking swollen thumbs but with small, white nuptial pads on thumbs.

Small tubercle on knee, one conical (and several nonconical) tubercle on heel, 2–3 subconical tubercles on outer edge of tarsus, and an elongate tubercle (or short fold) on inner edge of distal one-third of tarsus; inner metatarsal tubercle twice as long as wide; outer metatarsal tubercle minute, less than ⅛ size of inner, not visible in some individuals; a few small supernumerary plantar tubercles below toe IV; fringe along outer edge of sole; fringes coalesce at bases of toes, but webbing only encroaches onto proximal half of basal subarticular tubercles (except on toe V); subarticular tubercles broader than long, flat, not bifid; discs much broader than long, on expanded pads; toe pads apically round with only vague suggestion of emargination; heels of flexed hind legs overlap slightly.

Coloration.—Dark brown to pale yellow brown above with brown occipital W, sacral chevron, interorbital bar; canthal-supratympanic stripe and labial bars distinct on dark specimens (edged with cream) but vague on pale specimens; warts on lower back pale (nearly cream); flanks lack pattern, upper flanks darker, lower flanks cream; anal triangle gray to brown; thigh bars broadest proximally (much broader than interspaces); shank bars oblique, wider than to as wide as pale interspaces; innermost fingers and toes cream, without markings; posterior surfaces of thighs brown with a few cream flecks; ventral surfaces gray to cream, finely peppered with brown; throat darker than venter; undersides of limbs finely mottled with brown.

In life, *E. duellmani* is usually brown (pale to dark) above and gray to dirty cream below. Dorsal markings are normally obscure except for vague brown blotches and orange warts on the lower back and hind limbs. The iris is chocolate brown with black reticulations and a faint red horizontal streak. The posterior surfaces of the thighs vary from dull yellow to brown with dull yellow spots. The face and flanks usually bear small white spots.

The venter normally has diffuse cream spots or vague brown reticulation. Some individuals (mostly juveniles) are green above. A green tinge is evident in many adults.

Measurements of holotype in mm.—SVL 32.3; shank 18.6; HW 13.0; head length 11.1; upper eyelid width 3.2; IOD 2.7; eye length 4.9; E–N 3.2.

Etymology.—The species is named for William E. Duellman who first collected it and across whose trails I have trod in quest of Andean frogs.

Natural history.—*E. duellmani* prefers well-watered microhabitats. At the type locality, many individuals were seen perched on wet rock faces in the spray zone of the waterfall. Fewer individuals were seen on vegetation downstream. Above the type locality (14.8 km ESE Chiriboga), I found nine specimens beneath leaves, dirt, and rocks in a seep off the cliffside. The frogs were in the water in the spaces between rocks and organic debris. Searching 100 m on either side of the seep in less mesic habitats revealed no frogs. Along the Colombian border (ca. 14 km [airline] SE Maldonado) many frogs were found in a large seep on a hillside. Frogs were mostly found beneath rocks in the water and many escaped by jumping into the small streams. Both of these sites were inspected only in the daytime. At La Delicia on the Cordillera de Intac, *E. duellmani* was found only at night perched on branches and leaves immediately above (0.1–0.5 m) small streams.

Gravid females and males with swollen testes (and thumb pads) were collected in January, April, May, June, and July (in both dry and wet seasons). The largest juvenile male examined is 26.9 mm SVL (KU 179292). The largest juvenile female (oviducts not convoluted) is 38.1 mm SVL (KU 179285).

Distribution.—Upper cloud forests (1,920–2,700 m) in northwestern Ecuador. The following have been examined (in addition to the types): ECUADOR, *Prov. Carchi*: 14 km SW (airline) Maldonado, 2,500 m, KU 179251–72, 179274–95; *Prov. Imbabura*: La Delicia, 2,700 m, KU 179296–315; 9 km SE Tandayapa, 2,150 m, KU 165905–09; *Prov. Pichincha*: 14 km W Chiriboga, 1,960 m, KU 165910–12; 14.8 km ESE Chiriboga, 2,410 m, KU 179338–46.

Eleutherodactylus sobetes, new species

Fig. 1D

Holotype.—KU 179389, an adult female, obtained at the Quebrada Zapadores, 5 km ESE Chiriboga, Provincia Pichincha, Ecuador, 1920 m, on 9 July 1978 by John D. Lynch.

Paratype.—KU 179390, taken syntopic with holotype.

Diagnosis.—1) skin of dorsum smooth with many small pustules, that of venter coarsely areolate; pungent tubercles on upper eyelid; thin dorsolateral folds present; 2) tympanum absent; 3) snout subacuminate in dorsal view, round in profile; snout short, E–N < eye; canthus rostralis sharp; 4) cranial crests present; 5) vomerine odontophores massive; oval in outline; 7) first finger shorter than second; broad discs on all fingers; pads on II–IV; 8) fingers with thick lateral fringes; 9) ulnar tubercles indistinct; 10) conical heel tubercle; thin ridge with small tubercles on outer edge of tarsus; 11) two metatarsal tubercles, inner oval, 5–6 times size of outer; supernumerary plantar tubercles present at bases of toes; 12) toes with lateral fringes; broad discs on dilated toe pads; 13) pale brown with bold dark brown markings above; dorsolateral folds cream; venter cream with brown spots peripherally; posterior surfaces of thighs brown; iris orange in life; 14) adults moderate-sized, one adult female 41.3 mm SVL.

Eleutherodactylus sobetes is most similar to *E. surdus* (Boulenger) but differs in having the skin of the dorsum punctuated by pustules, in having pungent tubercles on the eyelid, knee, and heel, and in having a fleshy canthal ridge.

Description.—Head as wide as body, wider than long; nostrils not or only slightly protuberant, directed dorsolaterally; canthus rostralis sharp, slightly concave, its sharpness accentuated by canthal ridge; loreal region weakly concave, sloping abruptly to lips; lips not flared; upper eyelid bearing several pungent but small tubercles; one pungent tubercle between eyes; temporal region swollen, supratympanic fold replaced by ridge of low tubercles; postrictal tubercles subconical; roof of mouth vaulted so that when examined from directly above choanae are seen obliquely and appear small; choanae oval in outline, not concealed by palatal shelf of maxillary arch; vomerine odontophores 3–4 times size of a choana, lying medial to and posterior to choanae, separated on midline by distance equal ⅔ width of an odontophore, bearing a transverse row of 3–6 large, pointed teeth; tongue longer than broad, its posterior border not notched, posterior ¼ not adherent to floor of mouth.

Skin of dorsum smooth but beset with many small pustules which sometimes coalesce to form short ridges, that of flanks same but grading into uniform areolation towards edge of venter; pustules poorly expressed on side of head and on snout; a pair of thin dorsolateral folds extending from posterolateral corner of eye to above groin (curving medially at about level of forelimb); skin on limbs smooth with occasional tubercles (especially on shank); anal opening not extended in sheath; skin below and lateral to vent coarsely areolate, that of throat and venter areolate (but less coarse than that below vent) except in center of breast (nearly smooth); discoidal fold well anteriad to groin.

Ulnar tubercles present but not different from pustules on dorsal surfaces, except antebrachial larger; a tubercle on elbow; palmar tubercle strongly bifid (or divided into 2 tubercles, median one twice size of outer); median

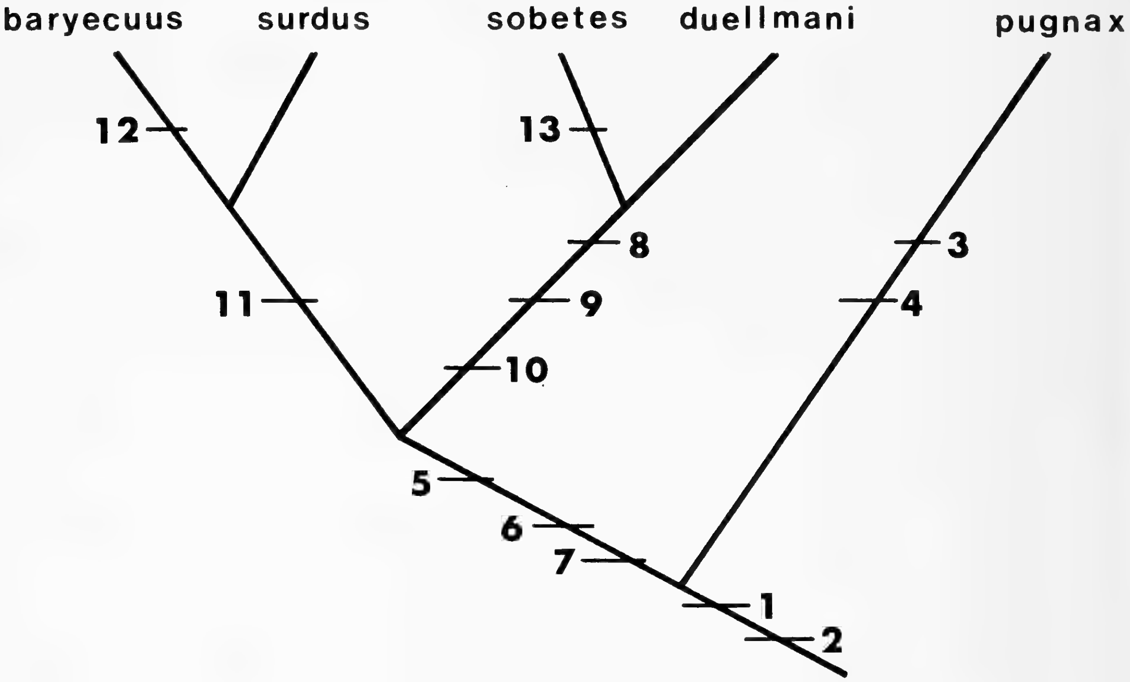

Fig. 2.—Postulated relationships within the *surdus* assembly of *Eleutherodactylus*. Traits are numbered (see text, p. 337).

palmar tubercle as large as oval thenar tubercle; numerous supernumary palmar tubercles, especially below fingers III–IV, smaller and less pungent than subarticular tubercles which are round, elevated; fingers bearing fleshy fringes (also present on outer edge of palm and finger IV and on inner edge of thumb); pad on thumb scarcely developed, those on fingers II–IV broad, rounded apically; largest pads on fingers III–IV; fingers relatively long.

A subconical tubercle on knee; an indistinct tubercle on inner edge of tarsus just proximal to inner metatarsal tubercle which is twice as long as wide, not compressed; outer metatarsal tubercle subconical; supernumerary plantar tubercles low, at bases of toes I–IV, sometimes with additional smaller tubercles lying proximal to other; subarticular tubercles round, pungent, more distal tubercles (toes III–V) smaller than basal tubercles; toes bearing fringe-like fleshy folds along lateral margins (including I and V) which coalesce basally forming rudimentary webbing (not encroaching on basal subarticular tubercles except on V); toe pads smaller than those of outer fingers but otherwise identical; heels of flexed hind legs barely overlapping.

Coloration.—Pale brown (almost dark cream-brown) above with dark brown markings including interorbital bar which joins an occipital W and with a sagittal ramus reaching toward snout; three chevrons on back, anteriormost long; dorsolateral folds cream, separating flank and dorsal patterns; flanks cream, bearing 3 slanting dark brown bars; canthal-supratympanic stripe and labial bars dark brown; limb bars oblique on shank, all relatively narrower than pale interspaces in paratype, more blotchy and broader than in holotype; upper arm with little brown pigment; anal triangle and posterior surfaces of thighs brown; groin and anterior thigh surface brown but with small brown spots scattered about; ventral surfaces dirty cream with brown spots towards periphery (and scattered over throat in holotype); undersides of thighs and shanks cream with gray vermiculation, of tarsus and to lesser extent forearm dark brown.

In life, *E. sobetes* is dark brown and dull olive-yellow. The posterior surfaces of the thighs and groin are pale violet. The venter is dirty yellow with brown markings. The iris is bright orange.

Measurements of holotype in mm.—SVL 41.3; shank 23.6; HW 17.1; head length 13.8; upper eyelid width 3.8; IOD 4.8; eye length 5.1; E–N 4.5.

Variation.—The paratype is a juvenile female. Its measurements are: SVL 34.4, shank 19.2, HW 13.8, head length 11.4, upper eyelid 3.4, IOD 3.7, eye length 4.4, E–N 3.7.

Etymology,—Greek, *sobetes,* meaning a frightener, reflecting my first impressions on seeing the frog with bright orange eyes (I conjured up an image of a goblin).

Natural history.—The holotype was found sitting on a branch 1 m above the forest floor in a wet forested alcove beside the Quebrada Zapadores. The paratype was sitting on low vegetation (fern-like encrustations) beside the stream.

Relationships within *surdus* Assembly

Five species are assigned here to the *surdus* assembly within the *unistrigatus* group of *Eleutherodactylus,* combining the *pugnax* and *surdus* assemblies (Fig. 2) recognized by Lynch and Duellman (1980). The synapomorphies of the assembly are (1) the loss of the ear and (2) development of a short snout. *Eleutherodactylus pugnax* is postulated to be the most primitive member of the assembly and is specialized in having (3) toe webbing and (4) a tarsal fold. The remaining four species share the following apomorphies: (5) an angular canthus, (6) cranial crests, and (7) large vomerine odontophores. *Eleutherodactylus duellmani* and *E. sobetes* share three apomorphies, (8) thick fringes on the fingers, (9) dorsolateral folds, and (10) warty skin on the dorsum. *Eleutherodactylus baryecuus* and *E. surdus* share (11) smooth skin on the dorsum. The remaining apomorphies are unique, (12) no finger fringes and (13) canthal fold (Fig. 2).

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RELATIONSHIPS BETWEEN NORTH AMERICAN TURTLES OF THE *CHRYSEMYS* COMPLEX AS INDICATED BY THEIR ENDOPARASITIC HELMINTHS

Carl H. Ernst and Evelyn M. Ernst

Abstract.—Comparisons of the similarity indexes of helminth faunas parasitizing North American species of the turtle genera *Chrysemys, Pseudemys,* and *Graptemys* indicate that these turtles represent three separate genera. *Pseudemys* species apparently are not congeneric with *Chrysemys picta* as suggested by other studies. Also, the species of *Graptemys* appear more closely related to *Pseudemys* than to *Chrysemys picta.*

McDowell (1964) revised the New World emydine genus *Chrysemys* on the basis of skull and foot morphology, including in it *C. picta* and the slider turtles of the genus *Pseudemys,* and suggested that three subgenera were involved (*Chrysemys, Pseudemys,* and *Trachemys*). Similarities in the choanal structure of *Chrysemys picta* and various species of *Pseudemys* upheld both the placement of the *Pseudemys* within the genus *Chrysemys* and McDowell's subgeneric distinctions (Parsons 1968). Zug (1966) found little variation in the penial structure of *Chrysemys picta* and *Pseudemys scripta, P. nelsoni, P. floridana,* and *P. concinna,* strengthening the inclusion of these turtles within *Chrysemys.* Weaver and Rose (1967) concurred with the inclusion of *Pseudemys* in *Chrysemys,* but showed the subgenera to be invalid, basing this on further examination of skull and shell characters.

Ernst and Barbour (1972), Conant (1975), and the Testudines Section of the *Catalogue of American Amphibians and Reptiles* (Society for the Study of Amphibians and Reptiles), of which the senior author is editor, recognize *Graptemys* and *Chrysemys.* There remains much disagreement about the generic arrangement of these turtles and many experts still maintain that *Pseudemys* is a separate genus.

Recently, Holman (1977) expressed doubts about the status of McDowell's (1964) genus *Chrysemys.* Holman points out that under McDowell's concept as many as four species may occur in the same water body in the southeastern United States and that, although they have similar courtship patterns, there are no records of hybridization between *Chrysemys picta* and other species of *Chrysemys.* However, hybrids are known within the subgenus *Pseudemys*: *C. floridana* × *C. concinna* (Smith, 1961)

Table 1.—Similarity indexes of the helminth faunas of North American *Chrysemys, Pseudemys,* and *Graptemys.*

	Chrysemys picta	*Pseudemys* (generic)	*Pseudemys scripta*	*Graptemys* (generic)
Chrysemys picta	—	50.0	48.2	38.7
Pseudemys (generic)	50.0	—	95.1	43.9
Pseudemys scripta	48.2	95.1	—	46.8
Graptemys (generic)	38.7	43.9	46.8	—

and *C. floridana* × *C. rubriventris* (Crenshaw, 1965). Holman (1977) urged additional study of the relationships within the genus. Consequently, the morphological, cytological, and biochemical characteristics are being reevaluated by investigators at the Carnegie Museum (Richard C. Vogt, pers. comm.).

We decided to approach the problem by comparing the species of endoparasitic helminths hosted by these turtles (see Ernst and Ernst, 1977; Rosen and Marquardt, 1978), excluding those helminths known only from experimental infections and those extralimital to *Chrysemys picta,* a species that is restricted to North America.

The helminths that parasitize any host are, in a sense, among the characteristics of that host (Manter, 1966). The fact that a certain species of turtle acts as the host of certain helminths characterizes that species of turtle just as do its morphological, cytological, or biochemical traits. Once established in a host, both the parasite and host evolve as a unit, while also undergoing their independent evolution. In time a given endoparasite becomes specifically adapted to the internal environment of its host species and it may not mature and survive except in that host, or in closely related species. Such host specificity may be used to show closeness of kinship between related species and is useful in determining phylogenetic affinities of hosts.

Materials and Methods

Table 3 lists the endoparasitic helminths known to occur in *Chrysemys picta,* the genus *Pseudemys, Pseudemys* (*Trachemys*) *scripta* (the species thought most closely related to *C. picta*), and the genus *Graptemys,* a third closely related genus (Ernst and Barbour, 1972).

Since the successful parasite is adapted to the ecological conditions of its microhabitat within the host, each host can be treated as a separate ecosystem. The methods of describing the relationships of species composition between ecosystems vary widely. One approach is comparisons based on

Table 2.—Similarity indexes of the helminth faunas of North American *Chrysemys*, *Pseudemys*, and *Graptemys*. A = excluding the trematodes *Polystomoides coronatum*, *Heronimus mollis*, and *Telorchis corti*, and the nematodes *Camallanus microcephallus*, *Spiroxys constrictus*, and *S. contortus*. B = excluding the same trematodes and nematodes and all acanthocephalans.

	Chrysemys picta		*Pseudemys* (generic)		*Pseudemys scripta*		*Graptemys* (generic)	
	A	B	A	B	A	B	A	B
Chrysemys picta	—	—	42.1	40.0	39.4	36.7	24.0	22.2
Pseudemys (generic)	42.1	40.0	—	—	94.5	93.3	34.3	33.3
Pseudemys scripta	39.4	36.7	94.5	93.3	—	—	36.9	36.4
Graptemys (generic)	24.0	22.2	34.3	33.3	36.9	36.4	—	—

diversity indexes. Sorensen's (1948) Index of Similarity is best suited for mathematically expressing the generic relationships of the helminth faunas of *Chrysemys*, *Pseudemys*, and *Graptemys*. To investigate the degree of similarity of the helminth faunas of each pair of genera, and between *C. picta* and *P. scripta*, all possible pairings were tested. The system of notation is

$$S = \frac{2C}{A + B} \times 100$$

where A = the number of helminth species in host A, B = the number of helminth species in host B, and C = the number of helminth species common to both hosts. Identity of host ecosystems is recorded as 100, and closely related, but not identical, hosts should show indexes approaching 100. The less closely related are the two hosts, the lower is the index.

Results

Table 1 presents the similarity indexes for all comparisons. The helminth fauna of *Pseudemys scripta* is similar (95.1) to the total helminth fauna reported from all of the North American members of the genus *Pseudemys* (McDowell's subgenus *Pseudemys*). This high index is indicative of closely related congeneric species which provide similar internal ecosystems for helminths. But *Chrysemys picta* has no index higher than 50.0 when compared with the total North American *Pseudemys*, and only a 48.2 index with *P. scripta*, with which it is thought to be most closely related. Present evidence suggests that *Chrysemys* and *Pseudemys* are sufficiently different to warrent recognition at the generic level. Also, the indexes given in Table 1 indicate that *Graptemys* is a separate genus.

Table 3.—Helminth faunas of North American *Chrysemys*, *Pseudemys*, and *Graptemys* (from Ernst and Ernst 1977, and Rosen and Marquardt 1978). + = present, − = absent.

	Chrysemys picta	*Pseudemys* (generic)	*Pseudemys scripta*	*Graptemys* (generic)
I. Monogenetic trematodes				
1. *Neopolystoma orbiculare*	+	+	+	−
2. *Polystomoidella hassalli*	−	+	+	−
3. *Polystomoidella oblongum*	+	+	+	−
4. *Polystomoides coronatum*	+	+	+	+
5. *Polystomoides multifalx*	−	+	−	−
6. *Polystomoides oris*	+	−	−	−
II. Digenetic trematodes				
1. *Allassostoma magnum*	−	+	+	−
2. *Allassostomoides chelydrae*	+	−	−	+
3. *Allassostomoides parvum*	+	+	−	−
4. *Auridostomum chelydrae*	+	−	−	−
5. *Cephalogonimus compactus*	−	+	−	−
6. *Cephalogonimus vesicaudus*	−	+	+	+
7. *Cotylaspis cokeri*	−	−	−	+
8. *Dictyangium chelydrae*	−	+	+	+
9. *Eustomos chelydrae*	+	−	−	−
10. *Henotosoma elephantis*	+	−	−	−
11. *Henotosoma haemotobium*	+	−	−	−
12. *Heronimus mollis*	+	+	+	+
13. *Macrovestibulum eversum*	−	−	−	+
14. *Macrovestibulum kepneri*	−	+	+	−
15. *Macrovestibulum kraatzi*	−	+	−	−
16. *Macrovestibulum obtusicaudum*	−	+	+	+
17. *Microphallus opacus*	+	−	−	+
18. *Pneumatophilus variabilis*	−	+	+	−
19. *Protenes angustus*	+	+	+	−
20. *Spirorchis artericola*	+	+	+	+
21. *Spirorchis blandingioides*	−	+	+	−
22. *Spirorchis elegans*	+	+	+	−
23. *Spirorchis innominatus*	+	+	−	+
24. *Spirorchis parvum*	+	−	−	−
25. *Spirorchis pseudemydae*	+	+	+	−
26. *Spirorchis scripta*	+	+	+	+
27. *Telorchis attenuatus*	+	−	−	−
28. *Telorchis corti*	+	+	+	+
29. *Telorchis diminutus*	−	+	+	−
30. *Telorchis gutturosi*	−	−	−	+
31. *Telorchis nectori*	−	−	−	+
32. *Telorchis nematoides*	+	+	+	−
33. *Telorchis robustus*	+	+	+	−
34. *Telorchis singularis*	−	+	+	−
35. *Unicaecum dissimile*	−	+	+	−
36. *Unicaecum ruszkowskii*	−	+	+	+

Table 3.—Continued.

	Chrysemys picta	*Pseudemys* (generic)	*Pseudemys scripta*	*Graptemys* (generic)
III. Cestodes				
1. *Proteocephalus testudo*	−	+	+	+
IV. Acanthocephalans				
1. *Leptorhynchoides* sp.	−	+	+	−
2. *Neoechinorhynchus chelonos*	−	+	+	−
3. *Neoechinorhynchus chrysemydis*	+	+	+	−
4. *Neoechinorhynchus emydis*	+	+	+	+
5. *Neoechinorhynchus emyditoides*	−	+	+	−
6. *Neoechinorhynchus magnapapillatus*	−	+	+	−
7. *Neoechinorhynchus pseudemydis*	+	+	+	−
8. *Neoechinorhynchus stunkardi*	−	+	+	+
V. Nematodes				
1. *Aplectana* sp.	+	+	+	−
2. *Camallanus microcephallus*	+	+	+	+
3. *Chelonidrancunculus* sp.	−	+	+	−
4. *Cissophyllus penitus*	−	+	+	−
5. *Cosmocercoides dukae*	−	−	−	+
6. *Cucullanus cirratus*	−	+	+	−
7. *Filaria* sp.	+	−	−	−
8. *Gnathostoma procyonus*	−	+	+	+
9. *Hedruris armata*	+	−	−	−
10. *Icosiella quadrituberculata*	−	+	+	−
11. *Oswaldocruzia leidyi*	−	−	−	+
12. *Oxyuroides* sp.	−	+	+	−
13. *Physaloptera* sp.	+	−	−	−
14. *Spironoura* sp.	+	+	+	−
15. *Spironoura affinis*	−	+	+	+
16. *Spironoura chelydrae*	−	+	+	−
17. *Spironoura concinnae*	−	+	+	+
18. *Spironoura gracilis*	−	+	+	−
19. *Spironoura procera*	−	+	+	−
20. *Spironoura wardi*	−	−	−	+
21. *Spiroxys constrictus*	+	+	+	+
22. *Spiroxys contortus*	+	+	+	+

Discussion

The number and variety of endoparasitic helminths which any host may have depends on favorable environmental conditions permitting contact between the final host and the infective stages of the parasite. This requires hosts to live in similar habitats (in this case, water bodies) and to feed on similar foods.

Use of the same water body occurs at Reelfoot Lake, Tennessee, where

Chrysemys picta, three species of *Pseudemys,* and at least two of *Graptemys* are sympatric. Also, Ernst (1971) and Moll (1973) have commented on apparent competition between *C. picta* and *P. scripta.* Thus, habitat differences alone cannot account for the low comparison indexes.

Chrysemys picta and the species of *Pseudemys* have similar feeding habits (Ernst and Barbour, 1972). They are carnivorous as juveniles, but become more herbivorous with age, eating many of the same animals and plants. Food habits do not explain their low parasite similarity. The species of *Graptemys* have different food preferences, being essentially insect or mollusk eaters, and this may result in the low similarity indexes with the other turtle groups.

This study assumes that all types of helminths are host specific. This is probably true of most species included in this study. Cestodes are definitely host specific (Baer, 1971). Many monogenetic and digenetic trematodes are specific as to their definitive host but others are not, and while these are specific to intermediate hosts, they depend more on the feeding habits of the final host (Manter, 1966). A similar situation may occur in some nematodes (Baer, 1971). *Polystomoides coronatum, Heronimus mollis, Telorchis corti, Camallanus microcephallus, Spiroxys constrictus,* and *S. contortus* parasitize *C. picta, Pseudemys, Graptemys* and many other species of turtles of several families (Ernst and Ernst, 1977), and probably fall into these latter groups. However, if these parasites are eliminated from the index calculations, the results are similar (Table 2) to those obtained earlier. This is also true if the turtle acanthocephalans are eliminated, which Fisher (1960) and Rosen and Marquardt (1978) feel are not sufficiently host specific (Table 2).

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FLORIASTER MAYA, NEW GENUS AND SPECIES OF THE FAMILY GONIASTERIDAE (ECHINODERMATA: ASTEROIDEA)

Maureen E. Downey

Abstract.—*Floriaster maya,* a new genus and species of goniasterid starfish from the Yucatan Channel, is described. It is mainly distinguished by the large, rough, cauliflower-like granules, and the single, irregular row of abactinal plates on the arms.

Among the many echinoderms collected by the Texas A&M University research vessel *Alaminos,* a single specimen of a goniasterid starfish was taken near the southern entrance to the Yucatan Channel in deep water. The specimen is in very good condition, and is so strikingly different that there is little doubt that it represents a new genus.

The Goniasteridae are a very large and widely distributed family, mainly from tropical and subtropical waters at moderate depths, but also with representatives in temperate, boreal, and austral waters, and in shallow and deep waters. They are abundantly represented in the Western Atlantic by about 34 species in 23 genera. Although Halpern (1970, 1970a) revised the Western Atlantic Goniasteridae, with particular attention to the Caribbean and Gulf of Mexico, new genera and species will undoubtedly be added as some of the less accessible and therefore less known areas of the region are explored (viz., the Yucatan Channel, Cayman and Puerto Rico Trenches, and the central Colombian and Venezuelan Basins).

Floriaster, new genus

Type-species.—*Floriaster maya,* n. sp.

Diagnosis.—Abactinal plates slightly tumid, irregular, closeset, not at all tabulate, surrounded by irregular row of rough, indented granules; some abactinals bare in center, many with 1–3 enlarged, rounded granules and/or small or large pedicellariae; superomarginal plates decidedly tumid, separated medially on arms by single row of abactinals; actinal plates large, few, mostly covered with large, irregular, indented granules, or 1–2 huge, cauliflower-like granules and/or tall, clapper-like pedicellariae; adambulacral furrow spines compressed, chisel-shaped.

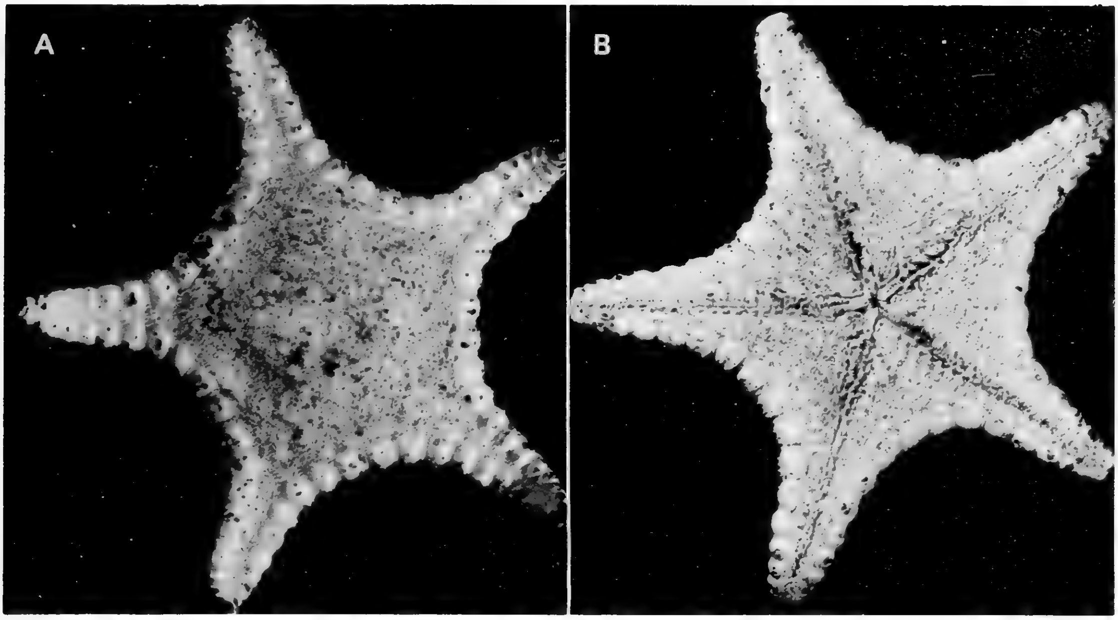

Fig. 1. *Floriaster maya*: **A,** Abactinal view; **B,** Actinal view.

Floriaster maya, new species

Type.—USNM E18324.

Type-locality.—Southern end of Yucatan Channel, 20°45′N, 86°27′W, 933–1,024 m, *Alaminos* Sta. 70A10–6, 6 July 1970.

Etymology.—Flos, floris (Latin)—flower (referring to the cauliflower-like granules); aster (Latin)—star, gender masculine; maya—a noun referring to the Mayan Indians of Yucatan.

Description.—Disc broad, thick; arms 5, moderately long, narrow; abactinal plates slightly tumid, irregular, very closeset, not at all tabulate; plates surrounded by row of rough, indented granules; some abactinals bare in center, most with 1–3 enlarged rounded granules and/or small or large pedicellariae (difficult to distinguish from granules); superomarginal plates on arms separated medially by single row of plates, bare or with single large granule; papulae single, scattered over entire disc; superomarginals decidedly tumid, bare, smooth, but with few, scattered, large, deciduous granules, each plate surrounded by single row of smaller granules (plates well-separated by these bands of granules); inferomarginal plates like superomarginals, with more granules and sometimes 1 or more tall, excavate pedicellariae; actinal areas large, plates large, few, irregularly polygonal, some with bare patch, most covered with large, irregular, indented granules or 1–2 huge, cauliflower-like granules or tall, clapper-shaped pedicellariae; adambulacral plates broader than long, with 7 compressed, chisel-shaped furrow spines, many (especially proximally) with flared, pitted tips, first spine short-

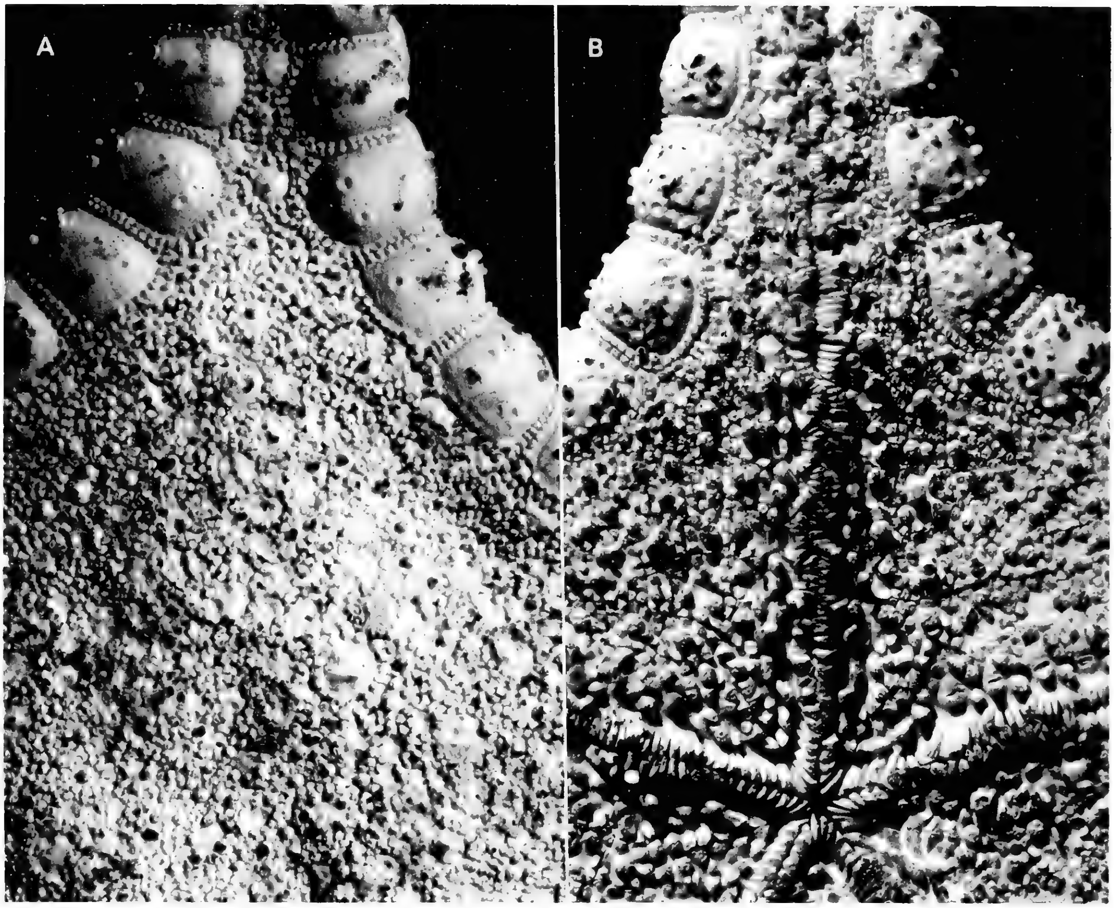

Fig. 2. *Floriaster maya*: **A,** Abactinal surface; **B,** Actinal surface.

er, broader, thicker; behind, plate bare except for 1 large, clapper-like pedicellaria and 0–2 large cauliflower-like granules; mouth plates large, triangular, with c. 10 compressed, chisel-like oral spines on each side, c. 10 rough, pitted granules, 1–2 large pedicellariae on surface; madreporite small, inconspicuous. Color: White (dried). R = 40 mm, r = 20 mm, R = 2; SM's = 20, R/SM = 2.

Discussion.—This new genus displays undoubted affinities with both *Circeaster* (Koehler, 1909) and *Astroceramus* (Fisher, 1906), but differs from both in the peculiar form of the granules and pedicellariae, in having a single (irregular) row of abactinal plates on the arms, and in the very tumid, strongly separated superomarginal plates. It differs also from *Circeaster* in lacking the enlarged abactinal plates on the arms, and in the size and shape of the granules and pedicellariae; and from *Astroceramus* in having none of the superomarginal plates in contact medially, and in lacking the bare abactinal plates covered with glassy bosses.

Acknowledgments

I thank Dr. Linda Pequegnat, of Texas A&M University, for sending me this interesting specimen. Thanks are also due to Dr. David L. Pawson, National Museum of Natural History, for reading the manuscript and making valuable suggestions.

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A NEW LIZARD OF THE GENUS *EMOIA* (SCINCIDAE) FROM THE FIJI ISLANDS

Walter C. Brown, John C. Pernetta, and D. Watling

Abstract.—A new species of *Emoia* from the Fiji Islands is described, with notes on its ecological niche relative to other species of the genus occurring in that group of islands.

Recent fieldwork in the Fiji Islands by several zoologists (the junior authors, B. Goldman, W. Beckon) has provided examples of a previously undescribed, relatively small *Emoia,* comparable in size to *E. cyanura* and *E. caeruleocauda,* which also occur in this island group along with several other skinks (Brown, 1956; Pernetta & Watling, in press). The Fiji collections in the British Museum (Natural History) provide three additional specimens of this heretofore undescribed species. The earliest specimen, accessioned in 1855, and one other were identified as *E. samoensis.* These were presumably regarded as juveniles, since the condition of the sex organs had not been examined. The third, accessioned in 1938, was labeled *Emoia* n. sp. in H. W. Parker's handwriting. We take pleasure in naming this species for Dr. Parker.

Emoia parkeri, new species
Figs. 1–3

Holotype.—California Academy of Sciences registry number 146960, mature female, collected at Naleboleba, Sigatoke Valley, Viti Levu Island, Fijis, by D. Watling, 16 March 1978.

Paratypes.—FIJI ISLANDS: Ovalou Island: BMNH 55.8.2.11; Taveuni Island: AM 71706, BMNH 1938.8.2.11; Viti Levu Island: AM 71707–08, CAS 146961–64; Kadavu Island: USP 4111–12, CAS 146965–66; specific island not recorded: BMNH 63.5.11.16, AMNH 117700. See acknowledgements for abbreviations.

Diagnosis.—A small *Emoia,* approximately 50 mm in snout–vent length for available mature specimens. This species differs from the two other small species of *Emoia* (*caeruleocauda* and *cyanura*) known from the Fijis and the Central Pacific Region in: (1) the distinct interparietal (Figs. 1 and 2); (2) the larger prefrontals which are usually in contact, separating the frontal from the frontonasal; (3) color pattern (Fig. 3); and (4) from *E. cyanura* in the less thinned and smaller number of subdigital lamellae. Other species of *Emoia* (*E. nigra,* and the E. *samoensis–concolor* complex)

Table 1.—Scale counts, measurements, and other characters for *E. parkeri* and related or sympatric species. Number of specimens in parentheses.

	Snout–vent length at maturity (mm)	Number of midbody scale rows	Number of scale rows between parietals & base of tail	Number of 4th toe lamellae	Interparietals	Prefrontals
Emoia speiseri	62.5–76.9 (9)	30–32	57–64	38–44	Small to moderate in size	Usually in contact
Emoia parkeri	48.5–53.8 (13)	28–32	52–59	34–43	Moderate in size	Usually in contact
Emoia caeruleocauda	41–48 (15)	28–32	54–59	38–44	Fused with frontoparietals	Not in contact
Emoia cyanura	41–61 (30)	26–29	54–63	58–85	Fused with frontoparietals	Not in contact
Emoia nigra	75–114 (50)	35–30	60–66	33–38	Small in size	Usually not in contact
Emoia samoensis	62–108 (9)	30–33	58–67	45–62	Small to moderate in size	
Emoia murphyi	62 (1)	30	56–58	79–81	Small or fused with frontoparietals	

known from the Fijis are readily distinguished from *E. parkeri* by their larger size and color pattern. *Emoia parkeri* is probably most closely related to *E. speiseri* (New Hebrides) from which is differs primarily in its much smaller size, distinct color pattern, and generally lower number of scale rows between the parietals and the base of the tail (Table 1).

Description.—An *Emoia* of relatively small size, snout-vent length of 4 mature males 48.5–51.5 mm, of 8 mature females 49.0–53.8 mm; snout long, tapering, round-pointed, rather strongly depressed, its length 40–45% of head length and 68–80% of head breadth; head breadth 54–62% of head length and 14–17% of snout-vent length; eye moderate, its diameter 51–63% of snout length, 37–45% of head breadth and 21–25% of head length; rostral broader than high, nearly truncate dorsally and in broad contact with frontonasal; supranasals small, widely separated; anterior loreal much longer than high, almost as long and about the same shape as posterior loreal (Fig. 1b); prefrontals in contact for 17 specimens and narrowly separated for five; frontal in contact with first two supraoculars, about the same length as the fused frontoparietals (fused for all but one specimen); four large supraoculars; interparietal small (Fig. 1a), about ⅓ length of frontoparietals; parietals large, in contact posteriorly; one pair of nuchals; 7 or 8 upper labials, 6th beneath the center of the eye; 6 or 7 lower labials; dorsal scales smooth or

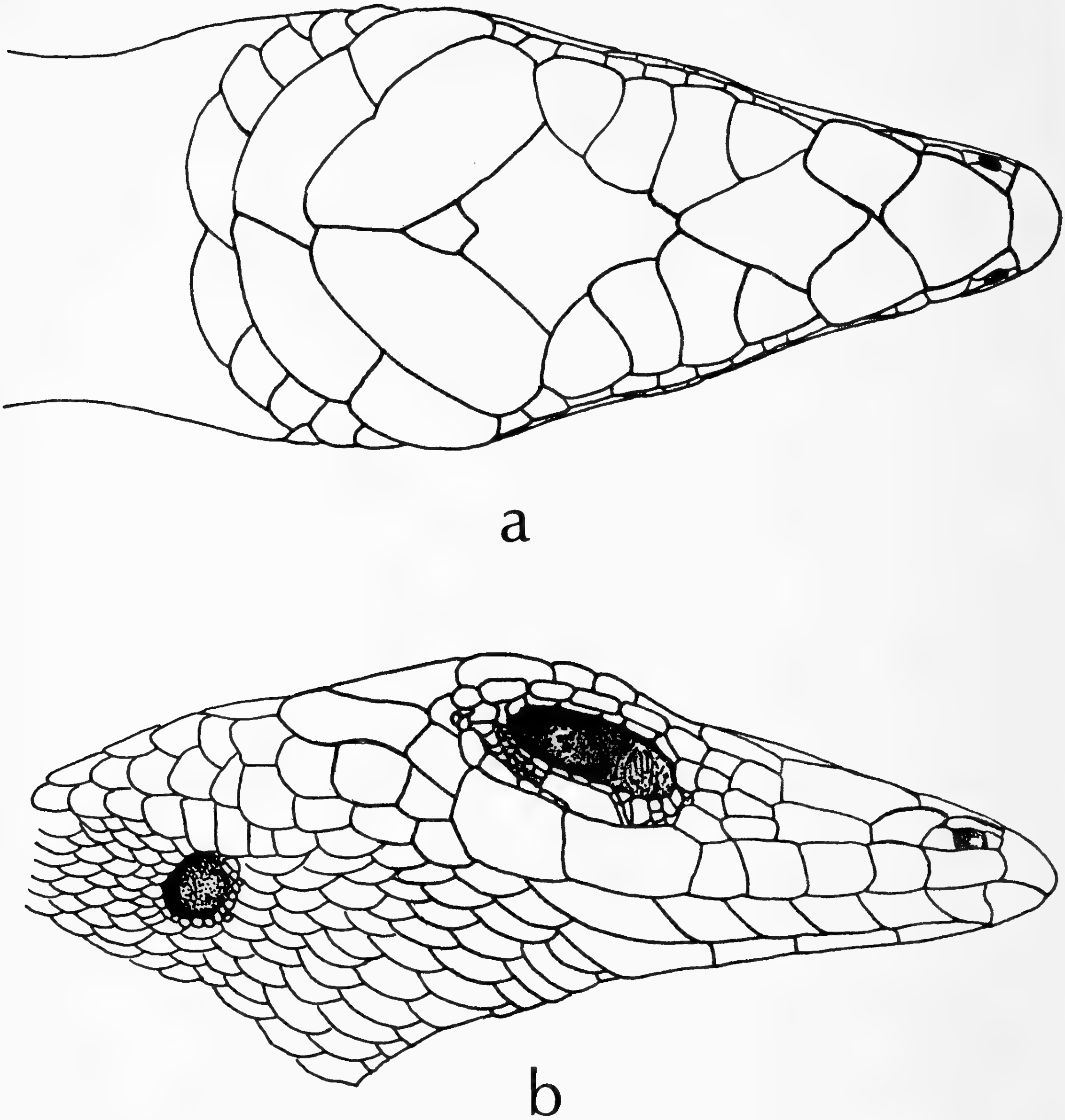

Fig. 1.—*Emoia parkeri* (paratype, USP 4111): **a,** Dorsal view of head; **b,** Lateral view of head.

very faintly keeled, relatively uniform in size and slightly larger than laterals, midbody scale rows 28–32 for 20 specimens; 52–59 transverse rows along the vertebral line between parietals and base of tail; preanals slightly enlarged; limbs well developed; length of extended hind limb 93–102% of axilla-groin distance and 45–52% of snout-vent length; 34–43 smooth lamellae beneath the 4th toe; rank of toes from the longest to the shortest is 4, 3, 5, 2, 1.

Measurements of holotype (mm).—Snout-vent length 51.7; tail length 81;

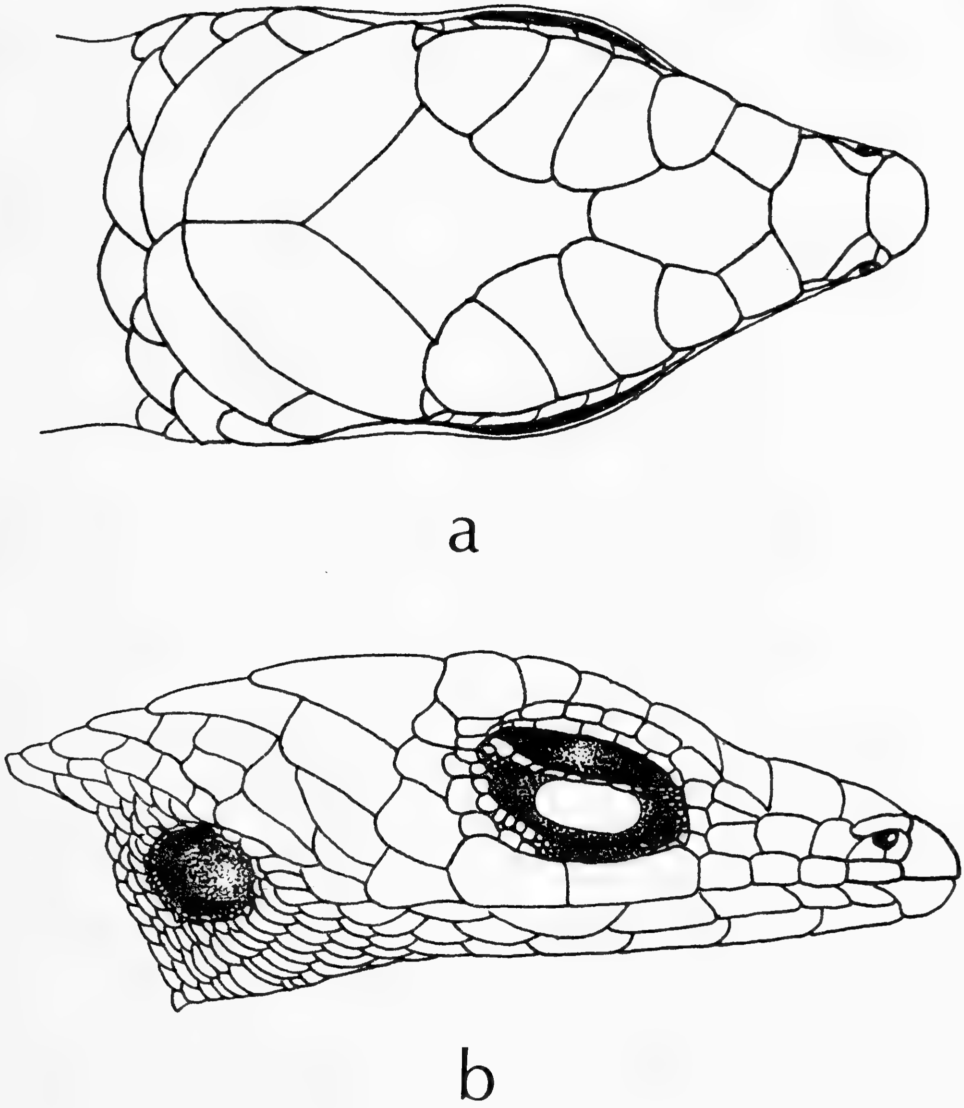

Fig. 2.—*Emoia caeruleocauda*: **a,** Dorsal view of head; **b,** Lateral view of head.

axilla-groin distance 25.5; length of hind limb 22.5; head length 12.4; head breadth 7.4; snout length 5.25; diameter of eye 3.0; diameter of ear 1.4.

Color.—The most striking feature in life is the gold-bronze head and upper lip which accentuates the black eye-stripe. The bronze of the head and neck merges into an olive-torquoise color which forms the basic color of the trunk. Below the eye the labial, subocular and loreal scutes are the same bronze color as the forehead and together accentuate the prominent black eye-stripe. This stripe extends along the body, becoming gradually less conspicuous until it is indistinguishable from the basic greenish-bronze color of the body around the hind limbs. Above this stripe on each side of the body there is, on some individuals, another stripe of black markings which runs

Fig. 3.—Photograph to show pigment pattern of *Emoia parkeri.*

from the fore limbs to the hind limbs. In other individuals this cannot be distinguished and is just a collection of black markings. On all specimens there is a clear line of basic greenish-bronze coloring along the spine. The basal half of the tail is more nearly torquoise-green, very conspicuously so in young specimens. The limbs are all bronze-olive on the dorsal surface, strongly speckled with dark and pale scutes. The tail is also speckled, but has a less granular appearance than the body or the limbs. The ventral surface is a pale yellow-green (Fig. 3a).

In preservative, the bright colors fade, becoming dull in formalin or alcohol. The mid-dorsal band (two half scales, or usually two scales in breadth) is greenish-blue, more or less uniform, bordered laterally by a broad blackish band (brownish in the faded, older specimens) which is disrupted or broken by numerous bluish scales or by clusters of light scales. There is also a dark band on the upper lateral surface, more or less uniform on the head and neck but also spotted by bluish-white scales on the body, the light mid-dorsal band merging into the bluish or tan color of the tail. The dorsal surface of the head is greenish-bronze; the venter is bluish-gray to light tan.

Eggs and hatchlings.—A single clutch of two eggs was collected by Watling from an earth-filled fissure between two trunks of a rain tree (*Samanea saman*) just above ground level. One egg hatched as it was collected. The other, which measured 13.0 × 9.0 mm, hatched two days later. Hatchling measurements: snout-vent length, 24 mm; tail 34 mm; hind limb, 12 mm.

Ecological note.—Emoia parkeri occupies the rainforest, being found in lowland forest near the coast to montane forest above 500 m. It has also been found in secondary forest in the intermediate zone vegetation of Viti Levu, and in trees from the dry western side of this island. On Viti Levu Island this species was observed primarily on lower tree trunks, up to about 7 m on some of the larger ones. It has not been observed on the boughs, branches or in the foliage. It is especially fond of large trees with epiphytes or creepers, or tree species with buttressed roots or deep fissures. When seen on the ground on this island the animal appeared to be moving from one tree to another. On Taveuni Island, *E. parkeri* was observed foraging on the ground alongside *E. cyanura* and *E. caerulecauda*.

Range.—Known at this time from four islands: Vitu Lavu, Ovalou, Taveuni, and Kadavu in the Fijis.

Discussion.—Unlike the other small species of *Emoia* in the Fijis, *E. parkeri* is difficult to catch by hand since it darts rapidly up the nearest tree when approached. Such behavior might explain why it has not formed a larger proportion of earlier collections from the Fiji Islands.

Also, unlike *E. cyanura, E. parkeri* is apparently confined to inland forest habitats. It appears not to occur on several small islands close to Suva which were extensively collected by the junior authors. While both *E. cyanura* and *E. caeruleocauda* are also found in forest habitats, they seem to be more abundant in open areas such as forest margins, glades, and native gardens, where they forage on the ground as noted above. Of the three species, *E. cyanura* is the most abundant and occupies the widest range of habitat types, being found from coastal associations up to the montane forest. *Emoia caeruleocauda,* the least common of the three species, appears to be confined to the lowland forest.

There also appears to be a marked ecological separation between *E. parkeri* and the green tree skink (*E. concolor–samoensis* complex). The latter, although much larger, is nearly always found high up in trees, on the limbs or in the foliage, although it often comes down the main trunk. On the basis of a couple of observations of each, the green tree skink sleeps up in the trees while the bronze-headed skink sleeps in fissures near the base.

Other ground-active skinks collected during the course of more extensive investigations on Fijian terrestrial vertebrates (Pernetta & Watling, in press) were *Lipinia noctua, Cryptoblepharus* sp., and *Emoia nigra,* all of which occur in coastal areas. The large *E. nigra* may be locally abundant, particularly in some coconut plantations. When it is present, the smaller ground-active *Emoia* species are invariably absent.

Acknowledgements

We are indebted to B. Goldman and W. Beckon as well as those early collectors who contributed to the British Museum (Natural History) for a few of the specimens of this species. We wish also to thank A. G. C. Grandison, British Museum (BMNH), Allen E. Greer, Australian Museum (AM), Richard G. Zweifel, American Museum of Natural History (AMNH), Alan E. Leviton, California Academy of Sciences (CAS), and the University of the South Pacific (USP) for the loan of pertinent material. The junior authors gratefully acknowledge the financial support of the University of the South Pacific and Cambridge University, and the senior author the financial assistance of the American Philosophical Society (Grant No. 7796).

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A NEW PSEUDOTHELPHUSID CRAB FROM THE STATE OF JALISCO, MEXICO

Horton H. Hobbs, Jr.

Abstract.—*Pseudothelphusa* (*Pseudothelphusa*) *seiferti* is described and illustrated from the Río Tuxpán basin in Jalisco, Mexico. Its affinities with *P.* (*P.*) *dugesi belliani* are discussed.

The only known specimen of the new species described herein was collected from the Río Tuxpán basin in Jalisco, Mexico, by Wayne Seifert of the Dallas Museum of Natural History. It appears to have its closest affinities with *Pseudothelphusa* (*P.*) *dugesi belliani* Rathbun (1898:515) which has been reported (Rodríguez and Smalley, 1969:82) from several localities in drainage basins to the south in the states of Guerrero, México, and Michoacán. Only two other members of the genus have been recorded from Jalisco (Rathbun, 1898:537): *Pseudothelphusa* (*P.*) *jouyi* Rathbun (1893:649) and *P.* (*P.*) *terrestris* Rathbun (1893:651).

My thanks are extended to Dr. Seifert, in whose honor the species is named, for donating the specimen to the Smithsonian Institution. I am also grateful to Raymond B. Manning and Austin B. Williams, colleagues in the Smithsonian, for their criticisms of the manuscript, and to Michael R. Carpenter for the photographs in Figure 1.

Pseudothelphusa (*Pseudothelphusa*) *seiferti*, new species
Figs. 1–2

Description.—The front of the carapace rises rather precipitously from the smooth inferior border, but no clearly defined superior border is evident (Fig. 1*a, b*). The inferior border is biconvex in dorsal aspect with the convexities slightly arched in frontal view. The carapace is weakly convex, and the several regions moderately well defined. The paired postfrontal lobules are rather distinctly delimited by a prominent median groove but are not clearly set off from the orbital areas. The limits of the epigastric regions are rather obscure, but the remaining usually recognized areas of the carapace can be readily discerned; the broadly V-shaped cervical groove is prominent as are the anterior arms of the branchiocardiac grooves. The anterolateral margin of the carapace is rather evenly rounded, but very weak emarginations are present immediately lateral to the orbit and at the anterior extremities of the cervical groove. The margin of the carapace posterior to the cervical groove is also rounded and devoid of denticles, and the dorsal

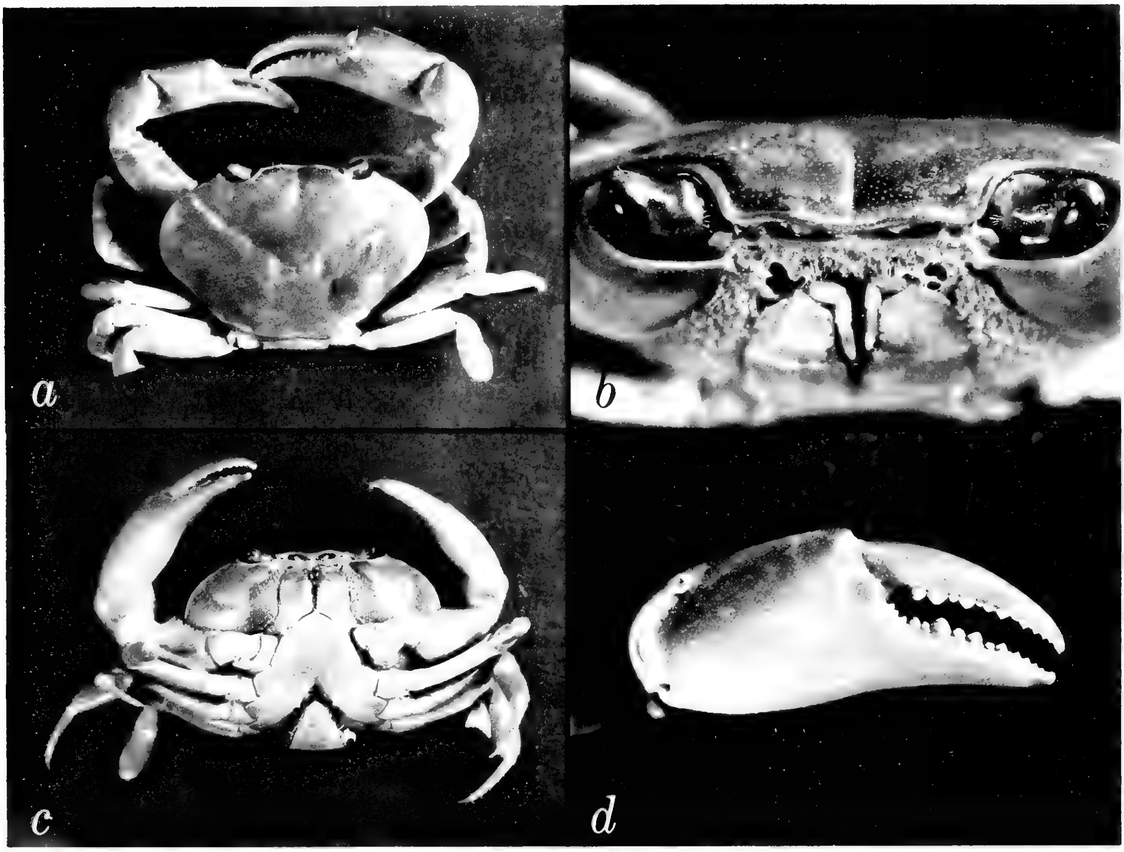

Fig. 1.—*Pseudothelphusa* (*P.*) *seiferti* (holotype): **a,** Dorsal view; **b,** Frontal view of occular region; **c,** Ventral view; **d,** Abductor surface of right chela.

surface is regularly punctate; whereas most of the punctations are small, a few larger ones are located in the frontal and hepatic regions, and an occasional one is present elsewhere.

The exopod of the third maxilliped (Fig. 1*c*), half the length of the ischium, reaches the base of the distal fourth of the latter. The right chela (Fig. 1*d*) is more robust than the left, its ventral margin is sinuous, and the surface of the palm and fingers is covered with fine punctations; two linear series of punctations are present on the fixed finger, one situated laterally and the other mesially, and both series are slightly depressed. Paired, less well defined series of fewer and somewhat larger punctations are present on the proximal extensor surface of the dactyl. The teeth on the opposable surfaces of the finger are of moderate size.

The gonopod of the male exhibits the following features: viewed mesially (Fig. 2*b*), the cephalodistal lobe of the appendage is produced in two rounded preapical lobules, the larger, more proximal one is directed proximally and the smaller one, cephalically; the difference in the size of the two is no greater than that in *Pseudothelphusa* (*P.*) *sulcifrons* Rathbun, 1898:522 (cf. Fig. 2*b* herein and Fig. 15c in Rodríguez and Smalley, 1969); in caudal

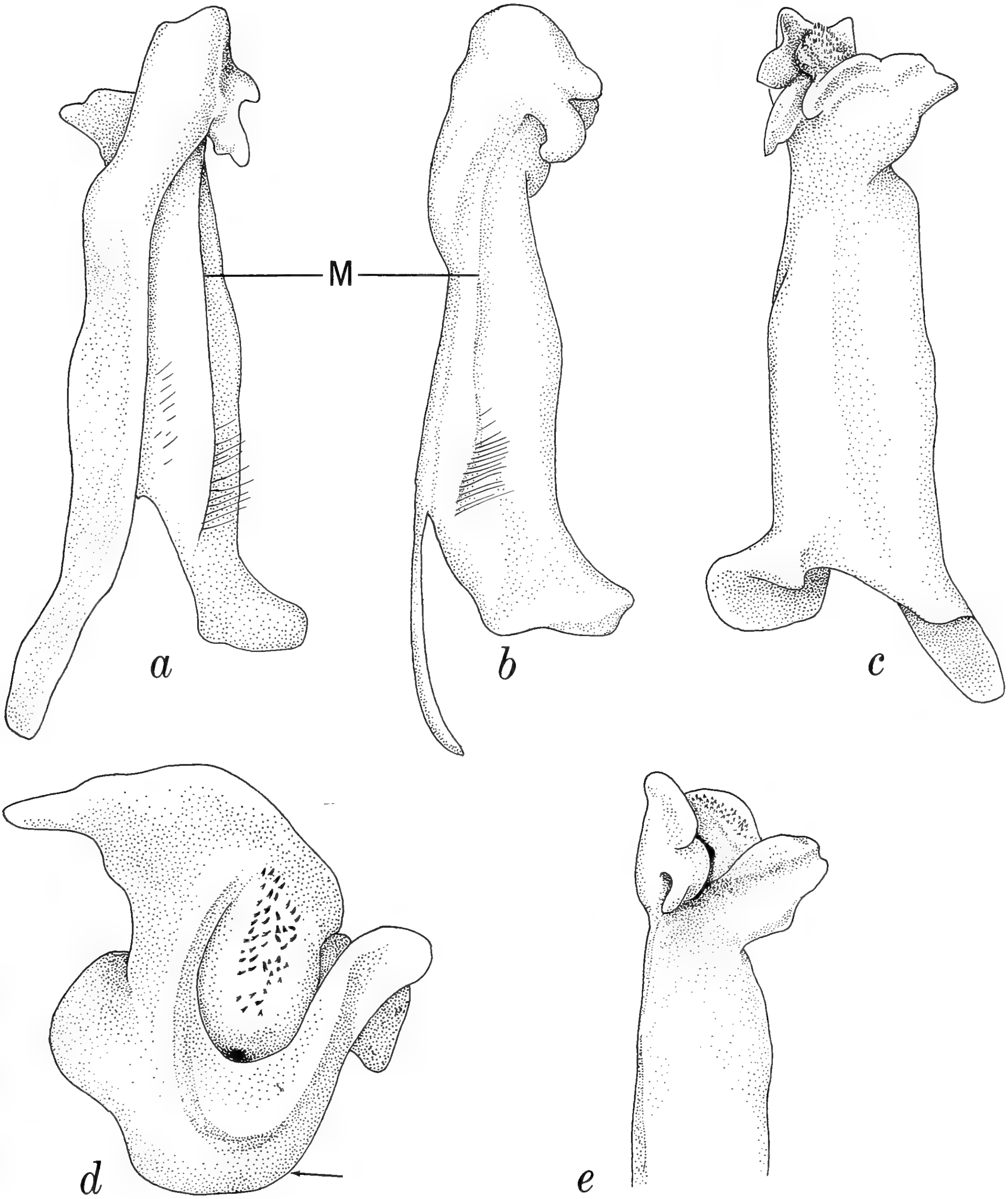

Fig. 2.—Right gonopod of *Pseudothelphusa* (*P.*) *seiferti*: **a,** Caudal view (M = "margin", see Smalley, 1964); **b,** Mesial view; **c,** Cephalolateral view; **d,** Apical view (arrow indicates approximate position of the "margin" proximally); **e,** Cephalomesial view.

aspect (Fig. 2*a*) the proximal larger lobule appears bilobed. A large and conspicuous lobe arising cephalolaterally is best viewed from the cephalolateral side of the appendage (Fig. 2*c*); it is not visible in mesial aspect, but in caudal aspect it appears as a broad triangular projection extending caudolaterally from the shaft of the appendage. The margin toward the distal end of the gonopod is undulating, and the subacute apex of the lobe is directed caudolaterally. In Figure 2*c*, the four apparent projections in the background are, from left to right, as follows: the larger and smaller (respectively) lobules on the mesial surface, the next is the crest of the mesial extremity of the gonopod, and the one on the right, the lateral elevated rim flanking the terminal setal field. The latter, best seen in apical view of the pleopod (Fig. 2*d*), is suboval and flanked by a horseshoe-shaped rim with the open end directed cephalolaterally; this exposed end of the field slopes proximally (Fig. 2*e*), and the sperm groove opens at the opposite end in a distinct subcircular pit. The setae are pale brown to tan.

Measurements (in mm).—Width of carapace 46.5; length of carapace 29.7; width of fronto-orbital region 12.8; length of the cardiac-intestinal region 13.2. The limits employed in these measurements are those used by Rodríguez and Smalley (1969:70).

Type.—The holotypic male is deposited in the United States National Museum of Natural History (Smithsonian Institution), no. 173884.

Type-locality.—A steep slope flanking a stream flowing along Highway 110, 38 kilometers south of Mazamitla, Jalisco, Mexico. On 24 July 1978, when the specimen was collected, there was a pumping station at the locality, and the crab was found in a damp area surrounding a drip from a leaking pipe. This collecting site is situated in the Río Tuxpán (a tributary to Río Coahuayana) watershed.

Relationships.—This crab appears to be more closely allied to *Pseudothelphusa* (*P.*) *dugesi belliana* than to the other two subspecies or their relatives (see Rodríguez and Smalley, 1969). The similarities are conspicuously evident in the structure of the distal part of the gonopod of the male. Basically the mesial (internal) and cephalolateral (external) lobes are much alike, but the smaller, more distal lobule of the mesial lobe is comparatively larger and more distinctly delimited basally in *P.* (*P.*) *seiferti* than it is in *P.* (*P.*) *d. belliana*; the more proximal lobule is comparatively smaller than it is in the latter. The cephalolateral lobe is more evenly rounded, and its mesial expanse is distinctly less than that in *P.* (*P.*) *d. belliana.* Perhaps more obvious is the difference in the front of the carapace in the two: in *P.* (*P.*) *seiferti* the superior border is lacking, and tubercles are absent; furthermore the anterolateral margins of the carapace are also devoid of tubercles that are sometimes present in members of *P.* (*P.*) *dugesi belliana.*

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THE SUPERFAMILIES, FAMILIES, AND GENERA OF RECENT STOMATOPOD CRUSTACEA, WITH DIAGNOSES OF SIX NEW FAMILIES

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Abstract.—Four new superfamilies are recognized: Bathysquilloidea, Gonodactyloidea, Lysiosquilloidea, and Squilloidea. Six new families are recognized: Hemisquillidae, for *Hemisquilla,* formerly assigned to the Pseudosquillidae; Odontodactylidae, for *Odontodactylus,* and Protosquillidae, for *Protosquilla* and three other genera, all formerly assigned to the Gonodactylidae; Coronididae and Nannosquillidae, based on three and 10 genera, respectively, previously assigned to the Lysiosquillidae; and Harpiosquillidae, for *Harpiosquilla,* previously assigned to the Squillidae. The first four new families have raptorial claws adapted for smashing, the last two for spearing. Original citations for the six previously established families and all 66 currently recognized genera of Recent Stomatopoda are included.

A review of the classification of Recent Stomatopoda has been in preparation for several years. Its completion has been delayed unavoidably and regrettably will be delayed further. Accounts now in preparation of the results of several different studies will be more meaningful if the proposed classification, which is now in manuscript form, could be used in them. For this reason, this account of six new families, accompanied by a key to superfamilies and families as well as a list of genera belonging to them, is presented here.

The more detailed review takes into account recent findings in morphology, evidence from behavioral studies by colleagues, and other information, such as the determination that although species of some genera, such as *Gonodactylus* (see Manning and Provenzano, 1963) and *Squilla* (see Giesbrecht, 1910), carry their egg mass in an irregular ball, some members of at least one genus, *Nannosquilla,* attach their eggs singly to the sides of their burrow (Manning, 1979), demonstrating fundamental differences in brood care within the group.

Recent studies on agonistic behavior of stomatopods (Caldwell and Dingle, 1975) have revealed the functional significance of the two kinds of raptorial claw found in the group. One is a spearing appendage, with a slender dactylus armed with teeth on its opposable margin, adapted for preying on soft bodied organisms; it is found in squillids, eurysquillids, pseudosquillids, and most of the genera then assigned to the Lysiosquillidae. The other is a smashing appendage, with the dactylus inflated proximally and usually unarmed, adapted for feeding on hard-bodied organisms such as mollusks and crustaceans: it is found in most genera hitherto assigned to the Gonodactylidae.

Three genera, *Coronida, Neocoronida,* and *Parvisquilla,* currently assigned to the Lysiosquillidae, differ from the remaining members of the family in that they possess a smashing claw (Manning, 1978a: figs. *7b, 8c*). A second group of 10 genera, *Nannosquilla* and allies, that has been placed in the Lysiosquillidae, differ from other lysiosquillids in their smaller size, in the shape of the endopods of the walking legs, and in having a distinct proximal fold on the inner margin of the uropodal endopod (Manning, 1969b: 21, first couplet of key). Each of these two groups of genera are assigned to new families.

Members of one genus of the very diverse family Squillidae, *Harpiosquilla,* share the spearing claw with the other members of that family, but differ in size and in numerous morphological features, including the deep excavations of the posterolateral angles of the carapace, unique within the Stomatopoda, and the structure of the claw, with numerous long, erect spines replacing the usual pectinations on the opposable margin of the propodus (Manning, 1969c). *Harpiosquilla* is relegated to a new family.

The representatives of the genus *Hemisquilla,* until now recognized as belonging to the Pseudosquillidae, differ from those of other genera in the family in being much larger, in having a large, globular eye, and in having an unarmed smashing claw (Manning, 1969b: figs. 68, 69), rather than a slender spearing claw armed with three or more teeth. *Hemisquilla* is assigned to a new family.

Certain genera previously recognized as belonging to the Gonodactylidae are transferred to new families. One contains *Odontodactylus* which differs from gonodactylids in being much larger, in having a different kind of telson ornamentation, a rostral plate that lacks an apical spine, and in having the dactylus of the smashing claw provided with teeth; the ischiomeral articulation of the claw in *Odontodactylus* is subterminal, as however, it is in the Gonodactylidae *s.s.* (Manning, 1969b: figs. 80, 81). A second group of four genera, related to *Protosquilla,* agrees with almost all other Recent stomatopods and differs from the Gonodactylidae as restricted herein in having the articulation of the distal segment of the uropod terminal rather than subterminal (compare figures 6b and 7b, terminal articulation, with figures 1b and 3c, subterminal articulation, in Manning, 1969a); these four genera are assigned to a new family herein.

The Stomatopoda represent an old crustacean stock, the Hoplocarida (Schram, 1969, 1973), the Recent members of which in my opinion are far more diverse than suggested by past classifications. Many genera that are now recognized appear to be relicts, broadly distributed but containing few species, each with relatively restricted ranges: *Pseudosquillopsis,* with one species in the East Atlantic, two in the East Pacific, and one in the Indo-West Pacific (Manning, 1977a: fig. 50), is a good example. Other genera, like *Gonodactylus* (35+ species), *Squilla* (30 species), and *Oratosquilla* (22 species), with larger numbers of species, each usually occupying relatively broad ranges, may well represent younger stock.

The proposed familial revision does not alter the concept that Recent Stomatopoda comprises four distinct lineages: 1, bathysquillid (Bathysquillidae); 2, squillid (Harpiosquillidae and Squillidae); 3, gonodactylid (Eurysquillidae, Gonodactylidae, Hemisquillidae, Odontodactylidae, Protosquillidae, and Pseudosquillidae); and 4, lysiosquillid (Coronididae, Lysiosquillidae, and Nannosquillidae). These four lineages are recognized herein as new superfamilies.

The Order Stomatopoda recently was divided into two suborders by Schram (1969). The Suborder Archaeostomatopoda Schram (1969:260) was established for the fossil family Tyrannophontidae Schram (1969:260), containing the single genus *Tyrannophontes* Schram (1969:260), represented by a single species from the Middle Pennsylvanian. The Suborder Opisterostomatopodea Schram (1969:266) was established to contain the fossil family Sculdidae Dames (1886:565), in which the uropodal exopod is one-segmented, and the four families of Recent Stomatopoda then recognized, Bathysquillidae, Gonodactylidae, Lysiosquillidae, and Squillidae, in which the uropodal exopod is two-segmented.

However, as pointed out by Holthuis and Manning (1969:R542), the subordinal category Unipeltata Latreille (1825:283) was recognized by that author for the Stomatopoda *sensu stricto.* Unipeltata Latreille has clear precedence over Opisterostomatopodea Schram.

It is clear that several morphological features, important at different levels of classification, have been retained or developed independently in different stomatopod lineages, including: body carination (Squillidae and Harpiosquillidae); smashing claws in the Coronididae and the Gonodactylidae, Hemisquillidae, Odontodactylidae, and Protosquillidae (armed with teeth in the Coronididae and Odontodactylidae), spearing claws in the other families; elongate antennular somite in *Parvisquilla* (Coronididae), *Eurysquilloides* (Eurysquillidae), and *Leptosquilla* and *Tuleariosquilla* (Squillidae); and spined rather than pectinate opposable margin of the propodus of the claw in Bathysquillidae and Harpiosquillidae.

These changes in the classification of Recent stomatopods have resulted largely from my own observations, some unpublished, stimulated and aided by discussions of problems in the group with Roy L. Caldwell, University of California, Berkeley, Hugh Dingle, University of Iowa, and Marjorie L. Reaka, University of Maryland, all of whom have freely shared field observations with me.

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Superfamilies, Families, and Genera of Recent Stomatopoda

Superfamily Bathysquilloidea Manning, 1967

Diagnosis.—Propodi of posterior 3 maxillipeds slender, not beaded or ribbed ventrally. Telson with distinct median carina. All marginal teeth of telson with movable apices.

Included families.—Bathysquillidae Manning, 1967.

Family Bathysquillidae Manning (1967:238)

Diagnosis.—Size large to very large. Body loosely articulated, depressed. Propodus of claw with erect spines, dactylus slender, opposable margin with teeth.

Included genera.—Two: *Bathysquilla* Manning (1963:323) and *Indosquilla* Ingle and Merrett (1971:193).

Superfamily Gonodactyloidea Giesbrecht, 1910

Diagnosis.—Propodi of posterior 3 maxillipeds slender, not beaded or ribbed ventrally. Telson with distinct median carina. At most submedian teeth of telson with movable apices. No more than 2 intermediate denticles present on telson.

Included families.—Eurysquillidae Manning, 1977, Gonodactylidae Giesbrecht, 1910, Hemisquillidae, new family, Odontodactylidae, new family, Protosquillidae, new family, and Pseudosquillidae Manning, 1967.

Family Eurysquillidae Manning (1977a:33)

Diagnosis.—Size very small to moderate. Body loosely articulated, depressed. Rostral plate unarmed or with up to 2 apical spines. Ischiomeral articulation of raptorial claw terminal. Dactylus of claw slender, not inflated basally, opposable margin armed with 4 or more teeth. Articulation of uropod segments terminal.

Included genera.—Five: *Coronidopsis* Hansen (1926:19), *Eurysquilla* Manning (1963:314), *Eurysquilloides* Manning (1963:315), *Manningia* Serène (1962:20), and *Sinosquilla* Liu and Yongliang (1978:89) [a senior synonym of *Eurysquillopsis* Makarov (1978:185)].

Family Gonodactylidae Giesbrecht (1910:148)

Diagnosis.—Size very small to moderate. Body compact, subcylindrical. Rostral plate with apical spine. Ischiomeral articulation of raptorial claw subterminal. Dactylus of claw stout, inflated basally, opposable margin unarmed. Articulation of uropodal exopod segments subterminal.

Included genera.—Seven: *Gonodactylolus* Manning (1970:206), *Gonodactylopsis* Manning (1969a:149), *Gonodactylus* Berthold (1827:271), *Hoplosquilla* Holthuis (1964:141), *Hoplosquilloides* Manning (1978a:6), *Mesacturoides* Manning (1978b:1), and *Mesacturus* Miers (1880:124).

Hemisquillidae, new family

Diagnosis.—Size large. Body compact, depressed. Rostral plate triangular, lacking apical spine. Ischiomeral articulation of claw terminal, merus not projecting posteriorly. Dactylus of claw inflated basally, opposable margin unarmed. Articulation of uropodal exopod segments terminal.

Included genera.—One, the type-genus, *Hemisquilla* Hansen (1895:72).

Odontodactylidae, new family

Diagnosis.—Size moderate to large. Body compact, subcylindrical. Rostral plate unarmed. Ischiomeral articulation of claw subterminal. Dactylus of claw inflated basally, opposable margin with teeth. Articulation of uropod exopod segments terminal.

Included genera.—One, the type-genus, *Odontodactylus* Bigelow (1893:100).

Protosquillidae, new family

Diagnosis.—Size very small to moderate. Body compact, subcylindrical. Rostral plate trispinous. Ischiomeral articulation of claw subterminal. Dactylus of claw inflated basally, opposable margin unarmed. Articulation of uropod exopod segments terminal.

Included genera.—Four: the type-genus *Protosquilla* Brooks (1886:84), *Chorisquilla* Manning (1969a:157), *Echinosquilla* Manning (1969a:155), and *Haptosquilla* Manning (1969a:159).

Family Pseudosquillidae Manning (1977a:95)

Diagnosis.—Size small to moderate. Body compact, subcylindrical or depressed. Rostral plate unarmed or with apical spine. Ischiomeral articulation of claw terminal. Dactylus of claw slender, opposable margin with teeth. Articulation of uropodal exopod segments terminal.

Included genera.—Four: *Faughnia* Serène (1962:17) (see Manning and Makarov, 1978:517), *Parasquilla* Manning (1961:7), *Pseudosquilla* Dana (1852:615), and *Pseudosquillopsis* Serène (1962:12).

Superfamily Squilloidea Latreille, 1803

Diagnosis.—Propodi of posterior 3 maxillipeds slender, not beaded or ribbed ventrally. Telson with distinct median carina. At most submedian teeth of telson with movable apices. 4 or more intermediate denticles present on telson.

Included families.—Harpiosquillidae, new family, and Squillidae Latreille, 1803.

Harpiosquillidae, new family

Diagnosis.—Size large to very large. Body depressed, carinate. Carapace with posterolateral margin deeply excavate. Propodus of claw with erect spines on opposable margin.

Included genera.—One, the type-genus, *Harpiosquilla* Holthuis (1964:140).

Family Squillidae Latreille (1803:36)

Diagnosis.—Size small to large. Body depressed, carinate. Posterolateral margin of carapace without deep excavation. Propodus of claw pectinate on opposable margin.

Included genera.—24: *Alima* Leach (in Tuckey, 1817: unnumbered plate), *Alimopsis* Manning (1977b:421), *Anchisquilla* Manning (1968:127), *Anchisquilloides* Manning (1977b:421), *Areosquilla* Manning (1976b:2), *Busquilla* Manning (1978a:23), *Carinosquilla* Manning (1968:135), *Clorida* Eydoux and Souleyet (1842:264), *Cloridopsis* Manning (1968:128), *Distosquilla* Manning (1977b:421), *Dictyosquilla* Manning (1968:131), *Kempina* Manning (1978c:39), *Lenisquilla* Manning (1977b:422), *Levisquilla* Manning (1977b:422), *Leptosquilla* Miers (1880:12), *Lophosquilla* Manning (1968:133), *Meiosquilla* Manning (1968:125), *Natosquilla* Manning (1978c:40), *Oratosquilla* Manning (1968:133), *Pterygosquilla* Hilgendorf (1890:172), *Schmittius* Manning (1972:300), *Squilla* Fabricius (1787:333), *Squilloides* Manning (1968:131), and *Tuleariosquilla* Manning (1978a:30).

Superfamily Lysiosquilloidea Giesbrecht, 1910

Diagnosis.—Propodi of posterior 3 maxillipeds broad, usually beaded or ribbed ventrally. Telson lacking distinct median carina. At most submedian teeth of telson with movable apices.

Included families.—Coronididae, new family, Lysiosquillidae Giesbrecht, 1910, and Nannosquillidae, new family.

Coronididae, new family

Diagnosis.—Size very small to moderate. Body depressed, compact. Dactylus of claw inflated basally, with teeth on opposable margin. Endopods of walking legs slender. Uropodal endopod lacking proximal fold on inner margin.

Included genera.—Three: *Coronida* Brooks (1886:84), the type-genus; *Neocoronida* Manning (1976a:222); and *Parvisquilla* Manning (1973:299).

Family Lysiosquillidae Giesbrecht (1910:148)

Diagnosis.—Size moderate to very large. Body loosely articulated, depressed. Dactylus of claw not inflated basally. Endopods of walking legs slender. Uropodal endopod lacking proximal fold on inner margin.

Included genera.—Four: *Heterosquilla* Manning (1963:320), *Heterosquilloides* Manning (1966:124) (until now considered to be a subgenus of *Heterosquilla*), *Lysiosquilla* Dana (1852:615), and *Lysiosquilloides* Manning (1977a:84).

Nannosquillidae, new family

Diagnosis.—Size very small to moderate. Body loosely articulated, depressed. Dactylus of claw not inflated basally. Endopods of anterior 2 walking legs ovate or subcircular. Uropodal endopod with strong proximal fold on outer margin.

Included genera.—Ten: *Acanthosquilla* Manning (1963:319); *Allosquilla* Manning (1977a:64); *Austrosquilla* Manning (1966:127); *Coronis* Desmarest (1823:345); *Hadrosquilla* Manning (1966:115); *Keppelius* Manning (1978a:9); *Nannosquilla* Manning (1963:318), the type-genus; *Nannosquilloides* Manning (1977a:89); *Platysquilla* Manning (1967:238); and *Pullosquilla* Manning (1978a:18).

Key to the Recent Superfamilies and Families of Stomatopoda

1. Propodi of third and fourth maxillipeds broad, usually beaded or ribbed ventrally. (Telson lacking sharp median carina) [Lysiosquilloidea] 2
– Propodi of third and fourth maxillipeds slender, not beaded or ribbed ventrally (Telson with sharp median carina) 4
2. Distal segment of endopod of anterior 2 walking legs broadly ovate or subcircular. Proximal portion of outer margin of uropodal endopod with strong fold .... Nannosquillidae, new family
– Distal segment of endopod of anterior two walking legs strap-shaped, elongate. Proximal portion of outer margin of uropodal endopod lacking strong fold 3
3. Dactylus of claw inflated basally. Propodus of claw pectinate proximally only. Rostral plate rounded or subrectangular .... Coronididae, new family

– Dactylus of claw not inflated basally. Propodus of claw fully pectinate. Rostral plate cordiform or triangular .. Lysiosquillidae Giesbrecht

4. All marginal teeth of telson with movable apices [Bathysquilloidea] .... Bathysquillidae Manning

– At most submedian marginal teeth with movable apices **5**

5. Four or more intermediate denticles present on telson [Squilloidea] **6**

– No more than 2 intermediate denticles present on telson [Gonodactyloidea] **7**

6. Posterolateral angles of carapace deeply emarginate .... Harpiosquillidae, new family

– Posterolateral angles of carapace rounded. Propodus of claw pectinate, lacking erect spines .... Squillidae Latreille

7. Ischiomeral articulation of claw subterminal, merus projecting posteriorly beyond articulation. Dactylus of claw inflated basally, with prominent, rounded projection on outer (extensor) margin **8**

– Ischiomeral articulation of claw terminal, merus not projecting posteriorly beyond articulation. Dactylus of claw not broadly inflated, lacking prominent projection on outer (extensor) margin **10**

8. Rostral plate lacking apical spine. Dactylus of claw with teeth on inner (flexor) margin .... Odontodactylidae, new family

– Rostral plate with apical spine. Dactylus unarmed on inner margin **9**

9. Articulation of segments of uropodal exopod subterminal, proximal segment projecting posteriorly beyond articulation .... Gonodactylidae Giesbrecht

– Articulation of segments of uropodal exopod terminal, proximal segment not projecting posteriorly beyond articulation .... Protosquillidae, new family

10. Rostral plate triangular. Cornea globular. Dactylus of claw unarmed .... Hemisquillidae, new family

– Rostral plate oval or pentagonal, not triangular. Cornea not globular. Dactylus of claw with teeth **11**

11. Body loosely articulated. Dactylus of claw with 4 or more teeth .... Eurysquillidae Manning

– Body compact. Dactylus of claw with no more than 3 teeth .... Pseudosquillidae Manning

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A NEW CRAWFISH OF THE GENUS *ORCONECTES* FROM EASTERN NEW YORK (DECAPODA: CAMBARIDAE)

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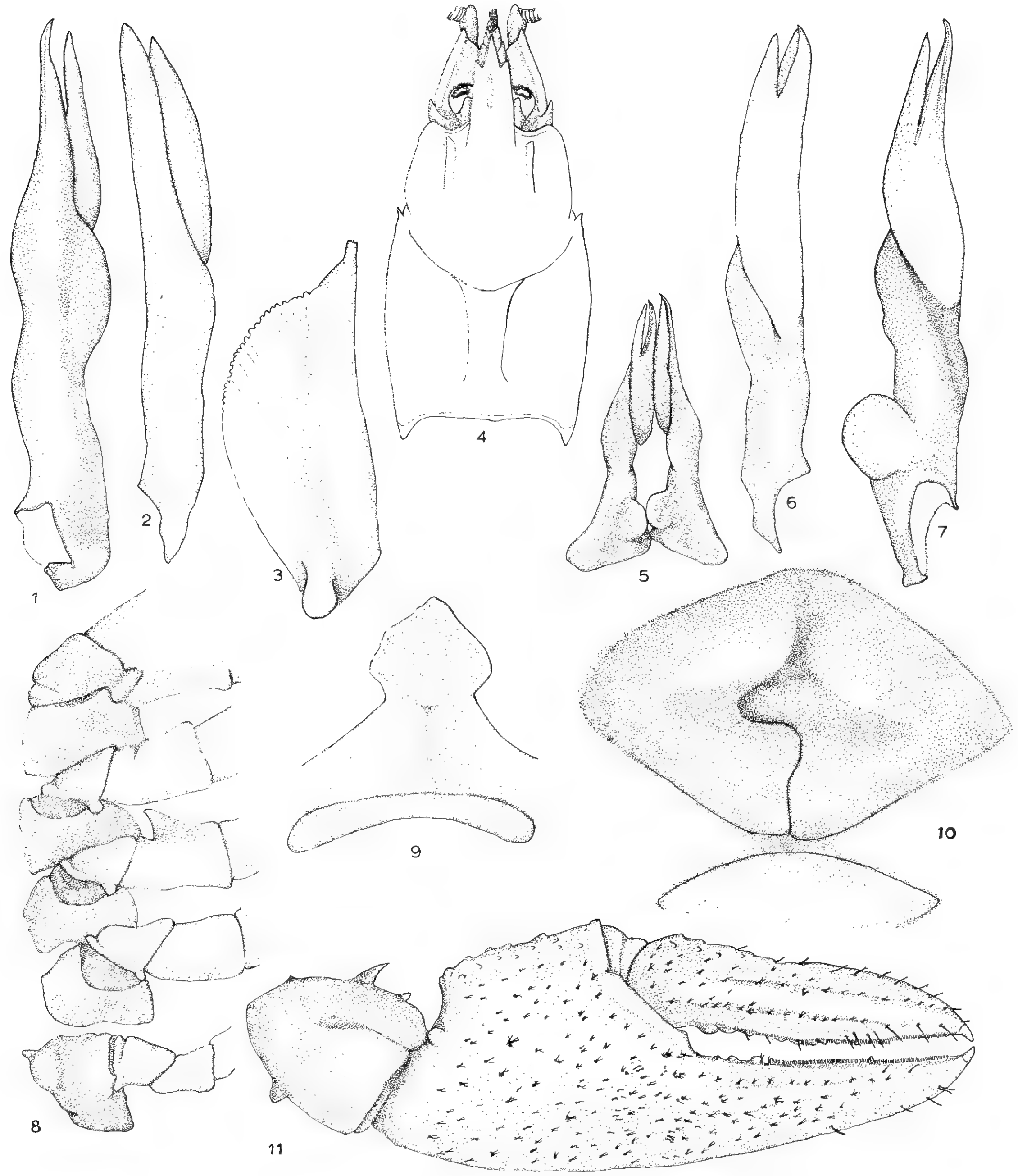
Abstract.—A new crawfish, *Orconectes kinderhookensis,* is described from Columbia and Rensselaer counties, New York. It is closely related to *O. propinquus* (Girard) and may be distinguished from it in that the mesial process of the first form male is markedly shorter than the central projection; the annulus ventralis of the female is also more sculptured. The distribution of the new species appears quite restricted.

The last comprehensive account of the New York crawfishes (Crocker, 1957) listed five species of the genus *Orconectes*: *O. immunis* (Hagen, 1870), *O. limosus* (Rafinesque, 1817), *O. obscurus* (Hagen, 1870), *O. propinquus* (Girard, 1952) and *O. virilis* (Hagen, 1870). These represent three remotely related groups. All but *O. obscurus* are represented in the drainages of the east bank of the Hudson River, but *O. propinquus* of this area was restricted to the "northern Hudson River" by Fitzpatrick (1967:146).

Recent collections in Kinderhook Creek in Columbia and Rensselaer counties indicated that four species of *Orconectes* inhabit the creek: *O. limosus, O. virilis, O. propinquus* and a species closely related to the latter but yet undescribed (Smith, 1979; JFP, personal collections). Surrounding stream systems are populated by *O. propinquus,* but in Kinderhook Creek, the populations of *propinquus* are scattered, restricted and entirely surrounded by populations of the undescribed species. The stream is an excellent fishing creek, supporting good populations of trout, largemouth and smallmouth bass, and other attractive fish. One is led to speculate, then, that one species is the native one, and that the other populations represent successful introductions by fishermen.

Crocker (1957:76) mentions that USNM no. 74712 is a collection of *O. obscurus* from the creek. We have examined this collection (Kinderhook Ck at Kinderhook, Rensselaer Co, NY, 5 ♂II, 31 Aug 1934, Townes and Nevin, collectors) and four of the specimens are *O. limosus* and the fifth is a member of the species described below. (W. L. Schmitt had identified it as *obscurus,* but the container has a note, initialled by Crocker and dated July, 1951, identifying the specimens as "Orconectes sp.") On page 77 he gave another Kinderhook Creek locality (DWC-132, now at USNM; Kinderhook Creek at crossing of Rte 9, between the towns of Valatie and Kin-



Figures 1–11 (All of holotype, unless otherwise noted). **1,** lateral view of first pleopod; **2,** lateral view of first pleopod of morphotype; **3,** antennal scale; **4,** dorsal view of carapace; **5,** caudal view of first pleopods; **6,** mesial view of first pleopod of morphotype; **7,** mesial view of first pleopod; **8,** basal podomeres of pereiopods; **9,** epistomal region; **10,** annulus ventralis of allotype; **11,** distal podomeres of cheliped.

derhook, 3 ♂II, 1 j♀, 1 July 1951, J. A. Gustafson and Earl Deubler, Jr., collectors). This collection has also been examined and we concur with his identification of these specimens as *O. limosus*. Smith (1979:134) reported *O. propinquus* from the creek in Nassau Township, Rensselaer County; we have seen these specimens and agree with his identification.

Orconectes kinderhookensis, new species

Figs. 1–11

Orconectes obscurus.—Crocker, 1957:76 [in part; see above].

Diagnosis.—Pigmented; eyes normal. Rostrum with margins slightly converging cephalically, sometimes subparallel, terminating in small acute spines; acumen prominent but not bearing median carina found on rostrum. Areola 29.51–36.10 (avg. 32.64) percent of entire length of carapace and 2.05–5.88 (avg. 4.15) times as long as wide, with 3–6 punctations in narrowest part. Cervical spines present, occasionally one bifid, but never paired on one side. Postorbital ridges strong, grooved dorsolaterally and terminating cephalically in acute spines. Branchiostegal spine small, but distinct and acute. Postorbital angle absent or very obtuse. Antennal scale broadest slightly distal to mid-length and 2.20–2.63 (avg. 2.43) times as long as wide. Ischia of only third pereiopods of male with hooks; coxa of fifth pereiopod with nearly tuberculiform, longitudinally-oriented boss. First pleopods of male symmetrical, terminating distally in two straight, subparallel parts; central projection of first form male 20.43–29.54 (avg. 25.40) percent of length of pleopod and of second form male 13.00–18.00 (avg. 15.77); mesial process shorter, in Form I males 78.57–89.06 (avg. 85.37) percent of length of central projection, in Form II males 68.97–84.85 (avg. 78.78); pleopod length divisible into carapace 2.84–3.17 (avg. 3.00) times for Form I males and 2.72–3.29 (avg. 3.06) for Form II males; central projection slender with acute tip curved slightly caudad; mesial process subsetiform and always terminating in very acute tip. Annulus ventralis immovable, subrhomboid in outline with conspicuous submedian longitudinal sulcus, prominent transverse trough in central part and sinus arising laterally in anterior region of trough curving and recurving before bisecting caudal third of annulus to margin.

Holotypic male, Form I.—Body pigmented, somewhat depressed, slightly compressed laterally (Fig. 4); eyes normal. Carapace punctate over most of surface but low squamous tubercles in extreme cephalolateral hepatic region of branchiostegite. Abdomen longer than cephalothorax (20.9 and 19.7 mm, respectively); carapace width greater than depth at level of caudodorsal margin of cervical groove (9.1 and 8.7 mm). Rostrum with moderately thickened margins, flanked medially by irregular row of setiferous punctations, slightly converging cephalically and terminating in acute spines, prominent carina in midcephalic half; acumen distinctly delineated basally and tip broken, but clearly upturned. Suborbital angle obsolete; branchiostegal spine strong and acute. Postorbital ridges well developed and terminating cephalically in spinose tubercles; cervical spine present. Areola 30.46 percent of entire length of carapace, 4.0 times as long as wide and with 4–5 punctations across narrowest part. Telson with two spines in each caudolateral corner of cephalic half; usual transverse sutures present. Proximal podomere of uropod with two prominent acute spines distally; inner ramus with strong spine in caudolateral corner and strong acute spine arising on dorsal mediodistal surface, neither spine overreaching distal margin of ramus; outer ramus with usual row of small subequal acute spines along distal margin of proximal element. Pleuron of second abdominal segment expanded cephalically, but remaining segments with subrectangular pleura. Lateral margins of thoracic sternites with moderately dense long setae not obscuring pleopods. Cephalic portion of epistome (Fig. 9) broadly subtriangular, without strongly developed marginal ridges or cephalomedian projection, surface nearly planar; main body with scarcely perceptible fovea in anterior portion of longitudinal bisecting furrow; epistomal zygoma very gently arched and without evident cephalolateral flanking pits. No rows of dense setae associated with maxillae or maxillipeds.

Chela (Fig. 11) somewhat depressed, 2.46 times as long as wide and with mesial margin of palm 33.33 percent of entire length of propodus; mesial margin of palm with row of 8 squamous tubercles, flanked dorsally by irregular rows of 6 and 2 and ventrally by irregular row of 4 (left chela with rows, in the same sequence, of 9, 7, 0, and 1); upper and lower surface of palm with setiferous punctations, moderately numerous, evenly distributed; lateral margin of palm not keeled. Opposable margin of fixed finger with row of three tubercles, increasing in size distally, in basal fourth, followed distally by relatively broad single band of crowded minute denticles, latter interrupted by tubercle at midlength, extending from third tubercle nearly to corneous tip of finger; finger with weak median longitudinal ridge above and below, ridge flanked mesially by row of small setiferous punctations through most of its length. Dactyl with double row of 9–10 tubercles, decreasing in size distally, along basal one-third of mesial margin; longitudinal ridges above and below only slightly more developed than those on immovable finger; opposable margin with row of 10 tubercles, decreasing in size distally, along basal two-thirds, last 5 interrupting row of crowded minute denticles extending along distal two-thirds of finger in form comparable with that on opposing finger.

Carpus punctate above, sparsely so below; mesial margin with strong acute spine at midlength and second strong spine in distomesial corner;

shallow longitudinal trough in middle half of central dorsal surface; lower laterodistal corner with strong acute spine, lower mesiodistal corner entire. Merus sparsely punctate on all surfaces; dorsal surface with strong acute spine on distomedian surface; ventral mesiodistal and laterodistal corners each with prominent articulating tubercle subtended by strong acute spine below; ventromesial margin with row of 8 squamous tubercles and ventrolateral margin unadorned except for strong acute spine at distal end. Remaining podomeres with punctate surfaces, otherwise not unusual; prominent suflamen on basis.

Hooks on ischium of third pereiopods only (Fig. 8); hooks simple and overhanging corresponding basis, but without opposing tubercle on basis. Only coxa of fifth pereiopod with boss; boss almost tuberculiform and oriented longitudinally.

First pleopods (Figs. 1, 5, 7) as described in ''Diagnosis''; central projection corneous. Pleopods reaching cephalic margins of coxae of third pereiopod when abdomen flexed.

Allotypic female.—Except for secondary sex characteristics and proportions (see Variations and Comparisons), differing from holotype in following respects: postorbital ridges terminating cephalically in strong, acute spines. Mesial margin of right palm with row of 8 tubercles mesially, but flanked dorsally by only single row of 5 and ventrally by row of 2; mesial margin of left with row of 9, flanked dorsally by rows of 5 and 3 and ventrally by no tubercles. Opposable margin of fixed finger with row of 5 tubercles in basal half and narrower row of crowded minute denticles along distal one-third; opposable margin of movable finger with 6 subequal tubercles and slightly longer, equally narrow row of denticles than that on immovable finger.

Annulus ventralis (Fig. 10) subrhomboid in outline, immovable, fused with antecedent sternite. Surface contoured with submedian sulcus in cephalic fourth and transverse trough, latter two-thirds width of entire annulus; sinus originating in deep trough at caudodextral end of sulcus, moving nearly transversely to midline and from there winding sinuously to caudal margin; prominent dextrally directed tongue just cephalic to sinus; sperm plug (not illustrated) present. Postannular sternite spindle-shaped, highest in center and slightly more than half as wide as annulus.

Morphotypic male, Form II.—Except for reproductively cyclic characters and proportions (see Variations and Comparisons) differing from holotype in following respects: postorbital ridges terminating cephalically in strong, acute spines. Mesial margin of right palm with row of 9 tubercles, rows of 3 and 6 dorsally and of 2 ventrally; left with rows of 8, 3, 6 and 1, respectively. Opposable margin of dactyl with row of 5 tubercles and row of crowded minute denticles intermediate in width between that of holotype and allotype, along distal four-fifths; similar row of denticles along distal two-

Table 1.—Measurements of types of *Orconectes kinderhookensis,* in mm.

	Holotype	Allotype	Morphotype
Carapace			
length	19.7	21.6	19.7
width	9.1	9.8	8.8
height	8.7	10.0	7.9
Rostrum			
length	6.1	6.4	5.7
width	2.8	3.2	3.1
Acumen			
length	1.5	2.1	1.9
Antennal scale			
length	4.0	4.7	4.4
width	1.8	2.3	2.0
Areola			
length	6.0	6.6	6.2
width	1.5	1.6	1.5
Abdomen			
length	20.9	19.2	22.6
width	8.5	8.6	10.8
Chela			
total length	15.0	12.0	12.8
width of palm	6.1	5.7	5.2
length of inner margin of palm	5.0	4.2	4.1
length of dactyl	9.2	7.6	7.4

thirds of opposable margin of fixed finger. Hooks on ischia of third pereiopods less well developed, but still distinct; bosses on coxae of fifth pereiopods nearly as well developed. Terminal elements of first pleopod (Figs. 2, 6) both non-corneous and more blunt than those of holotype; no evidence of juvenile suture.

Type-locality.—Kinderhook Creek, 0.4 mi (0.6 km) S of the Rensselaer County line on State Route 66, directly opposite Tennessee Gas Pipeline Compressor Station No. 254, Columbia County, New York.

Disposition of types.—The holotypic male, Form I, the allotypic female, and the morphotypic male, Form II, are in the National Museum of Natural History, Smithsonian Institution, nos. 148883, 148884, and 148885, respectively. Paratypes from Columbia Co. (17 ♂I, 6 ♂II, 23 ♀) and Rensselaer Co. (3 ♂I, 1 ♂II) are deposited in the same repository and another set is in the collection of the junior author.

Variations and comparisons with O. propinquus.—Based on the specimens at our disposal, *Orconectes kinderhookensis* is a morphologically very

Table 2.—Descriptive statistics for certain characters in *O. kinderhookensis* and sympatric *O. propinquus*.

	O. propinquus			*O. kinderhookensis*		
Characteristic	Mean	Variance	Range	Mean	Variance	Range
♂ I Carapace length	24.80	3.68	16.0–31.9	20.21	1.59	18.3–22.7
♂ II Carapace length	19.21	2.22	15.8–22.1	18.43	0.49	17.8–18.2
♀ Carapace length	23.34	4.99	16.4–33.2	23.20	4.80	18.8–32.5
♂ Antennal scale length	2.32	0.27	1.92–3.13	2.43	0.13	2.20–2.63
♀ Antennal scale length	2.45	0.25	2.16–2.94	2.63	0.23	1.90–2.78
Areola length (as % carapace length)	31.82	1.37	27.87–34.15	32.64	1.40	29.51–36.10
Areola length:width	4.19	0.62	3.40–5.50	4.15	1.03	2.05–5.88
♂ I Carapace length:pleopod length	3.24	0.28	2.81–3.75	3.00	0.10	2.84–3.17
♂ II Carapace length:pleopod length	3.06	0.19	2.72–3.29	3.22	0.05	3.15–3.27
♂ I central projection length (as % length pleopod)	24.50	4.38	19.85–33.33	25.40	2.58	20.43–29.54
♂ II Central projection length (as % length pleopod)	13.97	1.03	12.41–15.91	15.77	2.11	13.00–18.00
♂ I mesial process (as % length central projection)	98.21	2.57	93.18–104.69	85.37	3.52	78.57–89.06
♂ II mesial process (as % length central projection)	91.75	7.88	84.00–106.90	78.78	7.48	68.97–84.85

stable species. Each specimen was subjected to 14 measurements: (1) carapace length, (2) carapace width, (3) carapace height, (4) rostrum length, (5) rostrum width, (6) acumen length, (7) antennal scale length, (8) antennal scale width, (9) areola length, (10) areola width, (11) chela length, (12) palm width, (13) length of inner margin of palm, and (14) dactyl length; males were subjected to three additional measurements: (15) pleopod length, (16) central projection length and (17) mesial process length. Discriminate analysis indicated that the populations were distinct from *O. propinquus* (F = 3.2436, with 17 and 44 df; Mahalanobis $D^2 = 5.89$). These measurements were then compared using covariance analysis for sexual differences and for differences between the two species. Descriptive statistics were computed for areola length (as percent length of carapace), areola length:width, antennal scale length:width, carapace length:male pleopod length, central projection length (as percent length of pleopod) and central projection length:mesial process length. Meristic data were accumulated on (1) punctations across the narrowest part of the areola, (2) ornamentation of the mesial margin of the palm, (3) of the mesial surface of the merus, and (4) of the distal lower lateral and (5) distal lower mesial corners of the merus; data were recorded on (1) cervical spination, (2) marginal spines of the rostrum, (3) margins of the rostrum, (4) carina of the rostrum, (5) in males the development of ischial hooks and (6) in females the presence of a sperm plug. Where appropriate, frequencies were compared, using the G-test.

Sexual dimorphism was found in *O. kinderhookensis* in female carapace width ($P \geqslant 0.05$), antennal scale width, and chela length; in *O. propinquus* sexual dimorphism was noted in antennal scale width, chela length, length of the inner margin of the palm and number of punctations in the areola. This latter surprised us, but in males, 70 percent of the specimens have areolae with 2–4 punctations, while in females 89 percent of the specimens have 4–6. Significant differences between the two species were found in female carapace width, antennal scale width, areola width, dactyl length of male chela, and length of the mesial process.

Descriptive statistics are given in Table 2.

Among meristic data, differences in punctations across the narrowest part of the areola are noted, but other data proved not significantly different. Probably the most variable characteristic seen in *O. kinderhookensis* was in the tuberculation along the mesial margin of the palm. Basically, four very irregular rows of tubercles can be found in the species. The mesialmost varied from 2–8 in number with 2 and 5 being the most commonly occurring counts. Ventral to this row there usually are no tubercles, but a row up to 5 may be encountered. Two dorsal rows may occur, a more mesial one of 2 or 5 (sometimes absent) and a more dorsal row of 2–8, with seven the most common count. Because of the extreme irregularity of the rows, assignment to a specific row is often difficult, but, in males, the total number of mesially placed tubercles varies from 12–24, with the most common number being 15; in females the numbers are 15–21, usually 18, and statistically there is no sexual dimorphism. When compared with *O. propinquus* in a G-test, however, first form males differed significantly in the total number of tubercles, *O. propinquus* varying 13–24 with the most usual count being 18.

The rostral margins were parallel in 24.49 percent of the specimens of *O. kinderhookensis* and gently converging cephalically in 73.47 percent. This compared with equivalent figures of 32.14 percent and 67.86 percent for *O. propinquus,* but they were not statistically different.

All first form males had well developed hooks on the ischia of the third pereiopods and nowhere else. In second form males of both species hooks varied from tubercular knobs to rudimentary tubercles, apparently directly correlated with size of individuals. These hooks, too, showed no evidence of development except on the third pereiopod.

As collections were made only from mid-August to mid-September and early November, little can be said of the life history. Form I males and females with a sperm plug in the annulus ventralis were captured in all periods. Evidence for Fall breeding exists in sperm plug data, however. In

November collections 60 percent of the females had a sperm plug, compared with 20 percent in the earlier collections.

The largest female possessed a 33.2 mm carapace length and did not have a plug; the corresponding length of the smallest with a plug was 19.1 mm. Those of the largest and smallest first form males were 31.9 and 16.0 mm, respectively, and of the largest second form male, 22.1 mm. All of these values fit comfortably into the size distributions for *O. propinquus.*

Remarks and relationships.—*Orconectes kinderhookensis* is most closely related to *O. propinquus* and is assigned to the Propinquus Subgroup, Propinquus Group of the Propinquus Section of the genus. It may be distinguished from *O. propinquus* in that the terminal rami of the first pleopod of first form males are decidedly unequal in length; in females the annulus is much more sculptured, the transverse trough, anterior sulcus, and prominent tongue being much more evident than seen in *propinquus.* The most significant feature, however, which indicates that the two are discrete species is the fact that they occur together in the stream without apparent interbreeding.

More difficult than demonstrating their separation is explaining it. Kinderhook Creek, or a part of it, could not have served as a glacial refugium. All surrounding related populations in the creek are clearly assignable to *O. propinquus.* Subsequent to the preparation of this manuscript Dr. D. G. Smith (personal communication) wrote that he had collected specimens resembling *O. kinderhookensis* from sites in the Housatonic River system. Thus, the question of the species' emergence becomes more enigmatic.

One cannot help but notice, however, that both upstream and downstream other species of *Orconectes* replace Propinquus Section crawfishes. Bovbjerg (1961) has demonstrated the vigor of *O. virilis* as a competitor; perhaps *O. limosus* is equally strong, or at least more competitive than Propinquus stock. It is not, however, as competitive as *O. virilis* under certain environmental conditions (Schwartz et al., 1963). An early isolation of some *propinquus*-like populations in Kinderhook Creek or similar waters by headwaters and mouth invasions by more vigorous species could have allowed divergence of a small population by genetic drift. When the two populations, parental and descendant, reunited, possibly by introduction of the former, they were unable to interbreed. This thesis is supported by the apparent dominance of *O. kinderhookensis* over *O. propinquus* where they occur contiguously in the creek. More dominant individuals would have been favored in competition with species possessing high dominance potentials. Penn and Fitzpatrick (1962; 1963) have reported the results of some experiments to test such an hypothesis with respect to range changes occurring in some species of *Cambarellus.* This simplistic thesis must be accepted *cum grano salis* until more detailed information is acquired by scholars on the site.

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TWO NEW SPECIES OF *ANYROCEPHALUS* (MONOGENEA: DACTYLOGYRIDAE) FROM MARINE FISHES OF THE NORTHERN GULF OF MEXICO

Ernest H. Williams, Jr.

Abstract.—*Ancyrocephalus spirae* sp. n. is described from the longnosed killifish, *Fundulus similis* (Baird and Girard) and the Gulf killifish, *Fundulus grandis* Baird and Girard; *Ancyrocephalus trullae* sp. n. is described from the halfbeak, *Hyporhamphus unifasciatus* (Ranzani), from Dauphin Island, Alabama. *Ancyrocephalus spirae* is distinguished by the unique shape of its cirrus, and *A. trullae* by the groove on its bars.

Three species of *Ancyrocephalus* (*A. cornutus* Williams and Rogers, 1972; *A. lactophrys* (MacCallum, 1915); and *A. parvus* Linton, 1940) have been noted from marine fishes of the northern Gulf of Mexico (Hargis, 1955, and Williams and Rogers, 1972). In the present paper two new species of *Ancyrocephalus* are described from this region.

Materials and Methods

Fishes were collected by seine, dip net, or cast net and held alive until examined, within 2 hours of capture. The parasites were placed in a solution of hot 5% formalin. All measurements (in μm) were made with the methods of Rogers and Wellborn (1965) and were obtained from formalin-hardened specimens mounted in glycerine jelly. Averages are to the nearest μm and ranges are in parentheses. The illustrations were drawn with the aid of a camera lucida and a Bausch and Lomb Trisymplex microprojector.

Comparative material (all USNM Helm. Coll.) consisted of the holotype (8143) and a hypotype (72239) of *Ancyrocephalus parvus* Hargis, 1940; cotypes (35695) of *A. tylosuri* (MacCallum, 1917); and the holotype (72237) and paratypes (72238) of *A. cornutus* Williams and Rogers, 1972.

Ancyrocephalus spirae, new species
Figs. 1–7

Host and locality.—Longnose killifish, *Fundulus similis* (Baird and Girard) Dauphin Island Alabama Marine Resources Laboratory, Dauphin Island, Alabama (31 May 1970).

Additional host and localities.—*Fundulus grandis* Baird and Girard, Gulf killifish, seaward beach, Dauphin Island, Alabama (10 June 1970); State

Park, Mobile Causeway, Alabama (30 January 1971); Pensacola Bay, Florida (9 August 1969). Longnose killifish, Santa Rosa Island, Florida (3 July 1969).

Location on hosts.—Gill filaments

Specimens studied.—100 (10 measured)

Type-specimens.—Holotype and 2 paratypes USNM Helm. Coll. Nos. 76150 and 76151. Paratypes in author's collection.

Description.—Length 359 (315–381), greatest width 100 (69–126). Cuticle thin, smooth. Cephalic lobes well developed; eyespots subequal, component granules of anterior pair frequently dispersed, posterior pair farther apart. Pharynx spherical, transverse diameter 30 (27–35). Haptor distinct, suboval. Length 44 (31–51), width 68 (63–78). Anchors solid, dissimilar. Dorsal anchor 24 (22–26) from tip of base to most distant point of curvature, base 16 (15–18) long, superficial root 11–12 long, deep root 3 (2–4) long, point 3–4 long. Ventral anchor 24 (23–26) from tip of base to most instant point of curvature, base 11 (10–12) long, superficial root 8–9, long deep root 5–6 long, point 6 (5–7) long. Two bars subequal, variable. Dorsal bar 26 (25–27) long, 3–4 wide, with prominent subterminal indentations. Ventral bar 25 (23–27) long, 3–4 wide, slightly curved anteriorly, with distinct subterminal indentations. Marginal hooks 14, similar in shape, each with inflated base, elongate slender shaft and sickle-shaped point with FH loop; typically arranged. Length 13 (11–14), FH loop length 4–5. Cirrus 17 (16–18) long, with expanded base, tapering to slender shaft in acute turn, and forming long sickle-shaped anterior portion. Accessory piece 22 (20–25) long y-shaped, both rami with sharp points. Vagina not observed. Vitellaria dense, extending from pharynx to haptor.

Remarks.—*Ancyrocephalus spirae* differs from other members of genus in cirrus shape. The dorsal anchor of *A. parvus* Linton, 1940 (redescribed, Williams and Rogers, 1972) is very similar to the dorsal anchor of *A. spirae* but the remaining anchor and bars differ.

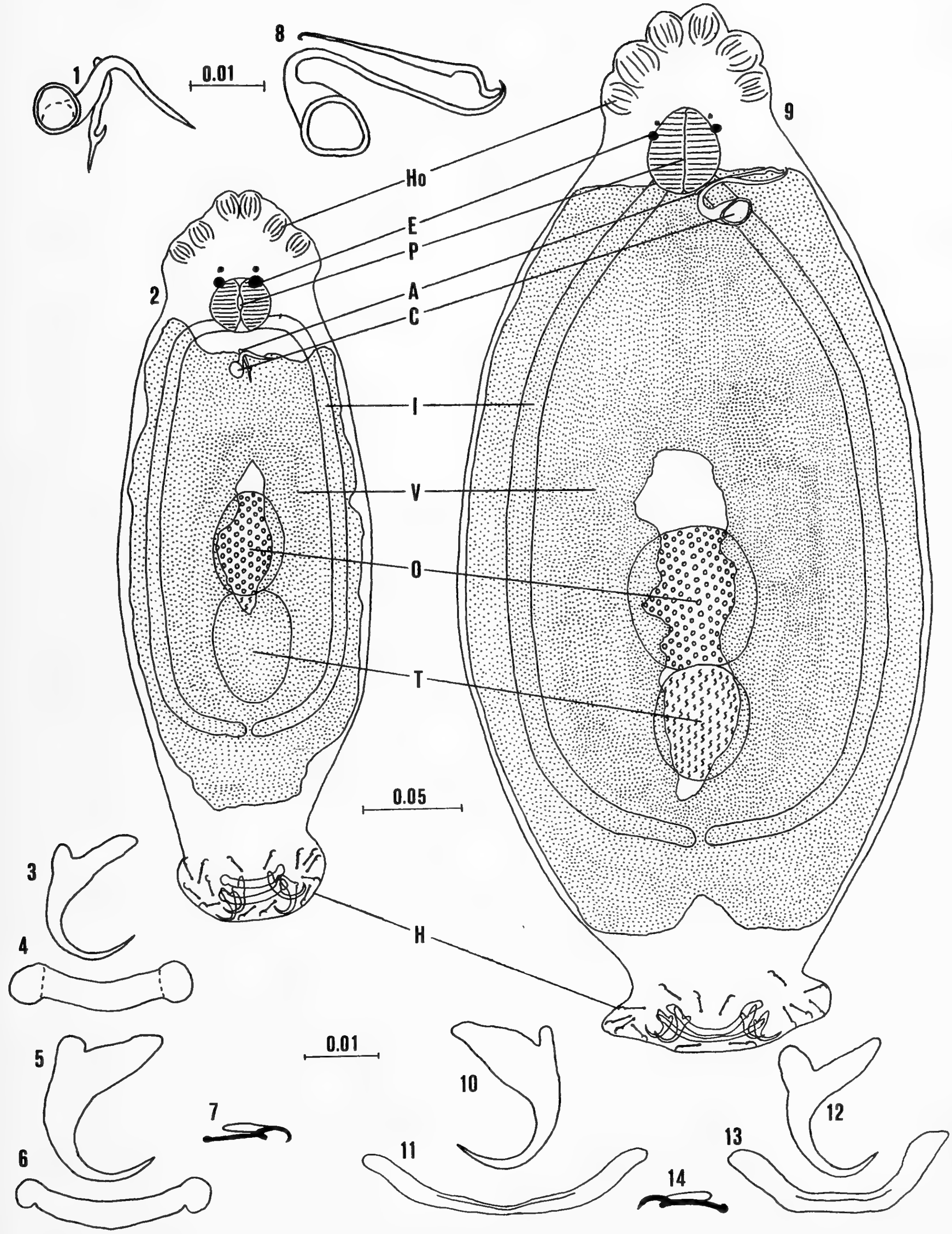
Gyrodactylus foxi Rawson, 1973 and *Gyrodactylus* sp. (Monogenea: *Gyrodactylidae*), *Trichodina* sp. (Protozoa: Ciliata), and *Oodinium cyprinodontum* Lawler, 1967 (Protozoa: Dinoflagellida) were associated with *A. spirae* on the gill filaments of *F. similis*. *A. spirae* was more abundant than either species of *Gyrodactylus*. Both protozoans were very light (Williams, 1972) in abundance.

The name is Latin (*spira*—a coil, twist) and refers to the shape of the cirrus.

Ancyrocephalus trullae, new species

Figs. 8–14

Host and locality.—Halfbeak, *Hyporhamphus unifasciatus* (Ranzani). Dauphin Island State Peir, Dauphin Island, Alabama (18 November 1971).



Figs. 1–7. *Ancyrocephalus spirae*: **1,** Cirrus and accessory piece; **2,** Whole worm; **3,** Dorsal anchor; **4,** Dorsal bar; **5,** Ventral anchor; **6,** Ventral bar; **7,** Hook. Figs. **8–14.** *Ancyrocephalus trullae*: **8,** Cirrus and accessory piece; **9,** Whole worm; **10,** Ventral anchor; **11,** Ventral bar; **12,** Dorsal anchor; **13,** Dorsal bar; **14,** Hook. **A**—Accessory piece. **C**—Cirrus. **E**—Eyespot. **H**—Head organs. **I**—Caecum. **O**—Ovary. **P**—Pharynx. **T**—Testis. **V**—Vitellaria.

Location on host.—Gill filaments.

Specimens studied.—6 (all measured).

Type specimens.—Holotype and 2 paratypes USNM Helm. Coll. Nos. 76152 and 76153. Three paratypes in author's collection.

Description.—Length 414 (374–489), greatest width 155 (102–156) about midbody. Cuticle thin, smooth. Cephalic lobes poorly developed; eyespots subequal, component granules of anterior pair occasionally dispersed, posterior pair further apart. Pharynx spherical, transverse diameter 32 (30–36). Haptor distinct, suboval, length 38 (33–40), width 95 (81–119). Anchors solid, dissimilar. Dorsal anchor 24 (22–26) from tip of base to most distant point of curvature, base 16 (15–17), superficial root 9–10 long, deep root 5 (4–7) long, point 7–8 long. Ventral anchor 21 (20–23) from tip of base to most distant point of curvature, base 16 (15–17), superficial root 11–12 long, deep root 5–6 long, point 5–6 long. Two bars dissimilar, both with transverse groove close to anterior margins. Dorsal bar 42 (39–45) long, 1–2 wide, with prominent subterminal identations. Ventral bar 31 (29–32) long, 2–3 wide, slightly curved anteriorly, with distinct subterminal indentations. Marginal hooks 14, similar in shape, each with inflated base, elongate slender shaft, and sickleshaped point with FH loop; typically arranged. Length 15 (13–16), FH loop length 7 (6–8). Cirrus 45 (40–49) long, with expanded horn-shaped base, rapidly tapering into a long slender shaft with abrupt curve to sharp point, not unlike the shape of an old English clay pipe. Accessory piece, 29 (27–31) a long slender blade, gradually expanding toward forked posterior; notch just anterior to y-shaped fork. Vagina not observed. Vitellaria dense, extending from pharynx to haptor.

Remarks.—Ancyrocephalus trullae differs from other members of the genus in having bars with a lateral median groove close to their anterior margins. Only 6 specimens of *A. trullae* occurred on the gills of the 2 hosts examined. No other parasites were observed on the gill filaments.

The name is Latin (*trulla*-ladle) and refers to the shape of the cirrus.

Acknowledgments

Thanks are extended to the Southeastern Cooperative Fish Disease Project, Department of Fisheries and Allied Aquacultures, Auburn, University, Auburn, Alabama for supporting this research; to Madison R. Powell, Wayne E. Swingle, Hugh A. Swingle, Walter M. Tatum, and other personnel of the Alabama Marine Resources Laboratory, Alabama Department of Conservation and Natural Resources, Dauphin Island, Alabama for help in collecting and loan of equipment and facilities.

Special thanks are extended to Dr. Wilmer A. Rogers, Southeastern Cooperative Fish Disease Project, and Lucy B. Williams, Department of Marine Sciences, for reviewing the manuscript, and to Dr. Joseph R. Sullivan for construction of Latin names.

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THE LARVA OF THE CONGRID EEL *ACROMYCTER ALCOCKI* (PISCES: ANGUILLIFORMES), AND THE DISTINCTION BETWEEN CONGRID AND OPHICHTHID LARVAE

David G. Smith and Mark M. Leiby

Abstract.—The larva of the congrid eel *Acromycter alcocki* is identified and described here for the first time on the basis of juvenile and metamorphic specimens from Hawaii and the western Atlantic. It is an elongate leptocephalus with ten prominent, pigmented loops in the gut. In this it differs from other congrid larvae and approaches the condition found in certain ophichthids. On the other hand, some ophichthid larvae have the characteristic swellings of the gut reduced and approach the condition found in congrids. Aside from the presence or absence of intestinal swellings, the following characters will distinguish congrid from ophichthid larvae: the form of the liver and gall bladder, the degree of expansion of the gut between esophagus and intestine, the termination of the kidney relative to the anus, the nature of the pigment on the intestinal swellings and behind the anus, the form of the caudal fin, the number of branchiostegal rays, and the chondrification of the basibranchials.

The identification of larval eels with their corresponding adult forms has been an empirical process based largely on the fortuitous capture of metamorphic specimens that combine the characters of larva and adult. When the larva of a particular species has been identified in this way, it is often possible to identify related species by inference even when metamorphic forms are not available. Over the years a framework of knowledge has been developed that has permitted a broad characterization of leptocephali of higher taxonomic groups. In this way most leptocephali can now be confidently identified to family even if the species is uncertain. Occasionally, however, the larva of a particular species may differ so sharply from its relatives that its true identity is not immediately evident. Such is the case presented here.

The senior author located, in the Bernice P. Bishop Museum, a single juvenile specimen of the congrid eel *Acromycter alcocki* (Gilbert and Cramer) 116 mm in total length (Fig. 1). This specimen, the smallest yet seen of the genus *Acromycter,* had twelve large black spots on the ventral midline from shortly behind the head to shortly before the tip of the tail, and a thirteenth spot midlaterally between the last ventral spot and the tail tip. These are not seen in larger specimens and were interpreted as remnants of

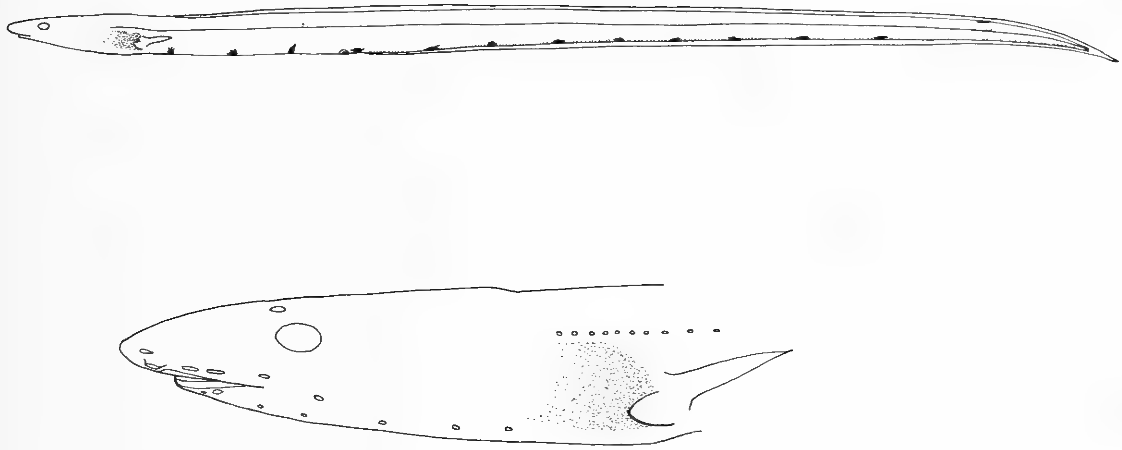

Fig. 1. *Acromycter alcocki,* juvenile, 116 mm TL, BPBM 21069.

the pigmentation of the larva. At the same time an unusual leptocephalus, 144 mm standard length, was found in the collections of the Honolulu Laboratory of the National Marine Fisheries Service (Fig. 2). It had twelve large ventral pigment spots from shortly behind the head to shortly before the end of the tail and a thirteenth at the level of the notochord between the last ventral spot and the tail tip. The first 10 ventral spots were each associated with a distinct loop or arch of the gut, a feature always considered characteristic of larvae of the Ophichthidae. Yet the correspondence between the pigment pattern of the larva and that of the juvenile *Acromycter* was so striking that a comparison could not be avoided. The larva had approximately 167 myomeres, well within the range of vertebral counts of *Acromycter alcocki* (164–172).

Meanwhile, the junior author had assembled seven similar larval specimens from the western North Atlantic, including a metamorphic specimen. Despite the prominent gut loops, he doubted their identity as ophichthids. His inquiry to the senior author led to a comparison of material and a conclusive identification of the larvae in question as *Acromycter*.

It has been commonly accepted (Castle, 1965; Fahay and Obenchain, 1978; Smith, 1979) that congrid larvae are characterized by a simple, straight gut, whereas the gut of ophichthid larvae has various loops or swellings. The larval stage of *Acromycter* shows that this is not always true. At the other extreme, some ophichthid larvae have the intestinal swellings greatly reduced. A further clarification of the distinction between congrid and ophichthid larva is needed.

Material and Methods

Specimens were obtained from the following sources: Bernice P. Bishop Museum, Honolulu (BPBM); material collected by R/V TOWNSEND CROMWELL (TC), Honolulu Laboratory, National Marine Fisheries Ser-

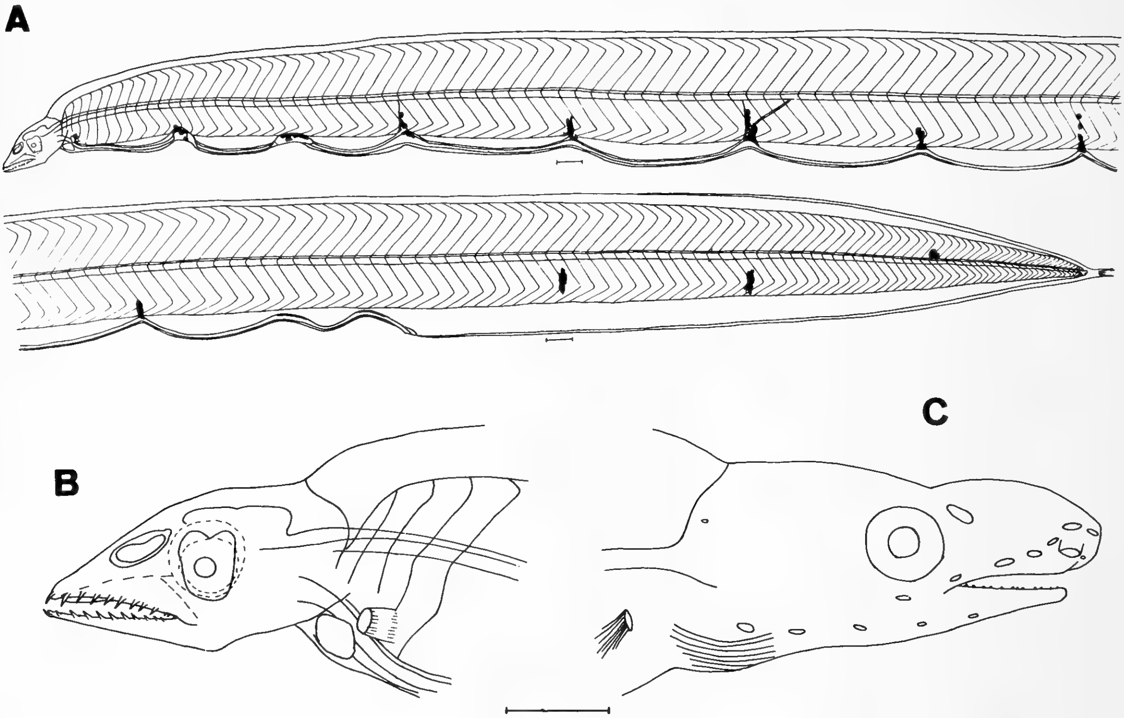

Fig. 2. *Acromycter alcocki*. **A,** Whole view, 170 mm SL, ACRE 9-5. **B,** Head, same. **C,** Head of metamorphic specimen, 146 mm SL, ACRE 7-13. Bar is 2 mm.

vice; Marine Biomedical Institute (MBI), Galveston; Rosenstiel School of Marine and Atmospheric Science, University of Miami (GERDA stations); the University of Rhode Island (Ocean Acre); and collections of F.F.S. ANTON DOHRN (AD), Biologische Anstalt Helgoland, West Germany. All specimens are deposited at the indicated institutions except the ANTON DOHRN specimen, which is at the Academy of Natural Sciences of Philadelphia (ANSP).

Most counts and measurements are self-explanatory. Nephric myomeres are those back to and including the one directly over the posterior end of the kidney, measured at the lateral midline. Predorsal and preanal myomeres are also measured at the midline. Unless otherwise specified, all measurements are standard length (SL).

Larva of *Acromycter alcocki*

Study material.—MBI 561 (17 mm), 20°30′N, 96°06′W, 24 Feb. 1977. ACRE 7-13 (146 mm, metamorphic), 32°18′N, 63°30′W, 8 Sept. 1969. ACRE 9-5 (170 mm), 31°54′N, 64°17′W, 17 March 1969. ACRE 12-35 B (ca. 183 mm), 32°28′N, 64°02′W, 7 Sept. 1971. ACRE 14-9A (87+ mm), 31°46′N, 63°38′W, 7 June 1972. GERDA 92 (60 mm), 25°10′N, 79°41′W, 19 Apr. 1963.

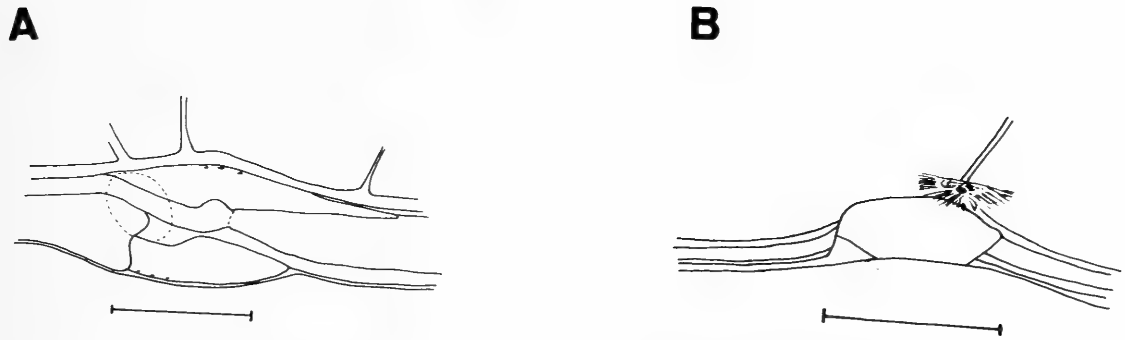

Fig. 3. **A,** Second liver lobe of an ophichthid, *Bascanichthys bascanium,* 79 mm SL, showing gall bladder and gut expanding posteriorly. **B,** Second liver lobe of *Acromycter alcocki,* 170 mm SL; gall bladder hidden by liver, gut not expanding posteriorly. Bar is 1 mm.

GERDA 497 (34 mm), 26°41′N, 79°00′W, 3 Feb. 1965. ANSP 143371, (158 mm, metamorphic), AD 183, 25°31′N, 62°00′W, 6 Apr. 1979. BPBM 24021 (144 mm), TC-59-44-2, 20°13′N, 160°10′W, 25 July 1972. BPBM 21069 (116 mm, juvenile), TC-66-11, 20°21′N, 158°08′W, 19 Aug. 1975.

Description of larvae.—Body elongate, depth 5–10% SL (deeper in small specimens); caudal fin well developed; preanal length 70–83% SL; head 3–9% SL (relatively longer in small specimens). Total myomeres 166(2), 167(2), 169(1), 172(1), 173(1); preanal myomeres 100–104; nephric myomeres 51–54. Ten loops or arches in gut, first two associated with lobes of liver, located beneath myomeres 13–16, 21–26, 29–34, 39–43, 50–54, 59–64, 69–74, 78–85, 89–94, and 97–104. Pigment associated apically with each loop, consisting of one or several melanophores internally and on body wall, sometimes extending dorsally almost to aorta. Three postanal pigment patches, mainly on body wall, first two located near ventral edge of myomeres 109–113 and 122–129, the third just above notochord at myomere 138–148.

Description of metamorphic specimens.—Body leptocephaloid; anus migrating forward, at myomeres 47–65. Head elongate with bulbous snout, posterior nostril near anterodorsal margin of eye; four pores along upper jaw, two on tip of snout, one just above anterior nostril, and eight in preoperculomandibular canal. Definitive teeth developing in a single series on mandible and maxilla, and in two parallel rows on roof of mouth.

Description of juvenile.—Typical of *Acromycter alcocki.* Twelve large, dark spots on ventral midline, from shortly behind head to shortly before tip of tail. A thirteenth spot laterally between last ventral spot and tip of tail.

Identification.—The metamorphic specimens and the juvenile show clearly that this type of larva belongs to the genus *Acromycter* Smith and Kanazawa. The Hawaiian species is *A. alcocki.* Work in progress by the senior

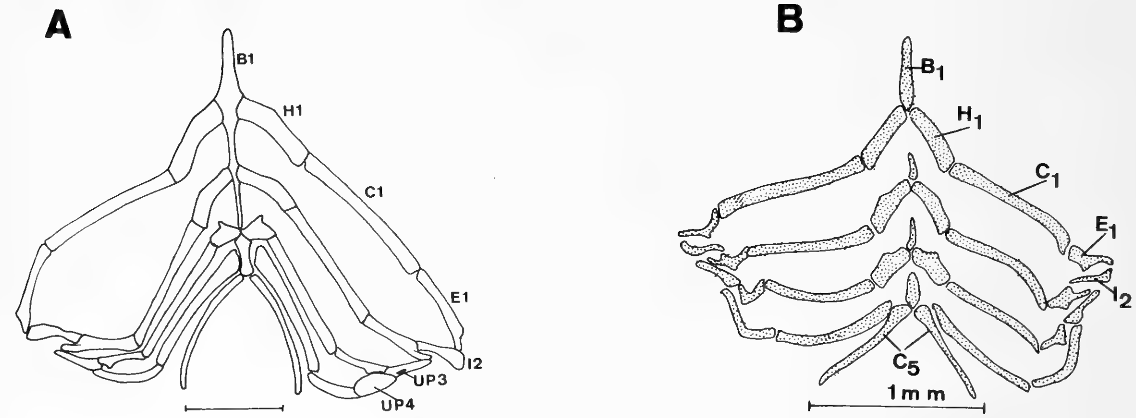

Fig. 4. **A,** Gill arches of metamorphic *Acromycter alcocki,* 146 mm SL, ACRE 7-13, showing single basibranchial bar for B_1–B_3. **B,** Gill arches of an ophichthid (metamorphic *Ophichthus ophis,* 120 mm SL), showing separate B_1–B_3. B = basibranchial, H = hypobranchial, C = ceratobranchial, E = epibranchial, I = infrapharyngobranchial.

author indicates that two species of *Acromycter* are present in the western Atlantic, differing only in the number of vertebrae. *Acromycter peturbator* (Parr) has 159–162 vertebrae and the other species has 167–171. The latter appears indistinguishable from the Hawaiian species and is therefore referred to *A. alcocki.* Based on the myomere counts, all the larvae examined seem to belong to *A. alcocki.*

Identification of Congrid and Ophichthid Larvae

Most congrid larvae have a simple, straight gut with at most a slight expansion at the liver. Most ophichthid larvae have prominent swellings or loops in the gut, each associated with some degree of pigmentation. The problem arises with a few ophichthids, such as *Bascanichthys* and some species of *Ophichthus,* in which the gut loops are greatly reduced, and a few congrids, principally *Acromycter,* in which distinct gut loops are present. In addition to learning these aberrant forms individually, several characters can be used to distinguish the larvae of the two families in a more general sense.

Ophichthid larvae have two (subfamily Ophichthinae) or three (subfamily Myrophinae) pronounced liver lobes along the thin esophagus. The gall bladder is on the last lobe and is not concealed by the liver (Fig. 3A). Most congrid larvae have a single liver lobe, but *Acromycter* has two. The gall bladder in *Acromycter* is associated with the second lobe, as in ophichthines, but it is largely hidden by the liver (Fig. 3B).

In ophichthid larvae the gut expands abruptly between the esophagus and the intestine (Fig. 3A); in *Acromycter,* the congrid most likely to be confused with an ophichthid, it does not (Fig. 3B).

In congrids the kidney terminates well in front of the anus, usually by more than 20 myomeres. In ophichthids the kidney terminates 0–15 myomeres in front of the anus.

In larvae of the Ophichthidae the caudal fin is often reduced or lost well before metamorphosis. In congrid larvae the caudal fin is always present.

In ophichthids the pigment associated with the gut swellings is located mainly below the kidney on the dorsal surface of the gut. In *Acromycter* the pigment associated with the gut loops lies dorsal to the kidney. Postanal pigment in ophichthids is either in the form of small superficial melanophores or 3–12 large internal spots just beneath the notochord. *Acromycter* has three large post-anal spots, but they are largely superficial; the first two are more ventral than those of ophichthids, and the last one is dorsal to the notochord.

In specimens near metamorphosis, the numerous (17 or more) branchiostegal rays characteristic of ophichthids, overlapping on the ventral midline, are visible. Congrids have fewer branchiostegals (generally fewer than 12), and these do not overlap on the ventral midline.

The gill arches of congrids and ophichthids differ in their development, although this can be seen only in stained preparations. In congrids the first three basibranchials develop as a single chondrification (Fig. 4A), whereas in ophichthids all four basibranchials develop as separate chrondrifications (Fig. 4B).

Acknowledgments

We thank the following for the loan of specimens. J. E. Randall, Bernice P. Bishop Museum, Honolulu; R. S. Shomura, Honolulu Laboratory, National Marine Fisheries Service; C. R. Robins, Rosenstiel School of Marine and Atmospheric Science, University of Miami; W. H. Kreuger, University of Rhode Island; F.-W. Tesch, Biologische Anstalt Helgoland. The MBI specimen was collected during a study of leptocephali of the Gulf of Mexico supported by the National Science Foundation (BMS 75-08675). Travel funds for the senior author's visit to Honolulu were also provided by the National Science Foundation (INT-77-12568). The senior author wishes to thank Dr. F.-W. Tesch for the opportunity to participate in the cruise of the F.F.S. ANTON DOHRN to the Sargasso Sea in 1979, during which one of the metamorphic specimens was collected. Figure 1 was drawn by Mary H. Fuges, the remainder by the junior author. This is a contribution from the Marine Biomedical Institute and the Department of Human Biological Chemistry and Genetics, University of Texas Medical Branch at Galveston.

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TWO NEW SPECIES OF *SONORELLA* (GASTROPODA: PULMONATA: HELMINTHOGLYPTIDAE) FROM THE PINALENO MOUNTAINS, ARIZONA

H. Lee Fairbanks and Richard L. Reeder

Abstract.—*Sonorella christenseni* and *S. macrophallus*, new species of pulmonate land snails, are described from the Pinaleno Mountains of southeastern Arizona. The relationships of these new *Sonorella* to each other and to other members of the genus are discussed.

Introduction

The Pinaleno Mountains, a rugged range dominated by 10,713 foot Mt. Graham, are located in Graham County, Arizona. The range contains the largest continuous area above 9,000 feet elevation of any mountain range in southeastern Arizona. There are three peaks above 10,000 feet in elevation with several additional peaks in excess of 9,000 feet. The Pinalenos lie directly north of the Dos Cabezas and Chiricahua ranges.

Prior to 1950, malacological collecting in the Pinaleno Mts. was rare. The earliest trip was made by J. H. Ferriss in 1913, and *Sonorella grahamensis* was described from the material he collected (Pilsbry and Ferriss, 1919). Beginning in 1954, collecting in the Pinalenos increased. In that year, M. L. Walton and W. O. Gregg collected material from the Mt. Graham area, and from that material *S. imitator* was described (Gregg and Miller, 1974). W. B. Miller began collecting in the Pinaleno Mts. in 1965, and since that time he and others have collected in many areas of the range. This paper describes two new species of *Sonorella* found in the course of several collecting trips to the Pinalenos from 1965 through 1978.

Sonorella christenseni, new species
Figs. 1A, 2B

Description of holotype.—Shell depressed, heliciform, convex above and below, thin, glossy, tan in color, with one chestnut-brown spiral band just above midline of rounded shoulder of body whorl; umbilicate, umbilicus contained approximately 7 times in diameter. Embryonic shell of approximately 1½ whorls, first ½ whorl, including apex, with radial striae only, remainder of embryonic shell having a reticulate pattern of fine lines that break up into a granular pattern in the last ¼ whorl. Post-embryonic whorls with granular surface superimposed upon the radial growth striae; faint spi-

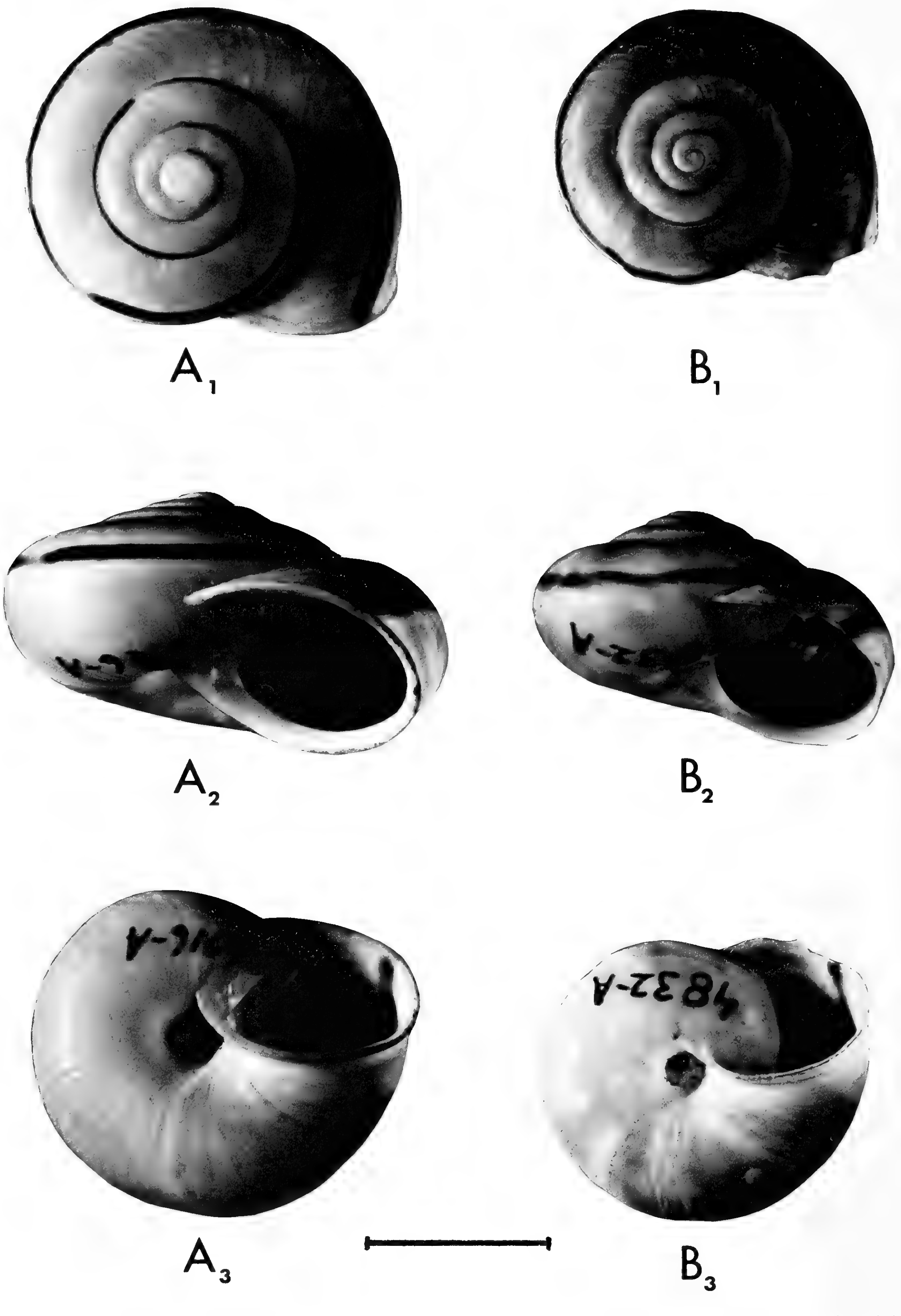


Fig. 1. Dorsal, ventral and side views of holotypes of *Sonorella christenseni* (A_1, A_2, A_3) and *S. macrophallus* (B_1, B_2, B_3). Scale bar equals 10 mm.

ral lines appearing, granular surface fading, just prior to beginning of body whorl; body whorl with radial growth striae plus spiral striae, the latter strongest near slightly recurved lip of aperture; spiral striae visible on dorsal surface of body whorl only near mid-line of shoulder; suture descends moderately to peristome. Aperture oblique, oval, slightly wider than high; parietal callus thin.

Measurements of holotype: Diameter—20.6 mm; height—11.0 mm; umbilicus diameter—2.9 mm; whorls—4⅔; embryonic whorls—1½.

Genitalia of holotype (Fig. 2B): Penis moderately long, gradually increasing in diameter to junction with vagina and containing a smooth cylindrical verge that nearly fills penial chamber. Verge approximately 64% length of penis, tapering gradually to a rounded point; seminal duct opens terminally. Penial sheath moderate in length, approximately 56% that of penis. Epiphallus slightly longer than penis, with large epiphallic caecum. Vas deferens same thickness as epiphallus. Length of vagina approximately 77% that of penis; free oviduct length 62% that of vagina.

Measurements of holotype genitalia: Penis—11.1 mm; verge—7.1 mm; penial sheath—6.2 mm; epiphallus—12.3 mm; epiphallic caecum—2.0 mm; vagina—8.6 mm; free oviduct—5.3 mm.

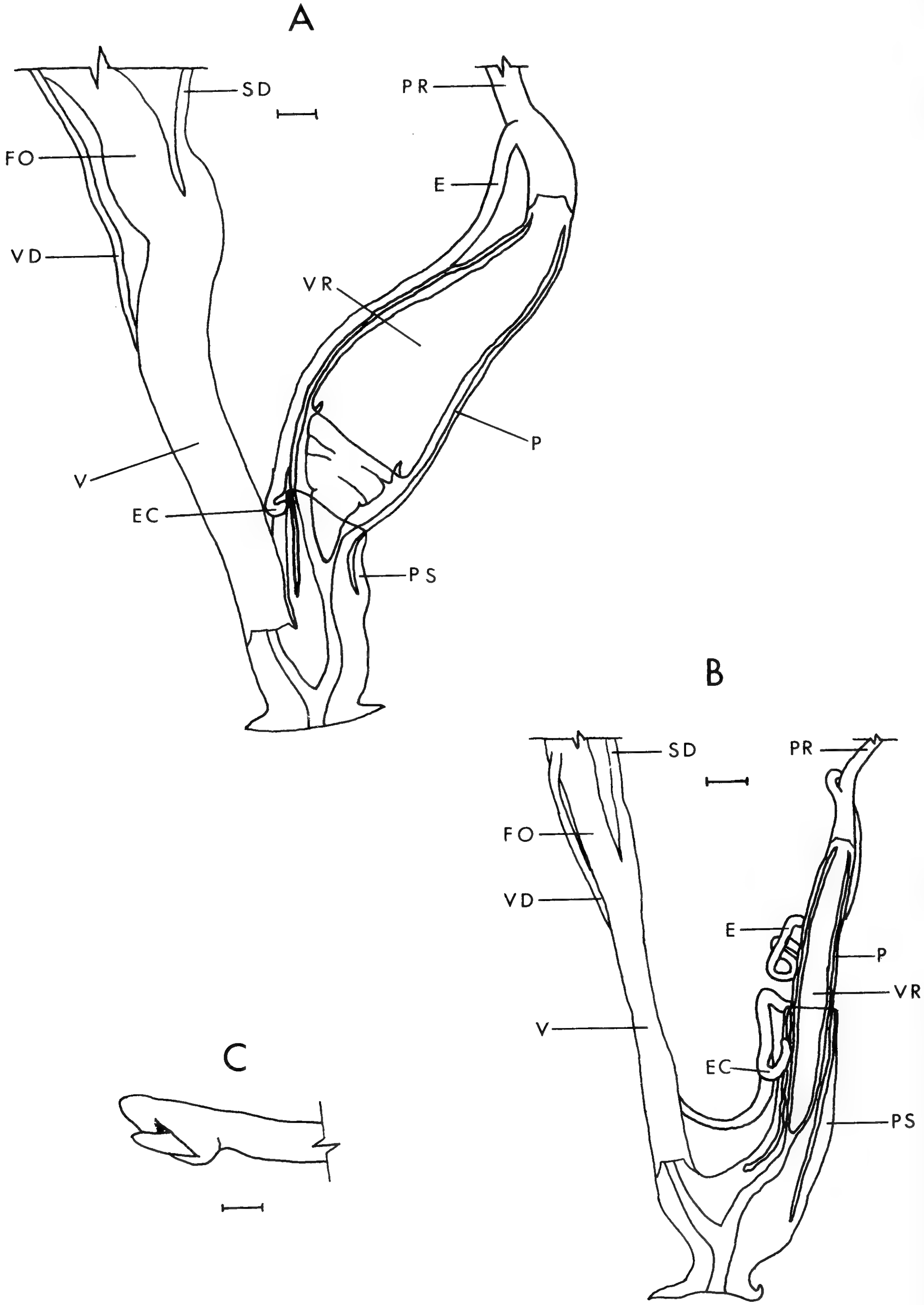
Type-locality.—Rock-slide on north slope of Clark Peak, ca. 8,700 feet, Pinaleno Mountains, Graham County, Arizona, 32°43.5′N; 109°59.1′W. No other known locations.

Disposition of type-material.—Holotype, USNM 783321, Paratypes, USNM 783322; W. B. Miller (University of Arizona, Tucson, Arizona 85721) 6916, 6916B; Carl C. Christensen (Bishop Museum, Honolulu, Hawaii) 4024B; H. Lee Fairbanks 2548; Richard L. Reeder (University of Tulsa, Tulsa, Oklahoma) USNM = United States National Museum of Natural History.

Diagnosis.—A species characterized anatomically by a large epiphallic caecum, vagina shorter than the penis, and a long, smooth, pointed verge.

Differential diagnosis.—*Sonorella christenseni* was found living sympatrically with *Sonorella imitator* Gregg and Miller, from which it is insepa rable on the basis of shell alone (Table 1). Examination of the genitalia separates the two species (Table 2; Figs. 2B, 3A). The penis and verge of *S. imitator* are easily twice the length and diameter of the penis and verge of *S. christenseni.* The reverse is true in comparisons of the epiphallic caecum and penial sheath, both of which are much larger in *S. christenseni* than in *S. imitator.* Despite sympatry, no gradation was found in size or shape of the genitalia.

Sonorella grahamensis Pilsbry and Ferriss, also found in the Pinaleno Mts., is somewhat different from *S. christenseni* in shell characteristics. However, the two are still difficult to separate with casual examination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(Table 1). Comparisons of the genitalia of these two species will separate them easily (Table 2; Figs. 2B, 3B).

In the genus *Sonorella,* there are many species that have a long slender verge; however, few are smooth as in *Sonorella christenseni.* No other species of *Sonorella* has a verge of the same size and shape as that of *S. christenseni.* In addition, the ratios of genitalia measurements in other members of the genus do not coincide with those of *S. christenseni.*

Sonorella macrophallus, new species
Figs. 1B, 2A

Description of holotype.—Shell depressed, heliciform, convex above and below, thin, light brown in color, with chestnut-brown band just above midline of rounded shoulder of body whorl; umbilicate, umbilicus contained approximately 7 times in diameter. Embryonic shell of approximately 1⅓ whorls, first ¼ whorl, including apex, with regularly spaced hyphen-like papillae superimposed upon radial striae; over remaining embryonic whorls, radial striae broken forming a granular surface with regularly spaced papillae superimposed upon it. Post-embryonic whorls radially striate with papillae present except for last 1½ whorls, which have only faint spiral lines appearing near suture; spiral lines visible on ventral surface of body whorl, suture descends moderately to a slightly expanded peristome. Aperture oblique, oval, slightly wider than high.

Measurements of holotype: Diameter—17.7 mm; height—10.6 mm; umbilicus diameter—2.5 mm; whorls—4½; embryonic whorls—1⅓.

Genitalia of holotype (Fig. 2A): Penis long and of large diameter, containing a verge that is large, expanded just distal of the midpoint of its length, and nearly fills the penial chamber. Distal end of verge modified to form a retractable tip that when fully extended comprises approximately ⅓ of total length of verge. Length of verge approximately 66% that of penis; seminal duct opens terminally. Penial sheath short, approximately 22% as long as penis. Epiphallus shorter than penis; epiphallic caecum small. Vas deferens about as thick as epiphallus. Length of vagina approximately 60% that of penis; free oviduct length 82% that of vagina.

Measurements of holotype genitalia: Penis—16.1 mm; verge—10.7 mm; penial sheath—3.5 mm; epiphallus—8.7 mm; epiphallic caecum—1.5 mm; vagina—9.7 mm; free oviduct—8.0 mm.

←

Fig. 2. Cutaway camera lucida drawings of genitalia of *Sonorella macrophallus* (**A**), *S. christenseni* (**B**), and distal end of verge of *S. binneyi* (**C**). Scale bars equal 1 mm. E, epiphallus; EC, epiphallic caecum; FO, free oviduct; P, penis; PR, penial retractor; PS, penial sheath; SD, spermathecal duct; V, vagina; VD, vas deferens; VR, verge.

Table 1.—Shell measurements of holotypes and paratypes of *Sonorella christenseni* and *S. macrophallus*, with shell measurements of some specimens of *S. imitator* and *S. grahamensis* for comparison. Upper numbers are means and ranges (in parentheses); lower numbers are standard deviations. Measurements are in mm, measured with vernier caliper.

	S. christenseni		*S. macrophallus*			
	Holotype	Paratypes	Holotype	Paratypes	*S. imitator*	*S. grahamensis*
No. of specimens	1	5	1	17	12	3
Diameter	20.6	20.4 (19.7–20.9) .5167	17.7	17.8 (16.4–19.5) .8455	19.7 (18.8–21.2) .8301	18.8 (18.2–19.5) .6658
Height	11.0	11.1 (10.5–12.0) .6285	10.6	10.6 (9.6–11.6) .6020	11.3 (9.9–12.8) .8433	10.9 (10.2–11.4) .6429
Umbilicus diameter	2.9	3.0 (2.6–3.4) .3194	2.5	2.5 (2.0–2.8) .2205	3.1 (2.7–3.5) .2290	2.7 (2.5–2.8) .1732
Whorls	4.67	4.5 (4.5–4.67) .0760	4.5	4.5 (4.25–4.75) .1598	4.4 (4.0–4.67) .1795	4.5 (—) .0000
Embryonic whorls	1.5	1.4 (1.33–1.5) .0760	1.33	1.5 (1.33–1.75) .1201	1.4 (1.25–1.5) .0786	1.4 (1.33–1.5) .0981

Type-locality.—Wet Canyon, Pinaleno Mountains, Graham County, Arizona, under rocks on the south side of the canyon ca. 300 feet from Highway 366 (Swift Trail) at ca. 6050 feet elevation; 32°39.1′N; 109°48.8′W.

Other localities.—Wet Canyon, Pinaleno Mountains, Graham County, Arizona, in rockslide approximately ⅓ mile up canyon from Highway 366 at ca. 6,400 feet elevation; also ca. 1.0 miles up Wet Canyon at ca. 6,900 feet elevation (C. C. Christensen, W. B. Miller, N. Babrakzai, P. Turk).

Disposition of type-material.—Holotype USNM 783324 Paratypes, USNM 783325; W. B. Miller (University of Arizona, Tucson, Arizona 85721) 4832, 14 paratypes.

Diagnosis.—A species of moderate size, having a shell with hyphen-like papillae on the dorsal surface, and a verge which is long, large in diameter, and with a retractable tip.

Differential diagnosis.—This species has been found only in Wet Canyon in the Pinaleno Mts. of southeastern Arizona. It is found there in sympatry with *S. imitator*. A previous report (Gregg and Miller, 1974) of *S. grahamensis* in Wet Canyon was found to be in error.

The shell of *Sonorella macrophallus* is somewhat smaller than that of the other 3 species of *Sonorella* found in the Pinaleno Mts. (Table 1). In addition, the papillae on the surface of the shells of *S. macrophallus* do not occur on the shells of the other species. However, erosion of the papillae can occur and thus this character may not be helpful in the identification of some specimens. Gregg and Miller (1974) reported that *S. imitator* had "suggestions of papillae" on the shell, but examination of 12 specimens of this species detected no papillae. Examination of 18 specimens of *S. macrophallus* found 16 with easily detectable papillae. The remaining 2 shells were old and worn. Neither *S. christenseni* nor *S. grahamensis* has papillae on the shell.

The genitalia of *Sonorella macrophallus,* in particular the verge, will immediately identify this species. The verge of *S. macrophallus* has a protrusible tip, a characteristic known in only one other species of *Sonorella, S. binneyi* from the Chiricahua Mts. The senior author has examined 6 stained and slide-mounted reproductive systems of *S. macrophallus* and has noted various stages of protrusion. The tip of the verge of the type-specimen (Fig. 2A) is nearly fully extended. There can be no confusion between *S. macrophallus* and *S. binneyi,* because in the former species the protrusible tip is terminal, whereas in the latter species it is subterminal (Fig. 2C).

Etymologies.—*Sonorella christenseni* is named in recognition of Dr. Carl C. Christensen, Bishop Museum, Honolulu, Hawaii, a friend and colleague of many field trips, and the person responsible for locating the site at which this species was found.

The name *macrophallus* (Greek, makros + phallos) refers to the large, distended verge found in this species.

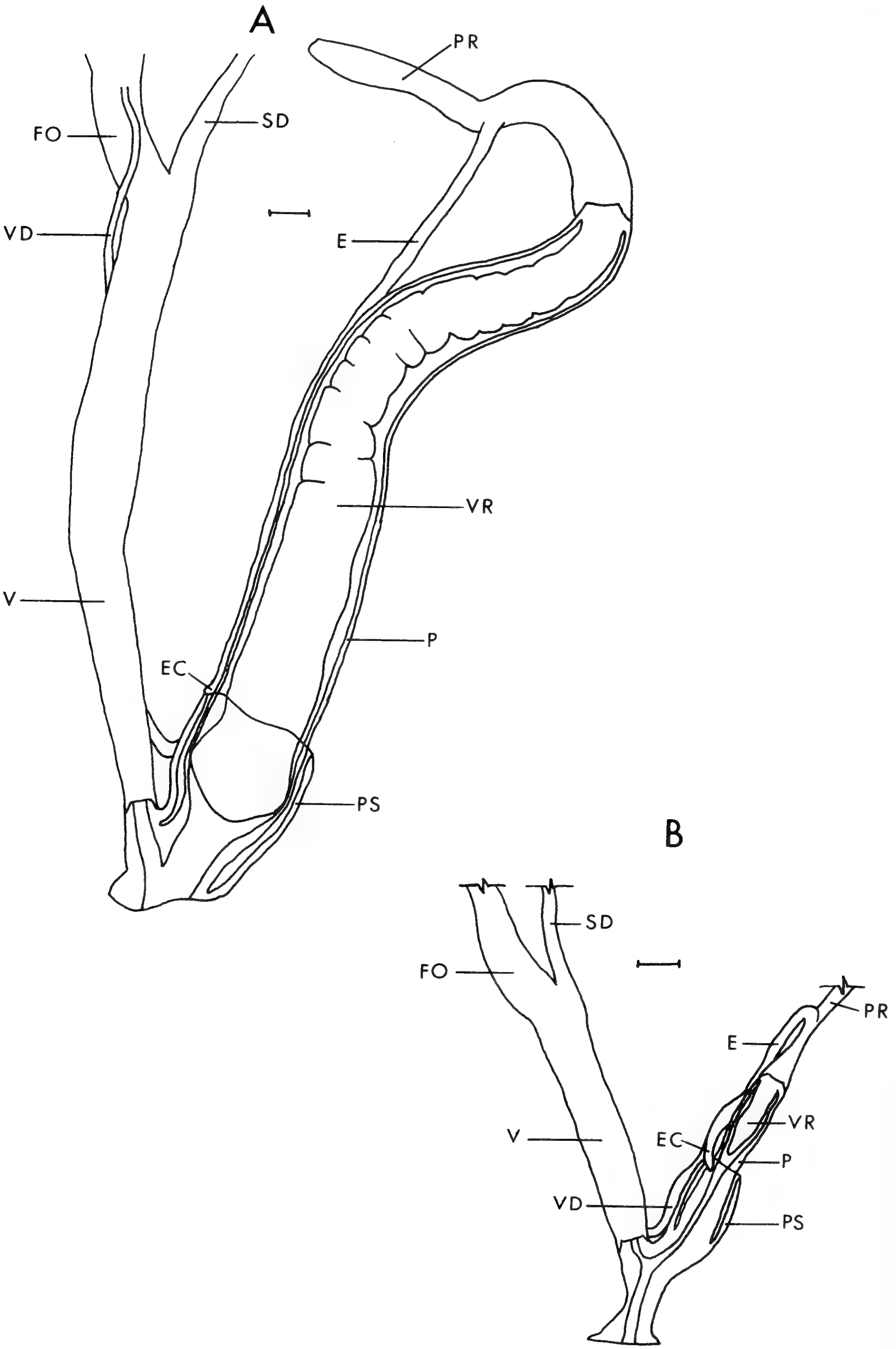

Fig. 3. Cutaway camera lucida drawings of genitalia of *Sonorella imitator* (**A**), and *S. grahamensis* (**B**). Scale bars equal 1 mm. Labeling as in Fig. 2.

Table 2.—Genitalia measurements of holotypes and paratypes of *Sonorella christenseni* and *S. macrophallus* with genitalia measurements of some specimens of *S. imitator* and *S. grahamensis* for comparison. Upper numbers are means and ranges (in parentheses), lower numbers are standard deviations. Measurements are in mm, made with ocular micrometer.

	S. christenseni		*S. macrophallus*			
	Holotype	Paratypes	Holotype	Paratypes	*S. imitator*	*S. grahamensis*
No. of specimens	1	5	1	8	5	3
Penis	11.1	10.7 (10.0–12.0) .8198	16.1	16.6 (14.2–18.5) 1.3815	23.7 (21.3–26.0) 1.7726	7.5 (7.1–8.4) .7506
Verge	7.1	6.2 (5.7–7.0) .5030	10.7	10.9 (9.3–12.9) 1.2992	17.1 (15.0–18.8) 1.6592	2.2 (2.0–2.4) .2082
Penial sheath	6.2	6.2 (5.0–8.3) 1.2390	3.5	4.1 (3.1–5.0) .6781	3.6 (3.0–4.8) .7348	2.9 (2.4–3.2) .4359
Epiphallus	12.3	9.2 (8.3–11.7) 1.4342	8.7	9.6 (7.2–12.2) 2.0345	14.0 (13.4–15.6) 1.0308	4.8 (4.3–5.3) .5033
Epiphallic caecum	2.0	1.8 (1.5–2.3) .3594	1.5	1.2 (0.9–2.0) .3732	0.3 (0.2–0.4) .1155	0.3 (—) .0000
Vagina	8.6	6.1 (5.4–8.2) 1.1832	9.7	10.1 (7.2–12.5) 2.0188	14.9 (14.4–15.8) .7155	5.4 (5.3–5.5) .0999
Free oviduct	5.3	4.5 (4.0–5.1) .4147	8.0	7.2 (5.6–9.9) 1.2456	4.2 (3.5–4.8) .4669	5.0 (5.0–5.1) .0577

Discussion

The difference in genitalia among the 4 species of *Sonorella* found in the Pinalenos appears to be too great to support the hypothesis that all evolved from a single ancestral population. A more probable hypothesis is that the ancestors of the current species arrived at the Pinalenos from other areas at different periods during the Pleistocene.

W. B. Miller (1967) in his revision of *Sonorella* recognized 2 subgenera. The subgenus *Sonorella* s.s., was subdivided into 3 complexes: the *hachitana* complex, the *binneyi* complex, and the *granulatissima* complex. Miller hypothesized that each of these complexes had a different center and time period of dispersal.

All 3 of Miller's complexes are represented among the species of *Sonorella* found in the Pinalenos, adding support to the hypothesis of emigration from different areas at different times.

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SYSTEMATICS AND VARIATION OF A NEW CYPRINODONTID FISH, *CYPRINODON FONTINALIS*, FROM CHIHUAHUA, MEXICO

Michael Leonard Smith and Robert Rush Miller

Abstract.—*Cyprinodon fontinalis,* new species, is described from a cluster of springs in the endorheic Guzmán Basin of northwestern Mexico. It differs from other pupfishes in head form, coloration, and meristic characters. Populations in five springs are variously distinct in coloration and meristic characters.

The Chihuahuan Desert of southwestern United States and northern Mexico is traversed by a few major tributaries of the Rio Grande system (Miller, 1978:fig. 1); however, the larger part of its area is divided into endorheic basins which are commonly occupied only by intermittent streams or isolated springs (Tamayo and West, 1964). During pluvial times, many now enclosed basins of the Chihuahuan Desert had outlets or contained lakes, as shown by abandoned shoreline bars and lacustrine sediments (Reeves, 1969). This formerly complex hydrographic system also left biological remnants: aquatic and semiaquatic organisms in isolated desert springs. Only recently, four new species of *Cyprinodon* were described from the Chihuahuan Desert in Mexico (Miller, 1976).

An additional relict pupfish of this genus is here described from a complex of isolated springs in the Bolsón de los Muertos, Chihuahua, Mexico, and variation among its five populations is examined. The new species is based on material in The University of Michigan Museum of Zoology (UMMZ), Field Museum of Natural History (FMNH), and United States National Museum (USNM).

Cyprinodon fontinalis, new species
Fig. 1

Holotype.—UMMZ 204189, male 45.5 mm SL: Mexico, State of Chihuahua, Ojo de Carbonera, about 36 airline km west of Villa Ahumada (106°51′W, 30°35′N), collected by R. R. Miller, E. Marsh and M. L. Smith, 28 May 1978.

Paratopotypes.—UMMZ 203022, 613 specimens (11.0–49.7 mm SL) including 20 cleared and stained individuals collected with the holotype; USNM 220601, 15 specimens including juveniles and adult males and females, 20.2–43.0 mm SL, ex UMMZ 203022; FMNH 83893, 15 specimens

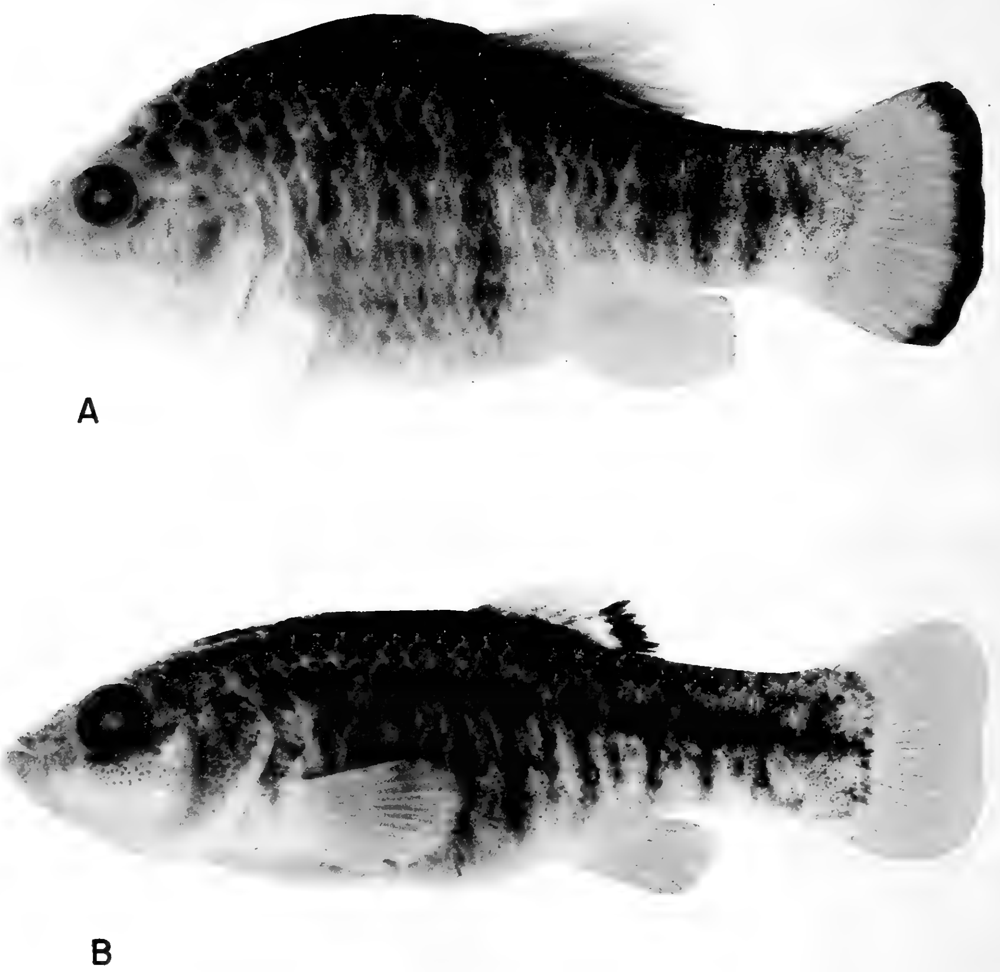

Fig. 1. *Cyprinodon fontinalis* n. sp. **A.** ♂ UMMZ 204189, holotype, 45.5 mm SL. **B.** ♀ UMMZ 203022, 30.7 mm SL. Mexico, State of Chihuahua, Ojo de Carbonera.

including juveniles and adult males and females, 22.1–14.0 mm SL, ex UMMZ 203022; UMMZ 204190, 36 specimens (8.8–44.2 mm SL) from the same locality as the holotype, collected by M. L. Smith and B. Chernoff, 1 June 1979.

Paratypes.—UMMZ 204191, 28 specimens (18.7–36.4 mm SL), Ojo del Apache, about 3 km SW of Ojo de Carbonera, 31 May 1979; UMMZ 204192, 105 specimens (15.3–40.7 mm SL), Ojo El Medio, about 0.5 km N of Ojo de Carbonera, 2 June 1979; UMMZ 204193, 53 specimens (12.1–39.2 mm SL), Ojo de las Varas, about 1 km N of Ojo de Carbonera, 2 June 1979; UMMZ 204194, 68 specimens (15.7–39.6 mm SL), Ojo Solo, about 3 km N of Ojo de Carbonera, 2 June 1979.

Table 1.—Morphometrics in thousandths of standard length of *Cyprinodon fontinalis*, based on UMMZ 203022, 204189, 204191, 204192, 204193, and 204194; holotype included with males.

	30 Males			30 Females	
	Holotype	Range	$\bar{x}$	Range	$\bar{x}$
Standard length, mm	45.5	22.4–48.8	32.8	25.9–44.6	33.6
Predorsal length	626	559–638	593	506–632	597
Prepelvic length	611	513–614	577	527–635	587
Anal origin to caudal base	360	339–497	381	298–371	347
Body depth	468	335–477	411	295–424	369
Body width	248	179–258	218	189–487	239
Head length	345	303–355	333	285–350	323
Head depth	413	290–413	345	261–405	316
Head width	231	195–258	221	189–257	226
Caudal-peduncle length	237	206–269	244	218–341	247
Caudal-peduncle depth	198	176–227	196	149–251	177
Interorbital width	119	94–127	106	93–119	107
Preorbital width	55	35–62	49	36–54	47
Postorbital width	149	137–166	154	125–165	149
Snout length	108	43–113	95	75–115	92
Eye diameter	86	55–94	82	66–99	82
Mouth width	90	71–121	93	80–113	95
Mandible length	83	73–106	89	72–141	88
Dorsal fin, depressed length	303	254–348	298	213–267	247
Anal fin, depressed length	231	201–281	246	176–218	201
Caudal-fin length	202	185–247	214	160–223	189
Pectoral-fin length	204	184–245	221	175–230	205
Pelvic-fin length	90	79–104	89	26–108	77

Diagnosis.—The new species is a *Cyprinodon* of typical body form (short and deep) which is distinguished from other members of the genus by the following characters. Breast and abdomen fully scaled. Scapular scale not notably enlarged in comparison to surrounding scales; cleithral process moderately developed. First dorsal-fin ray slender and flexible; outer half of dorsal fin of males yellow or cream-colored, basal half dusky; a pronounced ocellus present in the dorsal and sometimes anal fin of females. First anal-fin ray of mature females thicker than the rays which follow. Caudal fin short, 16–23% SL, ending in a jet-black band in males which is much wider than pupil. Pelvic fins small, barely reaching or falling short of anus, most often six-rayed. Mouth upturned; mandible heavy and robust, projecting beyond tip of snout. Branchiostegals 6.

Description.—Aspects of morphology and pigmentation are apparent in Fig. 1; morphometric data are given in Table 1. Methods of counting and measuring follow those described by Miller (1948). The last two closely approximated rays of both dorsal and anal fins are counted as one ray. Characters which show significant differences between populations are

Table 2.—Frequency distributions of cephalic sensory-pore counts in *Cyprinodon fontinalis*. Pores were counted on both sides of the head of each specimen.

	Mandibular pores					Preopercular pores				
	0,0	0,1	0,2	1,2	2,2	5,6	6,6	6,7	7,7	7,8
Ojo del Apache	3			3	14		9	7	2	2
Ojo de Carbonera	12	2	4	2	10	2	19	6	2	1
Ojo El Medio	15				5	1	13	4	1	1
Ojo de las Varas	5	1	3	1	10		11	7	2	
Ojo Solo	1		2		17		2	2	14	2
Total	36	3	9	6	56	3	54	26	21	6

treated by locality (Table 2); otherwise the data from all populations are combined. In the meristic data below, the count for the holotype is indicated by an asterisk.

Body deep and compressed. Median fins set back on body, dorsal-fin origin slightly behind pelvic insertion, closer to caudal base than to tip of snout. Predorsal length equals 51–64% SL.

First dorsal-fin ray slender and short, 51–79% as long as fourth ray. Dorsal-fin rays 9(1 count), 10*(54), 11(5). Anal-fin rays 9(2), 10(46), 11*(12). Pectoral-fin rays 12–14(1), 14–15(6), 14–16(2), 15–15*(31), 15–16(5), 16–16(14), 17–18(1). Pelvic-fin rays 0–0(1), 1–4(1), 3–4(1), 3–5(1), 5–5(6), 5–6(7), 6–6*(52), 6–7(1), 7–7(3). Caudal-fin rays 14(1), 15*(6), 16(29), 17(18), 18(4), 19(2).

Scapular scales about the same size as adjacent scales, the underlying cleithral process broad, but not much expanded posteriorly. Scales in lateral series 23(8), 24*(36), 25(15), 26(1). Body-circumference scale rows 23(1), 24(1), 25(5), 26(9), 27*(10), 28(20), 29(4), 30(10). Caudal-peduncle scale rows 14(5), 15(2), 16*(52), 18(1). Predorsal scales irregular, the diagonal rows numbering 14(5), 15(13), 16*(23), 17(15), 18(4). Total gill rakers on right anterior arch, including all rudiments, 16(3), 17*(14), 18(21), 19(16), 20(6). Total vertebrae (including hypural plate as 1), taken from radiographs, 25*(11), 26(46), 27(3). Precaudal vertebrae 11(4), 12*(53), 13(4). Caudal vertebrae 13*(10), 14(47), 15(4). Branchiostegal rays, from alizarin preparations, 6–6(20).

Sensory pores of acoustico-lateralis system on lacrimal 0–0(63), 0–1(2), 0–2(11), 1–1(1), 1–2(2), 2–2*(20), 2–4(4), 2–6(1), 3–3(1), 3–4(1), 4–4(3). Other sensory pore counts are given in Table 2.

Pelvic fin aberrations.—Pelvic fins are irregular in the 1979 collection from Ojo de Carbonera (UMMZ 204191). Aberrations occur in 33% of the 36 specimens. Although the pelvic girdle is always present, either or both fins may be absent, fin-rays may be imbedded in the skin of the abdomen, size and fin-ray counts may be reduced, or the fins may be connected to each other by a membrane. In other collections, aberrations occur in 5% of the specimens.

Sexual dimorphism.—The fins of males, particularly the dorsal and anal fins, are generally longer than those of females. With increasing size, males become very compressed and deep-bodied, developing a high predorsal crest (Fig. 1). In breeding males, contact organs develop on the head, the sides of the body between the dorsal and anal fins, and on the first six anal-fin rays. Breeding tubercles are not as well-developed in *C. fontinalis* as they are in many other *Cyprinodon*.

The first anal-fin ray of males is slender and flexible. In females, it is thickened and bow-shaped, with a wide interradial space between it and the second ray.

Color patterns as described in the next section also distinguish the sexes.

Coloration.—In life, adults are light gray-green on the back and sides; the breast, periproct and lower half of the head are silvery, sometimes with a yellow cast. The sides are crossed by 5 to 13 prominent gray-blue vertical bars which extend low onto the sides but are not continuous ventrally; the interspaces, silvery to milky white, are wider than the bars. Occasionally (particularly in females), the bars are expanded mid-way on the sides to form a lateral series of blotches which give the impression of a broken lateral stripe. The predorsal region may be bright iridescent purple-blue, particularly in males.

In adult males, the caudal fin ends in a jet-black marginal band wider than the pupil; the rest of the fin is hyaline. The margin and interradial membranes of the dorsal fin are yellow-orange or cream-colored; the rays and base of the fin are dusky. Anal-fin rays are cream-colored or yellow-orange with hyaline interradial membranes; the fin may end in a very fine black margin. Paired fins are yellowish, with a fine black edge.

In adult females, fins are mostly clear, but with a yellowish cast near the base of paired fins. The dorsal fin bears a black ocellus, the size of the eye or larger, in its posterior half. The ocellus is usually preceded by a contrasting spot of white. An ocellus occurs consistently in the anal fin of females from Ojo del Apache; it occurs rarely as a spot or faint ocellus in females from Carbonera, El Medio and Las Varas. The anal ocellus is consistently absent in females from Ojo Solo.

Juveniles (our specimens 8.8 to 18.3 mm SL) are mostly gray-green but the background color is lighter than in adults. The back is mottled by a series of dark blotches on both sides of the upper back; these blotches and the prominent vertical bars make the juveniles difficult to see against the coarse sand and fine gravel where they were collected. A faint ocellus may be present in the dorsal fin of immature males.

In ethyl alcohol, white, blue and gray-green colors disappear. The upper part of the body becomes leaden gray, the lower part yellowish or buff.

Fig. 2. Somatic chromosomes at metaphase of *Cyprinodon fontinalis*; female from the type locality.

Vertical bars remain prominent as do the black fin margins of males and ocelli of females. Males retain the characteristic dusky color in the lower half of the dorsal fin. The dorsal spots of juveniles quickly disappear in preservative.

Comparisons.—The cleithral process of *C. fontinalis* is only moderately

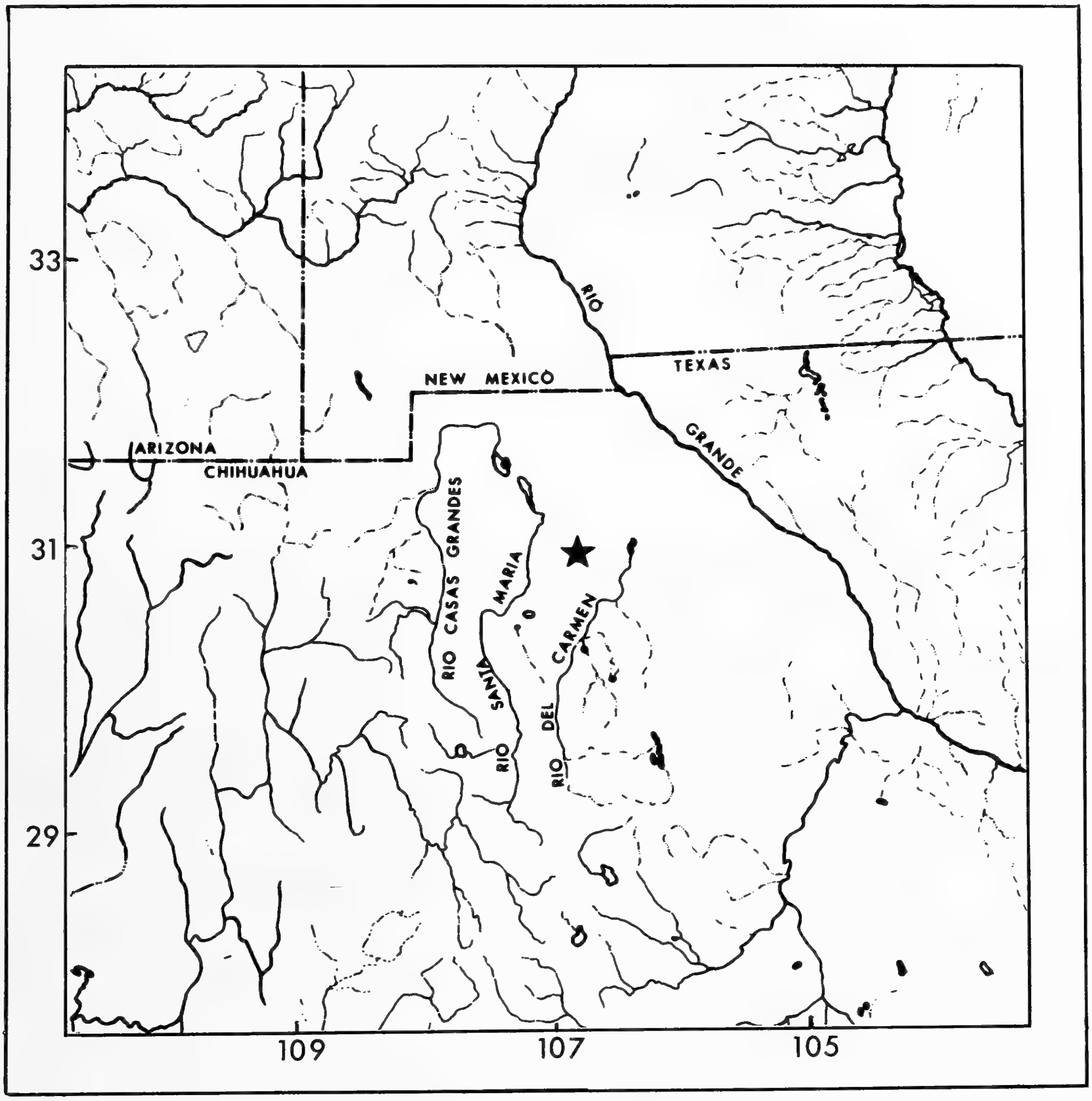

Fig. 3. Location of the habitat of *Cyprinodon fontinalis* in a complex of springs, marked by a star, in Chihuahua, northwestern Mexico.

developed for a *Cyprinodon,* about the same as in *C. nevadensis* (see Miller, 1956:fig. 1). In this respect, it differs from *C. variegatus, C. eximius, C. nazas, C. alvarezi* and *C. meeki* and closely resembles *C. atrorus, C. latifasciatus* and *C. macrolepis.* Further resemblances between *C. fontinalis* and *C. macrolepis* include low values for meristic characters: lateral scales 23–26 and 23–24, respectively; gill rakers 16–20 and 17–22; and total vertebrae 27 or fewer in both. These two species differ in coloration, head-pore counts and the stronger mandible of *C. fontinalis.*

The lower jaw is unusually prominent in the new species, equalled only by that of *C. alvarezi.* These species are also similar in general head and body form, presence of a wide terminal band on the male caudal fin, dusky color in the base of the dorsal fin, and reduced pelvic fins. *C. alvarezi* differs from *C. fontinalis* in numbers of mandibular pores and branchiostegal rays, presence of an irregular lateral stripe in females, milky white color of the male dorsal fin, and absence of vertical bars on the sides of males.

The ocellus in the anal fin of females from Ojo del Apache is unusual, though a similar pattern occurs in juveniles and females of *C. atrorus*. A small spot or faint anal ocellus is occasionally present in females of *C. alvarezi* and *C. meeki*.

Karyotype.—Chromosome squashes were prepared from gill epithelial cells of an adult male and female from the type locality. The diploid number is 48 including one pair of small metacentrics and 23 pairs of acrocentrics (Fig. 2). This is the typical karyotype of *Cyprinodon* (Miller and Echelle, 1975). A total of 38 cells were examined of which 24 yielded 48 chromosomes and 14 yielded 40 to 47 chromosomes.

Distribution and habitat.—*Cyprinodon fontinalis* is known only from five major springs and outflows around Ejido Rancho Nuevo in the arid Bolsón de los Muertos, Guzmán Basin, northern Chihuahua (Fig. 3). The springs lie within 12 km of an alkali flat, the southern lobe of a playa known as ''El Barreal.'' Much of Bolsón de los Muertos and nearby basins was inundated by pluvial Lake Palomas during post-Kansan time (Reeves, 1969). The most recent high stand of Lake Palomas is the 1220 m level marked by wave-cut features on Sierra Los Muertos, c. 130 airline km N of the Rancho Nuevo springs. Reeves (1969) speculated that the oldest (late Kansan to late Illinoian?) lake level may have been as high as 1250 m. It is likely that the Rancho Nuevo springs, which lie at about 1230 m, were inundated by Lake Palomas during or since late Kansan time.

At Ojo de Carbonera, the only spring which has not been highly modified, water rises from a complex of spring-heads and flows about 100 m as a shallow brook (less than 10 cm deep) before entering an irrigation system. *Cyprinodon fontinalis* is most abundant in solution holes which reach nearly a meter in depth and 1.5 m in diameter. It also occurs along the undercut banks of the outflow. Aquatic vegetation is sparse, consisting of filamentous algae, *Chara, Nasturtium,* and submerged grass. Substrates range from quicksand in the solution holes to gravel in the outflow. The water temperature in the spring was 27°C on 28 May 1978 and 6 June 1979.

C. fontinalis also occurs in irrigation ditches and four springs which have been impounded (Ojo Solo, Ojo de las Varas, Ojo El Medio, and Ojo del Apache). Pupfish are most abundant in water less than 0.5 m deep over sandy substrates; moving water is avoided. Aquatic vegetation is sparse though *Typha* and submerged grass occur around the pond margins. Water temperatures ranged from 25.5 to 28.0°C on 6–7 June 1979.

Gambusia affinis has been introduced and is common at all localities. Black bass are present by local account, but none was seen; an introduced

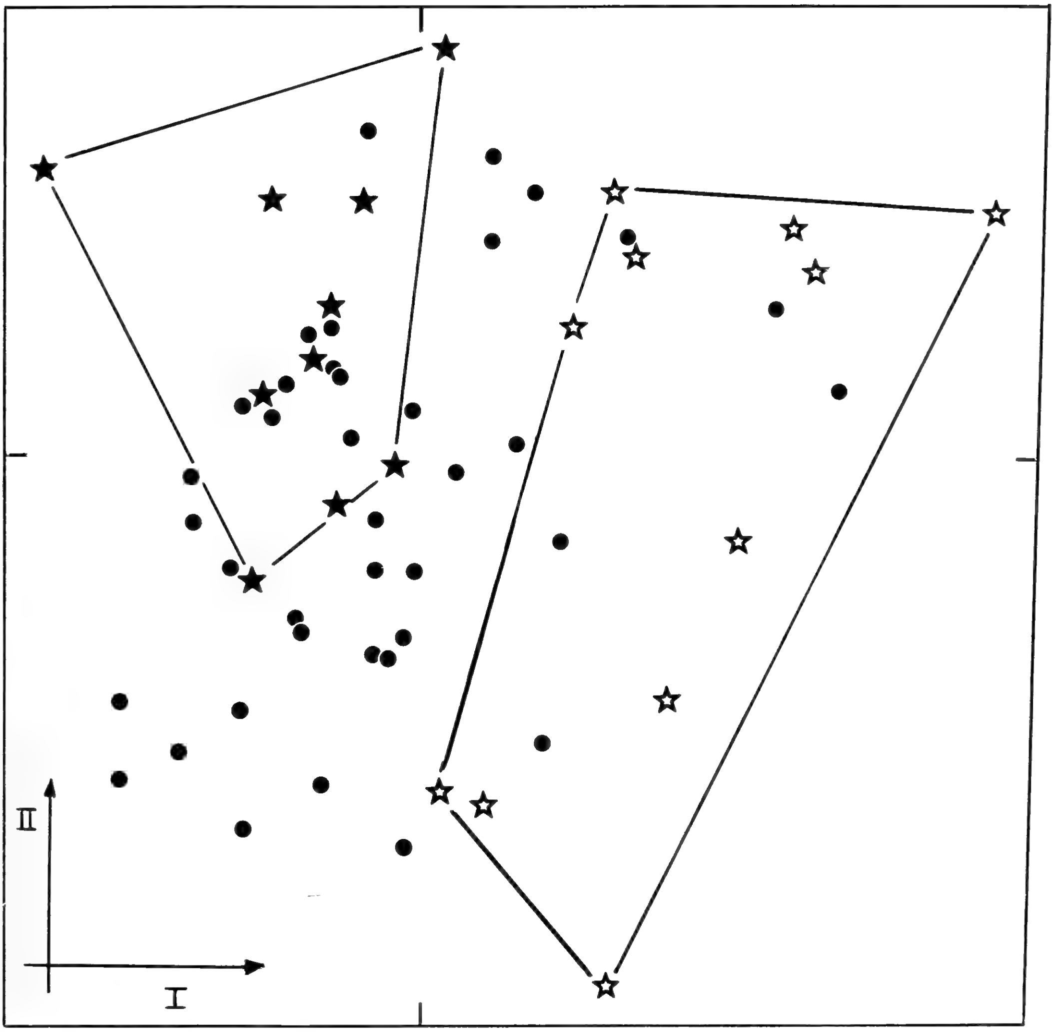

Fig. 4. Scatter diagram of principal components scores of 60 specimens of *Cyprinodon fontinalis*. Axes are components I and II which explain 20 + 15% of the total variance in an analysis of 19 meristic characters. Solid stars, Ojo del Apache; open stars, Ojo Solo; solid dots, central springs (Ojo de Carbonera, Ojo El Medio, Ojo de las Varas).

catfish, *Ictalurus melas,* was taken at Ojo Solo. The only native fish sympatric with *C. fontinalis* is an undescribed species of *Notropis,* known only from Ojo Solo.

A new species of crayfish, genus *Cambarellus,* from Ojo de Carbonera and nearby springs is being described by Hobbs (1980).

Status.—The original distribution and population size of *C. fontinalis* are unknown because its habitat had already been considerably modified when field studies were first undertaken in 1978. It is reasonable to infer, however, that the pupfish has suffered a decline in numbers because it is presently more abundant in remnant natural habitat (Ojo de Carbonera) than in the man-made ditches and impoundments at the other springs. Further modifications of the aquatic habitat at Ejido Rancho Nuevo can be expected because the area is being developed for agriculture and settlement. We therefore feel that *C. fontinalis* warrants special concern and have developed management guidelines which will be forwarded to fisheries management agencies of the Mexican government.

Etymology.—The species name is derived from the Latin *fontis,* spring, in reference to the habitat of the new species.

Geographic Variation

The populations of Ojo Solo and Ojo del Apache can be distinguished on the basis of several characters. Variation among all the populations was therefore examined. Principal components analysis was used as a method of displaying trends in variance (Sneath and Sokal, 1973). Specimens from each spring (total = 60) were scored for the 23 morphometric characters of Table 1 and 19 meristic characters: gill rakers, dorsal and anal rays, left and right pectoral and pelvic rays, caudal rays, lateral scales, scales around body, predorsal scales, circumpeduncular scales, total vertebrae, and left and right sensory pores on the preopercle, mandible and lacrimal. Principal components were calculated from the correlation matrix using the program available in the Michigan Interactive Data Analysis System. Calculations were performed separately for meristic and log-transformed morphometric data, and bivariate scatter diagrams were analyzed. Pair-wise and overall comparisons of the five populations were made.

Variation in morphometric characters is primarily size- or sex-related; significant variation among populations was not detected. Conversely, meristic variation is not significantly influenced by size or sex, and several meristic characters vary clinally among the five populations.

The populations from the three central springs (Carbonera, El Medio and Las Varas) cannot be distinguished on the basis of meristic characters. When scattered according to their scores on any two of the first ten principal components, specimens from these springs (which are close together and connected by irrigation ditches) form a single cluster.

A scatter diagram of specimens from the two more remote, isolated springs (Apache and Solo) reveals two distinct clusters (Fig. 4). Characters contributing strongly to the first component are, in order of importance, pelvic-fin rays, preopercular sensory pores and body-circumference scale rows. The second component is most strongly influenced by anal-fin rays, vertebrae, dorsal-fin rays and mandibular sensory pores.

Preopercular and mandibular sensory pores show the greatest differences in frequency distributions between populations (Table 2). In all other meristic characters, modal values are nearly the same for all populations. Separate clusters are formed by the Apache and Solo populations because their characters vary slightly, but in a direction which is characteristic for each population.

The Apache and Solo populations can also be distinguished on the basis of color patterns not included in the multivariate analysis. The population of Ojo del Apache is characterized by an ocellus consistently present in the anal fin of females, dusky color on all dorsal-fin rays in males, and vertical bars prominent and numerous (6 to 13). In specimens from Ojo Solo, the anal ocellus of females is consistently absent, dusky color is confined to posterior dorsal-fin rays of males (occasionally also present at base of anterior rays), and vertical bars are fainter and less numerous (5 to 8).

The distinctions between the Apache and Solo populations tend to be bridged by the populations from the central springs. The anal ocellus occurs sporadically in these fish. When plotted on the meristic axes calculated for Ojo del Apache and Ojo Solo, specimens from the central springs form an intermediate cluster overlapping the other two (Fig. 4). We do not erect separate subspecies because of the high variation and intermediacy of these populations.

Resumen

Cyprinodon fontinalis, nueva especie de la familia Cyprinodontidae, se describe de cinco manantiales aislados en el Bolsón de los Muertos, una cuenca cerrada en el noroeste del Estado de Chihuahua, México. Se distingue de *C. macrolepis* por el número de poros en la línea lateral cefálica y porque la mandíbula es más robusta. Se distingue de *C. alvarezi* por el número de poros sensorio-mandibulares y el número de radios branquióstegos. De otras especies del género, se distingue por la forma de la cabeza, la coloración y varios carácteres merísticos.

Acknowledgments

We are grateful to Edie Marsh and Barry Chernoff for assistance in the field, Edward C. Theriot for preparation of Fig. 1, and Teruya Uyeno and Tsutomu Miyake for assistance in determination of the karyotype. T. Miyake prepared Fig. 2. Permission to collect fishes in Mexico was kindly granted by the Dirección General de Regiones Pesqueras (Permits 3616 and 6243). Field work was supported by NSF DEB 77-17315 and the New York Zoological Society. David Schleser called our attention to this pupfish, and specimens sent by Joe Anascavage established that it was new.

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93(2), 1980, pp. 417–420

FIRST OCCURRENCE OF *TECHNITELLA* NORMAN 1878 (FORAMINIFERIDA: ASTRORHIZIDAE) FROM THE EARLY PLEISTOCENE, SANTA BARBARA FORMATION, CALIFORNIA

Richard W. Huddleston

Abstract.—*Technitella* sp. is noted in the fossil record of North America for the first time. This occurrence is based on specimens from the Santa Barbara formation, early Pleistocene of California. The test of *Technitella* sp. was composed of both monoaxon and polyaxon sponge spicules.

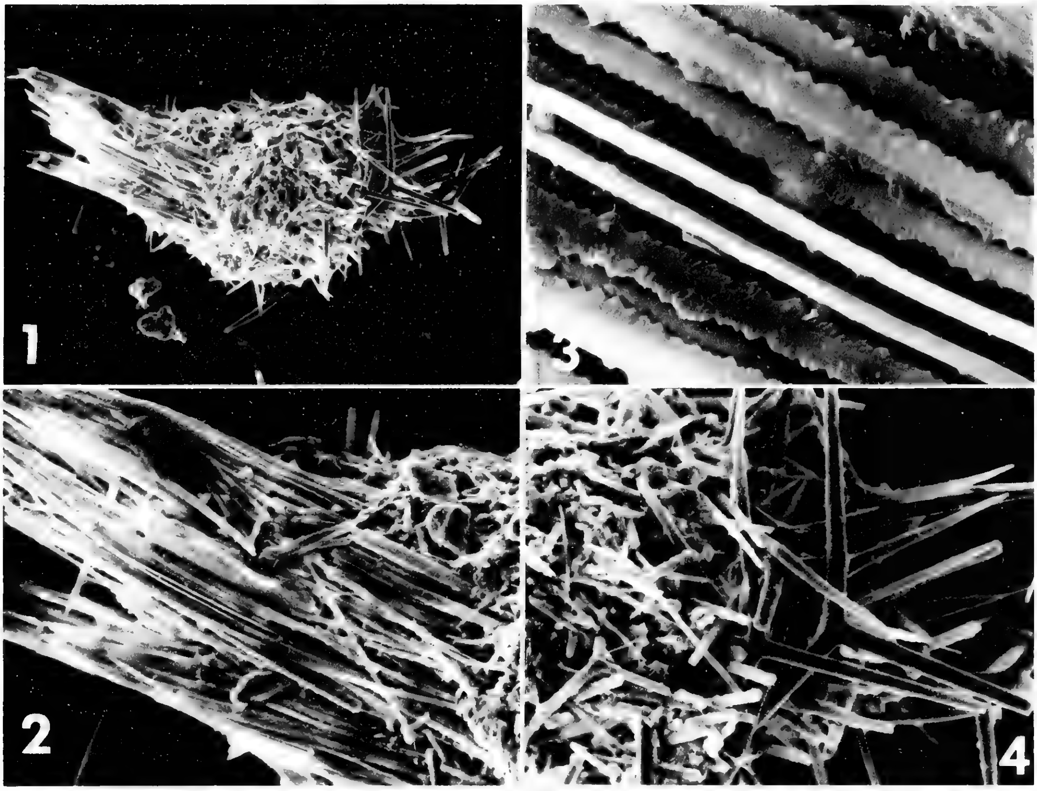
The Bathhouse Beach locality (119°41′38″W, 34°24′23″N) is an exposure of the Santa Barbara formation (early Pleistocene) that forms a high east-facing bluff on the west side of Cabrillo Blvd., Santa Barbara, California. Samples collected from the basal 60 cm of the exposure during August 1970 contained a rich foraminiferal assemblage, including several specimens referrable to the genus *Technitella* Norman 1878. The delicate nature of this form and its rarity in the fossil record warrant documentation of this North American fossil occurrence.

The richly fossiliferous samples comprised bryozoan fragments, small mollusc shells and foraminiferal tests. Occasional echinoderm fragments, crab claws and teleost otoliths were also encountered.

The Bathhouse Beach locality is exceedingly rich in foraminiferal remains, but reports concerning them are few. Loeblich and Tappan (1963) described *Montfortella bramlettei,* and Bullivant (1969) listed seven species (*Trifarina baggi, Cibicides fletcheri, Cibicides gallowayi, Cassidulina limbata, Cassidulina californica, Elphidium translucens,* and *Planulina arminensis*) as common at this locality.

The delicate nature of *Technitella* has rendered it unfavorable for preservation in the fossil record and consequently few occurrences have been documented. Stainforth and Stevenson (1946) described *Technitella archaeonitida* from the upper Eocene-upper Oligocene of Ecuador. *Technitella archaeonitida* was again mentioned from the Eocene of Ecuador by Cushman and Stainforth (1951) and later by Hofker (1956). *Technitella nitida* was noted from the Miocene of Upper Egypt by Stainforth (1949). Colom (1958) reported *Technitella legumen* as occurring frequently in the lower Miocene of Majorca. Dondi and Papetti (1968) also reported *T. legumen* from the lower Pliocene of Italy.

Originally, *Technitella* was described as having an unattached test (Nor-



Figs. 1–4. *Technitella* sp., Bathhouse Beach locality: **1,** 125×; **2,** Anterior section, 324×; **3,** Anterior section, 3000×; **4,** Posterior section, 324×.

man, 1878). Subsequent workers have followed this interpretation. Haman (1967, 1971) however, discovered attached as well as unattached forms of *Technitella* from Tremadoc Bay. Haman (1967) further pointed out that what had been previously described as an aperture was in fact the attachment area, and the aperture was positioned at the opposite end, generally obscured by sponge spicules. Both attached and unattached specimens of *Technitella teivyense* were described from Cardigan Bay by Haynes *et al.* (1973) who commented, "There is no evidence of branching of the cylindrical body chambers in *T. teivyense* so the colonies appear to be composed of separate individuals."

The specific levels of *Technitella* have been defined and differentiated on the basis of the external morphological variations of test size, test shape and degree of test inflation. However, Haman (1967) suggested that these features may represent ontogenetic variations of colonial development. The same author detailed this feature in 1971 along with a corrected emendation of the genus. Postmortem destruction of the colony may result in some specimens appearing to have free unattached tests. In view of the reinterpretation and emendation of *Technitella* by Haman (1967, 1971) it is difficult to evaluate the taxonomic significance of the external morphological differences among the specimens which are known from only unattached tests.

There is considerable variation in the *Technitella* from the Bathhouse beach locality. At present several of these forms are questionable and will be discussed in a later study. *Technitella* sp. (Fig. 1) possesses a subelongate, irregularly oval test covered by both monaxon and polyaxon sponge spicules. The presumed anterior end (D. Haman, personal communication) consists of long, thin, densely packed monaxon spicules (Fig. 2). Some of these roughly parallel, anteriorly projecting spicules are laterally compressed with a series of flattened, subangular serrated edges (Fig. 3). An apertural opening is not discernable, presumably obscured by collapse of the anteriorly projecting spicules. The central area of the test consists of a subspherical mass of agglutinated material and few spicules. The posterior end is composed of large irregularly arranged multiradiate spicules (primarily tetraxon and hexaxon). These spicules are circular or subcircular in cross-section with a minute series of serrations or thorn-like projections along the lateral sides (Fig. 4).

Technitella sp. from the Bathhouse Beach locality differs from *T. legumen* by lacking a subcylindrical test, the absence of a short tubular neck and a rounded attachment area (previously referred to as the aperture). *Technitella* sp. differs from *T. melo* by lacking a spheroidal test composed of long monaxon sponge spicules alligned lengthwise.

Both *Technitella legumen* and *T. melo* have been reported from the North Pacific and Bering Sea (Cushman, 1910; Anderson, 1963). In view of the absence of Recent representatives of *Technitella* from the vicinity of the Bathhouse Beach locality (apparently none recorded within several thousand miles of the locality) and the potential extent of variation reflected in test morphology, formal description of the specific level of the Bathhouse Beach specimens would be premature at this time.

The distribution of *Technitella* is primarily in the temperate, boreal regions of the Arctic, Antarctic, Bering Sea, North and South Atlantic and Pacific Oceans. There are also several records from warm tropical regions. *Technitella* apparently prefer shallow water with minimal wave action or disturbance by currents in a region of slow sedimentation (D. Haman, personal communication).

Preliminary investigation of several samples collected from the Bathhouse Beach locality suggests that there are several micro-environments discernable in this formation and *Technitella* sp. (represented by approximately 100 specimens) may be confined to a narrow range within the Bathhouse Beach locality.

In his evaluation of the paleoenvironmental conditions of the Bathhouse Beach locality, Bullivant (1969:93) stated: "The interpretation that emerges then, is that there was a bank rising to 20–30 fathoms in a region of slow sedimentation. The physical factors of the marine environment were much as they are today although the temperature was perhaps a little lower." This interpretation is in agreement with the type of environment preferred by *Technitella*.

Acknowledgments

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A NEW SPECIES OF *SOLENOCERA* (CRUSTACEA: DECAPODA: SOLENOCERIDAE) FROM NORTHERN AUSTRALIA

Isabel Pérez Farfante and D. L. Grey

Abstract.—Solenocera australiana, new species, a close ally of *S. halli* and *S. melantho,* is described from material collected in shallow water, 15 to 24 m, off the Northern Territory, Australia. This species is characterized by the antennular flagella which gradually narrow distally toward the 2 or 3 distalmost articles; the roughly lanceolate distal part of the dorsolateral lobules of the petasma which are supported by submesial ribs; and the presence of two pairs of thelycal protuberances on the anterior part of sternite XIV, the mesial one usually considerably larger than the lateral, as well as by the straight anterior border of the thoracic ridge.

In July 1972, during routine fishery monitoring by the staff of the Fisheries Division, Department of Primary Production, Darwin, a collection of shrimps of the genus *Solenocera* was taken from commercial grounds north of Groote Eylandt in the western Gulf of Carpentaria. Since that time additional specimens have been obtained during the course of sampling of penaeid shrimps by fishery research vessels in waters adjacent to the Northern Territory, mostly in Van Diemen Gulf, but also in other localities off this province by commercial trawlers.

Van Diemen Gulf has not attracted significant commercial fishing for penaeid shrimps—the only members of the superfamily Penaeoidea that at present are economically important in northern Australia—and to make a preliminary evaluation of its potential as a fishery, a series of brief surveys were made between May 1977 and February 1978. Although the surveys were neither comprehensive nor very conclusive, large concentrations of small penaeids were found. Along with these shrimps, particularly in the 15 to 24 m depth zone, a total of 108 individuals of what proved to be an undescribed species of *Solenocera* were obtained. Further specimens became available from the commercial catches of the *F. V. Taroona* in Van Diemen Gulf through the courtesy of Mr. P. G. MacLean, and from factory samples taken from fishing grounds north of Melville I–Port Essington.

Representatives of the genus *Solenocera* have been previously reported from Australian waters. Schmitt (1926) noted the occurrence of *S. melantho* De Man, 1911, off the east coast, 19 km NNE of Bowen, Queensland, but the single specimen available to him has not been examined by us. Because of the close similarity between De Man's species and the one described herein, it is not possible to ascertain to which, if to either, that specimen belongs. Recently J. A. Redfield (personal communication) collected a *Solenocera* sp. among 27 species of shrimps collected in the Gulf of Carpentaria, at Albatross Bay, and noted that this find represented a new Australian record. In addition, W. Dall has informed us that he has found *S. alticarinata* Kubo, 1949, and "*S. depressa* [Kubo, 1949] (?)," off western Australia, and added that the latter might have belonged to the species described here. Unfortunately, his material is no longer extant.

The paucity of records of *Solenocera* off Australia is rather surprising considering the studies that have been made of the commercial shrimp catches and of collections obtained during exploratory surveys in many areas of the continental shelf. Perhaps this new member of the genus *Solenocera* exists in limited quantities in company with small penaeids in several areas off the coast of Australia. Probably it has been present in many catches obtained in the past, but was overlooked because commercial operations in Australian waters are aimed at larger species such as *Penaeus* (*Penaeus*) *esculentus* Haswell, 1879, tiger prawn; *Penaeus* (*Penaeus*) *semisulcatus* De Haan, 1844, green tiger prawn; *Penaeus* (*Fenneropenaeus*) *merguiensis* De Man, 1888, banana prawn; *Metapenaeus endeavouri* (Schmitt, 1926), endeavour prawn; and *Metapenaeus ensis* (De Haan, 1844), offshore greasy back prawn.

Solenocera australiana, new species

Figs. 1–7

Material.—(All from off the Northern Territory, Australia).

Holotype: ♀, USNM 173115, 40 mm carapace length, about 125 mm total length; type locality: north of Groote Eylandt, Gulf of Carpentaria, 13°34′S, 136°30′E, 22 m, 14 July 1972, *Apache* sampling cruise 21, haul 3. Allotype: ♂, USNM 173117, 20.5 mm carapace length, about 72 mm total length, fishing grounds north of Melville I–Port Essington, commercial catch (sample from processing plant in Darwin), September 1977.

The paratypes are deposited at the USNM, the Australian Museum (AM) and the Fisheries Division, Department of Primary Production (FDP): 1 ♂ 4 ♀, USNM, collected with holotype. 1 ♂ 10 ♀, USNM, 1 ♀ (FDP), collected with allotype. 1 ♂ 10 ♀, USNM, 1 ♂ (FDP), Van Diemen Gulf, 11°47′S, 132°27′E, 20 m, 20 August 1977, P. G. McLean, *Taroona* (commercial catch). 2 ♂ 2 ♀, USNM, Van Diemen Gulf, 11°52′S, 132°26′E, 22 m, 26 October 1977, *Sandra-K,* survey cruise 9, haul 8. 1 ♂ 20 ♀ 3 intersexes, USNM, 2 ♂ 7 ♀, BMNH, Van Diemen Gulf, 12°04′S, 131°43′E, 15 m, 9 June 1977, *Sandra-K,* survey cruise 6, haul 7. 2 ♂ 14 ♀, USNM, Van Diemen Gulf, 12°02′S, 131°41′E, 15 m, 5 May 1977, *Sandra-K,* survey cruise

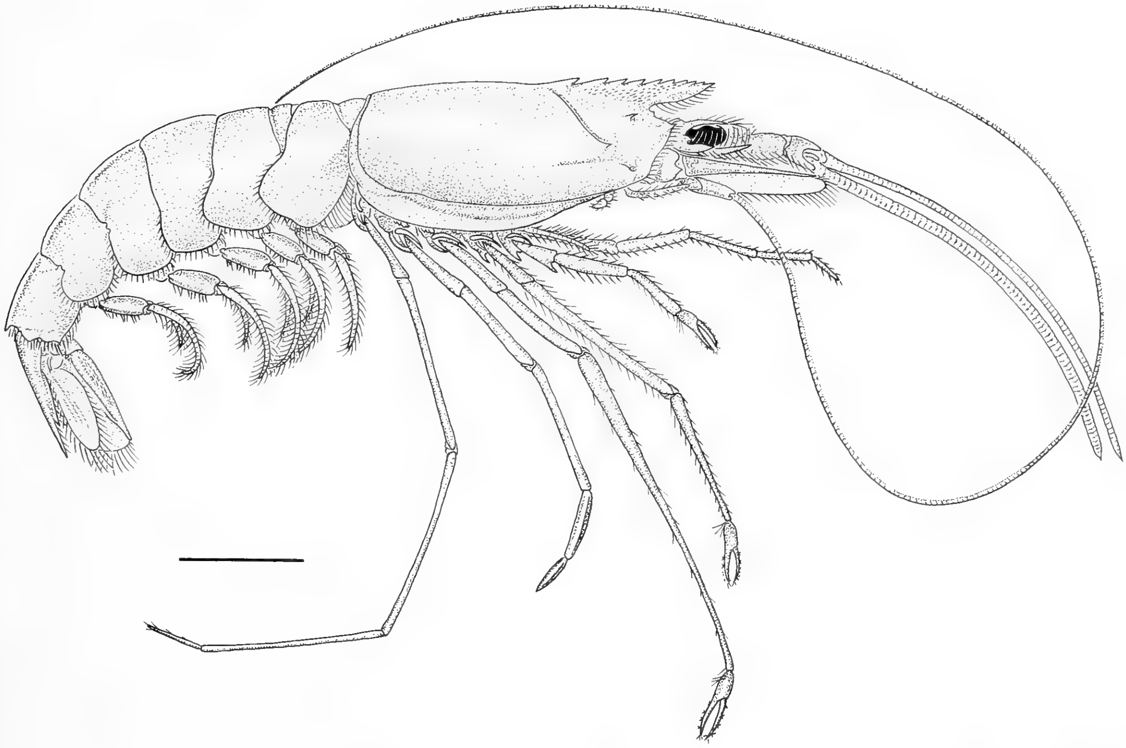

Fig. 1. *Solenocera australiana,* paratype, USNM 173118, ♀ 27 mm cl, Melville I–Port Essington fishing grounds, Australia: Lateral view. Scale = 10 mm.

4, haul 9. 2 ♀, USNM, Van Diemen Gulf, 12°04′S, 131°39′E, 16 m, 5 May 1977, *Sandra-K,* survey cruise 4, haul 5. 3 ♂ 6 ♀, AM, Van Diemen Gulf, 12°00′S, 131°35′E, 24 m, 5 May 1977, *Sandra-K,* survey cruise 4, haul 4.

Forty five additional specimens were examined by the second author and are deposited in the collection of the Fisheries Division, Department of Primary Production, Northern Territory.

Description.—Body glabrous (Fig. 1), but with elongate subtriangular patch of setae covering rostrum above adrostral carina and continuing to epigastric tooth (Fig. 2). Rostrum straight, deep, with ventral margin convex basally then almost straight to apex, and reaching to about distal extremity of eye. Number of rostral plus epigastric teeth 8 to 10 (percentage distribution: 8-5, 9-75, 10-20: N = 44); epigastric tooth about 1.4 times as far from first rostral tooth as latter from second; and fifth tooth (in occasional specimens fourth) in line with orbital margin. Postrostral carina well defined, blunt, extending almost to posterior margin of carapace; median sulcus consisting of fusiform or teardrop-like depression preceded and/or followed by few pits. Orbital spine short, postorbital spine slender, continuous with low blunt carina; antennal and hepatic spines small; pterygostomian and branchiostegal spines lacking. Cervical sulcus deep, almost reaching midline, and merging ventrally with dorsally directed groove and hepatic sulcus in

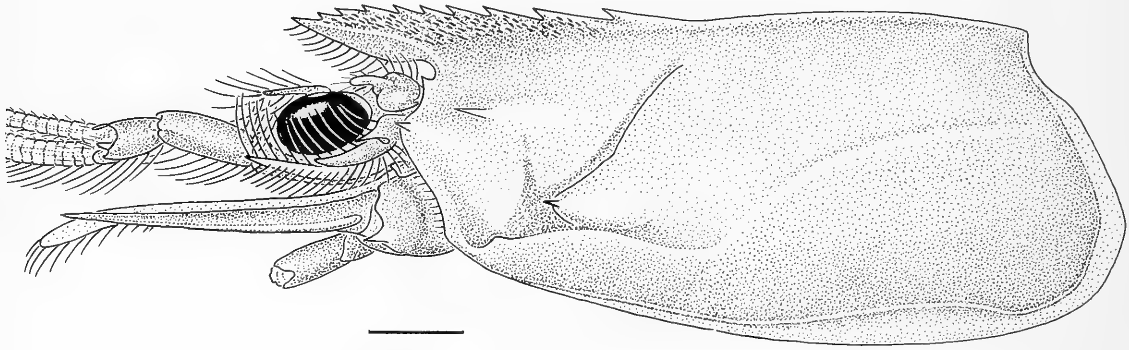

Fig. 2. *Solenocera australiana,* paratype, USNM 173116, ♀ 32 mm cl, N of Groote Eylandt, Gulf of Carpentaria, Australia: Anterior region, lateral view. Scale = 5 mm.

broad depression; hepatic sulcus extending posteriorly to slightly beyond dorsal extremity of cervical sulcus. Hepatic carina almost indistinct posteriorly, sharp anteriorly, forming arc bordering semicircular depression on pterygostomian region. Branchiocardiac carina weak but long, extending from or near posterior extremity of hepatic carina almost to posterior margin of carapace.

Prosartema falling short of distal margin of first antennular article, but its long terminal setae attaining proximal fourth of second article. Stylocerite relatively short, length equivalent to 0.6 of distance between its proximal end and mesial base of distolateral spine; distolateral spine short, barely surpassing distal margin of first article. Antennular flagella (Fig. 3A) with terminal part gradually narrowing toward distalmost 2 or 3 minute articles; flagella subequal in length, about twice as long as carapace in shrimp with 20 mm carapace length (cl), and 1.5 and 1.4 times as long in shrimp with 27 and 37 mm carapace length, respectively.

Scaphocerite surpassing antennular peduncle, sometimes by as much as 0.15 of its own length, occasionally only reaching distal end. Antennal flagellum incomplete in all specimens examined.

Third maxilliped exceeding scaphocerite by at least half length of dactyl, and at most, by entire dactyl. First pereopod overreaching carpocerite by length of dactyl or, at most, by entire propodus. Second pereopod surpassing scaphocerite by propodus or by maximum of propodus and one-fourth of carpus. Third pereopod overreaching scaphocerite by propodus and at least two-fifths, and at most by two-thirds, of carpus. Fourth pereopod almost reaching, or exceeding scaphocerite at most, by dactyl and one-third of propodus. Fifth pereopod surpassing scaphocerite by dactyl and four-fifths of propodus or by maximum of dactyl, propodus, and tip of carpus. Last two podomeres of fourth pereopod broadened, flattened, and carinate along midline on both surfaces. Data above based on 16 well preserved specimens.

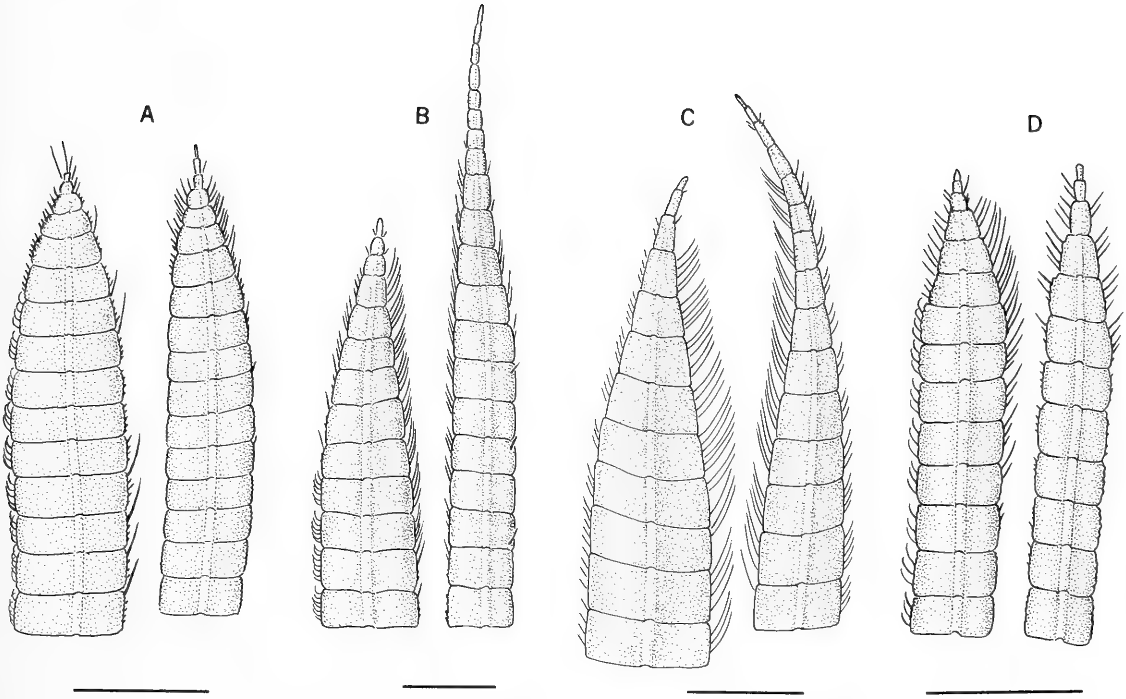

Fig. 3. Terminal parts of left antennular flagella: **A,** *Solenocera australiana* n. sp., paratype, USNM 173118, ♀ 26 mm cl, Melville I–Port Essington fishing grounds, Australia; **B,** *Solenocera melantho,* ♀ 29.5 mm cl, T'o-kou, T'ai-tung Hsien, Taiwan; **C,** *Solenocera melantho,* ♀ 33 mm cl, Pujada Bay, Mindanao, Philippines; **D,** *Solenocera halli,* ♂ 16.5 mm cl, off Pangkor, Strait of Malacca, Malaysia. Scales = 1 mm.

First pereopod armed with spine on basis and ischium, and second with one on basis. In female, coxa of fifth pereopod produced in long, slender, distomesial spine overreaching coxobasial articular membrane; in male, coxa bearing flattened, laterally curved, distomesial spine.

Abdomen bearing middorsal carina from third through sixth somites, carina low on third, keel-like and progressively higher along last three; sixth somite bearing small spine at posterior end of carina, and similar spine posteroventrally. Telson armed with small pair of fixed lateral spines. Mesial ramus of uropod falling short of, or slightly overreaching, apex of telson; lateral ramus slightly overreaching mesial one, with lateral rib extending to distal margin, there forming blunt spine.

Petasma (Fig. 4A–B) with ventromedian lobule extending distally slightly beyond dorsolateral lobule, latter both surpassing distally and extending over ventral costa. Terminal margin of petasma, except unarmed dorsomedian lobule, bearing numerous outwardly directed spinules or short spines: ventromedian lobule with 15 to 26 spinules increasing in length laterally; dorsolateral lobule with 20 to 40 usually decreasing in length proximolaterally, but sometimes proximal spinules long; and ventral costa with strongly recurved distal part bearing 7 to 13 short spines. Distal part of

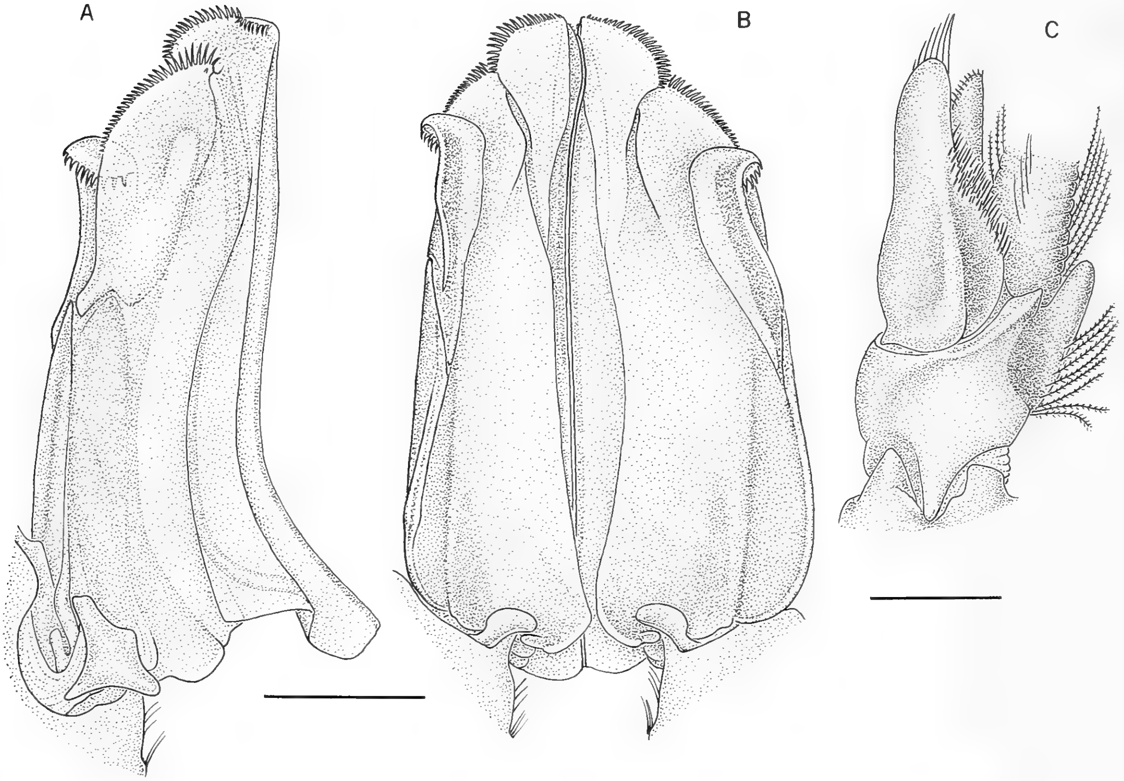

Fig. 4. *Solenocera australiana,* allotype, USNM 173117, ♂ 20.5 mm cl, Melville I–Port Essington fishing grounds, Australia: **A,** Left half of petasma, dorsolateral view; **B,** Ventral view of same; **C,** Right appendix masculina, dorsolateral view. Scales: A, B = 2 mm; C = 1 mm.

dorsolateral lobule roughly lanceolate, its lateral margin strongly convex, mesial margin slightly to markedly so, and bearing submesial rib, lateral edge of which is elevated above adjacent membranous area. Rib continuous proximally with broader thickening produced into short subrectangular projection reaching lateral margin. Junction of free distal and proximal parts of ventral costa marked by shallow emargination.

Appendix masculina (Fig. 4C) with basal part of longitudinal, dorsal ridge curved mesially; strongly concave lateral margin bearing long patch of closely set setae; and apical margin studded with row of long ones. Appendix interna falling slightly short of appendix masculina, strongly concave laterally, and bearing minute spinules along distomesial margin. Basal sclerite with marginal, distolateral ridge terminating in short projection at mesial base of blunt ventrolateral spur.

Thelycum (Fig. 5A–B) with subquadrangular posterior depression delimited by raised (ventrally) lateral margins of sternite XIV and transverse ridge situated at about base of anterior third of sternite; two pairs of setose protuberances situated immediately anterior to ridge: more mesial one rounded

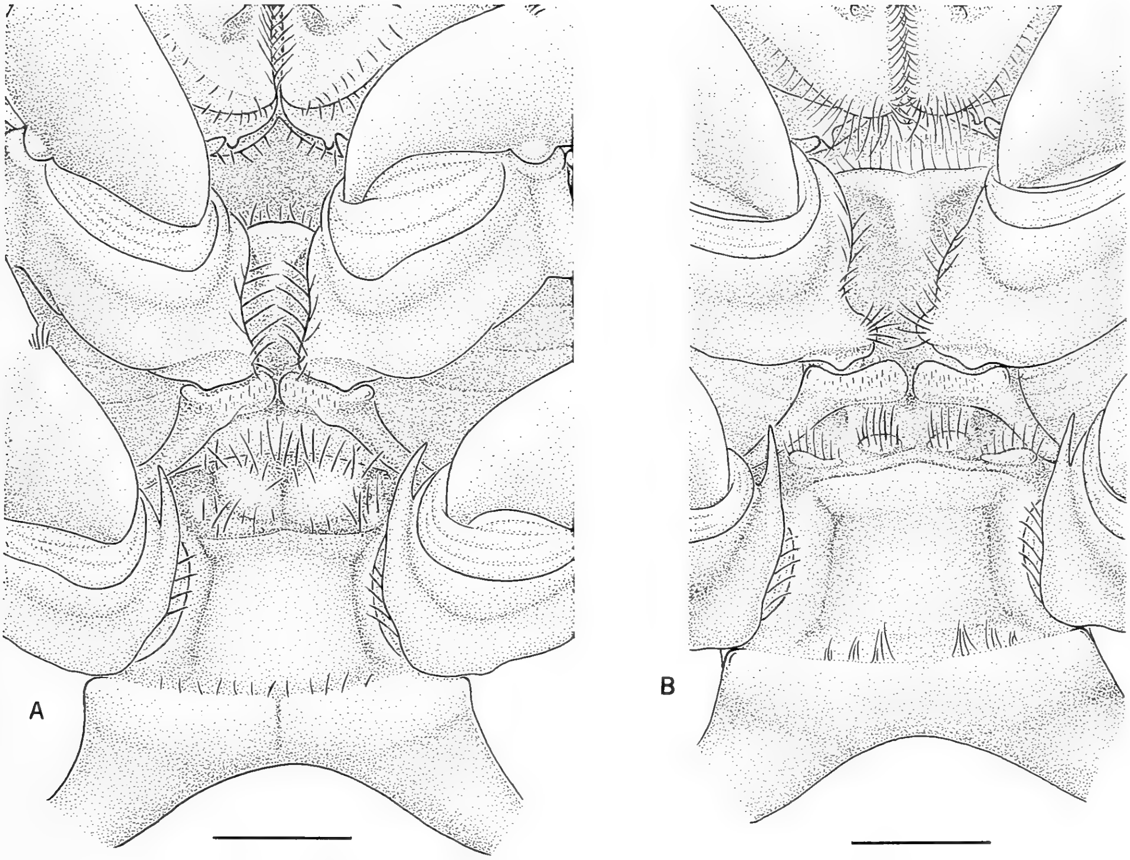

Fig. 5. Thelyca: *Solenocĕra australiana*: **A,** Holotype, USNM 173115, ♀ 40 mm cl, N of Groote Eylandt, Gulf of Carpentaria, Australia; **B,** paratype, USNM 173116, ♀ 42 mm cl, same locality. Scales = 2 mm.

or oval, variable in size but usually larger (often considerably so) than lateral pair; latter rounded to elongate subelliptical. Posterior part of sternite XIII with vertical shelf bearing pair of strong setose, broad thickenings separated by median slit; sternite XIII crossed by setose transverse elevation slightly anterior to midlength, elevation continuous posteriorly with median ridge. Posterior thoracic ridge with anterior border almost straight and sparsely set with setae; narrow short median groove often bisecting ridge.

Size.—Carapace lengths of males examined 11 to 25.5 mm, of females 10 to 42 mm.

Geographic and bathymetric ranges.—Thus far this species has been found only in waters adjacent to the Northern Territory: north of Groote Eylandt (western Gulf of Carpentaria), in Van Diemen Gulf, and immediately to the north of Melville I–Port Essington. It occurs at depths between 15 and 24 m on muddy bottoms with a mixture of rock, coral, and shell; with or without vegetation.

Affinities.—*Solenocera australiana* is closely allied to *S. halli* Starobo-

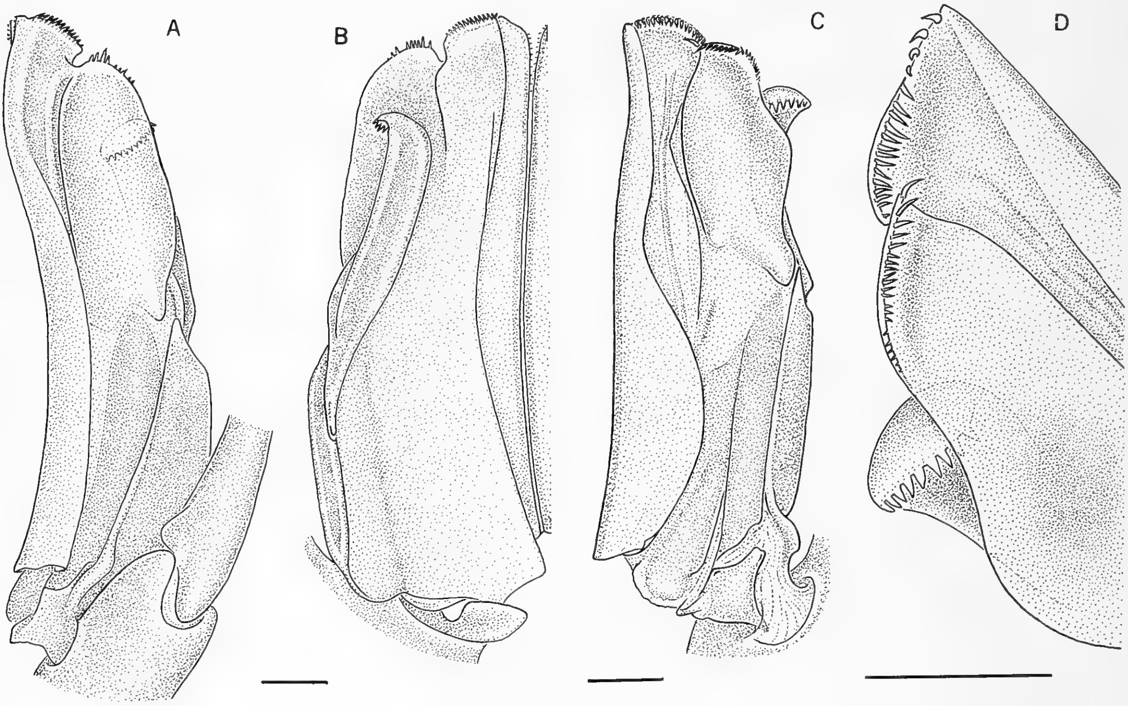

Fig. 6. Petasmata: **A,** *Solenocera melantho,* syntype, ZMA De. 102.477, ♂ 24 mm cl, E of Saleh Bay, north coast of Sumbawa, Indonesia, right half of petasma, dorsolateral view; **B,** Ventrolateral view of same; **C,** *Solenocera halli* ♂ 19 mm cl, off Pangkor, Strait of Malacca, Malaysia, dorsolateral view of right half of petasma; **D,** ♂ 21.5 mm cl, same locality, distal part of left half. Scales = 1 mm.

gatov, 1972, and *S. melantho* De Man, 1907. *Solenocera halli* has been found off Madras, Bay of Bengal, in the Andaman Sea (Starobogatov, 1972), along the Strait of Malacca (Hall, 1961; 1962 [both under *S. melantho,* part]), and northwest of Borneo, South China Sea (Hall, 1962). *Solenocera melantho* occurs in the waters of southern Indonesian islands (De Man, 1907), off Taiwan (Maki and Tsuchiya, 1923), Japan (Balss, 1914 [part, fide Burkenroad, 1959]; Kubo, 1949; Starobogatov, 1972), and the Philippines (recorded herein). It also has been reported off east India by Muthu (1968) and the east coast of Australia by Schmitt (1926), but these two records need to be confirmed. Among the Indo-West Pacific *Solenocera* that lack branchiostegal and pterygostomian spines and in which the hepatic carina extends anteriorly (rather than recurving posteriorly) beyond the hepatic spine, these three species are unique in possessing a low postrostral carina which is only slightly depressed at the level of the cervical sulcus, i.e., not interrupted by a deep notch or incision. These three also bear a short, terminal spine on the marginal costa of the lateral ramus of the uropod.

The rostrum of the three is quite similar except that in *S. melantho* the ventral margin tends to be somewhat concave, instead of straight or slightly convex along the middle third (De Man, 1907; 1913). Although the numbers of teeth (rostral plus epigastric) overlap in the three species, 8–10 in *S. australiana,* 8 or 9 in *S. halli* and 6–10 in *S. melantho,* we have found only one specimen of the latter with 10 whereas 20% of specimens of the former are so armed. Furthermore, in *S. australiana* the fifth tooth (rarely the fourth) is located opposite the orbital margin, whereas in the other two species the fourth (occasionally the third in *S. melantho*) occupies that position.

The median sulcus of the postrostral carina is very variable in the three shrimps. In *S. australiana* it is represented by a series of pits or by an elongate depression preceded and/or followed by pits disposed along the posterior part of the carina, in *S. melantho* it may be absent, or represented by very few pits, or by one or two depressions, plus a few pits. In *S. halli* the sulcus, better defined than in *S. australiana,* consists of two or more long depressions and numerous pits, and in most, but not all, specimens the posterior part of the carina is divided into two branches as Crosnier (1978) has noted.

In *S. australiana* the antennular flagella are subequal in length, and their terminal articles gradually narrow toward the distalmost minute 2 or 3, whereas in *S. melantho* (Fig. 3B–C) the mesial flagellum is distinctly or considerably longer than the lateral, the terminal part of both taper considerably, that of the lateral flagellum consists of about 8 articles and that of the mesial of about 12, the distal half of it forming a leash. In *S. halli* (Fig. 3D) the flagella are subequal, as they are in *S. australiana,* but their 5 or 6 terminal articles taper more rapidly.

The petasma of *S. australiana* may be distinguished from that of the other two species in that the distal part of the distolateral lobule is roughly lanceolate, its free lateral margin is strongly convex, the mesial margin variably so. In *S. halli* (Fig. 6C–D) the corresponding part is irregular in shape, its lateral margin sinuous (with a concavity preceding a terminal convexity) and the mesial margin slightly convex, and in *S. melantho* (Fig. 6A–B) the dorsolateral lobule is subelliptical. Also in *S. australiana* the dorsolateral lobule is supported by a submesial rib which is absent in that of the other two species, the lobule being flexible in *S. halli* and somewhat rigid in *S. melantho*. Furthermore, in *S. australiana,* as well as in *S. halli,* the terminal margin of the dorsolateral lobule bears numerous spinules (18 to 40) that increase in length proximolaterally (in *S. halli* occassionally a few long ones are present proximally), whereas in *S. melantho* the margin is unarmed or bears fewer (1 to 13) spinules that are variable in length. Finally, the junction between the mostly-free distal and the proximal parts of the ventral costa is marked by a shallow emargination in *S. australiana* and by a deep one in the other two species.

In the female of both *S. australiana* and *S. halli,* two pairs of protuberances are present anterior to the transverse ridge of sternite XIV. The size

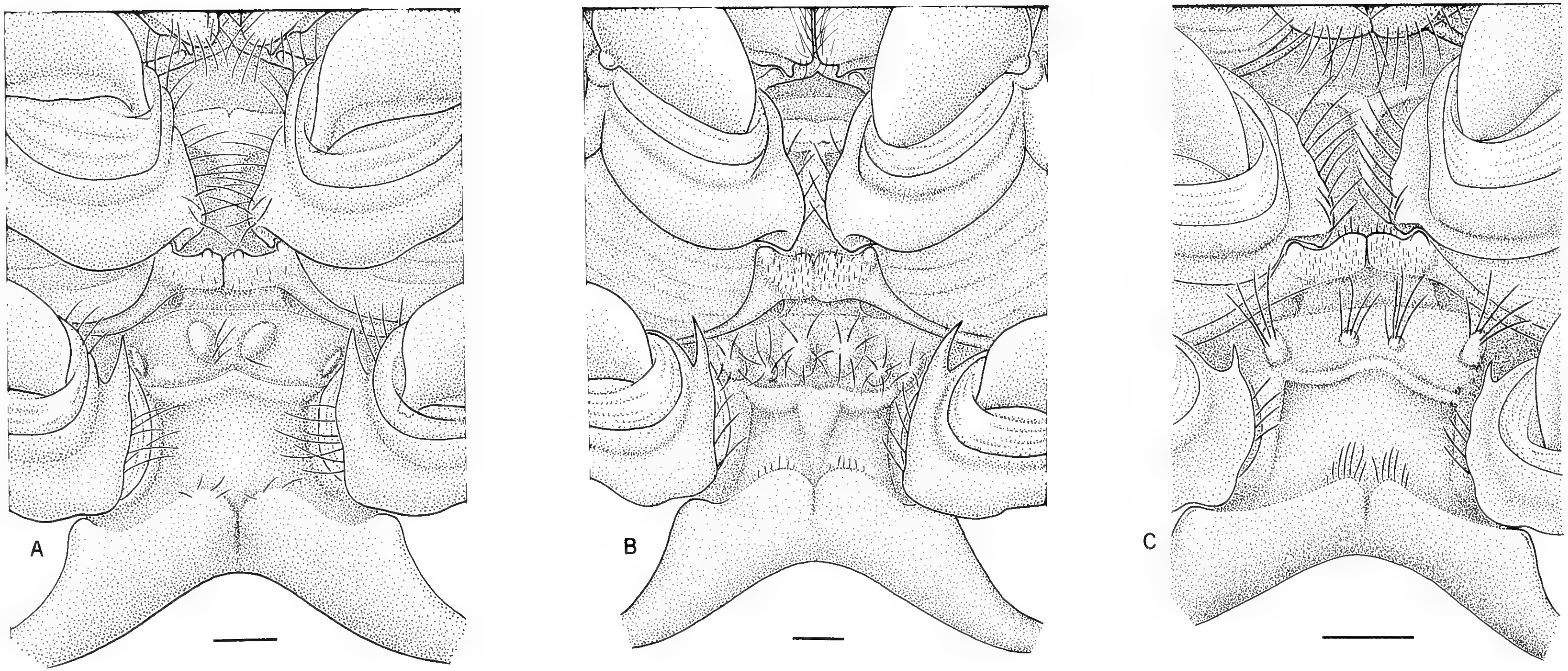

Fig. 7. Thelyca: **A,** *Solenocera melantho,* syntype, ZMA De. 102.476, ♀ 32.5 mm cl, E of Roti I, Indonesia; **B,** *Solenocera melantho,* ♀ 37.5 mm cl, Tabayas Bay, Luzon, Philippines; **C,** *Solenocera halli,* ♀ 24.5 mm cl, off Pangkor, Strait of Malacca, Malaysia. Scales = 1 mm.

of the protuberances aid in the recognition of these shrimps for in *S. australiana* the submesial ones are as large as, or more often larger than, the lateral ones, whereas in *S. halli* the lateral protuberances are larger than the submesial (Fig. 7C).

In *S. melantho* four or six protuberances may be present, if four, the lateral ones are smaller than the submesial (Fig. 7A), but the latter are not so large as in many individuals of *S. australiana*. If six are present (Fig. 7B) this immediately distinguishes these females from those of the other two species. In the young of the three species the protuberances are weak or indistinct. Furthermore, the posterior thoracic ridge in *S. australiana* is almost straight anteriorly and smooth, or, in occasional specimens, bears a narrow median groove, whereas in *S. halli* and *S. melantho* it is bilobed, and the ridge is bisected by a groove that ends anteriorly in a deep, broad emargination. Finally, in females of *S. halli* the coxal spine of the fifth pereopod is short, hardly reaching the distomesial extremity of the coxobasial articular membrane; in *S. australiana* and *S. melantho* it is long and distinctly surpasses this level. It should be noted that the bathymetric range of *S. melantho* is different from that of *S. australiana* and *S. halli*: the former species occurs on the upper slope of the continental shelf whereas the latter two occupy shallow water.

Remarks.—It seems pertinent to add here a few notes concerning imprecise information in the literature pertaining to *S. halli* and *S. melantho*. Both in his key to Indo-West Pacific *Solenocera* and in his description of *S. halli,* Starobogatov (1972) cited as a feature of the female of this species the presence of a median groove in the posterior part of the trapezoidal plate of sternite XIV, a feature that is also clearly depicted in his illustration of the thelycum. The examination by us of specimens of this shrimp from the Strait of Malacca [those recorded by Hall (1962) as *S. melantho* and later identified as *S. halli* by Starobogatov from Hall's illustrations] demonstrated that although the posterior thoracic ridge is divided by a median groove, this does not extend anteriorly along the trapezoidal plate. Consequently, the presence of such a groove on the plate is not a diagnostic character.

Regarding the morphological features of *S. melantho,* De Man (1907; 1911) in his description of the female noted that "between the anterior vertical plate and the quadrangular, horizontal, sternal plate [of sternite XIV] are situated two small, oblong tubercles, in the middle, near one another." One of the two large syntypic females, and the three females from Taiwan available to us bear four "tubercles" or protuberances: in addition to the two submesial ones, two other smaller (slender) lateral protuberances are present, situated at the angular corner between the transverse ridge and the raised lateral margins of sternite XIV. The other large female possesses a barely distinct tubercle between the submesial and lateral ones, and intermediate tubercles are clearly developed in the specimen the thelycum of which was illustrated by Starobogatov (1972, pl. 2–8d) as well as in all the specimens from the Philippines examined by us.

Starobogatov, in discussing his conclusion that *S. prominentis* Kubo (1949) is a synonym of *S. melantho,* indicated that two tubercles are present posterior to the vertical shelf in the thelycum of this species, but in his illustration six are depicted, as noted above. This discrepancy cannot be explained on the basis of the females studied by us, none of which possess two.

Finally, the statement by Crosnier (1978) that *S. halli* differs from *S. melantho* and *S. koelbeli* De Man, 1911, by the presence of a longitudinal groove on the trapezoidal plate of sternite XIV in the former and of a carina in the latter two, is applicable to *S. koelbeli,* but not to *S. halli* (see above), and not always to *S. melantho.* Although most specimens of the latter from the Philippines examined by us bear such carina, a few exhibit only a broad, barely perceptible elevation, while in some it is absent as is, apparently, the case in those from Japanese waters examined by Kubo (1949), and in the females from Taiwan recorded below. Kubo made no reference to it in his description of *S. prominentis* [=*S. melantho*] and did not depict it in the illustration of the thelycum. Curiously, he neither represented the anterior thelycal protuberances on sternite XIV in the latter illustration nor noted their presence in the text. In spite of this omission, all other features discussed by him leave little doubt, as Starobogatov (1972) and Crosnier (1978) pointed out, that his specimens belonged to *S. melantho.*

The notes above on the morphological features of *S. halli* and *S. melantho* and discussions of their relationships with *S. australiana* are based on the following specimens.

Solenocera halli: Malaysia—8 ♀, BMNH and 3 ♂ 2 ♀, USNM, off Pangkor, Strait of Malacca, 48 m, 26 February 1956, *Manihine* stn C 7-33. 1 ♂, BMNH, off Langkawi Is, Strait of Malacca, 75 m, 21 February 1956, *Manihine* stn C 7-26.

Solenocera melantho: Indonesia—2 ♂ 2 ♀, ZMA, E Saleh Bay, north coast of Sumbawa, 8°19′S, 117°41′E, 274 m, 14 February 1900, *Siboga* stn 312. 9 ♂ 6 ♀, ZMA, E Lobetobi Strait, 8°27′S, 122°54.5′E, 247 m, 8 February 1900, *Siboga* stn 306. 1 ♀, ZMA, E Roti I, 10°27.9′S, 123°28.7′E, 216 m, 2 February 1900, *Siboga* stn 302. [All Indonesian material constituting syntypic series.] Philippines—1 ♂, USNM, Batangas Bay, Luzon, 183 m, 8 June 1908, *Albatross* stn 5266. 1 ♂ 2 ♀, USNM, Tabayas Bay, Luzon, 274 m, 24 February 1909, *Albatross* stn 5372. 1 ♀, USNM, Tabayas Bay, Luzon, 357 m, 24 April 1908, *Albatross* stn 5222. 2 ♂ 3 ♀, USNM, off Limbujan, Masbate, 245 m, 15 March 1909, *Albatross* stn 5397. 2 ♂ 3 ♀, USNM, Pujada Bay, Mindanao, 393 m, 14 May 1908, *Albatross* stn 5241. 1 ♀ juv., USNM, off Jolo I, Sulu Archipelago, 209 m, 15 September 1907, *Albatross* stn 5545. Taiwan—2 ♀, USNM, Kao-hsiung, Kao-hsiung Shih, 26 April 1923, M. Maki. 1 ♀, USNM, T'o-kou, T'ai-tung Hsien, 20 April 1920, M. Oshima.

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(IPF) National Marine Fisheries Service Systematics Laboratory, National Museum of Natural History, Washington, D.C. 20560; (DLG) Fisheries Division, Department of Primary Production, P.O. Box 5160, Darwin, N.T. 5794, Australia.

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A NEW SPECIES OF *NEOCHOERUS* (RODENTIA: HYDROCHOERIDAE) FROM THE BLANCAN (LATE PLIOCENE) OF NORTH AMERICA

Mary Ellen Ahearn and John F. Lance

Abstract.—*Neochoerus dichroplax,* a new species of hydrochoerid from the Blancan of Arizona and Florida is described. This description extends the stratigraphic range of the genus into the Blancan (late Pliocene) of North America. *Neochoerus dichroplax* differs from other *Neochoerus* species in the presence of bifurcations in the second to ninth or eleventh plates of the M^3.

The family Hydrochoeridae is represented today only by one or two species of *Hydrochoerus,* the capybaras, which are the largest living rodents. In the fossil record of South America, however, the family is represented by more than fifteen genera ranging from Oligocene to Recent time (Hartenberger 1975, Mones 1975). In North America two genera of hydrochoerids, *Hydrochoerus* and *Neochoerus,* are known from Pleistocene localities in Texas, South Carolina, Florida, and the Lake Chapala region of Mexico (Hay 1926, Simpson 1930, Lance 1966). At present, *Hydrochoerus* ranges from Panama east of the Canal Zone southward into South America, east of the Andes to the mouth of the Rio Parana (Anderson and Jones 1967, Mones 1973).

In North American Pleistocene localities *Neochoerus,* the extinct giant capybara, is represented by a single species, *Neochoerus pinckneyi* (Hay). Five other species, *N. magnus, robustus, siraskae, sulcidens* and *tarijensis,* are known from Central and South America (Mones 1975). These giant forms closely resemble the living species of capybara, *Hydrochoerus hydrochaeris,* with the following differences: larger size, two to four additional laminae in M^3, and the masseteric ridge extending farther anteriorly on the mandible (Hay 1926).

The material described here extends the stratigraphic range of *Neochoerus* into the Blancan (late Pliocene) and thus includes the earliest records for the family in North America. It also extends the geographic range of the genus into southeastern Arizona, where it occurs at the 111 Ranch and Dry Mountain localities in Graham County (see Hypodigm for more complete locality data). The other records reported here are from Florida at Sommer's Pit in Sarasota County and Mule Pen Quarry in Collier County. A late Blancan (late Pliocene) age has been established for each of these localities based upon the associated vertebrate material (Downey 1962, Lindsay and Tessman 1974, Waldrop, pers. comm.).

Dental terminology used is a simplification of that of Kraglievich (1930) and Rusconi (1939).

Order Rodentia
Family Hydrochoeridae
Neochoerus dichroplax, new species
Figs. 1 and 2

Holotype.—F:AM 107691, left M^2, M^3, Dry Mountain locality, NW ¼ of SW ¼ of SE ¼, sect. 33, T. 8 S., R. 28 E., San Simon Creek drainage system, 20 miles southeast of Safford, Graham County, Arizona.

Age and distribution.—Late Blancan of Arizona and Florida.

Diagnosis.—M^3 with bifurcations in second to ninth or eleventh laminae. M^3 composed of fifteen or sixteen laminae. P_4 with prisms I, II and III united; prism II with three internal edges and one external edge.

Hypodigm.—Dry Mountain locality, NW ¼ of SW ¼ of SE ¼, sect. 33, T. 8 S., R. 28 E., San Simon Creek drainage system, 20 miles southeast of Safford, Graham County, Arizona: F:AM 107680, crushed skull with crushed left and right P^4–M^3; F:AM 107698, crushed skull with partial left and right M^3; F:AM 107692, partial palate with left P^4–M^3 and right P^4, M^1 and M^3; F:AM 107694, left M^1, M^2 and partial M^3 in partial maxilla and right P^4–M^2; F:AM 107682, maxillary fragments with left M^2 and M^3; F:AM 107695, maxillary fragment with left M^3; F:AM 107693, partial left dentary with P_4–M_2; F:AM 107690, partial left dentary with partial incisor; F:AM 107686, partial dentary with P_4; F:AM 107685 and 107688, partial left dentaries; F:AM 107684, partial right dentary, P_4 and fragment of M_3; F:AM 107699, right M_1 with dentary fragments; F:AM 107697, right P_4 with dentary fragments.

111 Ranch, 15 miles southeast of Safford, Graham County, Arizona: UALP 1183, crushed skull with right P^4–M^3 and left P^4, M^1 and M^3; UALP 1191, partial maxilla with right M^3; UALP 1153 and 1167a, left M^3; UALP 1157, right M^3; UALP 1158, partial left dentary with P_4–M_3; UALP 1186, partial left dentary with P_4 and M_1; UALP 1151, partial left dentary with I and P_4; UALP 1222, mandible with left P_4; UALP 74, partial right dentary with P_4; UALP 1170, mandible with left P_4–M_3 and right P_4–M_2; UALP 1225, left M_3; UALP 1666, right M^3, partial left M_1; UALP 1168, fragments of right M^3, M_1 and M_2.

Sommer's Pit, Sarasota County, Florida: TRO 550, partial right M^3; TRO 1451, 1452, 1453, and 1454, partial left M^3s; TRO 1455, partial right M^3; TRO 1456 and 1457, left M_3s; TRO 1458, right M_1; TRO 1459 and 1460, left

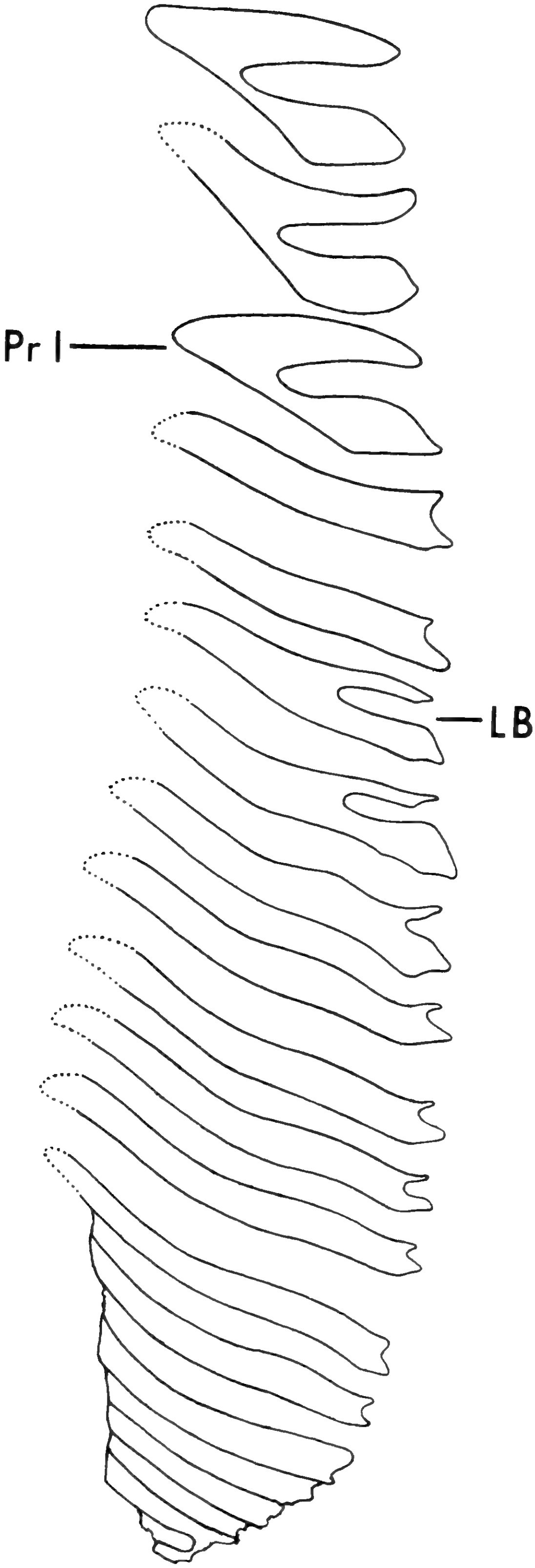

Fig. 1. *Neochoerus dichroplax*. F:AM 107691, left M^2 and M^3, holotype. Labial to right, anterior to top. **Pr I**, prism I; **LB**, labial bifurcation.

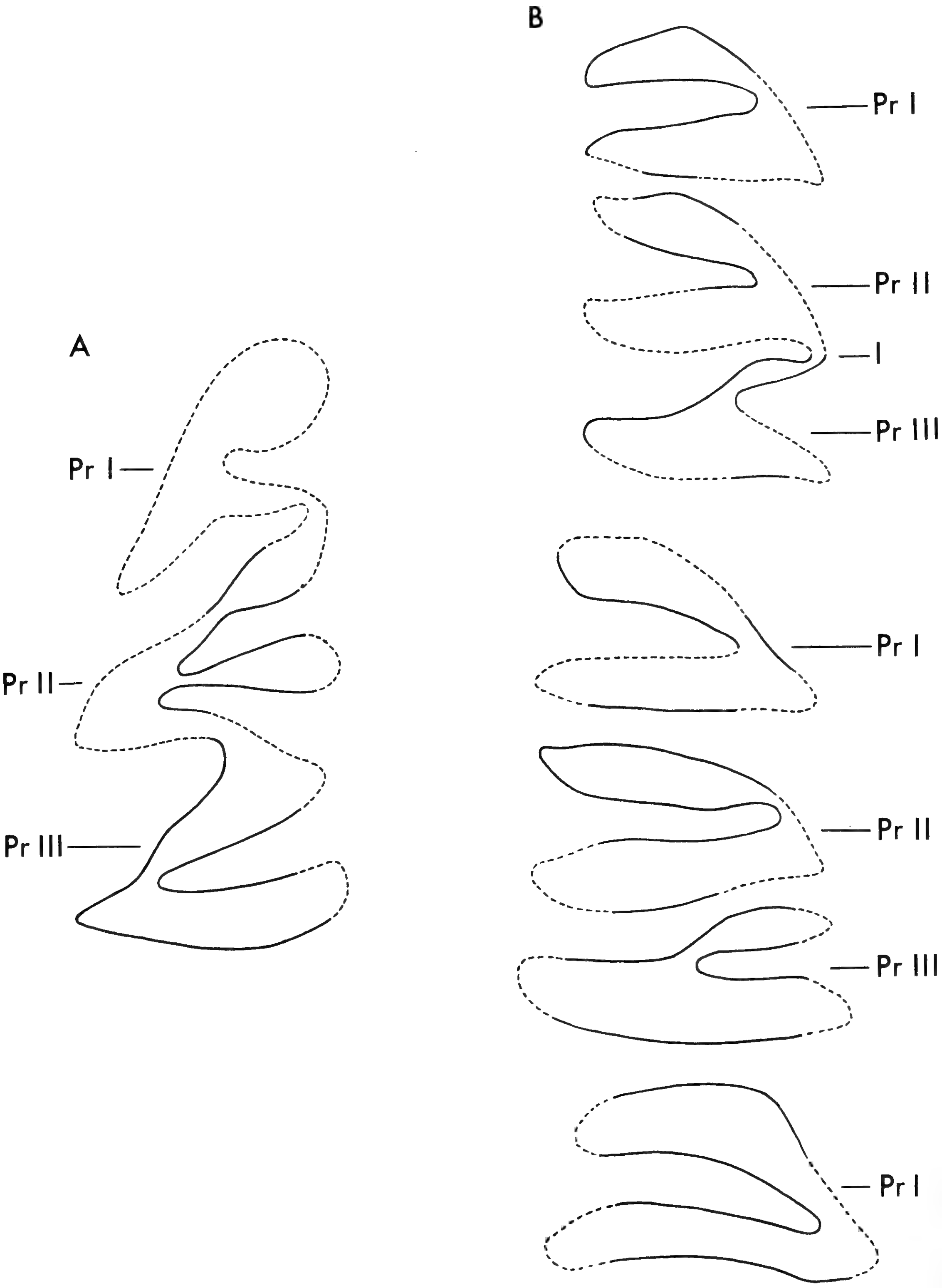

Fig. 2. *Neochoerus dichroplax*. **A,** F:AM 107686, left P_4. Labial to left, anterior to top. **Pr I**, prism I; **Pr II**, prism II; **Pr III**, prism III. **B,** F:AM 107693, right M_1, M_2 and partial M_3. Labial to right, anterior to top. **I**, enamel ithmus; Pr designations as in A.

M_1s; TRO 1461, partial right M_3; TRO 1462, partial left M_2; TRO 1463, partial right dentary with P_4.

Mule Pen Quarry, Collier County, Florida: TRO 1464, partial right M^3; TRO 1465, partial left M^3; TRO 1466, partial right M_1.

Description.—P^4 does not differ in shape from that of other North American hydrochoerids. It is made up of two isolated prisms with the laminae of the first wider anteroposteriorly than those of the second prism. The second prism is slightly concave on the anterior side. Each of the two prisms is V-shaped in cross-section with the fissure opening labially and directed somewhat toward the posterior lamina.

M^1 is composed of two nearly identical isolated prisms with V-shaped cross-sections. The anterior face of the second prism is very slightly concave giving it a less well developed appearance than the first prism.

M^2 resembles M^1, except that it has a deeper concavity on the anterior face of the second prism.

M^3 is composed of fifteen to sixteen laminae. The first is a prism of V-shaped cross-section that resembles the first prism of M^1. The next eight to ten laminae have bifurcations on their labial sides. The depths of the bifurcations range from slight indentations to deep fissures extending one-fourth of the width of the lamina. The remaining laminae are simple, with no bifurcations. In general, the laminae are set at an oblique angle to the longitudinal axis of the tooth.

The lower incisors are roughly triangular in cross-section with a shallow longitudinal sulcus on the labial face. The incisor extends posteriorly approximately to the end of P_4. In most specimens of *Neochoerus* and *Hydrochoerus* it extends to this point, but may reach to M_1.

P_4 is composed of three prisms, united at their lingual edges. These are three labial and five lingual angles. The anterior prism contains a fissure extending less than half the width of the tooth. The middle prism is V-shaped in cross-section with an additional column in the center of the V. The fissures on either side of the center column extend half the width of the tooth. The third prism is a single V-shape in cross-section with the fissure extending approximately two-thirds the width of the tooth. In the Arizona specimens, the second and third prisms share a broad connection. Specimens from Florida have the third prism connected lingually to the second by only a thin band of enamel.

M_1 is composed of three prisms. The first prism is separate from the second. The second and third prisms are united labially by a band of enamel and dentine. The first prism is V-shaped in cross-section with the fissure extending anterolingually more than two-thirds the width of the tooth. The second prism resembles the first except that it has a posterolingual connection with the third prism. The third prism is Y-shaped in cross-section with a labial opening and the base directed toward the anterior lamina of the prism.

M_2 is composed of three isolated prisms. The first two prisms are identical. They are V-shaped in cross-section with lingual openings and the fissure extends nearly the full width of the tooth. The third prism is Y-shaped in cross-section. The opening is on its labial side and extends halfway across the tooth. The anterior face of this prism is concave lingually, convex labially.

M_3 is composed of three prisms. The first is V-shaped in cross-section with the fissure opening lingually and directed toward the anterior lamina. The second prism consists of two isolated laminae. In the Arizona specimens, the third prism is V-shaped in cross-section with the fissure opening labially. In the Florida specimens it is Y-shaped in cross-section with the fissure extending only one-third the width of the tooth.

Comparisons.—Neochoerus dichroplax differs from the other known species of *Neochoerus* in having bifurcated laminae in M^3. M^3 is composed of fifteen or sixteen laminae. *Neochoerus* shows a range of 14–15 laminae in *N. tarijensis* and *N. magnus* to 15–17 in *N. pinckneyi* (Hoffstetter 1952).

In P_4 of *N. dichroplax,* as in *N. tarijensis,* the second labial fissure is directed between the second and third prisms of the tooth. This differs from *N. pinckneyi* in Florida and *N. magnus, siraskae* and *sulcidens* in South America in which the fissure is shifted forward to lie in front of the third lingual fissure (Rusconi 1939). *N. dichroplax* also differs from all other known species of *Neochoerus* in having a reduced connection between the first and second prisms of P_4.

Etymology.—Dikros (Greek), forked, and *-plax* (Greek), plate, for the bifurcated plates in M^3.

Discussion.—The large sample of teeth and partial jaws of *Neochoerus dichroplax* from Dry Mountain and 111 Ranch provides a range of individuals from immature to large adults. The immature individuals can be identified by their smaller size and the presence of a thin enamel band connecting the laminae of M^3 on the labial surface. Mones (1975) correlates such connections with immaturity in recent capybaras from Uruguay.

In this ontogenetically diverse sample the diagnostic dental characters of *N. dichroplax* can be seen at all developmental stages. For example, labial bifurcations are well developed on F:AM 107692, a partial palate of an immature individual. In M^3 of this specimen, a thin band of enamel connects five of the posterior laminae on the labial surface. Labial bifurcations can be seen in laminae two through eleven of the tooth.

One important distinction between *Neochoerus* and *Hydrochoerus* is the extent of the masseteric ridge on the lateral side of the mandible. The ridge forms a bony shelf for insertion of portions of the masseter muscle. It begins at the condyloid process and in *N. dichroplax* ends at the third prism of P_4.

This places the anterior portion of the masseteric fossa at the rear of P_4. In other species of *Neochoerus* the ridge extends to approximately the same level. In *Hydrochoerus,* by contrast, the ridge extends to the middle of P_4, thus placing the anterior portion of the fossa farther forward (Hay 1926). This shift must have important functional consequences as it shifts the most effective forces of the masseter muscle forward during the power stroke of mastication.

Neochoerus is larger than *Hydrochoerus* and has more laminae in M^3—14–17 in *Neochoerus* versus 12–13 in *Hydrochoerus* (Hoffstetter 1952, Pascual 1967).

The description of *N. dichroplax* as a late Blancan (late Pliocene) species of *Neochoerus* raises questions concerning the ancestry of the genus. Presumably, *Neochoerus* represents a progressive lineage which shared a common ancestry with *Hydrochoerus*. The oldest *Hydrochoerus* presently recognized are *H. ballesterensis* and *H. gracilis* from the "Puelchense" Formation of Uquian Age (Early Pleistocene) of Villa Ballester, Argentina (Mones 1975). This paper documents the oldest North American records of *Neochoerus,* in southeastern Arizona and central Florida. *Neochoerus* is known from Pleistocene localities as far south as Argentina (Mones 1975); therefore it is probable that its late Pliocene-early Pleistocene range was much greater than is presently documented.

The presence of *N. dichroplax* in southeastern Arizona and central Florida during the late Pliocene is additional evidence for a Plio-Pleistocene Middle American savanna fauna extending around the Gulf of Mexico and through Central America (Webb 1978). Such a fauna must also have extended west into southeastern Arizona. By early Pleistocene time, in North America, the western limit of the savanna fauna may have been restricted as seen by the western limit of *Neochoerus* in Texas (Hay 1926) and Mexico (Lance 1966). On the east coast of North America the northern limit was extended to the Ashley River, South Carolina (Hay 1923, 1926).

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A NEW CRAB FAMILY FROM THE VICINITY OF SUBMARINE THERMAL VENTS ON THE GALAPAGOS RIFT (CRUSTACEA: DECAPODA: BRACHYURA)[1]

Austin B. Williams

Abstract.—*Bythograea thermydron,* a new genus and new species of brachyuran crab, is described from the vicinity of submarine thermal vents on the Galapagos Rift. About 160 of the crabs in various states of maturity were collected by means of baited traps, suction, and mechanical arm with the aid of the deep submersible, *Alvin. Bythograea* represents a new family that exhibits some characters of the families Portunidae and Xanthidae, with superficial resemblance to the family Potamidae s. l. It is placed in an independent superfamily.

Introduction

The Galapagos Rift zone supports a community of organisms living on hard bottom within and somewhat beyond the influence of thermal vents in the ocean floor. Investigators aboard the deep submersible *Alvin* viewed and photographed these organisms, taking a few samples in February and March 1977 (Corliss and Ballard, 1977; Corliss *et al.,* 1979), and on a second expedition in February 1979, secured far more abundant samples of the biotic community among which were numerous adult brachyuran crabs taken in baited fish traps and a few megalopae associated with mussel clumps (Grassle *et al.,* 1979; Ballard and Grassle, 1979). Further observations were made and a few specimens collected during a third expedition in November–December 1979. The crabs are here described.

I am greatly indebted to J. F. Grassle, Woods Hole Oceanographic Institution (WHOI), chief scientist on the second and third expeditions, for transmitting to me the material on which the description is based as well as observations from the submersible, and to his associates L. Morse-Porteous and I. Williams for assistance in laboratory study of the crabs; to D. M. Cohen, National Marine Fisheries Service, Systematics Laboratory, National Museum of Natural History, whose traps baited for capture of fishes were the adult crab collectors, not only for that good fortune but also for his observations on crab sizes, distribution and behavior; and to J. R. Chil-

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dress, University of California, Santa Barbara, who contributed observations on color as well as a megalopa for study. F. A. Chace, Jr., D. M. Cohen, and R. B. Manning critically read the manuscript. I thank M. R. Carpenter, National Museum of Natural History, for photographing the specimens, and María Dieguez for carefully preparing the drawings and photographic plates.

Superfamily, Bythograeoidea, new superfamily

Carapace flattened. Antennules folding transversely, basal articles contiguous, antennular septum absent. Mouth field slightly diverging anteriorly. Sternum broad. Chelipeds with fused basis-ischium. Megalopa crablike, carapace broader than long.

Family, Bythograeidae, new family

Adult characters.—Front of moderate width. Supraorbital border present. Stalked eyes movable, cornea unpigmented. Antennae inserted below eyestalks, peduncular articles slender. Carpus of third maxilliped articulating near anteromesial corner; endognath of first maxilliped with mesial lobe. Male openings coxal, female openings sternal.

The family contains only the following genus.

Genus, *Bythograea,* new genus

Carapace transversely elliptical, regions indistinct; anterolateral region produced, spineless. Front of moderate width, slightly produced and bilobed. Orbits incomplete; supraorbital margin short in adult; suborbital plate nearly horizontal and almost fully visible in dorsal view in adults and subadults, but incompletely developed in early crab stages. Third maxillipeds with long, setose palp. Chelipeds moderately unequal, hands inflated; walking legs with dactyls pointed. Male abdomen with segments 4 and 5 partly fused; mature female abdomen broad, segments free, biramous pleopods on 2–5.

Type-species.—Bythograea thermydron, new species.

Name.—From the Greek, "bythos," the deep, the depths of the sea, and "graia," sea crab (Liddell and Scott, 1940). The gender is feminine.

Bythograea thermydron, new species
Figs. 1–11

Material.—Thirty-six ♂ and 100 ♀ from dives of the *Alvin* on 3 vent areas along the Galapagos Rift: Dive 880, Mussel Bed, 21 January 1979, 0°48.89′N, 86°09.12′W, 2493 m, 1♂; Dive 887, Mussel Bed, 12 February 1979, 2488 m, 19♂, 4♀; Dive 888, Mussel Bed, 13 February 1979, 2483 m, 12♂, 29♀ (2 ov); Dive 890, Rose Garden, 15 February 1979, 0°48.25′N, 86°13.48′W, 2447 m, 24♀ (2 ov); Dive 894, Rose Garden, 19 February 1979, 2457 m, 6 ♀; Dive 895, Rose Garden, 20 February 1979, 2482 m, 1 ♂; Dive 896, Rose Garden, 21 February 1979, 2460 m, 3 ♂, 36 ♀ (2 ov); locality unrecorded, 1 ♀.

The following are designated and labelled as types deposited in the crustacean collection of the National Museum of Natural History, Smithsonian Institution, Washington, D.C.: 172830, holotype ♂, Dive 887; 172831, allotype ♀, Dive 896; 172832, paratypes, 4 ♂, 1 ♀, Dive 887; 172833, paratypes 2 ♂, 4 ♀, Dive 896. To be transferred from the USNM collection are the following paratypes: 1 ♂, Dive 887, 1 ♀, Dive 890, to the Museum of Comparative Zoology, Harvard University, Cambridge, Mass.; 1 ♂, Dive 887, 2 ♀, Dive 890, to the Allan Hancock Foundation, University of Southern California, Los Angeles, Calif.; 1 ♂, Dive 887, 2 ♀, Dive 890, to the British Museum (Natural History), London; D32621, 1 ♂, Dive 888, D32622, 2 ♀, Dive 890, to the Rijksmuseum van Natuurlijke Historie, Leiden, Netherlands; 1 ♂, Dive 887, 1 ♀, Dive 890, to the Museum National d'Histoire Naturelle, Paris, France.

Remaining specimens are at the Woods Hole Oceanographic Institution.

Description.—General aspect cancroid, depressed. Carapace broad, transversely elliptical, its rounded lateral angles displaced somewhat anteriorly; almost flat in middle dorsally, very slightly arched from anterior to posterior and near lateral margins; anterolateral region produced, margin not toothed; surface finely granulate anteriorly and laterally, smooth but minutely punctate to unaided eye over posterior ⅔ to ¾; regions indistinct. Frontoorbital width ca. ¼ carapace width.

Front obscurely bilobed; median depression shallow; projecting over folded antennules and somewhat deflexed; margin entire, usually slightly concave mesially and beaded with line of fairly uniform sized, low and flattened, sometimes coalesced, often dark tipped granules (neither dark tipped nor flattened in white female allotype); transverse submarginal row(s) of smaller similar granules merging with marginal row at inner corner of short supraorbital margin and continuing laterad past deeper outer orbital notch, arching forward slightly to merge with anterolateral margin running from beneath eye along edge of suborbital plate posterolaterally to broadly rounded lateral angle, edge of margin beaded with nearly uniform, close-set, low and flattened, often dark-tipped granules (forward trending in females); tract of forward trending, often dark-tipped (unpigmented in female) granules lying between double row at frontal margin with its lateral extensions and line(s) of smaller, more closely spaced similar granules posterior to it; tract sweeping submarginally along anterolateral border and narrowing to disappear near lateral angle (i.e. along undifferentiated frontal, orbital, hepatic and anterolateral regions); still other similar granules behind this tract most prominent near anterolateral margin and on anterior gastric region. Carapace with almost smooth part behind these anterior areas microscopically granulate anteriorly grading posteriorly into network of exceedingly fine lines and finally into almost featureless surface near posterior margin, network of fine lines also among anterior and anterolateral granules. Regions (proto-, meso-, metagastric, cardiac, cf. Renaud, 1977) dimly indicated; faint, thin, serpentine line of obsolescent granules in extremely shallow epibranchial groove in male (groove absent in female) originating posterior to lateral angle at each side and curving anteromesially over branchial region, then posteromesially toward mesogastric region. Posterolateral margins convergent, slightly sinuous above bases of fifth legs. Posterior margin concave, slightly beaded with granules and paralleled by submarginal groove becoming more pronounced above fifth legs.

Subhepatic and subbranchial regions ornamented with often dark-tipped granules in males, usually unpigmented in female, coarsest along hepatic region but becoming finer and more numerous near base of chelipeds, line of fine granules along lower subbranchial margin defined by pleural line. Males with dense mat of soft plumose hairs in narrow tract below posterior part of anterolateral margin and along posterolateral margin, with continuation on subbranchial region, and protruding somewhat between bases of legs; females with shorter more restricted patch on subbranchial region.

Orbits highly modified and almost non-existent; short supraorbital margin bearing 2 or 3 often dark-tipped granules; mesial corner of outer orbital area forming recess lined with hairs for reception of cornea; lower margin occupied by subtriangular suborbital plate almost fully visible in dorsal view, slightly exceeding front and tilted slightly anteroventrally from frontal plane, lateral to and almost at same level as epistome, and separated from polygonal, narrow but transversely broadened, granular outer orbital area by prominent oblique uncalcified suture disappearing laterally; suborbital plate separated mesially from epistome by articular membrane, large irregular operculum covering opening of antennal gland, and fixed basal antennal article.

Eyestalks reduced, projecting anterolaterad, movable, depressed and

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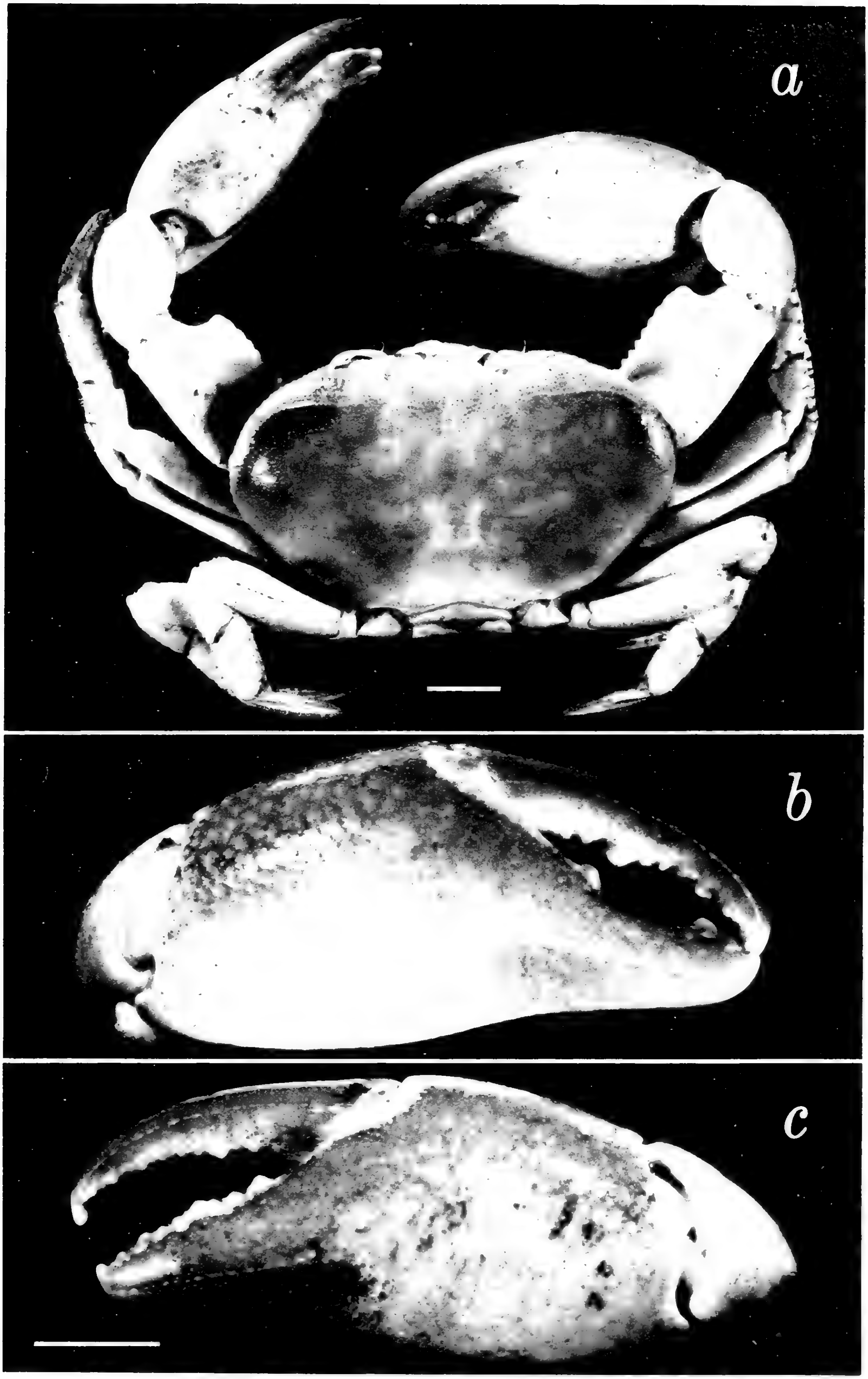
Fig. 1. *Bythograea thermydron.* Male holotype: **a,** Dorsal view; **b, c,** Right and left chelae in external view. Scale = 1 cm.

Fig. 2. *Bythograea thermydron.* Male paratype USNM 172832, left first and second walking legs missing: **a,** Dorsal view; **b, c,** Right and left chelae in external view. Scale = 1 cm.

Fig. 3. *Bythograea thermydron.* Female allotype: **a,** Dorsal; **b,** Ventral view. Scale = 1 cm.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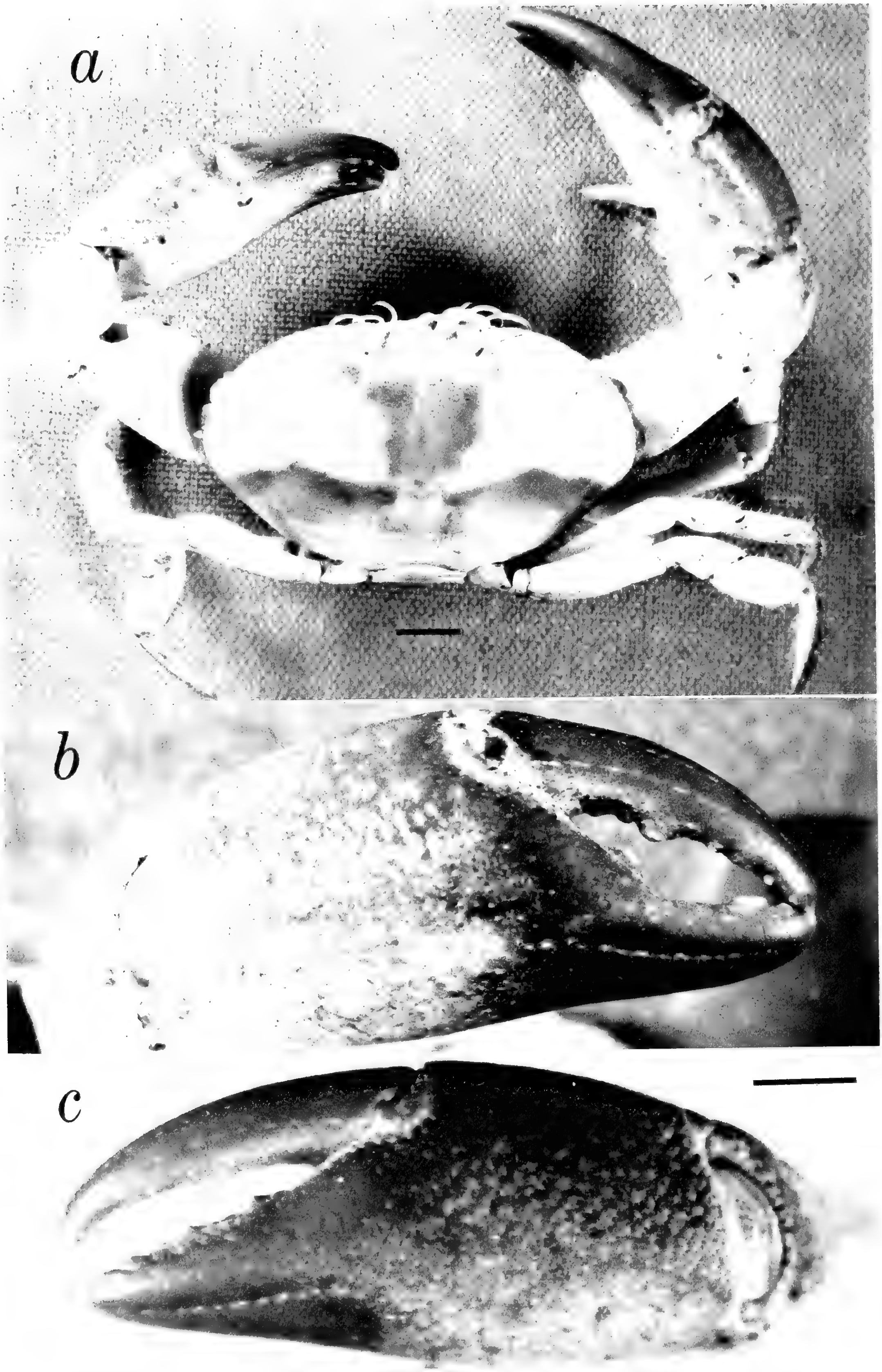
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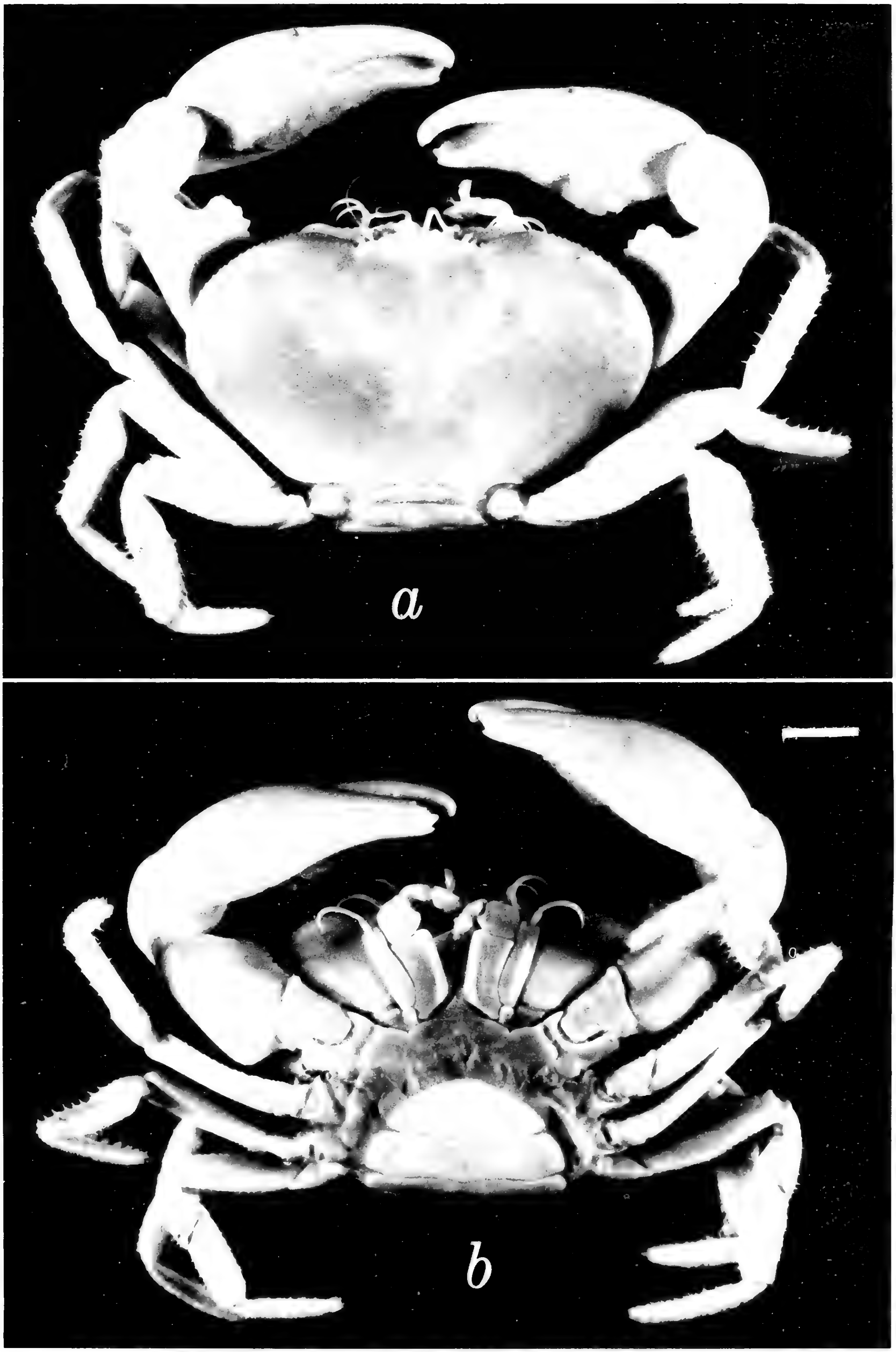
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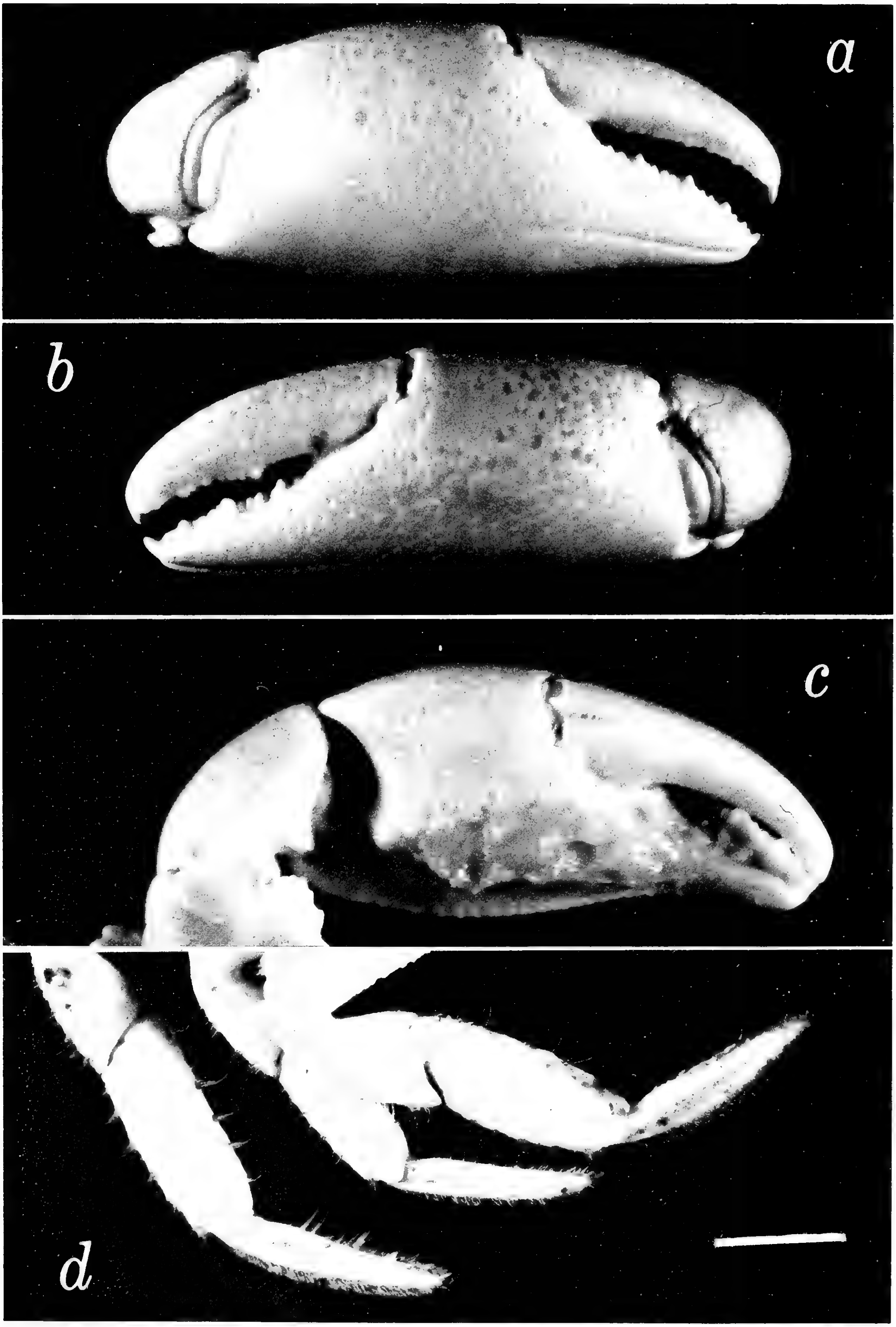


Fig. 4. *Bythograea thermydron.* Female allotype: **a,** Right, **b,** Left chelae in external view; **c,** Left chela, internal view. **d,** Female paratype (USNM 172832), distal articles of third–fifth legs. Scale = 1 cm.

broadened proximally where hidden under front but distally narrowing at base of compressed but slightly swollen, fusiform tip; unpigmented cornea laterally oriented, smooth, exposed beyond supraorbital margin, fringed with soft hairs laterally.

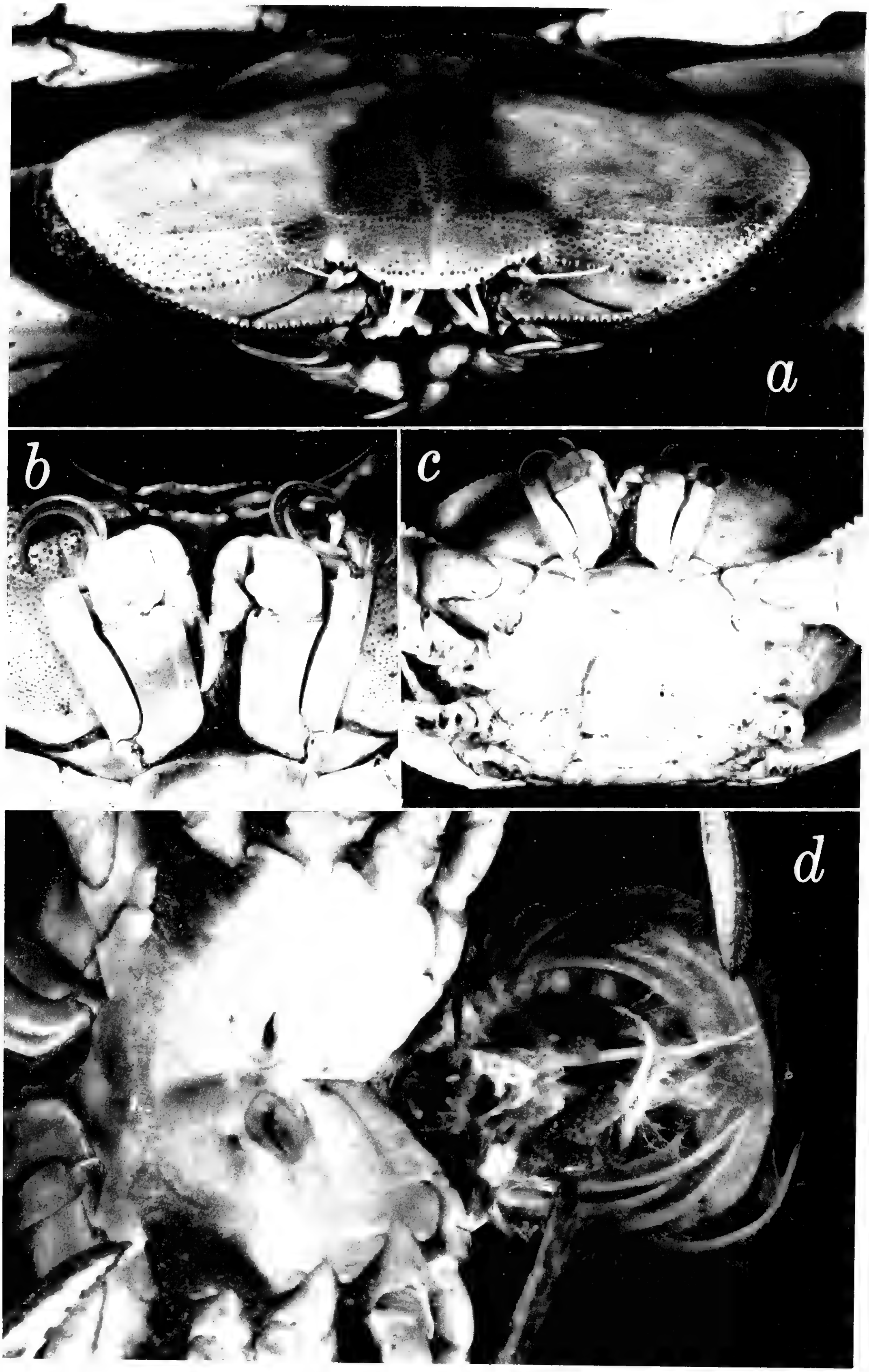
Epistome projecting well beyond front, lying nearly in frontal plane, its anterior margin cut into 6 unequal lobes variably darkened at edge, submedian lobes separated by narrow deep notch, intermediate lobes less advanced, laterals large, irregular, and folded slightly ventrad in males.

Antennules folding transversely, stouter than antennae, large bulbous basal articles contiguous, concealed beneath front, interantennular septum represented by minute remnant at upper and lower edge of antennular fossa; slender penultimate and terminal articles of peduncle nearly equal in length, former slightly hollowed laterally, latter slightly longer and more slender. Flagella short; mesial 8-segmented ramus slender; slightly shorter lateral ramus curved, multisegmented, thick at base but tapering to point, its dense mesial brush of long sensory setae exceeding chord of curve.

Antennal insertion below eyestalk; peduncle mesial to eyestalk, extending obliquely nearly to margin of cornea in situ; fixed article broad but short; first free article slender, ca. 1.8 times length of second article; latter broadened distally; terminal article short, its diameter only slightly greater than that of flagellar base; flagellar length ½ to slightly exceeding frontal width.

Afferent branchial openings above base of chelipeds broad.

Mouth field divergent anteriorly, its frame broadest posteriorly and somewhat swollen and granular at anterolateral corners, maximal inside anterior width about 1.25–1.4 times minimal inside posterior width. Third maxillipeds filling mouth field except for narrow gap of nearly uniform width between ischia of endognaths and rather irregular gap anteriorly between meri-carpi of endognaths and epistome; exognaths overlapping sides of mouth frame. Endognaths with exposed surface of ischium nearly smooth; elongate polygonal in outline but primarily rectangular, greatest (distal) width 1.2–1.8 times narrowed part ca. ⅓ length from base; mesial margin straight, toothless, bearing many stiff straight setae, submarginal zone somewhat thickened and flanked laterally by shallow longitudinal groove; anterior margin nearly perpendicular to mesial margin except for anteriorly projecting truncate lobe at inner corner, beaded with tiny, often darkened granules; lateral margin concave; posteromesial margin obliquely convex; basi-ischial suture line visible posterolaterally. Merus slightly narrower than ischium, tilted dorsally from insertion in flexed position; ventral surface punctate, occasionally with scattered, obsolescent granules having tips directed anteromesially (often darkened and in irregular oblique rows); irregularly quadrate perimeter flanked by submarginal thickened zone and groove similar to mesial counterpart on ischium except on straight proximal side, anterolateral angle broadly rounded, anteromesial angle at insertion of palp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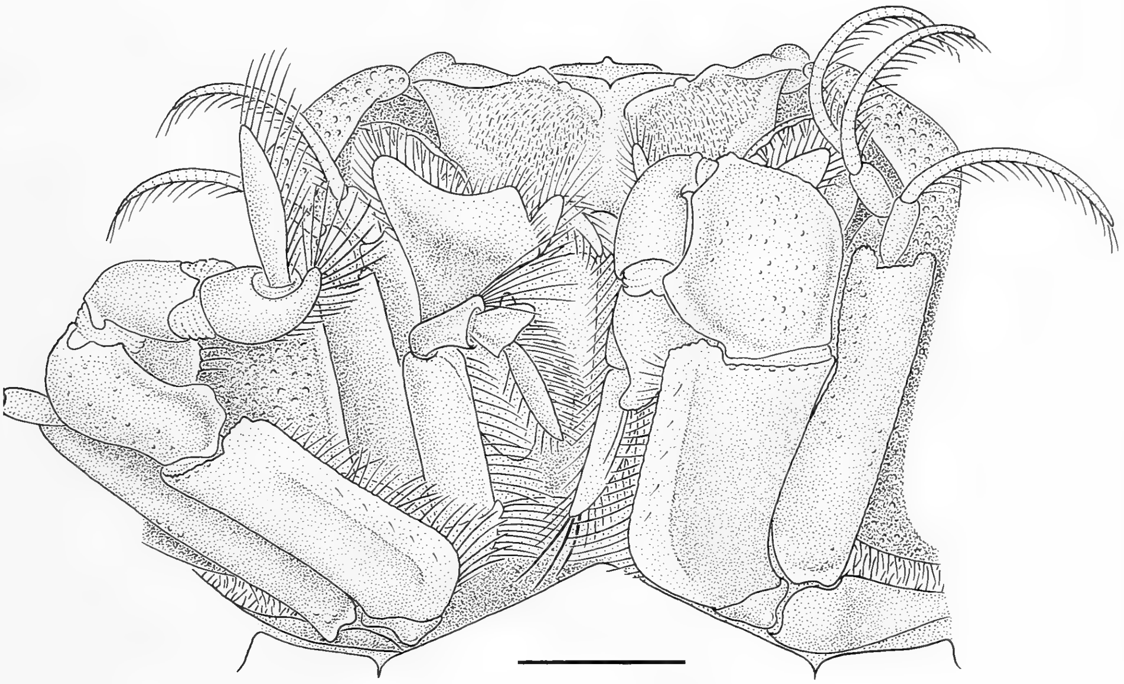

Fig. 6. *Bythograea thermydron*. Female allotype. Mouth field region showing third maxillipeds, endognath of right second and first maxillipeds in situ with overlying third maxilliped turned aside, outline of right mandible, and pubescent mesial part of endostome. Scale = 5 mm.

shorter and oblique; mesial margin doubled for reception of palp, its ventral (exposed) side almost straight distally but lobed at level of carpo-propodal articulation, posteromesial corner fitted to projecting lobe of ischium, dorsal (hidden) side produced behind carpus, its margin setose. Palp large, dactyl reaching posteriorly about ½–⅔ length mesial margin of ischium. Carpus expanded distally, narrowed proximally, bent nearly at right angle near insertion and crimped inside angle; dense tuft of setae on disto-oral surface. Propodus wider than carpus, longer than broad; asymmetrically ovate in ventral view; distal (longest) margin convex, densely beset with rows of strong serrated setae, longest distally; distal tuft of such setae on dorsal surface. Dactyl half-ensiform (knife blade-like), deeply inserted in mesial and distal sides of propodus in flexed position, mesial edge (back of knife blade) straight, gently curved lateral margin (knife edge) setose like propodus. Exognath narrow, not extending to full length of merus; ventral

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Fig. 5. *Bythograea thermydron*. Male paratype USNM 172832: **a**, Frontal region; **b**, Third maxillipeds; **c**, Sternum with abdomen in situ. **d**, Female paratype (USNM 172832) with abdomen unfolded showing sternum, female openings, pleopods and small egg mass.

surface with few granules as on endognath; slightly curved mesially to fit closely lateral side endognathal ischium, with dorsomesial flange (widest distally) fitting beneath latter; palp conspicuous, flagellum densely beset with setae in hollow of curve.

First maxilliped with lacinia of endopod broad, its somewhat concave to slightly sinuous distal edge advanced anterolaterally in rounded corner; anteromesial corner less advanced and separated by conspicuous notch from still less advanced moderately ovate mesial lobe.

Endostome large, divided by low median sagittal ridge bifurcated somewhat anteriorly and merging into projecting endostome; each half of palate shallowly concave, mesial ⅓ variably covered with velvety pubescence limited laterally by low longitudinal ridge curving from near base of large mandibular palp to lateral epistomial lobe, lateral smooth ⅔ receiving broad efferent branchial channels; each palatal ridge most prominent posteriorly and bearing single row of very fine, close-set, transverse rugae.

Chelipeds heavy, unequal; surface slightly and variably rugose (pebbled), tending to slight imbrication here and there with transverse pattern on meri, punctate; chelae externally inflated, lower margin of palm arched downward and with rather pronounced keel merging into fixed finger, inner surface with concavity above keel limited by swollen central surface of palm most pronounced proximally (rather sharply so in females), that surface glabrous in males but bearing central patch of dense plumose hairs in females. Males with fixed fingers rather short, stout, distal half of lower margin almost straight but abruptly curved upward at narrowly spooned tip, a mesiolateral, longitudinal impressed line running from base of terminal tooth to distal part of palm; dactyls more slender, rather long, arching down to close in distal notch of spooned tip of fixed finger. Major chela of males often with strongest tooth (low and essentially tripartite) on each finger almost opposed at about ⅓ length; dactyl with 2 low teeth proximally and 3 or more low irregularly spaced and shaped teeth distally, but cutting edge sometimes essentially as minor chela; fixed finger with diastema between major tooth and 3-toothed (low) area on raised external edge of spoon near tip, inner edge of spoon shorter and less elevated. Minor chela with fingers more uniformly toothed, but teeth low and entire cutting edge sometimes nearly toothless; spoon essentially as on major chela. Chelae of female with fingers not gaping; tooth rows continuous and fairly regular; that of major fixed finger continuous, 12 teeth, 4 larger ones including tip, 2 smaller teeth in intermediate spaces, largest central tooth with minute flanking cusp to each side forming triad; minor fixed finger with 14 smaller, more uniform teeth. Dactyls each with complete tooth row, those of major somewhat larger and more irregular.

Carpus with internal margin rounded in outline, granular. Merus broadened mesially into cristate flange slightly rounded in distal extension falling short of mero-carpal condyle, strong granules in single line along margin; outer surface rounded. Fused basis-ischium articulated with merus. Coxa broadly emarginate ventrally for insertion of basis-ischium, cup thus formed projected anteriorly into stout triangular spine and posteriorly into longer, stout spine with subterminal notch and suture.

Walking legs rather long, flattened, length decreasing slightly from first to last; conspicuous darkened setae in 3 rows of rather sparse tufts on extensor surface of carpus and propodus, on flexor surface of propodus and more densely spaced on dactyl, also scattered tufts laterally on these articles, densest tract of setae on extensor surface of dactyl. Meri with upper margins granular, posterior sides of first 2 pairs slightly rugose, that of last 2 pairs less granular; lower margins granular, somewhat cristate, anterior lower margin present throughout length but posterior lower margin obsolescent proximally. Carpi with posterior, shallow, longitudinal groove paralleling dorsal margin. Mean maximum length of propodi about 2.5–3.0 times mean maximum width (of last leg relatively shortest and broadest), that of dactyls about 4.5–5.5 times width. Dactyls slightly shorter than propodi, narrowly lanceolate, shallowly grooved longitudinally on flattened anterior and posterior sides, tip stout, corneous.

Sternum broadest between first and second legs, narrower posteriorly.

Male abdomen composed of 6 free segments gradually increasing in length distally, 4 and 5 partly fused; first 2 and part of 3 visible in dorsal view; 1 arched to fit contour of adjacent carapace, 2 and 3 filling all of space between fifth legs, 3 broadest, 4 nearly as broad, 5 narrowing, 6 narrowest with almost parallel sides, its greatest width 1.6 times its median length. Telson broadly triangular, width 1.37–1.4 times length; no sternal groove anterior to tip; furry covering on sternum beneath; entire abdominal groove deep.

Abdomen of mature female nearly covering sternum, ovate in outline and densely fringed with hairs, fully segmented; narrowest first segment arched dorsally to fit contour of adjacent carapace, segments 2–5 of about equal length, 6 longest, 2–3 broadening abruptly to greatest width reached in 4–6; telson nearly as broad as 6, broadly arched distally. Segments 2–5 bearing large, well developed biramous pleopods, outer curved branch lying near edge of abdomen heavily plumed with soft hairs laterally and mesially, inner branch more sparsely equipped with ovigerous setae and jointed.

Sternum beyond outline of abdominal segments bearing dense fringe of fine plumose hairs, tract extending to limited extent on coxae of legs 1–4, chiefly 2 and 3. Female openings large, oval membranous area (1.88 × 3.5 mm in ♀ 172831); 1.75 × 3.0 mm in ♀ 172832) surrounding central, transverse, lunate slit.

Eggs spherical to slightly oval (mean of 5 = .77 × .83 mm short and long axes).

Male openings coxal. First pleopods stout, dextrally twisted, S-curved,

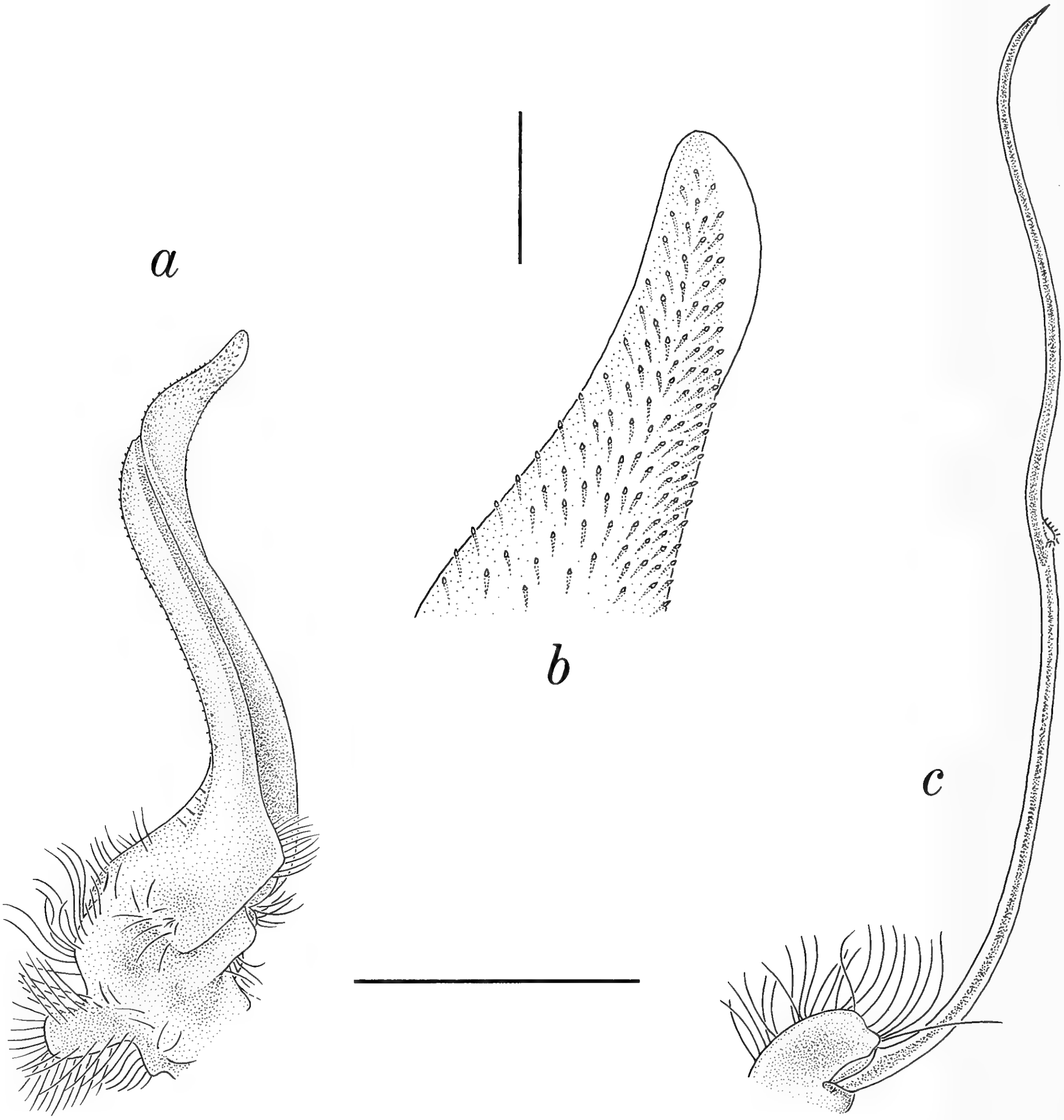

Fig. 7. *Bythograea thermydron.* Male paratype USNM 172832: **a,** First, **c,** Second pleopods in ventral (abdominal) view; **b,** Tip of first pleopod. Scales: **a, c** = 5 mm; **b** = 0.5 mm.

well separated, darkened somewhat distally and drawn to acute but slightly spatulate tip reaching almost to darkened locking tubercles on sternite V, shaft angled in X-section and grooved mesioventrally in proximal half for lodgment of second pleopod; multitude of exceedingly minute retrogressive spinules in lateral and anterolateral tract, and less densely distributed to each side of this and around tip; meso-abdominal aspect nearly smooth, a setose angle over second pleopod near base. Second pleopods slender, long, crossed, exceeding first pleopods and extending almost to tip of telson lodged halfway along sternite IV; distal half amber-translucent and whiplike.

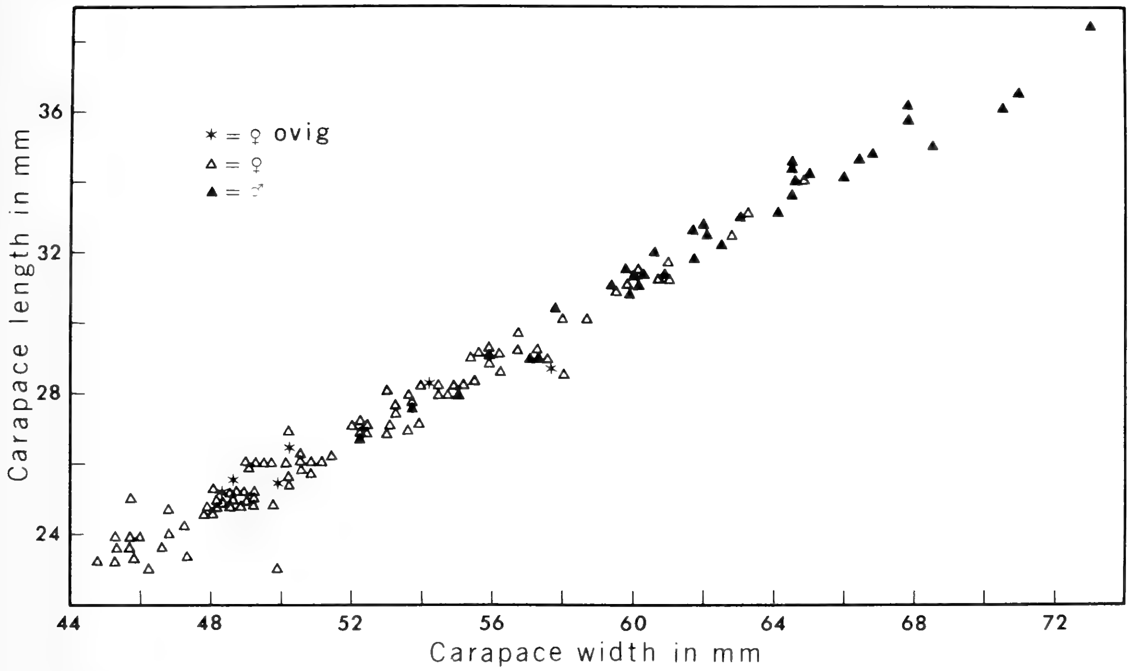

Fig. 8. Carapace length-width relationships of mature *Bythograea thermydron*. ♂, N = 36; ♀, N = 100.

Measurements in mm.—Holotype ♂ (USNM 172830), allotype ♀ (USNM 172831), R right, L left.

	Length carapace	Width carapace	Depth thorax	Orbito-frontal width	Propodus lower margin	Dactyl length	Palm height	Palm thickness
H ♂	33.1	59.4	21.0	15.3	R 48.3 L 45.6	R 28.5 L 25.7	R 23.5 L 21.8	R 16.0 L 15.2
A ♀	30.7	57.7	18.5	14.3	R 38.8 L 38.7	R 22.5 L 22.5	R 18.8 L 18.8	R 12.2 L 13.0

Selected measurements of material studied, including the above type-specimens are shown in Figs. 8 and 9. All specimens are mature. Openings to the traps were size selective. The complete range of sizes is not represented in this sample. Both smaller and larger crabs were observed from the submarine during the third set of dives in November–December 1979 (D. M. Cohen and J. F. Grassle, personal communication).

Carapace length-width relationships of males and females fall in a narrow band that describes a straight line (Fig. 8), the range limits for the two sexes covering spans of almost equal length, but males on the whole attain larger sizes than females. Ovigerous females are scattered along the female size range but do not occur at the extremes of this sample.

Cheliped sizes also reflect sex differences, and, moreover, their bilateral

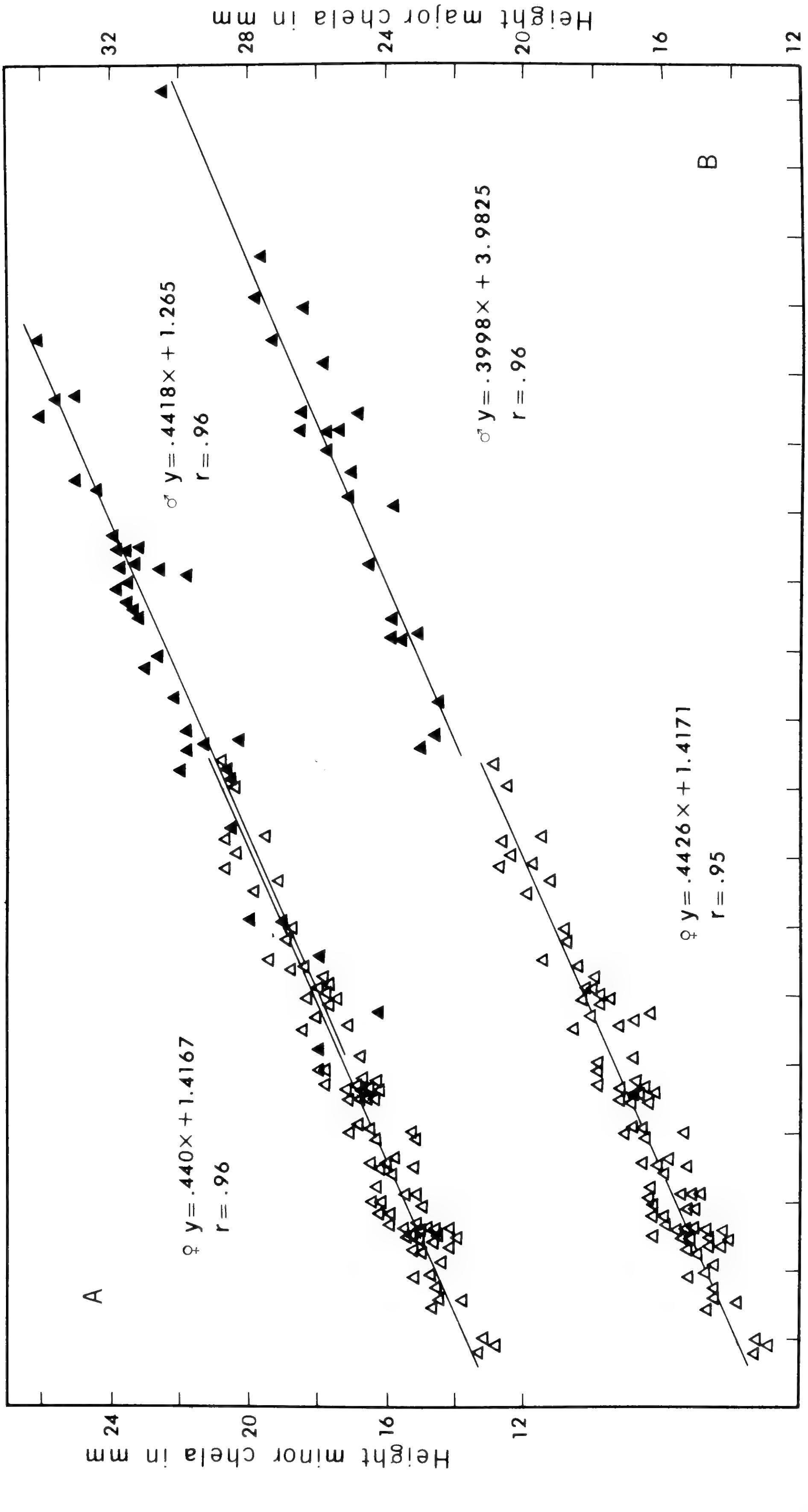

Fig. 9. Mature *Bythograea thermydron*. A. Length-height relationships of minor chelae (length lower margin of propodus–maximum height of palm) regardless of size, excluding those obviously distorted by injury. ♂, N = 35; ♀, N = 84. B. Same for major chelae (either the larger of two chelae on a specimen or an undoubted major where minor was missing). ♂, N = 23; ♀, N = 84.

asymmetry in form (major–minor) can be altered by loss and reversals in form that accompany regeneration. Although there appear to be intermediate forms associated with cheliped regeneration and reversal, there is always some difference in the size of these two limbs on an individual. These differences can be represented by plotting the straight-line length of the lower propodal margin against maximum height of palm for each chela measured. For this sample, the scatters of points describe straight line relationships (Fig. 9) for both major and minor chelae. Range limits for the minor chela of males and females overlap, those for males covering a greater span at larger sizes than for females (A), but the scatter of points for both fall on essentially a common line. The plot for the major chela differs in two easily observable ways; the female hand is both shorter and less elevated than that of the male, there being no overlap in length for the two sexes in this sample. The elevated male palm height follows a common trend in the Brachyura for sexually mature males to possess noticeably enlarged crushers.

Color in life.—Dominant color white with chelae dark to quite black, especially on fingers. Ova in female's bodies reddish or pronounced pink; hepatic gland grayish. Crabs from "The Rose Garden" white and not worn; those from "The Mussel Bed" quite stained, worn, and with quite black chelae, the mussel beds themselves being somewhat darkened (J. J. Childress, personal communication).

Color in preservation.—Predominantly whitish or moderately greenish but variable; latter color (which possibly results from ruptured internal organs) on subdivisions of gastric, hepatic, subhepatic, suborbital parts of pterygostomian and subbranchial regions, and solid, variable or mottled on branchial, cardiac or intestinal regions in some specimens, often along epibranchial line, and with almost symmetrical greenish spots on lighter green background in still other specimens. Fingers with outer aspect slate colored, in males often solidly so, but females often with darker color below impressed lateral line of fixed finger than immediately above it; color extending almost solidly along upper margin of palm and variably from below tooth row and base of fixed finger onto outer surface of palm, often reticulated and darker along upper half, especially in males, and grading into lighter background of white sometimes tinged with pink on relatively uncolored lower proximal quadrant. Inner surface of fingers less solidly colored. Males with sooty to dusky speckles dusted on palm; carpus lightly dusted with continuation of external speckles on outer surface of palm, suggestion of same externally on inner corner of merus as well as a few such areas (sometimes faded) on walking legs. Some females entirely white.

Of 36 males and 99 females, all males had variable dark coloration as above; many females were similar but usually lighter colored, the darkened areas of the chelae varying from shadowy light or pinkish gray to tannish gray to slate color. Color pattern and intensity varied greatly. Lighter colored, "cleaner" individuals appeared to be more freshly molted, having sharply granular or punctate though completely hard exoskeletons, than the darker more worn individuals. Degree of wear, mainly in males, appears to be associated with increasing number and density of the irregular sooty or dusky spots, blotches and trace marks, suggesting that these are at least in part induced by friction, especially on prominences where oblique marks give evidence of abrasion.

Name.—The specific name from the Greek "thermydron," hot spring, is a noun in apposition, referring to discovery of the species in association with the thermal vents.

Megalopae and Juveniles
Figs. 10–11

Clumps of mussels taken from the bottom (discussed and figured, Corliss and Ballard, 1977; Corliss et al., 1979) sheltered a few specimens best characterized as "crablike megalopae," and early crab stages. One juvenile was found in association with vestimentiferan tubes. None of these were taken in the traps. J. F. Grassle saw one megalopa swim past a viewing port of the *Alvin* on a November–December 1979 dive.

Material.—Two megalopae, USNM 173501, Galapagos Rift, Garden of Eden, 25 January 1979, 0°47.69′N, 86°07.74′W, 2482 m, *Alvin* Dive 884. Five megalopae + 1 megalopal exuvium and 6 early crab stages, USNM 180065, Rose Garden, 30 November 1979, 0°48.25′N, 86°13.48′W, 2460 m, *Alvin* Dive 983 (mussel washings). One juvenile ♂, USNM 180066, Rose Garden, 7 December 1979, 2458 m, *Alvin* Dive 990 (found with vestimentiferan tubes).

Megalopa description.—The megalopae have megalopal eyes and abdominal characters but resemble early crab stages in general body shape.

Integument clothed with numerous, conspicuous, plumose hairs trapping a flocculent material. Carapace crablike, elliptical, broader than long, mostly smooth dorsally, regions somewhat defined. Anterolateral margins arched, notched between hepatic region and remaining margin; edge running to corneous outer orbital tooth in smaller specimens but a little below this tooth in larger specimens; tiny, corneous, forward trending spines on hepatic margin and surface dorsally, becoming smaller and reduced to granules posteriorly on anterolateral margin and disappearing at lateral angle; slight offset behind lateral angle at juncture of epibranchial line with convex posterlateral margin; short posterior margin concave.

Eyestalks thick and short; cornea globular, swollen and facetted, amber in preservation, not black; folding laterally into cupped orbits with both upper and lower margin complete, 1 or 2 low spines on upper edge.

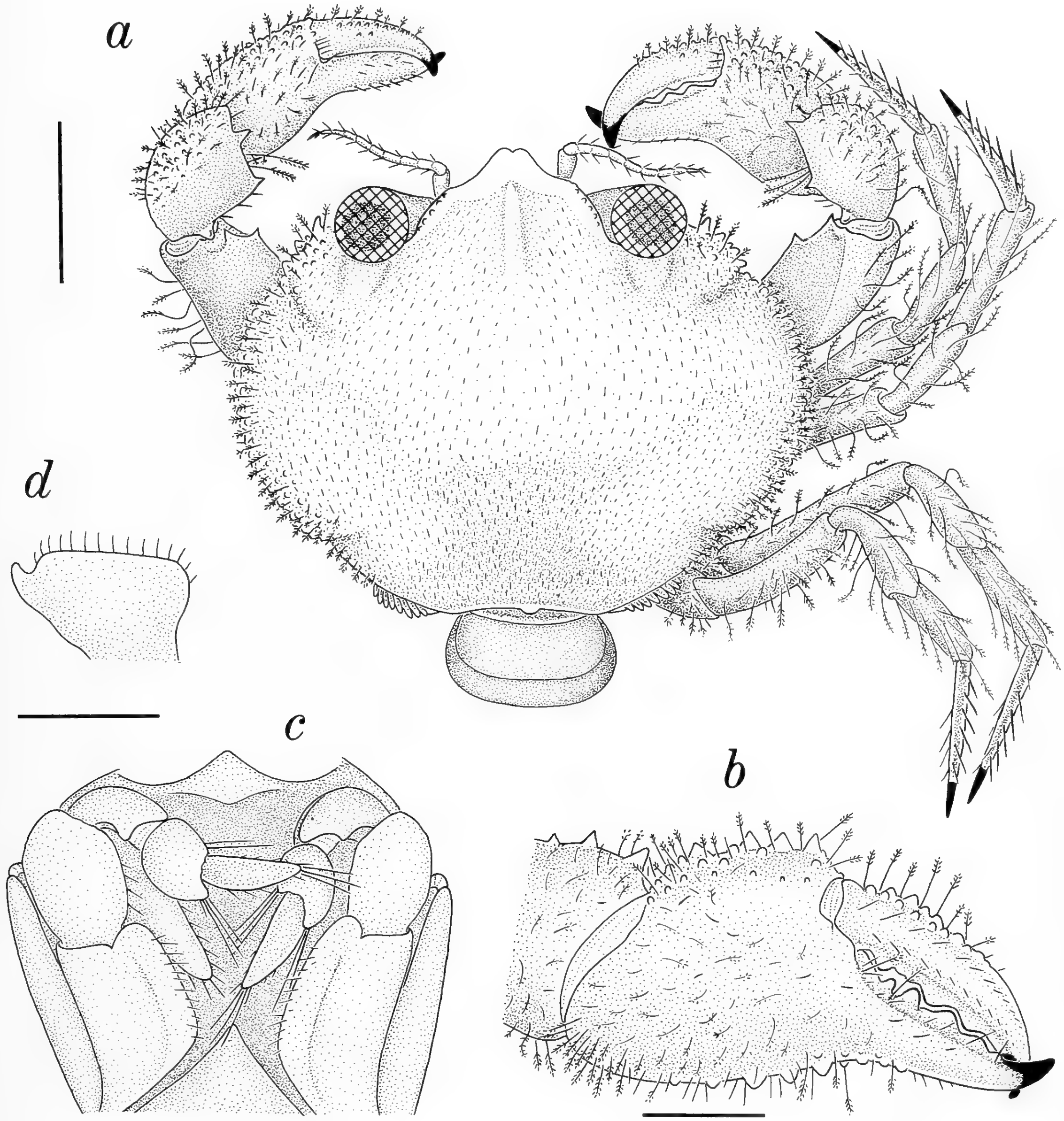

Fig. 10. Larger megalopa from mussel clumps. **a,** Dorsal view, walking legs of left side not shown; **b,** Right chela, external view; **c,** Mouth field showing third maxillipeds with palp of right turned aside, endognath of second maxilliped beneath; **d,** Distal part of left first maxilliped, showing mesial lobe on lacinia. Scales: **a** = 2 mm; **b–d** = 1 mm.

Rostrum bilobed in dorsal view, concave between submedian and inner orbital lobes (latter covering more of eyestalks in larger than in smaller specimens), rather obtuse triangular tip deflexed and extended well below bases of antennal peduncles (somewhat shorter in smaller specimens).

Interantennular septum incomplete.

Antennal flagellum reaching about ⅓ its length beyond outer orbital tooth.

Chelipeds well formed, strong, essentially equal; palms inflated, conspicuous but scattered, rounded, corneous granules on external surface continued both on carpus and proximodorsal edge of dactyl, largest and most dense dorsally (more prominent on smaller specimens); fingers moderately slender, deflexed, irregularly but completely armed with closely fitting teeth, narrowest proximally, broadest in distal half, tips subacute, crossing (dactyl inside) and darkened; merus with short spine at anteromesial angle; carpus with similar spine at middle of inner margin and another between it and articulation with propodus; palms smooth internally.

Walking legs shorter than chelipeds but fairly long, slender, and slightly flattened distally, coxal spines absent; dactyls acute, that of fifth leg about 1.5 times length of propodus.

Mouth field with sides slightly divergent anteriorly; outline of third maxillipeds resembling that of adult crabs described above but merus relatively longer. First maxilliped with lacinia of endognath broadened distally and bearing mesial lobe.

Sternum longer than broad, larger specimen with sternites I–IV almost equilaterally triangular in outline and nearly equal in area to V–VIII; deeply and broadly grooved for reception of abdomen. Abdomen not fixed beneath thorax, 6-segmented, first segment very short, anterior of remaining segments longest; posterolateral spines absent from sixth segment. Four pairs of biramous pleopods with exopods diminishing in length from anterior longest to posterior shortest, each on larger specimens bearing about 36 very long setae, endopods short, slender, tipped with retinacula coupling with member of opposite side; uropods flanking sixth segment short and uniramous, those of smaller specimens bearing 21–22 and of larger specimens 26–28 setae; telson broadly convex distally.

Measurements in mm.—15 specimens examined.

USNM	Length carapace	Width carapace	Frontoorbital distance
173501 Megalopae	4.3	5.3	3.8
	6.1	7.6	5.1
180065 Megalopae	3.8	5.3	3.4
	4.3	5.5	4.0
	4.4	5.8	4.1
	6.3	8.0	5.1
	6.3	8.1	5.4
Megalopa exuvium, width in 8-mm class			
Early crab stages	4.1	6.0	
	4.3	6.3	
	4.3	6.6	
	4.3	6.8	
	4.4	6.6	
	4.5	6.8	
180066 Juvenile ♂	12.5	21.1	

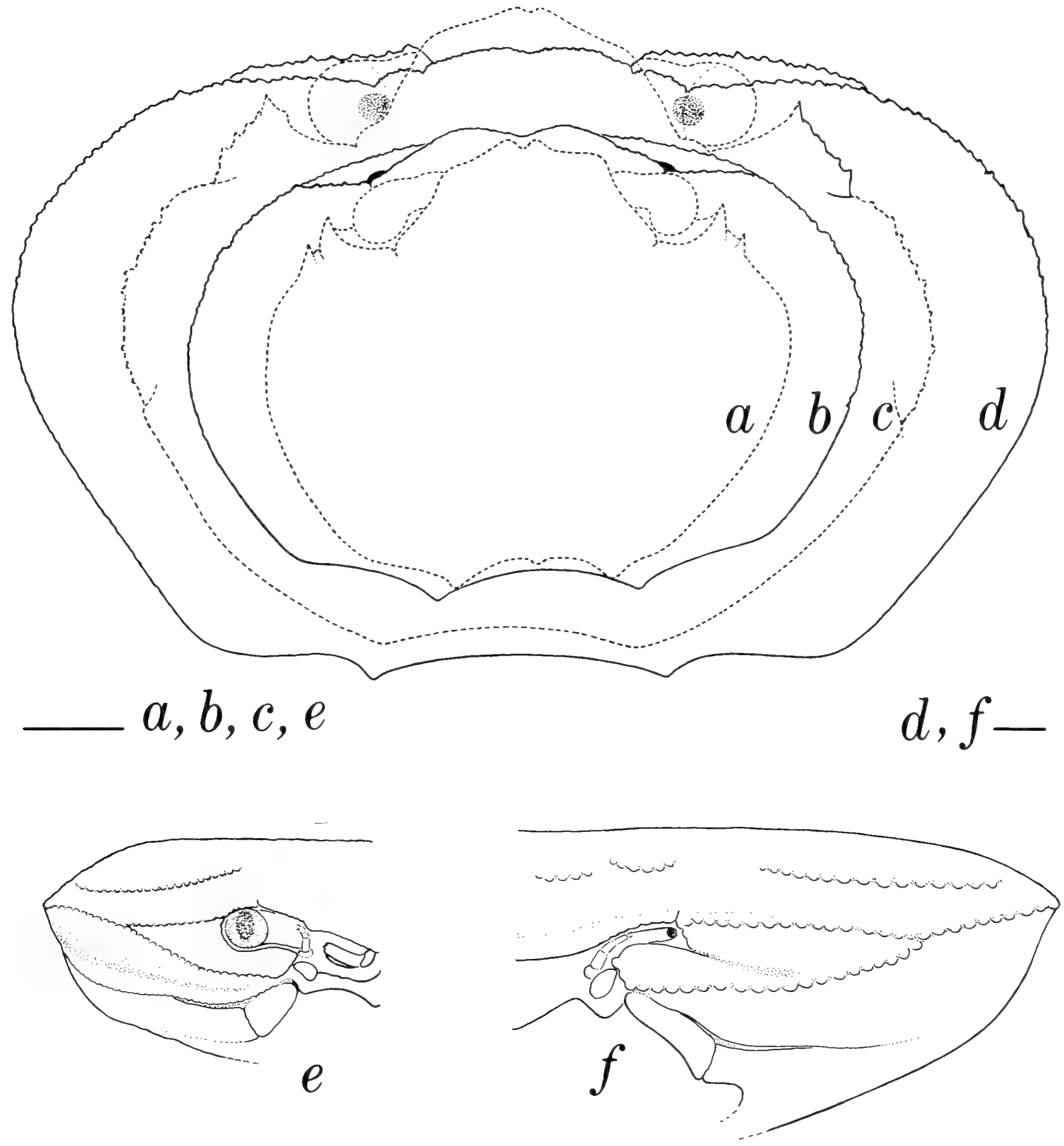

Fig. 11. **a–b,** Outlines of carapace, megalopae and juveniles in dorsal view, see length measurements: **a–c,** USNM 180065, 3.8, 6.3, and 4.5-mm specimens; **d,** USNM 180066, 12.5-mm specimen; **e,** Orbital area of 4.5-mm specimen in frontal view, antenna deleted; **f,** same, 12.5-mm specimen. Scales: **a–c, e** and **d, f** = 1 mm.

Early crab stage.—Adult in general facies but transitional between megalopae and later stages as follows (Fig. 11):

Carapace often nearly featureless dorsally except for indication of most prominent granular lines on surfaces and margins. Front deflexed; shallow median concavity visible in dorsal view; submarginal row of granules slightly interrupted medially. Orbits slightly arched over eyes and open laterally but bounded there by line of granules along supraorbital margin and along edge of suborbital plate converging at anterolateral margin; suborbital plate hidden in dorsal view.

Eyestalks thick, extending laterally; corneal surfaces amber colored but with facets obsolete.

Epistome hidden under front but its essential features present.

Third maxilliped with sides of ischium nearly parallel; merus approximately same width.

Chelipeds similar in size but already somewhat asymmetrical. Chelae, carpi, and meri minutely rugose on all surfaces, tendency on palms to arrangement in alternate rough and smooth horizontal bands on outer surface and raised granular or rugose rows dorsally and ventrally, in transverse rows on meri laterally. Fingers with longitudinal ridges bearing many close-set, distally directed, minute, acute teeth on external surfaces; tips light colored; tooth rows on prehensile edges well formed, in incipient cutter-crusher form, though sharp and more completely developed on fixed finger than on dactyl. Carpus with tiny internal spine and longitudinal, shallow dorsal groove. Merus with mesiodistal spine at end of distal crest.

Abdomen broadest basally, tapering distally, intersegmental sutures slightly narrowed, that between 5–6 narrowest. Telson convex distally.

Pilose patches absent.

Juvenile ♂.—Essentially as adult but transitional from earlier stages as follows:

Eyes reduced, almost hidden, cornea slightly darkened.

Frontal, orbital and outer orbital margin finely milled; anterolateral margin bearing numerous acute, close-set, exceedingly fine, foreward trending teeth diminishing to obsolescence on posterior margin.

Pilose patches on subbranchial areas and chelae as in older males.

Remarks

Adults.—*Bythograea thermydron* has an appearance that immediately suggests the cancroid crabs, but is so obviously modified that no known family of crabs has a suite of characters that includes it (Table 1). The bythograeid family characters are suggestive of portunoid or xanthoid affinities; indeed only the Portunidae have a ''portunid lobe'' on the endognath of the first maxilliped. Balss's (1957) keys place *B. thermydron* in the Tribe Brachygnatha, Superfamily Brachyrhyncha, between the Families Portunidae and Potamidae s. l. (emend. Glaessner, 1969). In Glaessner's (1969) system, *B. thermydron* could be placed in the Section Brachyrhyncha, Superfamily Portunoidea; the front in that superfamily is defined as ''narrow or wide, dentate or lobed,'' and hence broadly interpreted could accommodate it. Also, the flattened but not leaflike distal articles of the fifth legs resemble those of *Carcinus maenas* (Linnaeus) (Carcininae), *Catoptrus inaequalis*

(Rathbun) (Catoptrinae), and *Caphyra rotundifrons* (A. Milne Edwards) (Caphrinae), and the broad rounded adult female abdomen with wide telson resembles that of *Caphyra laevis* (A. Milne Edwards) (Stephenson, 1972; Stephenson and Campbell, 1960). The chelae, however, are not ridged except for the mesioventral palmar keel somewhat resembling that of *Ovalipes* (Polybiinae). The produced anterolateral margin, granular and lacking teeth or lobes, is reminiscent of some freshwater Potamidae s. l., but in other respects this similarity must be regarded as superficial (Table 1).

Following are additional considerations that make the systematic placement of this crab difficult:

The predominantly smooth inflated chelae with spooned fixed finger are more xanthoid than portunoid. These appendages undoubtedly are adapted for feeding, for the crabs were caught in baited traps, indicating ability to scavenge. Moreover, patches of dense plumose hairs on the submarginal and subbranchial areas of the carapace, bases of legs, endostome mesial to the palatal ridge, and on the inside of female palms and sternum at perimeter of the abdomen may be at least partly for entrapment of finely particulate food, recalling similar patches of hair among the Goneplacidae, *Euryplax nitida* Stimpson or *Frevillea hirsuta* (Borradaile); for example (Guinot, 1969). C-CD video tapes from the Galapagos II Expedition show the crabs moving backward over the large vestimentiferan (pogonophoran) tubes, apparently sweeping fine material from the tube surfaces toward the mouth by alternate movements of the third maxillipeds. Also, females may preen egg masses with aid of the internal hairs on the chelae. Tufted bands of setae on the walking legs suggest great tactile sensitivity (activity viewed on C-CD video tapes).

Capacious branchial areas with large afferent and efferent branchial openings suggest adaptation to an environment that can be low in dissolved oxygen (Corliss et al., 1979).

The male first pleopods have the same general curvature as in many portunids with short pleopods, but they are much stouter; the long whiplike second pleopods are unlike any in the Portunidae (usually short or whiplike) but resemble those of xanthids such as *Menippe mercenaria* (Say) (Williams, 1965) and platyxanthids (Guinot, 1968; 1978). Females have correspondingly enlarged gonoducts. All females taken in the samples are adult, therefore no data are available on abdomen shape in juvenile females which might give clues indicating family affiliations.

The greatly modified adult orbits result from combined reduction of eyestalks and lateral expansion of the carapace, the supraocular border *per se* becoming relatively shortened, but the narrow granular, outer orbital area lying between the extended anterolateral margin and dorsal line of granules lateral to the supraorbital margin becoming larger during development. Neither this complex nor the projecting somewhat deflexed suborbital plates

Table 1.—Comparison of predominant adult characters in five closely allied families of Brachyura; there are many exceptions.

				Xanthidae	Goneplacidae
Character	Portunidae	Bythograeidae	Potamidae s. l.	(Not sharply distinguished)	
Carapace	Flat, moderately transverse, usu. widest at last marginal spine	Flat, transversely oval	Rectangular, oval or rounded	Broader than long, oval, hexagonal, subrectangular, rarely circular	Trapezoidal to rectangular
Anterolateral margin	Variably convex, usually toothed	Convex, not toothed	Convex, toothed or not	Usually toothed or lobed	Usually toothed or lobed
Branchial region	Normal	Expanded	Expanded	Normal	Normal
Front	Horizontal, toothed or lobed	Nearly horizontal, bilobed	Mostly broad, straight or bilobed, deflexed	Broad, often notched, occ. toothed, never produced as rostrum	Transverse, slightly notched; occ. deflexed
Orbits	Bipartite, large	Incomplete	Bipartite, large	Bipartite, normal	Not bipartite, normal, reduced, or large
Eyestalks	Moderately large or elongate	Reduced, blind	Moderate to large	Normal	Small to large, occ. elongate
Antennules fold	Transversely or obliquely	Transversely	Transversely	Transversely or slightly obliquely	Transversely
Interantennular septum	Present	Absent	Present	Present	Present
Chelae	Palm ridged; fingers extended	Palm inflated, ventrally keeled; fingers mod. extended, tip of fixed spooned	Palm usually smooth; fingers extended	Palm smooth, toothed, spined or tuberculate; fingers short, tip of fixed occ. spooned	Palm usually smooth, fingers usually deflexed

Table 1.—Continued.

Character	Portunidae	Bythograeidae	Potamidae s. l.	Xanthidae	Goneplacidae
				(Not sharply distinguished)	
Mouth frame	Sides nearly parallel; mxp. often overlapping ant. margin	Sides divergent; mxp. not overlapping ant. margin	Sides nearly parallel; mxp. not overlapping ant. margin	Sides nearly parallel; mxp. not overlapping ant. margin	Sides divergent; mxp. not overlapping ant. margin
Mxp 1 endognath	Usually lobed	Lobed	Not lobed	Lobe extremely rare	Not lobed
P 5 flattening	Marked; dactyl leaf-shaped usually	Marked; dactyl narrowly lanceolate	Moderate; dactyl ambulatory, often spined	Moderate; dactyl rarely leaf-shaped	Moderate; dactyl ambulatory
♂ gonoducts	Coxal	Coxal	Coxal	Coxal	Sternal or coxal with sternal grooves

and associated projecting epistome have an exact counterpart in the Brachyura. Blindness is a common reductive adapatation in deep-sea animals. Although there are no known blind portunids, a rough parallel to this orbital plate development might be found in *Euphylax dovii* Stimpson or *Podophthalmus vigil* (Weber), portunids (Podophthalminae) with greatly elongated eyestalks which fold into transverse troughlike orbits open laterally for the reception of an expanded cornea.

Narrowing of the interantennular septum is carried to an extreme, that structure being indicated only by minute remnants in the adult and for all practical purposes is absent.

Megalopae and Juveniles.—Characters of the megalopae can be compared to those of the portunid subfamilies Carcininae and certain species in the Polybiinae: i.e., rostrum directed downward, no coxal spines on legs, no sternal cornua, posterolateral spines on the fifth abdominal segment absent in both of the subfamilies, and pleopods with setal count closest to that in *Ovalipes* of the second subfamily (31–40 on the first four and ca. 22 on the uropods) (Rice and Ingle, 1975). However, the great width of the carapace sets *B. thermydron* apart.

The megalopae at first sight seem completely different from adult *B. thermydron*. While the adult is obviously specialized for life in the lightless, rift vent environment, the megalopa is seemingly less so, showing well developed though not darkly pigmented eyes, fully formed normal orbits, and some regionalization on the carapace. The shape and ornamentation of the carapace and shape of the first and third maxillipeds, however, already suggest progression toward the morphology of adult *B. thermydron* in this late larval form. Tremendous changes that occur in the orbital region and chelae during development are foreshadowed in the larger megalopae whose eyestalks are somewhat less exposed than in the smaller, and in the anterolateral margin less strongly developed in the outer orbital region. Natatory pleopods and observation from the *Alvin* by J. F. Grassle indicate weak swimming capability.

The smallest juvenile crab stages are smaller than the larger megalopae and are proportionately broader for a given length. Indeed, the length–width relationships of the juveniles, if plotted on an extension of the scatter of points shown in Fig. 8, fall directly on a straight line, indicating that there is no noticeable proportional change in body shape associated with attainment of sexual maturity (Fig. 8 was plotted before material from the late 1979 samples were received in March 1980).

The juvenile series dramatically demonstrates ontogenetic changes from late larva to adult. The ocular area becomes broadened with increasing width of the carapace, the subocular plate and epistome are gradually projected forward, and the eyestalks degenerate. The interantennular septum, completely absent in the megalopa, becomes barely visible as a minute remnant at upper and lower edges between the two antennular fossae in the largest juvenile. General failure of this structure to develop may be functionally related to loss of sight along with heightened dependence on antennular chemoreception in a lightless environment, both this and great development of the megalopa seeming to be neotenic tendencies.

Development of marine Brachyura does not always progress through a stereotyped set of planktonic zoeal stages and single megalopa followed by staged growth into adults. Wear (1967) described the larval development of *Pilumnus lumpinus* Bennett (Xanthidae) which, in eggs 1.1 × 1.25 mm, passes through embryonic nauplius, metanauplius and complex, much modified zoea to hatch as a megalopa that swims free of the female. He contrasted this to the development of *P. novaezealandiae* Filhol whose embryonic development in eggs 1.5 × 1.4 mm passes through nauplius, metanauplius, four zoeal stages and a megalopa transition stage before hatching into a soft, flaccid megalopa which remains mostly beneath the abdomen of the female until molting to first crab stage 35 days later. The megalopa in both of these cases has a loosely flexed abdomen with biramous pleopods on abdominal segments 2–5 and short uniramous ones on the sixth segment as described above, though the number of natatory setae is fewer. Hale (1931) observed that the 1.1–1.5-mm diameter eggs of *Pilumnus vestitus* Haswell hatch directly into flaccid megalopae which remain under the abdomen of the female, molting eventually into a first crab stage which retains the megalopal abdomen and natatory hairs, but that the succeeding stage loses its pleopods completely. He reviewed published information on such degeneration of megalopal pleopods in other genera. Hale (1925) noted that *Petalomera* (=*Paradromia*) *lateralis* (Gray) (Dromiidae) hatches directly from 1.14 × 1-mm eggs into a form that can be termed a megalopa, the brood young having loosely flexed abdomen with natatory pleopods. A second stage following this, ¼ larger, had developing spines on the carapace, telson, etc., but the abdomen and pleopods were as in the first. He also judged that young of *Cryptodromia octodentata* Haswell hatch from 2-mm diameter eggs directly into miniature crabs with pleopods as above and remain in a brood under the female abdomen. Rathbun (1914) recorded abbreviated development in *Paranaxia* (=*Naxoides*) *serpulifera* (Guérin) (Majidae), the brood chamber of a female with carapace 59 mm wide containing 162 young representing two stages. The first stage had a carapace ca. 3.5 mm long, and the second ca. 5.7 mm long. Both had features of the adult and could be termed megalopae. Hyman (1924) reviewed the early work of Cano on development of *Pachygrapsus marmoratus* (Fabricius) (Grapsidae) showing that it has two megalopal stages following free swimming zoeal stages, the first with body longer than broad and forward projecting rostrum, the second relatively broader and more depressed, without projecting rostrum and with fully developed natatory pleopods as above.

Aikawa (1937) described two megalopal stages for *Plagusia dentipes* de Haan, a first that swarms in the open sea following a pelagic zoeal development, and a second that lives on weeds and timbers and exists in two forms, the second larger than the first (cl. 7.5 and 9.0 mm respectively), before transforming to first crab stage. Both megalopae have maxillae and maxillpeds of adult form and apparently natatory uropods; form a of the second stage has a projecting rostrum but b lacks it.

In contrast, Soh (1969) discussed another kind of abbreviated development in a nonmarine grapsid, *Sesarma (Geosesarma) perracae* Nobili, whose 1.6-mm diameter eggs hatch into modified zoeae which pass through a successive similar stage and then a highly modified megalopa reminiscent of a juvenile crab before becoming true juveniles. He also reviewed direct development in *Potamon* (Potamidae) (Gurney, 1942) whose females bear young crabs in the abdominal pouch. Lucas (1971) showed that species of *Halicarcinus* (Hymenosomatidae) from subtropical Australia have remarkable larval adaptations to habitat, marine and estuarine species suppressing the megalopa and a freshwater species suppressing all larval stages.

From these accounts, it is evident that representatives from six families have abbreviated larval development proceeding from rather large eggs (where egg size is recorded) and incorporating 0–2 megalopal stages. Herring (1974) examined egg sizes in a number of crustaceans, including 26 species of shrimps, 2 of galatheids, 1 polychelid, and 1 deep-sea crab (*Geryon*), finding egg sizes to vary somewhat within species and during development, large eggs having relatively high lipid content and low density when compared with small ones. He judged this relationship to be probably a consequence of abbreviated development in species with large eggs. Species with large and small eggs were found in all depth horizons; *Geryon* sp. had eggs .66 × .66 mm in diameter. *Geryon tridens* Kröyer has four zoeal and single megalopal stages (Ingle, 1979). The moderate sized eggs of *B. thermydron* (.77 × .83 mm) do not suggest storage of yolk for abbreviated development; rather, the large crablike megalopa found in the same environment may result from extension of larval development through multistaged late larvae. Such relatively inactive stages could diminish chances for dispersal away from a restricted benthic habitat.

Conclusion.—While the family Bythograeidae shares features with other brachyuran families, it fits comfortably into none of the recognized superfamilies. Therefore, the most conservative approach is to erect an independent superfamily to receive it.

Behavioral note.—During November–December 1979, observers aboard the *Alvin* noted that *B. thermydron* is distributed on hard bottom both in and well away from the warm vents, apparently not confined to the warm areas. Earlier, C-CD video tapes showed that the crabs readily move in and out of the warmed areas. Though blind, the crabs show classic brachyuran agonistic postures such as lateral stretch of chelipeds in response to intrusion of conspecifics, or other species (a galatheid), in which smaller individuals yield to larger ones, especially in presence of bait (D. M. Cohen, personal communication). The stimulus mechanism for this remarkable behavior in blind crabs is unknown.

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Addendum.—After this manuscript was sent to press, two specimens of *B. thermydron* were received from J. D. Corliss, Oregon State University, Department of Oceanography. Both specimens were collected on 16 March 1977. USNM 181292, National Geographic Camera Trap (lowered to bottom from ship), Clambake 1, 0°47.8′N, 86°8.9′W, (depth unrecorded but approx. 2480 m), 1 ♀, cl 27.7, cw 47.2 mm; remnants of an egg clutch are among hairs on the pleopods. USNM 181293, *Alvin* Dive 733, Garden of Eden, 0°47.69′N, 86°07.74′W, 2482 m, 1 juv., cl 6.6, cw 11.5 mm. The outline of the juvenile carapace would slightly exceed that of Fig. 11*d* at the *a–e* magnification; eyes of the specimen are reduced more than those outlined in Fig. 11*b,* and are hidden under the frontoorbital border as in Fig. 11*d.* Overall color of the juvenile is white; the slightly darkened cornea is dorsally visible through the carapace.

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GEOGRAPHIC VARIATION IN THE YELLOW WARBLERS (*DENDROICA PETECHIA*: PARULIDAE) OF THE PACIFIC COAST OF MIDDLE AND SOUTH AMERICA

Storrs L. Olson

Abstract.—Three new subspecies of *Dendroica petechia* are described from Panamá and Colombia and the characters and distribution of related forms from the Pacific coast are discussed. *D. p. aithocorys* n. subsp. occurs on the Pacific coast of western Panamá. *D. p. iguanae* n. subsp. is confined to tiny Isla Iguana off the Azuero Peninsula, Panamá. *D. p. jubaris* n. subsp. occurs from Darién, Panamá, to Buenaventura, Colombia, and specimens cited herein are the first to be identified from the Pacific coast of Colombia north of Nariño.

The Yellow Warbler, *Dendroica petechia,* comprises three groups of subspecies that were once considered separate species: the migratory *aestiva* group (Yellow Warbler), which is widely Nearctic in distribution; the *petechia* group (Golden Warbler) of the West Indies, Isla Cozumel, and most of coastal Venezuela; and the *erithachorides* group (Mangrove Warbler) on both coasts of Middle America and South America to Peru on the Pacific side, including the Galápagos and Cocos Island and to the Paraguaná Peninsula of Venezuela on the Atlantic side. Except on certain islands, birds of the *petechia* and *erithachorides* groups are usually confined to coastal mangrove swamps.

Hellmayr (1935) considered the *erithachorides* and *petechia* groups to constitute one species and maintained the *aestiva* group as a separate species based on differences in the proportions of the wing and tail. Aldrich (1942) discussed the systematics of these birds and concluded that *petechia* and *aestiva* were conspecific. In most recent works (e.g. Lowery and Monroe, 1968), all three groups are considered to belong to a single species, *Dendroica petechia.*

Large series of previously unidentified specimens of the resident populations from Panamá and Colombia permit the recognition of three additional subspecies in the *erithachorides* group. All the specimens examined in this study are in the collections of the National Museum of Natural History, Smithsonian Institution (USNM), except those of *D. p. peruviana,* which were borrowed from the American Museum of Natural History, New York.

Dendroica petechia xanthotera Todd

Dendroica bryanti xanthotera Todd, 1924, Proc. Biol. Soc. Wash. 37:123. Puntarenas, Costa Rica.

Characters.—Males with chestnut coloration on head dark, restricted on lower parts to chin and throat; ventral streaks narrow; females with ventral streaks narrow and generally confined to the throat or only faintly indicated on upper breast.

Range.—Pacific coast of Central America from Guatemala to Costa Rica.

Specimens examined.—GUATEMALA: San José (2); HONDURAS: San Lorenzo (1); COSTA RICA: Puntarenas (1); Pigres (24).

Remarks.—This subspecies is not known from Panamá although Wetmore (1957) had tentatively listed birds of the following subspecies under this name. Hellmayr (1935:381) referred specimens in the Field Museum from "Punta Mala," Costa Rica to *xanthotera.* Wetmore (unpublished notes) examined these in 1960 and found them to have been collected by G. K. Cherrie at Punta Mala, Río Diquis (=Río Terraba). This he then considered to be the southernmost record of *xanthotera.*

Dendroica petechia aithocorys, new subspecies

Holotype.—USNM 400752, adult male, from 5 miles east of La Honda, near Los Santos, Los Santos Province, Panamá; collected 15 March 1948 by Alexander Wetmore and W. B. Perrygo (original number 13861).

Characters.—Compared to *xanthotera,* male with chestnut portions somewhat lighter in color, hood much more extensive, including the upper breast; ventral streaks markedly wider and more profuse; female with throat and breast much more heavily streaked with chestnut. Compared to *aequatorialis* of Panamá Province, males with chestnut portions darker, upper breast not streaked with yellow; females of both races variable but *aithocorys* generally with more chestnut below than *aequatorialis.* Similar to *erithachorides* but males with chestnut hood and streaks somewhat more extensive, yellow of underparts brighter, more golden.

Range.—Pacific coast of western Panamá from at least as far west as Puerto Armuelles, Chiriquí, east as far as Puerto Aguadulce, Coclé, and including Isla Coiba and the coasts of the Azuero Peninsula.

Specimens examined.—CHIRIQUÍ: Puerto Armuelles, Olivo (3); Alanje, Estero Rico (2); VERAGUAS: Puerto Vidal, Río Vidal, Isla Corocita (3); Islas Contreras, Isla Brincanco (8); Isla Coiba (15); Puerto Mutís, Isla Verde, mouth of Río San Pedro (5); LOS SANTOS: Pedasí, Bajadero (1); Tonosí, Puerto Piña (2); Los Santos, 5 miles E of La Honda (6); HERRERA: Monagrillo, Río Parita (1); Paris, 4 miles NE of Alvina (19); COCLÉ: Aguadulce (4); Puerto Aguadulce, Río Pocrí (8).

Etymology.—Greek, *aithos,* burnt, reddish-brown, and *korys,* helmet, in reference to the extensive chestnut-colored hood of this subspecies.

Remarks.—Wetmore (1957:90) clearly recognized that this population differed from *aequatorialis* to the east, but tentatively referred it to *xanthotera* pending the collection of specimens from Chiriquí. Although he stated that these birds were "intermediate between *aequatorialis* and *xanthotera,*" and they were so regarded by Lowery and Monroe (1968), this is true only in that the chestnut portions approach *xanthotera* in being darker. Otherwise, the relationships of *aithocorys* are much closer to *aequatorialis.* In the greater extent of chestnut on the throat and upper breast, *aithocorys* is equalled only by *chrysendeta* Wetmore, of the Guajira Peninsula in Colombia. It differs from *chrysendeta* in being less heavily streaked below and in having less yellow in the secondary coverts.

As Wetmore (1957) noted, *aequatorialis* occurs west as far as western Panamá Province, so that intergradation with *aithocorys* could be expected to take place along the coast of Coclé. Indeed, some of the specimens from the Aguadulce area show a bit more yellow in the upper breast than typical *aithocorys.*

Dendroica petechia subsp.

Characters.—Plumage like *aithocorys* but size evidently larger.

Range.—Isla Bolaños and possibly Isla Parida, Chiriquí, Panamá (about 45 km SE of Davíd).

Specimens examined.—One male and two females collected on Isla Bolaños in February 1963 by Alexander Wetmore.

Remarks.—These are the only specimens of Yellow Warbler that Wetmore collected on Isla Bolaños. His field notes record that he saw the species on adjacent Isla Parida, but he was unsuccessful in his attempts to collect it there. The male is notably larger (wing chord 70.2 mm) than any of 30 males of *aithocorys* (wing chord 62.3–68.1, mean 64.9). The two females (wing chord 66.0 and 63.7) are near the upper limits of *aithocorys* (wing chord 59.4–66.4, mean 61.8, n = 30). Without additional material it cannot be determined that this population merits nomenclatural recognition.

Dendroica petechia iguanae, new subspecies

Holotype.—USNM 462360, adult male from Isla Iguana, Los Santos Province, Panamá. Collected 27 February 1957 by Alexander Wetmore (original number 21338).

Characters.—Males nearest *aithocorys* but chestnut of head much darker, less rufescent; green of dorsum darker, less yellowish; breast and particularly the lower belly more densely streaked with chestnut; yellow of underparts and tail darker, appearing dingy and greenish. Females like *aithocorys* but tending to be more heavily streaked, yellow of underparts dingier as in the males.

Range.—Confined to Isla Iguana, about 7 km ENE of Pedasí and 18 km N of Punta Mala, Los Santos Province, eastern coast of Azuero Peninsula, Panamá (7°38′N; 80°W).

Specimens examined.—Holotype; 6 male and 6 female topotypes with the same data except that two of the males were collected the previous day.

Etymology.—Named for the type locality, Isla Iguana.

Remarks.—Isla Iguana is a small island, probably less than 1 km^2, lying approximately 6 km from the mainland. It is the only island along the eastern and southern coasts of the Azuero Peninsula. Considering that, with the possible exception of the birds from Isla Bolaños, none of the island populations of Yellow Warblers in Panamá have differentiated from those of the mainland, it is rather surprising to find that those of Isla Iguana are so distinct. Even in the field, Wetmore (field journal) noted the more greenish coloration of these birds.

The fauna of Isla Iguana is dominated by a great nesting colony of Maginificent Frigatebirds (*Fregata magnificens*) interspersed with Brown Pelicans (*Pelecanus occidentalis*). According to Wetmore's field journal, *Dendroica petechia* "was the only abundant small bird on the island, where it ranged everywhere, from the tall bunch grass above the rocky shore to the scrub forest inland. I saw them hopping about on bare rocks above high tide mark in early morning, and fifteen or twenty ranged about the outdoor kitchen near the house, where they came out familiarly in low perches, as well as higher among the leaves of the trees. In the forest I found them often examining tufts of leaves almost among the frigate-birds perched in the branches. Many were in pairs, and males sang occasionally, though they were not breeding."

The only other land birds Wetmore collected on the island were three specimens each of two species of tyrannid flycatchers (*Myiarchus panamensis* and *Sublegatus arenarum*) and one specimen each of two species of hummingbirds (*Chlorostilbon assimilis* and *Lepidopyga caeruleogularis*). In addition he sighted two hawks that he thought probably were *Buteogallus anthracinus*.

Dendroica petechia aequatorialis Sundevall

Dendroeca petechia aequatorialis Sundevall, 1870, Ofvers. Vetensk.-Akad. Förhandl. 26:609. "Guayaquil" = Panamá City (cf. Peters, 1931, Bull. Mus. Comp. Zool., 71:334).

Characters.—Male with crown, cheeks, and throat uniform chestnut but of a lighter shade than in *aithocorys,* upper breast streaked with yellow.

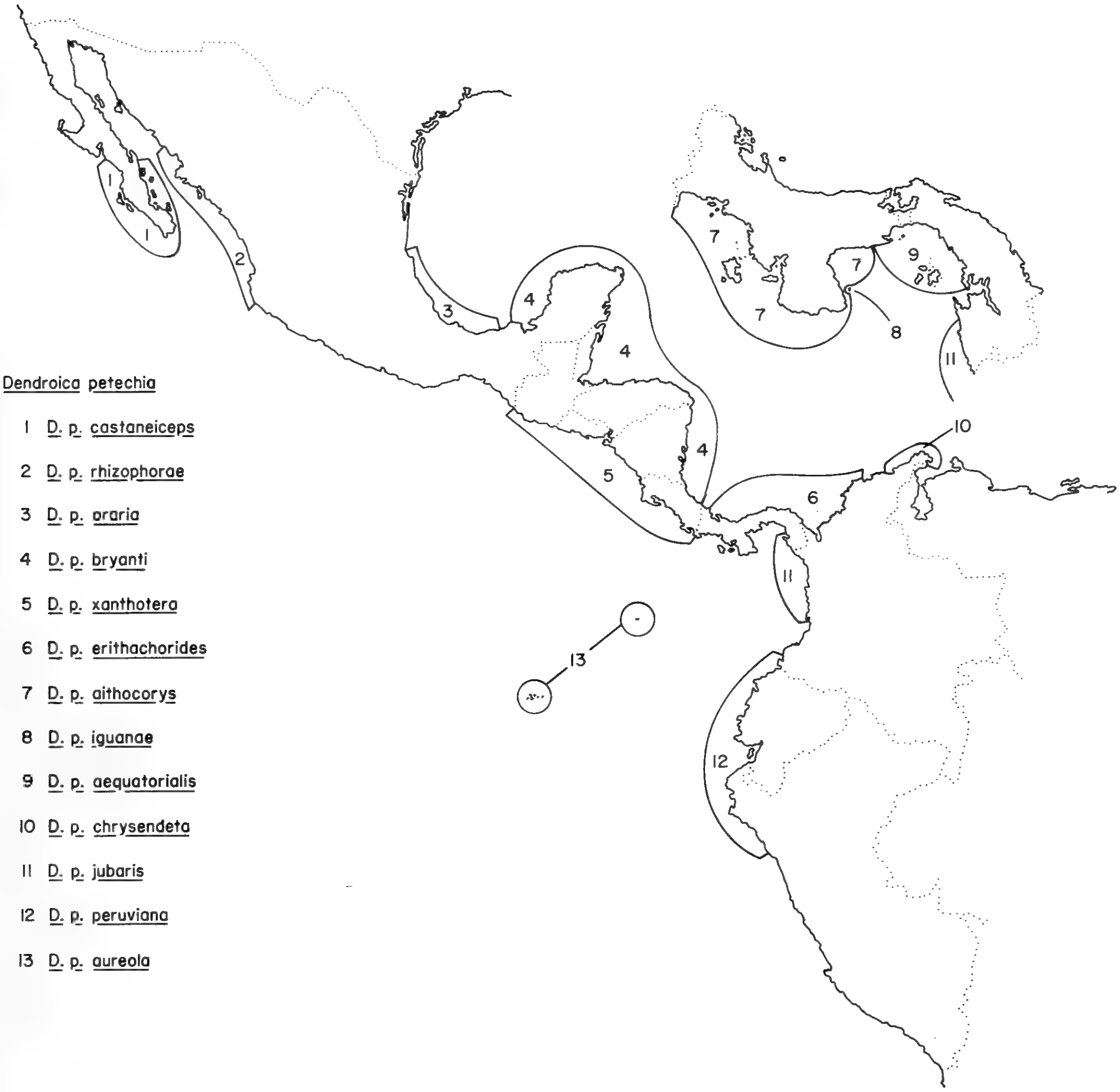

Fig. 1. Outline of map of Middle America and adjacent South America showing the approximate known distribution of the subspecies of the *erithachorides* group of *Dendroica petechia*. Inset shows detail of the distribution of Panamanian subspecies. *D. p. paraguanae* of Venezuela omitted.

Range.—Pacific coast of the Province of Panamá and the Archipiélago de las Perlas.

Specimens examined.—PANAMÁ PROVINCE: Bejuco, Puerto El Tigre (11); Taboguilla Island (8); "near Panama City" (1); Chico, mouth of Río Chico (12); Majé, mouth of Río Majé (10); CANAL ZONE: Farfan Beach (3); Corozal (3). ARCHIPIÉLAGO DE LAS PERLAS: Isla San José (20); Isla Moreno (4); Isla Pedro Gonzalez (3); Isla San Miguel (5); Isla Saboga (1); Isla Chapera (4); Isla Santelmo (3); Isla Bayoneta (5); Isleta Málaga (2).

Remarks.—There is a greater amount of individual variation in this subspecies than in any of the preceding. Thayer and Bangs (1905) and Wetmore (1946) have remarked on the occasional individuals from the Archipiélago de las Perlas that have the yellow portions of the plumage replaced with orange, of which there are two in the USNM series from Isla San José. Some of the adult males from Majé show traces of yellow in the cheeks, perhaps an indication of intergradation with the following subspecies.

Dendroica petechia jubaris, new subspecies

Holotype.—USNM 443695, adult male from Nuquí, Dept. Chocó, Colombia (5°40′N). Collected 22 January 1951 by M. A. Carriker. Jr. (original number 19284).

Characters.—Compared with *aequatorialis,* males with chestnut portions of plumage lighter, more tawny; throat and chin either suffused with, or distinctly streaked with yellow; cheeks and lores suffused with yellowish, contrasting with the darker crown, so that the birds appear distinctly capped, as opposed to *aequatorialis* in which the entire head is chestnut; belly less streaked with chestnut, appearing more brightly yellow. Closest to *peruviana,* but cheeks, lores, and chin of males, tawny chestnut, less yellow; females more heavily streaked with chestnut below.

Range.—Panamá in Darién, south along the Pacific Coast of Chocó, Colombia, at least to Buenaventura, Valle del Cauca.

Specimens examined.—PANAMÁ: DARIÉN: Jaqué (15); COLOMBIA: CHOCÓ: Nuquí (10); VALLE DEL CAUCA: Buenaventura (1).

Etymology.—Latin, *jubar,* radiance of the heavenly bodies, light, sunshine; so named for the brilliance of the yellow plumage.

Remarks.—No resident form of *Dendroica petechia* has heretofore been identified from the Pacific coast of Colombia north of Tumaco, Nariño. The specimen listed above from Buenaventura was collected in 1864 by Hicks and cataloged in the USNM collections in 1878 but seems never to have found its way into the literature. This had been identified as *peruviana* by Wetmore, but probably in the absence of comparative material, as the USNM still lacks representatives of this subspecies.

Dendroica petechia peruviana Sundevall

Dendroeca petechia peruviana Sundevall, 1870, Ofvers. Vetensk.-Akad. Förhandl. 26:609. Callao, Peru.

Characters.—Males like *jubaris* but with cheeks, lores and chin more yellowish, less suffused with tawny chestnut; females with chestnut streaks of underparts obsolete, nearly absent. Males of *D. p. aureola* Gould of the Galapagos and Cocos Island differ in having only the cap chestnut, with the sides of head, chin, and throat yellow, and the ventral streaks generally less prevalent, particularly on the lower throat.

Range.—Known from Tumaco, Dept. Nariño, Colombia, south through coastal Ecuador to northern Peru, at least as far south as Tumbez.

Specimens examined.—COLOMBIA: NARIÑO: Tumaco (2); ECUADOR: ESMERALDAS: Esmeraldas (2); EL ORO: Isla de Jambelí (2).

Remarks.—This subspecies shows some variation in the extent of chestnut on the sides of the head and throat, so that occasional intensely colored individuals would probably be difficult to separate from the lightest individuals of *jubaris*. Over 300 km separate the known northern limits of *peruviana* at Tumaco from the southern limits of *jubaris*, as represented by the single old specimen from Buenaventura.

Discussion

Some peculiar patterns of distribution in the *erithachorides* group deserve to be called to attention. The subspecies from the Pacific coast of Costa Rica northward (*xanthotera, rhizophorae, castaneiceps*) and those of the Atlantic side of Costa Rica northward (*bryanti, oraria*) are more similar to one another than any of these subspecies are to those along either coast of Panamá (Fig. 1). These northern birds could be designated as the "*bryanti* subgroup," characterized by having the chestnut of the throat more restricted and the ventral streaks narrower and sparser. Birds from the Pacific coast of Panamá (*aithocorys, iguanae, aequatorialis*) are more similar to those of the Atlantic coast of Panamá and South America (*erithachorides, chrysendeta, paraguanae*) than to the *bryanti* subgroup. These could be designated as the "*erithachorides* subgroup," characterized by the more extensive hood, and wider, more profuse ventral streaks.

The chestnut-capped birds from the Galápagos and Cocos Island (*aureola*) appear to be more similar to some of the subspecies in the West Indian *petechia* group than to the adjacent *erithachorides* group. However, through the progression *aithocorys-aequatorialis-jubaris-peruviana,* along the mainland, *aureola* could be viewed as the endpoint in a southward increase of yellow on the head and cheeks, in which case its similarities to West Indian subspecies would have evolved independently.

Acknowledgments

I thank Lester L. Short and John Farrand, Jr., for lending specimens of *D. p. peruviana* from the collections of the American Museum of Natural History, New York. Eugene Eisenmann and Kenneth C. Parkes kindly read and commented on the manuscript. This is Contribution Number 3 of The Wetmore Papers, a project supported in part by trust funds from the Smithsonian Institution for completing unfinished work and study of undescribed material left by the late Alexander Wetmore.

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A NEW ATYID SHRIMP, *PALAUATYA DASYOMMA*, FROM PALAU, CAROLINE ISLANDS

C. W. Hart, Jr.

Abstract.—A new genus and species of atyid shrimp, *Palauatya dasyomma,* is described from an anchialine habitat on Anguar Island, Palau, Caroline Islands. Its relationships with *Limnocaridella* and *Edoneus* are discussed.

In the course of their work as Peace Corps biologists on Palau, Caroline Islands, Mr. Jeffrey June and Mr. Greg R. Bright made a number of collections of freshwater and marine crustaceans, which they deposited in the National Museum of Natural History, Smithsonian Institution. Among these were two collections from a former phosphate mine, both of which consisted entirely of specimens of a new genus of shrimps of the family Atyidae. I am grateful to Mr. June and Mr. Bright for making the collections available to the Smithsonian Institution, and to Dr. Raymond B. Manning, who brought the specimens to my attention. I also thank Dr. Fenner A. Chace, Jr. and Dr. Horton H. Hobbs, Jr. for criticisms of the manuscript.

Palauatya, new genus

Diagnosis.—Carapace smooth, without spines; rostrum short, unarmed. Eyes pigmented. Abdominal pleura rounded. Telson bearing 2 pairs of dorsal spines, 4 pairs of spines and a pair of simple setae on posterior margin. Exopods present only on maxillipeds. Epipods borne on second and third maxillipeds and first, second, and third pereiopods. Branchiae limited to pleurobranchs corresponding to pereiopods 1 through 4. Single mastigobranchs present on coxae of pereiopods 1 through 4. Endopod of first pleopod of male without appendix; endopod of second pleopod of male with strong appendix masculina overreaching endopod. Lateral ramus of uropod bearing 5 to 9 spines mesiad of lateral angle and overlapping diaeresis.

Type-species.—Palauatya dasyomma, new species.

Relationships.—This genus belongs to Bouvier's "série caridellienne" (Bouvier, 1925:41, 89–91), and shows affinities with *Limnocaridella* Bouvier (1913) and *Edoneus* Holthuis (1978). Its branchiae and exites are more closely allied with those of *Limnocaridella* (from Lake Albert) than with those of *Edoneus* (from New Guinea). However, it differs from *Limnocaridella* in that it does not possess an antennal spine, its rostrum is short and unarmed, and the caridean lobe is vestigial.

Table 1.—Principal features differentiating *Limnocaridella, Edoneus,* and *Palauatya.*

	Palauatya	*Edoneus*	*Limno-caridella*
Pleurobranchs on pereiopods	1st 4	all	1st 4
Pleurobranchs on maxillipeds	–	–	–
Arthrobranchs	–	–	1*
Mastigobranchs on 1st 4 pereiopods	x	?	x
Epipods on 2nd & 3rd maxillipeds; 1st 3 pereiopods	x	–	x
Epipods on 2nd & 3rd maxillipeds (maybe 1st); 1st 4 pereiopods	–	x	–
Telson dorsal spines	2 pr.	>2 pr.	2 pr.
Telson posterior spines	4 pr.	5 pr.	4 pr.
Caridean lobe on 1st maxilliped well developed	–	x	x
Caridean lobe on 1st maxilliped vestigial	x	–	–
Antennal spine	–	–	x
Rostrum long, armed dorsally and ventrally	–	–	x
Rostrum short and unarmed	x	x	–

* Rudimentary.

The principal features differentiating the three genera are summarized in Table 1.

Name.—From Palau (in the Caroline Islands) plus *Atya.*

Palauatya dasyomma, new species

Rostrum (Figs. 1–3) simple, spinelike, not reaching beyond eyes. Carapace smooth, without spines; antennal angle produced slightly anteriorly; pterygostomian area rounded, not produced.

Pleura of abdominal somites (Fig. 1) broadly rounded.

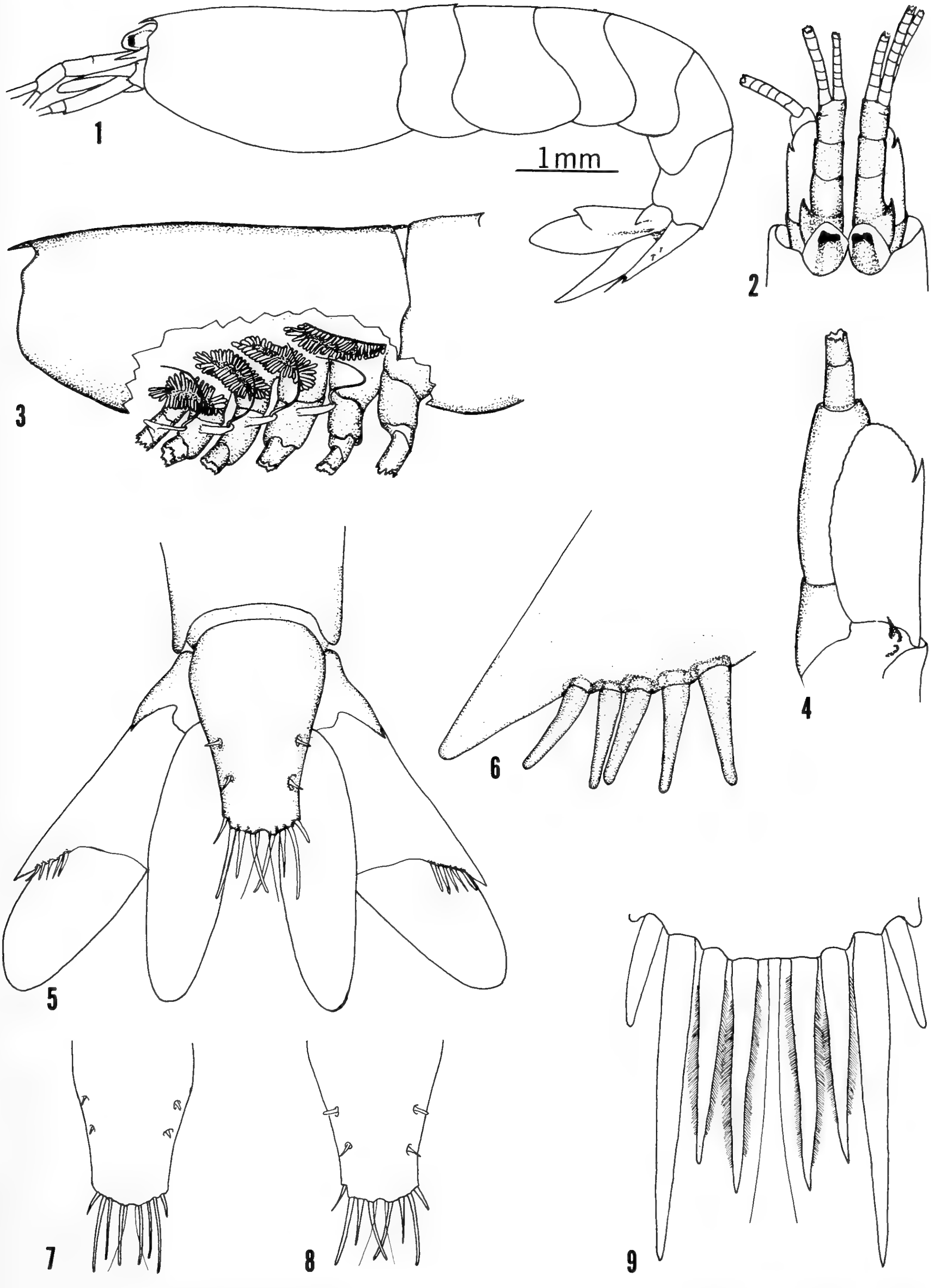
Telson (Figs. 5, 7–9) 1 ½ times as long as broad; anterior pair of dorsal spines situated near midlength; posterior pair situated about midway between anterior pair and posterior margin. Telson terminating in 4 pairs of unequal spines and a single pair of simple setae situated between median pair; mesial 2 pairs of spines with fine setae (Fig. 9).

Lateral ramus of uropod (Figs. 5, 6) with 5 to 9 spines mesiad of lateral angle and overlapping diaeresis.

Eyes (Figs. 1, 2, 28–31) large, pigmented, and, in all specimens examined, with pigmented portion apparently retracted from transparent non-faceted corneal covering. Covering of each eye bulbous (possibly artifact of fixation); surface bearing scattered setae.

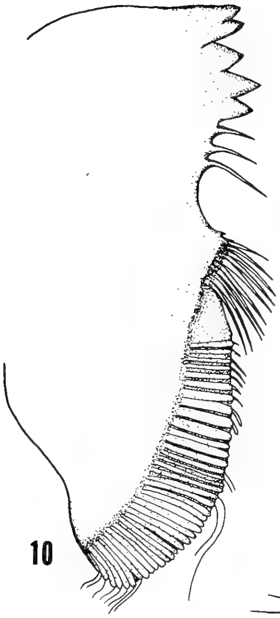
Antennular peduncle (Fig. 2) with short, acute stylocerite reaching past midlength of basal segment. Second segment subequal in length to third.

Antennal scale (Fig. 4) more than twice as long as wide; outer margin



Figs. 1–9. *Palauatya dasyomma*: **1,** Lateral view of male holotype; **2,** Dorsal view of anterior part of same specimen; **3,** Lateral view with part of carapace removed to show pleurobranchs, mastigobranchs, and epipods; **4,** Antennal scale; **5,** Telson and uropods; **6,** Lateral angle of lateral ramus of left uropod; **7, 8,** Variations in telson configuration; **9,** Detail of terminal part of telson, showing fine setae on mesial 2 pairs of spines.

Scale refers only to Figs. **1** and **2.**



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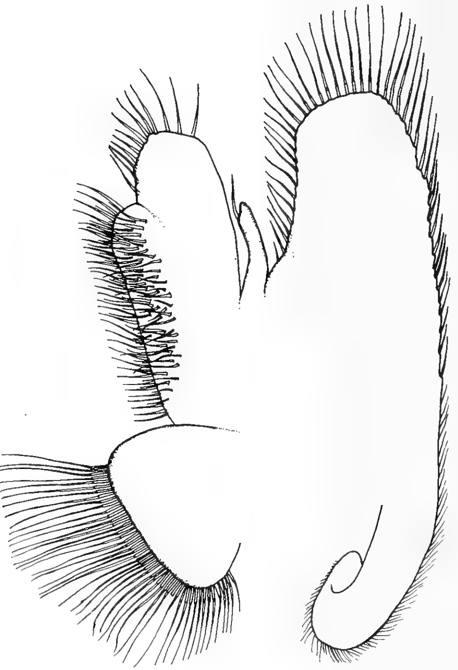

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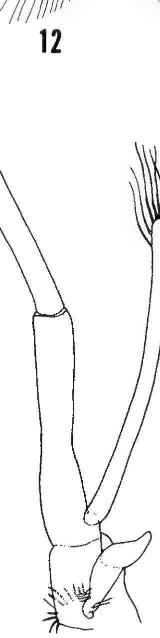

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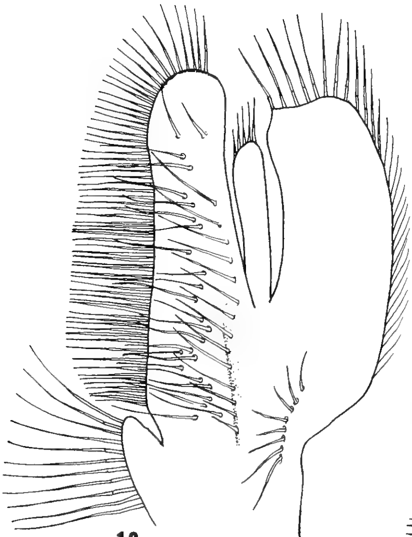

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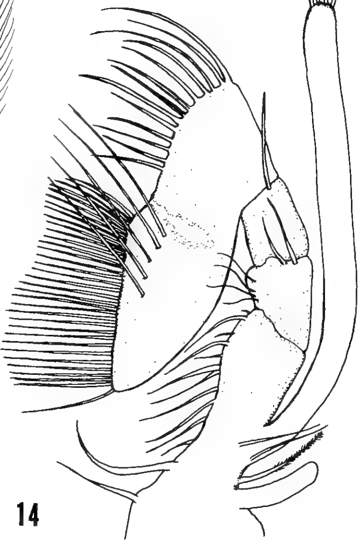

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nearly straight, ending in tooth; scale almost reaching distal end of antennal peduncle.

Mandible (Fig. 10) with incisor process bearing 5 strongly developed teeth, three adjacent setae, and mesially situated brush of 8 to 15 setae; molar process with dense row of parallel elements, some bearing spinules or setae. First maxilla (Fig. 11) with distal lacinia spatulate, supporting double row of short spines on mesial face; proximal lacinia rounded; palp weakly tapered and bearing 2 subterminal spines. Second maxilla (Fig. 12) with scaphognathite broadly rounded distally, recurved proximally; palp small, with single subterminal spine; distal endite rounded; middle endite (lower endite of Holthuis 1978:221) densely spined mesially and, in some specimens, rolled laterally on itself, appearing as spiny process rather than flattened lobe; proximal endite rounded.

First maxilliped (Fig. 13) with rounded palp bearing several terminal setae; endites unremarkable; exopod subtruncate distally with vestigial caridean lobe; epipod absent. Second maxilliped (Fig. 14) with well developed exopod overreaching endopod by less than $^{1}/_{6}$ its own length and bearing several terminal setae and small digitiform epipod, but lacking podobranch. Third maxilliped (Figs. 15, 16) with well developed exopod and epipod; gills absent; endopodal segments subequal in length; terminal segment bearing 12 rows of coarse spines on proximal ⅔ of flexor face, single spine between these and distal end, and three terminal spines.

Branchiae and endites as follows:

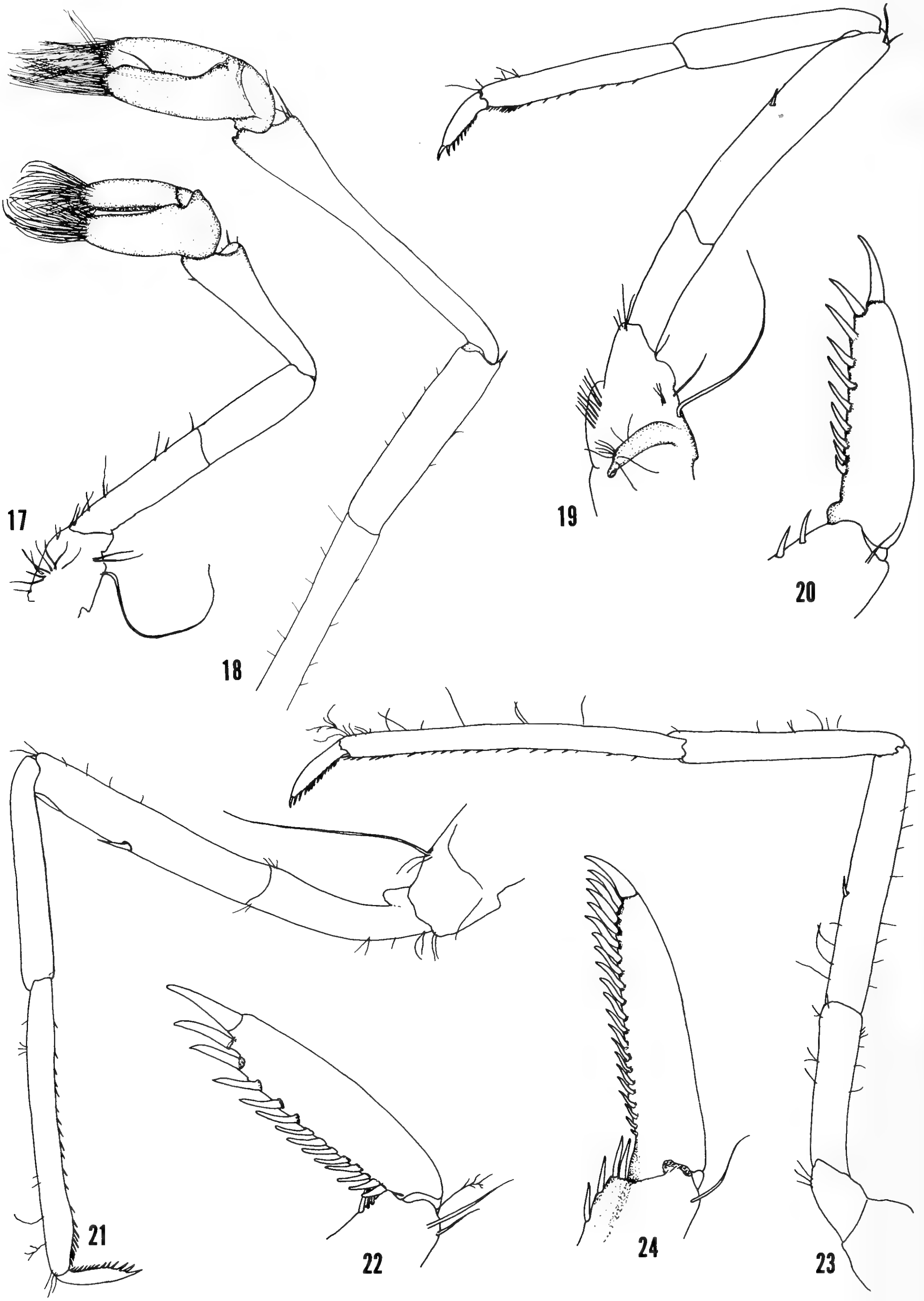
	Maxillipeds			Pereiopods				
	1	2	3	1	2	3	4	5
Pleurobranchs	–	–	–	1	1	1	1	–
Arthrobranchs	–	–	–	–	–	–	–	–
Podobranchs	–	–	–	–	–	–	–	–
Mastigobranchs	–	–	–	1	1	1	1	–
Epipods	–	1	1	1	1	1	–	–
Exopods	1	1	1	–	–	–	–	–

Pereiopods as illustrated (Figs. 17–24). Fingers of chelae of first and second pereiopods bearing terminal tufts of hair. Second pereiopod longer than first. Third, fourth, and fifth pereiopods slender; dactyl and propodus armed with multiple spines on flexor face; merus equipped with single spine about midlength.

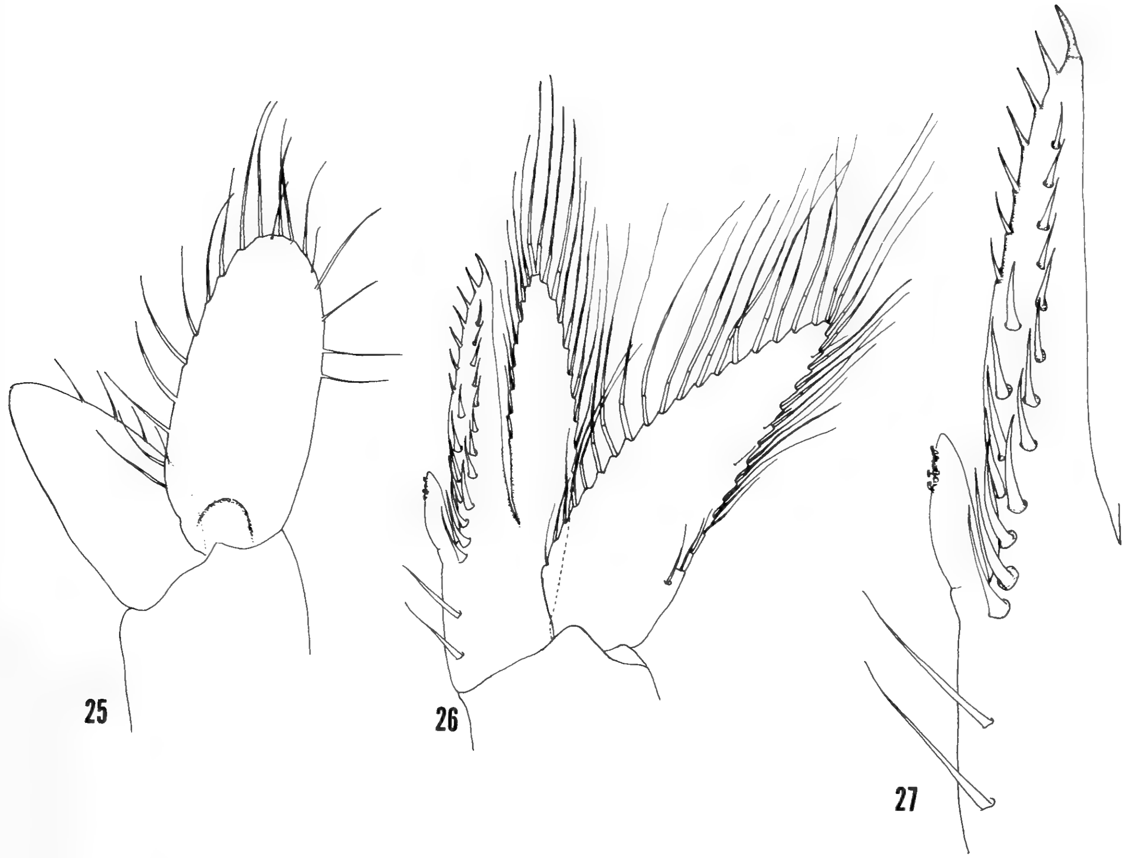
Endopod of first pleopod of male (Fig. 25) subtriangularly ovate, without appendix; several setae present on lateral margin; exopod larger, bearing

←

Figs. 10–16. *Palauatya dasyomma*: **10,** Mandible; **11,** First maxilla; **12,** Second maxilla; **13,** First maxilliped; **14,** Second maxilliped; **15,** Third maxilliped; **16,** Detail of terminal segment of third maxilliped.



Figs. 17–24. *Palauatya dasyomma*: **17,** First pereiopod; **18,** Second pereiopod; **19,** Third pereiopod; **20,** Detail of dactyl of third pereiopod; **21,** Fourth pereiopod; **22,** Detail of dactyl of fourth pereiopod; **23,** Fifth pereiopod; **24,** Detail of dactyl of fifth pereiopod.



Figs. 25–27. *Palauatya dasyomma*: **25,** Endopod and exopod of first pleopod of male; **26,** Terminal part of second pleopod of male; **27,** Detail of appendix masculina and appendix interna of second pleopod of male.

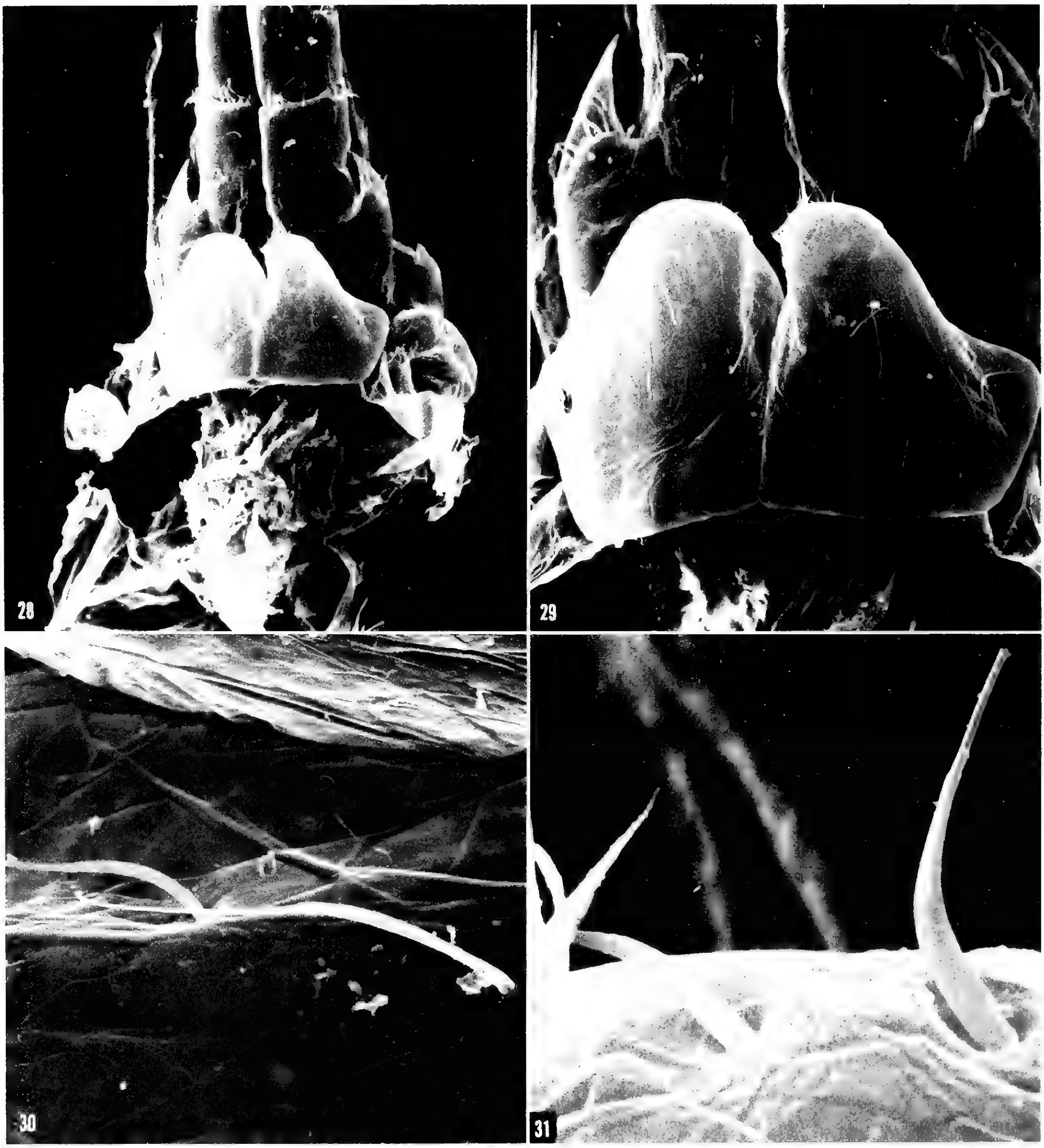
mesial, distal, and lateral setae. Appendix masculina of second pleopod of male (Figs. 26, 27) overreaching endopod, armed with spines on mesial and posterior faces and bearing single terminal spine; appendix interna small, not so long as width of endopod base.

Size.—Postorbital carapace length of male holotype 2.0 mm. Postorbital carapace lengths of 4 male specimens 2.0 to 2.25 mm (average, 2.12 mm). Postorbital carapace lengths of 8 female specimens 2.0 to 2.75 mm (average, 2.28 mm).

Disposition of types.—The holotypic male, allotypic female, and a series of paratypes are deposited in the National Museum of Natural History (USNM 180168, 180169, 180170, 180171).

Distribution.—Known only from an anchialine lake formed by phosphate mining operations on Anguar Island, Palau, Caroline Islands (6°54′49″N; 134°08′12″E).

Ecological data.—The lake in which the shrimps were collected is a former phosphate mine, which was worked from 1909 to 1955. Now filled with



Figs. 28–31. *Palauatya dasyomma*: **28,** Scanning electron microscope (SEM) view of anterior part of body, carapace removed, showing bulbous corneal covering (×50); **29,** Same (×100); **30,** Mesial view of right corneal covering, showing anteriorly directed setae (×600); **31,** Dorsal view of anterior part of left corneal covering, showing detail of setae (×1,000).

water, the lake averages 5 m in depth, is 2,000 m^2 in surface area, and is connected to the sea by subterranean fissures. The chloride content of the water in this anchialine habitat (see Holthuis, 1973) was recorded as 14000 ppm by the collectors.

The shrimp which are bright red when living, were abundant on algal mats and were reported to have been feeding on this algae near the banks of the lake. Collections were made on 10 November 1977 and on 27 March 1979.

Name.—From the Greek "*dasys,*" hairy and "*omma,*" eye. Gender feminine.

Remarks.—Because the genera *Palauatya, Edoneus,* and *Limnocaridella* are each monotypic, the relationships between them, discussed above, hold for the individual species.

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THE GENUS *GRANDIFOXUS* (CRUSTACEA: AMPHIPODA: PHOXOCEPHALIDAE) FROM THE NORTHEASTERN PACIFIC OCEAN

J. Laurens Barnard

Abstract.—*Grandifoxus* now comprises 3 valid species, as follows: *G. grandis* (Stimpson) (=*milleri* Thorsteinson); *G. longirostris* (Gurjanova), and an unnamed species R; the latter is assumed to be *Pontharpinia robusta* Gurjanova, an obscure species. Taxa called species J and species 51 are also described but are believed to be seniles; their validity remains to be demonstrated. The genus is fossorial, lives in very shallow water, has some of the largest species in the family and ranges between Bering Sea and Monterey Bay California, and possibly into the Japan Sea.

The phoxocephalid genus *Grandifoxus* was recently carved out of the polytypic *Paraphoxus* by J. L. Barnard (1979). The species comprising this genus are now presented. In the Americas the generic taxonomy of this family is very subtle, so that *Grandifoxus* differs from *Metharpinia,* the southern ancestral genus, in characters of small magnitude requiring meticulous observation. Evolutionary flow appears to proceed from Magellan South America to the North Pacific Ocean and Bering Sea. Usage of "America" herein includes the entire Western Hemisphere.

The diagnoses of *Grandifoxus* and its cohorts were given by J. L. Barnard (1979). *Grandifoxus* appears to have descended from *Metharpinia* through loss of basally articulate spines on the apical margins of the rami on uropods 1–2, and the development in adults of 2 modifications: the presence of more than 2 facial setae on article 3 of antenna 2 and in a majority of individuals the development of a bulge, tooth, or cusp on article 1 of antenna 2 (a condition known as "ensiform").

Like *Metharpinia,* the telson of adults in *Grandifoxus* bears supernumerary dorsolateral spines (uncommon in Phoxocephalidae), epimeron 3 has more than 3 setae and its posterior margin does not grossly depart from a "normal" condition (see below), the rostrum is constricted, article 2 of antenna 1 has widespread ventral setae, the mandibular molar has 4 or more spines, the right lacinia mobilis is present, article 4 of antenna 2 has more than one row of facial spines and the genus otherwise belongs in the birubiin-parharpiniin group of phoxocephalid genera as defined by Barnard and Drummond (1978).

The kind of characters now considered important in Phoxocephalidae makes the identification of genera difficult and tedious. Much practice with obvious adults (females with brood plates, males with penes) must be undertaken within a faunistic region before juveniles of certain species can be identified; and occasionally juveniles seem to be unidentifiable or at best their identification is unreliable. *Grandifoxus* occurs from California northward to Alaska and east Siberia, but much of the seabottom off Canada and Alaska is unexplored, hence reliable keys to juveniles are yet impossible because undiscovered species presumably await description. This treatment is therefore simply exploratory.

Unfortunately, *Pontharpinia robusta* Gurjanova (1938) and *Pontharpinia robusta lindbergi* Gurjanova (1953) which probably belong to *Grandifoxus* need to be redescribed from original material before they can be fitted among the taxa here described. Perhaps their names should be applied to taxa here designated only by letters or numbers.

In Australia the scores of species in the birubiin-parharpiniin group were found by Barnard and Drummond (1978) to be strongly divisible into genera but in the Americas these generic distinctions are poorly developed. This led J. L. Barnard (1960) to put all such species into *Paraphoxus* but that was before the Australian species had been described and clarified. Without the Australian taxonomic basis one doubts that the American species would be considered to be worth dividing generically at this time. The present division may actually fall apart as more species are found which link the weakly distinguished groups. Nevertheless, the establishment of these genera has forged a better understanding on the origin and deployment of their species and also focuses more intently on the need for extreme care in identification of phoxocephalids.

The normal kind of epimeron 3 mentioned above is defined by Barnard and Drummond (1978:24, fig. 83, parts 4–15) as lacking any gross posterior ornamentation, and bearing more than 3 setae (can be in various places). In *Grandifoxus* epimeron 3 has a straight or weakly concave, convex or sinuous posterior margin with 3 or more setae near the ventral end of the margin and usually has one or more setae on or near the horizontal ventral margin of the epimeron. Adults also have significant posterior setae on epimeron 2, a helpful signal to identification but not a character limited to this genus.

In identifying American phoxocephalids my usual procedure is to examine characters in the following sequence:

1. Article 2 of pereopod 5 broad or narrow, tapering or even (broad and even in *Grandifoxus*).
2. Rapid examination for grossly unusual characters such as giant spines; elongate peduncle of uropod 3; shortened rami of uropods 1–3; giant teeth on urosome or pereopods; large gnathopods; unusual coxae.
3. Head shape (from dorsal view rostrum unconstricted in *Grandifoxus*).

4. Article 2 of antenna 1 length and ventral setation: most American taxa (including *Grandifoxus*) with ordinary length and wide ventral setation; alternative in *Eobrolgus* is short with setation shifted towards or onto apex.

5. Spination on article 4 of antenna 2: usually with 2 or more well developed spine rows; alternative in true *Paraphoxus* is one row or one well developed row with second row of sparse and thin spines or setae.

6. Setation of article 3 on antenna 2: most genera with 2 tiny setae almost impossible to see except by dissection and mounting of antenna 2 on slide for observation by compound microscopy. *Grandifoxus* bears 3 or more long setae in adults.

7. Presence or absence of ensiformity on article 1 of antenna 2 (bulge, tooth or cusp common in American taxa, rare in Australian or southern taxa except in other subfamilies such as Harpiniinae); absent in *Metharpinia*, present in full adults of *Grandifoxus*.

8. Presence or absence of supernumerary armaments on telson; ordinary telson has only apical spines, usually fewer than 4 on each lobe, plus pair of tiny lateral setae almost too small to see except with high powered compound microscopy. *Grandifoxus* has supernumerary subapical spines and setae on each side of telson.

9. Presence or absence of erect and flexible spines on dorsal margins of rami on uropods 1–2 near but not precisely at apices. A majority of phoxocephalids bear apical spines, usually partly to strongly immersed in apex to form nails like human fingernails. Supernumerary apical nails or apical spines are prevalent in harpiniin and pontharpiniin phoxocephalids but in birubiin-parharpiniin taxa these are rare and very useful as taxonomic markers, as in *Metharpinia*. The presence of only one accessory apical nail (erect) on just one ramus of uropods 1–2 is sufficient to mark *Metharpinia*. Therefore, specimens with broken uropods are poor material for practicing identifications until one obtains experience on perfect specimens.

10. Presence or absence of displaced apical spine on peduncle of uropod 1; if present this spine is attached to the apex and not to the lateral margin of the peduncle. In Australia the presence or absence of this spine has generic significance but in the Americas the spine exists in vestigial form on certain intermediary species and therefore has not developed its generic significance; and it is not perfectly correlated with other characters of generic value. However, it is a very useful specific character-alternative in most American species.

Many other less frequently occurring character anomalies must be checked within each genus until familiarity is attained with the 10 external characters listed above sufficient to guide the identifier close to specific decision.

11. Most importantly is the need to dissect the mandibles, mount them separately in refractive medium (glycerin is adequate) on 2 different slides,

adding sand grains around the mandibles to support the cover slips and prevent crushing while allowing the mandibles to be rotated and inspected. The characters to be checked are: (a), number of incisorial teeth, usually 3 but rarely otherwise; (b), form of right lacinia mobilis, usually bifid and distinct from raker spines but rarely so similar to spines so as to be indistinguishable; shape often strongly congruent and consistent within growth stages and races of certain species but in other species varying in degree from juvenile to adult stages and widely variable among members of a deme or between geographic races; (c), number of spines on molars, in Brolginae 3 or fewer, in parharpiniin-birubiniin taxa 4 or more; molar must be rotated and examined carefully under high power of compound microscope; (d), shape and setation of palp; and (e), size of mandibular hump to which palp is attached. Ultimately, within a narrow fauna, identification of species need not involve mandibles except in rare cases.

12. Maxillipeds dissected and mounted on slide to check: (a), number of peg-like apical spines on inner plate (consistent in growth stages generally) and (b), degree of fusion of apical spine on palp article 4. Ultimately, most external characters suffice for identification although one species of *Rhepoxynius* is distinguishable mainly on maxillipedal spine counts.

Until experience is gained and the identifier is automatically and rapidly inspecting numerous other characters, one should make a point of grossly examining coxae, gnathopods, pereopods, and epimera for conformity to specimens already identified, taking into account size and remoteness of locality to explain minor proportional and setational differences on loci not already known to have critical generic or specific characteristics. To see the presence or absence of setae on the side of urosomite 1 and the face of uropod 1 at the base is often a tedious chore requiring careful dissection and mounting of parts on slides for examination under high power microscopy. In several species outside *Grandifoxus* these have importance so that further work on *Grandifoxus* may require checking such loci.

Trends in amphipod taxonomy lately have been mixed, one group of splitters carving out species, even genera, on the basis of patterns in armaments (setae and spines), and one group of lumpers synonymizing genera, even species, by showing wide variability in armanent patterns. Owing to the paucity of exploration in phoxocephalids we remain in the splitting stage. This requires close examination of minor characters and description of numerous morphs.

Corrections to previous work.—In J. L. Barnard (1979) transcription errors occur: on p. 368, under *Metharpinia,* last line of first paragraph in diagnosis, apical nail should be noted as "strongly distinct"; in line 2 of paragraph 3 the first word "out" should be eliminated so as to indicate that uropod 1 has a displaced apicomedial spine.

On p. 376, line 16 and p. 377, line 31, the phrase "pereopods 1–2" should read "pereopods 3–4."

On p. 377, line 5, remove the second "2" so as to indicate that article 5 is elongate only on gnathopod 1.

The illustrations of J. L. Barnard (1960) should be used for general identification as the illustrations presented herein are only supplemental.

Grandifoxus J. L. Barnard

Grandifoxus J. L. Barnard, 1979:374 (*Phoxus grandis* Stimpson, 1856, =*Pontharpinia milleri* Thorsteinson, 1941).

Diagnosis.—See J. L. Barnard (1979).

Remarks.—As in so many phoxocephalids there appears to be a great deal of variability in specimens of this genus, especially museum collections which usually are composed of the largest or oldest or most senile specimens or are composed of material from the shallowest of waters where surf is heaviest or in ponded waters of inlets where environmental factors are variable and harsh. I have linked these specimens all together into 2 main taxa, the *longirostris* group or assumed plesiomorph in which the displaced spine on uropod 1 is well developed and uropod 3 has a series of paired spines, and the *grandis* group in which the displaced spine is vestigial or absent and spines on uropod 3 are in triads. The latter group has 2 weakly divided species based on presence or absence of a spine on the inner ramus of uropod 2 and the degree of setation on epimeron 3. The latter character is especially difficult to use because setation is so variable in taxa such as phoxocephalids which have hugely variable size ranges and degrees of maturation. However, in a genus yet to be presented, *Foxiphalus,* species based on setation patterns of epimeron 3 have been detected and in *Birubius,* the diverse Australian genus, Barnard and Drummond (1978) concluded they could identify almost any adult in the genus on epimeron 3 setation pattern alone.

Names for two difficult specimens, one related to *grandis,* the other to species R, are reserved for better collections; in each case they are characterized by rhombic spines on uropods 1–2.

Within the Californian phoxocephalid fauna *Grandifoxus grandis* (=*milleri*) is rather easy to detect because of the sharply cuspidate coxae but in more northerly waters this ease of detection deteriorates. Coxal protrusions are well developed but blunt in *G.* species R, weak in *G. longirostris* and almost absent in its Alaskan form (near Kyska) and almost indetectible in *Grandifoxus* sp. 51.

The ensiform condition that distinguishes so many American genera from Australian genera is very poorly developed in many demes of *G. grandis,* especially in those in which sexual maturity is reached at small body size, especially in the southern part of its range. On a global basis this could be confusing if one were attempting to identify "unknowns" in a teacher's practice session. When faunistic keys are devised for the Californian and Alaskan provinces the ensiformity of antenna 2 should be deemphasized.

Pontarpinia [sic] *nasuta* Gurjanova (1936) remains enigmatic; it is close to *Grandifoxus* but has 2 strong spines on the mandibular molar and therefore is assumed to be in a distinct genus.

Key to the species of *Grandifoxus*

1. Medial apex of peduncle on uropod 1 with large displaced spine, urosomite 1 lacking row of lateral facial setae .... *G. longirostris*
– Medial apex of peduncle on uropod 1 with ordinary to small spine at corner, not displaced, urosomite 1 with row of lateral facial setae **2**
2. Inner ramus of uropod 2 with marginal spine(s) **3**
– Inner ramus of uropod 2 without marginal spines **4**
3. Spines on rami of uropods 1–2 ordinary, setae on coxa 1 widely spread .... *G. grandis* (*=milleri*)
– Spines on rami of uropods 1–2 short, especially on inner rami, setae on coxa 1 narrowly spread .... *Grandifoxus* sp. J
4. Lateral spines on article 1 of outer ramus on uropod 3 in triads, spines on rami of uropods 1–2 of ordinary size .... *Grandifoxus* sp. R
– Lateral spines on article 1 of outer ramus on uropod 3 in pairs, spines on rami of uropods 1–2 very short .... *Grandifoxus* sp. 51

Grandifoxus grandis (Stimpson), new synonymy

Fig. 1, upper right

Phoxus grandis Stimpson, 1856:90; 1857:81–82.
Pontharpinia milleri Thorsteinson, 1941:82, pl. 5, figs. 52–62 (new synonym).
Paraphoxus milleri.—J. L. Barnard, 1958:147; 1960:266–269, pl. 40.

Nomenclature.—Barnard (1979) made this the type-species of *Grandifoxus*. The odd coxae are quite sufficient within the faunal framework to pick out Stimpson's species and to make *milleri* its junior synonym. This disposes of a long pending case of obscurity for *grandis* but, despite a 50-year rule in the ICZN, little inconvenience should ensue by sinking *milleri* because the name has seldom been used; it is moderately well known to several Californian taxonomists identifying materials for unpublished Bureau of Land Management surveys and local pollution studies. I understand in general their convenience would be suited by deciding what *grandis* represents and honoring the name. For years, on size alone, I entertained an

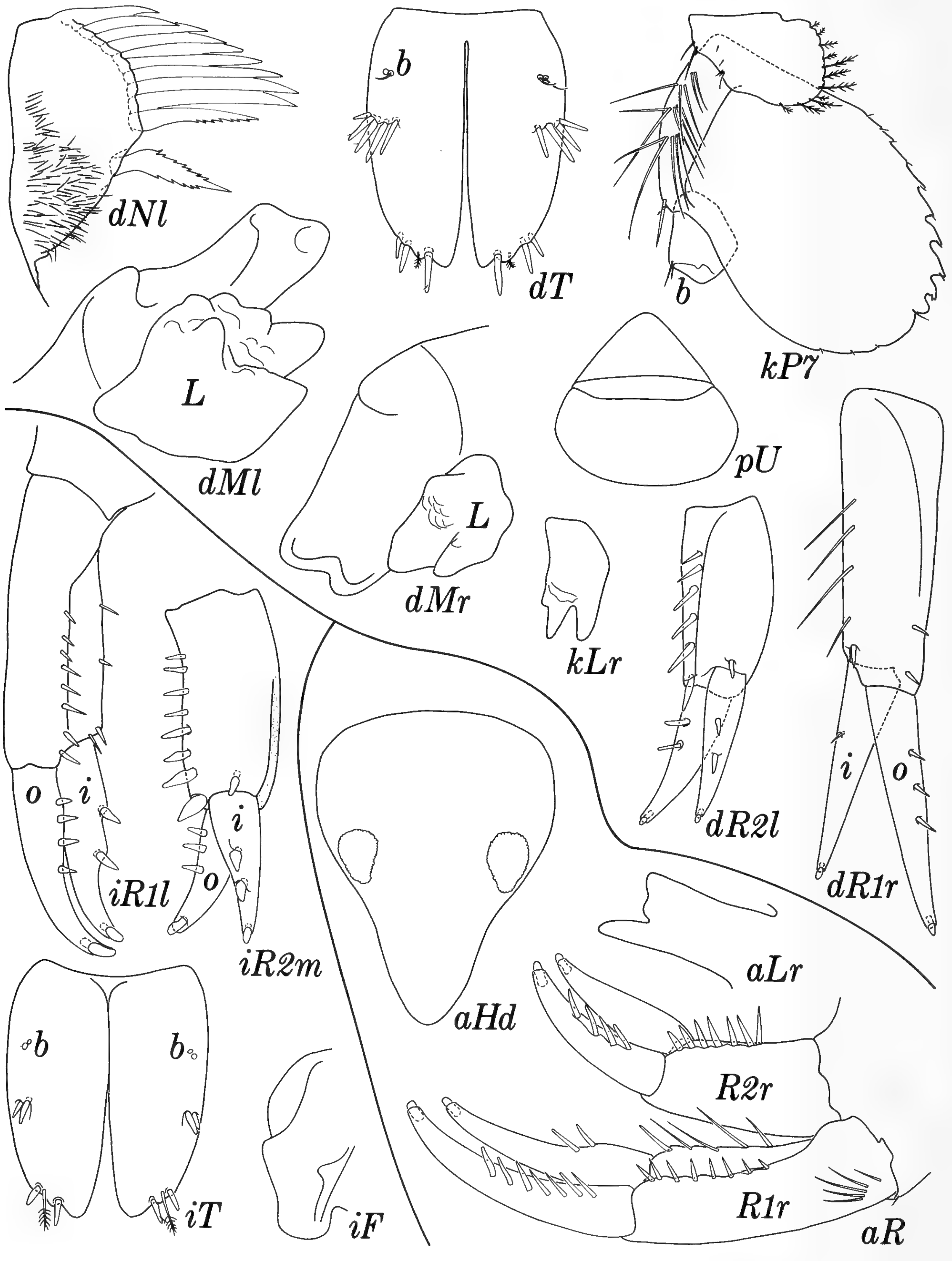

Fig. 1. Upper right, *Grandifoxus grandis*: **d** = female "d," **k** = male "k," **p** = female "p." Lower left, *Grandifoxus* sp. J: **i** = female "i." Lower right, *Grandifoxus* sp. 51, a = female "a."

Capital letters refer to parts; lower case letters to left of capitals refer to specimens cited in "Voucher Material" for each taxon; lower case letters to right of capitals refer to adjectives cited below: **C,** coxa; **E,** epimera; **F,** epistome, lateral; **G,** gnathopod; **H,** head; **L,** lacinia mobilis; **M,** mandible, **N,** molar; **P,** pereopod; **R,** uropod; **T,** telson; **U,** upper lip; **W,** pleon. **b,** broken; **d,** dorsal; **i,** inner; **l,** left; **m,** medial; **o,** outer; **r,** right; **s,** setae.

idea that *Foxiphalus major* (J. L. Barnard, 1960) was a junior synonym of *Phoxus grandis* but large specimens of *milleri* bearing the appropriate coxae described by Stimpson have clinched the argument.

Description of female "d."—Head about 20+ percent of total body length, greatest width about 75% of length, rostrum constricted, narrow, short, reaching middle of article 2 on antenna 1. Eyes small to medium, largely occluded with pigment, ommatidia ordinary. Article 1 of peduncle on antenna 1 about 1.2 times as long as wide, about twice as wide as article 2, ventral margin with about 17 setules, weakly produced dorsal apex with 2 setules, article 2 about 0.7 times as long as article 1, with ventral doubled over crescent of 20 widely spread setae and apicolateral crescent of 8 setae, primary flagellum with 12 articles, about 0.8 times as long as peduncle, bearing one short aesthetasc each on articles 6–11, accessory flagellum with 11 articles. Article 3 of antenna 2 with 2 rows of 6 and 6 setae, distal row horizontal, proximal row vertical, article 1 not ensiform (exception to generic plan). Spine formula of article 4 on antenna 2 = 13-9, dorsal margin with 4 notches bearing 3 setae and one spine each, ventral margin with 15 groups of 1–6 long-to-short setae, one ventrodistal long spine, article 5 apically stout, about 0.75 times as long as article 4, facial spine formula = 12, dorsal margin bearing 4 sets of 1–3 small setae, ventral margin with 10 sets of 2–4 long to short setae, ventrodistal group of many long setae, 2 long subdistal facial spines; flagellum about 0.8 times as long as or longer than articles 4–5 of peduncle combined, with 15 articles.

Mandibles with medium palpar hump, right incisor with 3 teeth, third highly distad, left incisor with 3 humps in 2 branches, right lacinia mobilis bifid, flabellate, distal branch longer than proximal, with facial humps, proximal branch with facial hump, left lacinia mobilis with 4 teeth plus 2 facial teeth, right and left rakers 10 each, molars composed of bulbous plaques, right molar with 9 primarily long spines plus one spine weakly disjunct, left molar with 10 primarily long spines plus one medium spine weakly disjunct, each molar with proximal scattered plume; palp article 1 short, article 2 with 3 short to medium inner apical setae and one other shorter inner seta, article 3 about as long as article 2, oblique apex with 11 spine-setae, basofacial formula = 3-4 or 2-4, groups opposite but skewed. Lower lip lacking cones. Inner plate of maxilla 1 ordinary, bearing one medium apical pluseta, one similar apicomedial seta, 2 apicolateral scarcely shorter setae, palp article 2 with 7 apical and medial marginal setae and 6 scarcely submarginal setae. Inner plate of maxilla 2 shorter than outer, outer broader than inner, outer with 4 apicolateral setae, inner with 2 medial setae. Inner plate of maxilliped with 2 large thick apical spines, 4 apicofacial setae, 7 medial setae, outer plate with 10 medial spines, 4 apicolateral setae, no cusp, palp article 1 without apicolateral setae, article 2 with 3 groups of 6 apicolateral setae, medial margin of article 2 strongly setose, article 3 with many strewn facial setae, triad of lateral setae, nail of article 4 short, bifid or with scale, mostly fused, with 2 accessory setules.

Coxa 1 scarcely expanded apically, anterior margin weakly convex, main ventral setae of coxa 1–4 = 17-10-13-13 (+13 posterior setae), widely spread, posteriormost seta of coxae 1–3 shortest, coxae 1–3 with sharp posteroventral cusp, anterior and posterior margins of coxa 4 parallel, posterior margin straight, posterodorsal corner sharp, posterodorsal margin short, concave, width-length ratio of coxa = 2:3. Gnathopods weakly trichophoxin, anterior margins of hands strongly setose, width ratios on articles 5–6 of gnathopods 1–2 = 28:28 and 29:29, length ratios = 65:47 and 67:44, palmar humps very small, palms weakly oblique, article 5 of gnathopod 1 elongate, ovate, posterior margin flat, long, article 5 of gnathopod 2 elongate, ovate, posterior margin flat, short.

Pereopod 4 stouter than pereopod 3 especially on articles 4–5, facial setae formula on article 4 = 8 and 6, tight, confined to and parallel to apex, on article 5 = 10 and 10, main spine of article 5 extending to M. 80 on article 6, article 5 with no proximoposterior spines and naked proximally, spine formula of article 6 = 13 + 12 and 12 + 11 and no middistal seta or spine, some spines especially long, acclivity on inner margin of dactyls of pereopods 3–4 distad, sharp, produced as tooth, emergent setule short, midfacial pluseta ordinary. Coxae 5–7 posteroventral seta formula = 14-13(none proximoventral)-11. Articles 4–5 of pereopods 5–6 broad, facial spine rows dense, facial ridge formula of article 2 on pereopods 5–7 = 0-1-1, dactyls short, width ratios of articles 2,4,5,6 of pereopod 5 = 58:70:62:23, of pereopod 6 = 105:90:56:20, of pereopod 7 = 90:27:29:12, length ratios of pereopod 5 = 108:52:52:38, of pereopod 6 = 115:66:62:75, of pereopod 7 = 101:25:36:37, article 2 of pereopod 7 almost reaching apex of article 4, posterior margin with 9–10 serrations, several large, ventralmost rounded and bounded by seta, medial apex of article 6 not combed, bearing 1–2 weak digital processes, moderately spinose.

Posteroventral corner of epimeron 1 weakly protuberant, posterior margin weakly convex, serrate, setose (11), corner without setule, anteroventral margin setose, posteroventral face with row of 4–6 long setae, several other facial setae below ridge. Posteroventral corner of epimeron 2 weakly protuberant, without setule sinus, posterior margin straight, serrate, setose (20), anteroventral setae = 14, facial setae = 11–12, widely strewn, several in vertical pairs. Posteroventral corner of epimeron 3 rounded, weakly protuberant, without setule sinus, posterior margin straight or weakly convex, weakly serrate, with one setule notch and 5–7 posteroventral setae tightly confined, ventral margin with 11 setae widely spread, several in vertical pairs.

Urosomite 1 with 6 lateral setae far anteriad plus ventral brush, articulation line almost complete, urosomite 3 unprotuberant dorsally. Rami of uropods 1–2 with articulate but tightly fixed apical nails, none with accessory nails, outer ramus of uropod 1 with 3 dorsal spines, inner with one, outer ramus of uropod 2 with 2 dorsal spines, inner with 2 dorsomedial spines, peduncle of uropod 1 with 2 basofacial setae and 2 small apicolateral spines, medially with 5 thin marginal spines, apicalmost a very small spine plus slightly larger weakly displaced spine, peduncle of uropod 2 with 6 widely spread dorsal spines, distalmost not enlarged, proximalmost small, medially with one small apical spine, apicolateral corner of peduncles on uropods 1–2 without comb. Peduncle of uropod 3 with 5 basoventral and 8 proximoventral spines, dorsally with 2 lateral spines, one medial spine and setule, rami submasculine, inner extending to M. 100 on article 1 of outer ramus, apex with 2 setae, medial and lateral margins with many setae and 4 setae respectively, article 2 of outer ramus very short, 0.05, bearing 2 medium setae, medial margin of article 1 widely setose, lateral margin with 5 acclivities, spine formula = 2-3-3-3-3-2, spines short, setal formula = 0.

Telson especially long, length-width ratio = 19:14, almost fully cleft, each apex of medium width, weakly pointed, then beveled, lateral acclivities deep, narrow, with 2 lateral and one medial spines separated by setules, armament widely spread, plus spray of 4–5 dorsolateral spines, lateral setules somewhat basad, weakly diverse, of medium size.

Remarks on female "d."—This specimen was selected for redescription because it was in a sample of material in Smithsonian collections originally identified by Thorsteinson, the describer of the species. However, the following items have been taken from female "p" to confirm broken or poorly preserved features on the specimen: maxillipeds and flagella of antennae. Article 3 of antenna 1 is unusual in bearing a crescent of 5+ setae. Despite Thorsteinson's original description and most other adult specimens of *grandis* (=*milleri*), antenna 2 is not ensiform on female "d." The epistome resembles that shown for "jeweled *milleri*" (=*Grandifoxus* sp. J).

Female "p."—Setal armament of epimeron 1 anteroventral = 19 in bundles, facial = 6 plus posteroventral oblique row of 6 (or in pairs from margin onto face), posterior = 18; epimeron 2, anterior = 10, facial = 14 strewn, posterior = 27; epimeron 3, anterior = 19, ventral = 11 widely spread and several in pairs and triads set vertically, posterior = 7.

Male "k" young.—Poorly developed as male phoxocephalid, eyes scarcely enlarged, pubescence absent from antennae. Article 2 of antenna 1 with 22 ventral setae in reversed crescent, apex with 8 setae, article 3 with 5 medial setae, primary flagellum with 14 articles, accessory with 11, primary flagellum proliferating basally, aesthetascs moderately well developed on articles 6–13.

Article 3 of antenna 2 with 5 + 5 setae on face, spines on article 4 = 13–

10, on 5 = 11, flagellum short but proliferate; article 4 of peduncle dorsally with 3 notches, spines = 3, setae = 3+ each per notch.

Left mandible like female, right lacinia mobilis bifid, branches equal (illustrated). Inner plate of maxilliped with 2–3 apical stout spines (third more slender than others), outer plate with 9 medial spines, no cusp, 3 apicolateral setae, lateral setae on palp article 1 = 0, article 2 = 3 apical, 1 lateral, article 3 = 12 plus strewn facials and 4 lateral, article 4 = nail short, bifid, almost fused, accessory setules = 2.

Epimera slightly broadened, setae of epimeron 1 anteroventral = 14, posteroventral face = 2 slightly oblique rows of 3 and 2, 3 other facials, ventral = 1, posterior = 13; epimeron 2 facial = 13 broadly strewn, posterior = 16; epimeron 3, ventral = 8 widely spread, four of these in 2 vertical pairs, posterior = 8 on about half of margin (lower).

Urosomite 1 with 4 thick facial setae. Uropod 1 with 2 basofacial setae, apicolaterally with 3 widely spread spines, medially with smallest spine being displaced, outer ramus with 3 spines, inner with 1. Uropod 2 peduncle with 5 lateral spines, outer ramus with 3, inner with 2. Uropod 3 outer ramus article 1 lateral spines = 2-2-2-2-2-2, short setae = 0-0-0-0-0-3.

Telson with one lobe normal to female, other lobe with 1 apical spine, then setule, next 2 spines (towards lateral edge) widespread, fourth fully lateral; dorsal surface with only 2 spines; all spines shorter than in female, denticle rows rudimentary.

Voucher material.—Female "d" 10.00 mm, USNM 105464, Pt. Roberts, Washington, USA, coll. E. D. Thorsteinson, 29 January 1931; female "p" 10.45 mm, North Sandspit (?British Columbia), +6.0′, sand burrowing amphipods, Stubbs, 10 June 1946; young male "k" 8.66 mm, *Albatross* H. 5172, San Francisco Bay, California, USA.

Other material.—Pacific Grove, California, USA, July, 1895, G. O. Snyder (1); Humboldt Bay, California, USA, surface sand, 2 January 1931, G. E. MacGinitie (1); Puget Sound, Washington, USA (USNM Acc. 161068) (10) and specimens from following *Albatross* stations, apparently all in San Francisco Bay, California: H. 4987, 4989, 5083, 5106, 5107, 5109, 5111, 5146, 5167, 5168, 5295 [no biological samples are said to have been taken at H stations but regular station numbers are out of context with vial labels, = China Seas, etc.].

Distribution.—Pacific Grove, California to Strait of Georgia, British Columbia, intertidal and shallow water.

Grandifoxus species J
Fig. 1, lower left

Nomenclature.—Known as "jeweled *milleri*" because of the rhombic form of spines on uropods 1–2, this unique specimen from Pacific Grove, California, is suspected of being a senile *grandis* (=*milleri*): it has male penial processes and no brood plates but otherwise has no secondary sexual characters of males. This specimen also differs from *G. milleri* in the narrow spread of setae on coxae 1–2, the lack of facial setae on urosomite 1 and the presence of pairs (not triads) of spines on article 1 of the outer ramus on uropod 3.

Description of senile male "i."—Head about 17 percent of total body length, greatest width about 75 percent of length, rostrum constricted, narrow, short, not reaching apex of article 2 on antenna 1. Eyes medium to large, clear of pigment (old material), ommatidia ordinary. Article 1 of peduncle on antenna 1 about 1.5 times as long as wide, about twice as wide as article 2, ventral margin with 2 setules, weakly produced dorsal apex with 2 setules, article 2 about 0.8 times as long as article 1, with ventral redoubled crescent of 16 setae, primary flagellum with 15 articles, about 0.78 times as long as peduncle, bearing several short aesthetascs (formula unavailable owing to breakage), accessory flagellum [unknown, broken]. Article 3 of antenna 2 with 2 rows of 2 and 2 setae, distal row horizontal, proximal row vertical, article 1 not ensiform, spine formula on article 4 = 11-8, mixed long and short, dorsal margin with 3 notches bearing 1–3 setae and one spine each, ventral margin with 9 groups of 1–4 long to medium setae, one ventrodistal long spine, article 5 about 0.75 times as long as article 4, facial spine formula = 2-5, mixed long and short, dorsal margin bearing 6 sets of short setae, ventral margin with 11 sets of 1–3 long to short setae, 2 ventrodistal long to medium spines set facially, flagellum about 1.1 times as long as articles 4–5 of peduncle combined, with 17 articles.

Mandibles with medium palpar hump, right incisor with 3 teeth, third moderately distad, left incisor with 3 humps in 2 branches, right lacinia mobilis bifid or trifid, flabellate, distal branch little shorter than proximal, latter with facial hump, left lacinia mobilis with 4 teeth plus several facial teeth, middle teeth weakly shortened, right rakers 9, left rakers 10, molars composed of bulbous plaques, right molar with 7 primarily long spines plus one spine weakly disjunct, left molar with 8 primarily long spines plus one spine weakly disjunct, each molar with plume, palp article 1 short, article 2 with 2 short inner apical setae and 1–2 other shorter inner setae, article 3 about as long as article 2, oblique apex with 9–11 spine-setae, basofacial formula = 1-1-2 (latter opposite) or 2-2-4. Inner lobes of lower lip each with one tiny cone. Inner plate of maxilla 1 ordinary, bearing one long apical pluseta, one shorter apicomedial seta, 2 apicolateral much shorter setae, palp article 2 with one apical spine, one apicolateral and 5 medial and 3 submarginal spine-setae. Plates of maxilla 2 extending subequally, outer scarcely broader than inner, outer with 5 apicolateral setae, inner with 2 medial setae. Inner plate of maxilliped with 2 large thick apical spines, 3 apicofacial setae, 7 medial setae, outer plate with 10 medial spines, 6 apicolateral setae, no cusp, palp article 1 with no apicolateral seta, article 2 with 2 groups of 3 apicolateral setae, medial margin of article 2 strongly setose, article 3 with 13 strewn facial setae, 5 lateral setae in one group, nail of article 4 short, almost fused and weakly sleeved, with 2 accessory setules.

Coxa 1 scarcely expanded apically, anterior margin straight, main ventral setae of coxa 1–4 = 17-13-12-8 (and 17 posterior setae), narrowly spread, posteriormost seta of coxae 1–3 shortest, coxae 1–3 with weak blunt posteroventral cusp, anterior and posterior margins of coxa 4 parallel, posterior margin weakly convex, posterodorsal corner rounded, posterodorsal margin short, almost straight, width-length ratio of coxa 4 = 2:3. Gnathopods with wrists very elongate, hands weakly trichophoxin and anterior margins strongly setose, width ratios on articles 5–6 of gnathopods 1–2 = 20:27 and 21:26, length ratios = 65:45 and 64:43, palmar humps ordinary, small, palms transverse, article 5 of gnathopod 1 elongate, ovate, posterior margin flat, long, article 5 of gnathopod 2 elongate, ovate, posterior margin rounded.

Pereopod 4 stouter than pereopod 3, especially on articles 4–5, facial setae formula on article 4 = 6 and 7 parallel to apex, on article 5 = 4 and 6, main spine of article 5 extending to M. 75 on article 6, article 5 with no proximoposterior spines and naked basally, spine formula of article 6 = 9 + 10 and 8 + 9 plus no middistal seta, some spines especially long, acclivity on inner margin of dactyls pereopods 3–4 distad, sharp, produced as tooth, emergent setule short, midfacial pluseta ordinary. Coxae 5–7 posteroventral seta formula = 14-11-10. Articles 4–5 of pereopods 5–6 broad, facial spine rows dense, facial ridge formulas of article 2 on pereopods 5–7 = 0-1-1, width ratios of articles 2,4,5,6 of pereopod 5 = 52:48:45:20, of pereopod 6 = 90:66:41:15, of pereopod 7 = 76:19:22:10, length ratios of pereopod 5 = 93:52:48:37, of pereopod 6 = 100:65:61:78, of pereopod 7 = 100:23:35:32, article 2 of pereopod 7 reaching middle of article 5!, posterior margin with 11–12 serrations, several large, ventralmost rounded and bounded by seta, medial apex of article 6 finely combed, bearing 1–2 digital processes, moderately spinose.

Posteroventral corner of epimeron 1 rounded, posterior margin weakly convex, serrate, setose (7), anteroventral margin with 11 short to medium setae, posteroventral face at posterior margin with 4 and 2 long setae set in 2 vertical groups or 4 in set and 4 others strewn. Posteroventral corner of epimeron 2 rounded-quadrate, posterior margin straight, serrate, setose (11), facial setae = 5–8 strewn, 2 pairs set vertically. Posteroventral corner of epimeron 3 rounded, weakly protuberant, posterior margin weakly concave, then convex, with 2–3 setule notches, with 6 setae tightly confined to lower corner, ventral margin with 4–5 setae.

Urosomite 1 with lateral setule at base of uropod 1, articulation line almost complete, urosomite 3 unprotuberant dorsally. Rami of uropods 1–2 with articulate but tightly fixed apical nails, no accessory nails, outer ramus of uropod 1 with 4 dorsal spines, inner with 2, outer ramus of uropod 2 with 3 dorsal spines, inner with 2 dorsomedial spines, spines of inner rami extremely rhombic, peduncle of uropod 1 with 2 basofacial setae and 8 lateral spines, medially with 3 small marginal, widely spread spines, apicalmost ordinary, plus tiny displaced spine, peduncle of uropod 2 with 8 dorsal spines, apicalmost thick and rhombic, basalmost small, medially with one large apical spine, apicolateral corners of peduncles on uropods 1–2 without comb. Peduncle of uropod 3 with 6 ventral spines, dorsally with one lateral spine, 2 medial spines, rami masculine, inner extending to M. 110 on article 1 of outer ramus, apex with 2 setae, medial and lateral margins strongly setose, article 2 of outer ramus short, 0.05, bearing 2 medium setae, medial margin of article 1 widely setose, lateral margin with 3 acclivities, spine formula = 2-2-2-0, setal formula = 0-0-0-2. Telson especially long, length-width ratio = 19:15, almost fully cleft, each apex of medium width to narrow, rounded-protuberant, lateral acclivities broad, weak, with short lateral and medial spines separated by longer setule, each lobe with pair of short dorsolateral spines, midlateral setules broken, position normal to *milleri*.

Material.—Senile male "i" 14.60 mm, Pacific Grove, California, USA, 1895 July, G. O. Snyder.

Grandifoxus longirostris (Gurjanova)
Fig. 2, lower

Pontharpinia longirostris Gurjanova, 1938:263–267, 385, fig. 7; 1951:385–387, fig. 235 (not *Paraphoxus milleri* of J. L. Barnard, 1960 and not *P. robusta* Gurjanova, 1938).

?*Pontharpinia robusta lindbergi* Gurjanova, 1953:224–225, figs. 7, 8.

Nomenclature.—J. L. Barnard (1960) thought *longirostris* to be a synonym of *milleri* (Thorsteinson) but specimens demonstrate the presence of a strong displaced spine on uropod 1 of *longirostris*. Modern rules and practice allow extraction of *longirostris* from its former homonymy with *Paraphoxus longirostris* Schellenberg, 1931; its senior synonym is not now congeneric.

Pontarpinia [*sic*] *robusta lindbergi* may be a snyonym of *longirostris* because the lateral spines on the outer ramus of uropod 3 are paired; uropod 1 of that species is, however, unknown, and final identification cannot be confirmed. The only specimens available are a juvenile identified by Gurjanova and given to Smithsonian Institution presumably in the 1930's and a giant female; many small clues suggest the two specimens are conspecific and truly represent *longirostris*.

Description of juvenile "h" (=juvenile or *longirostris* form).—Head

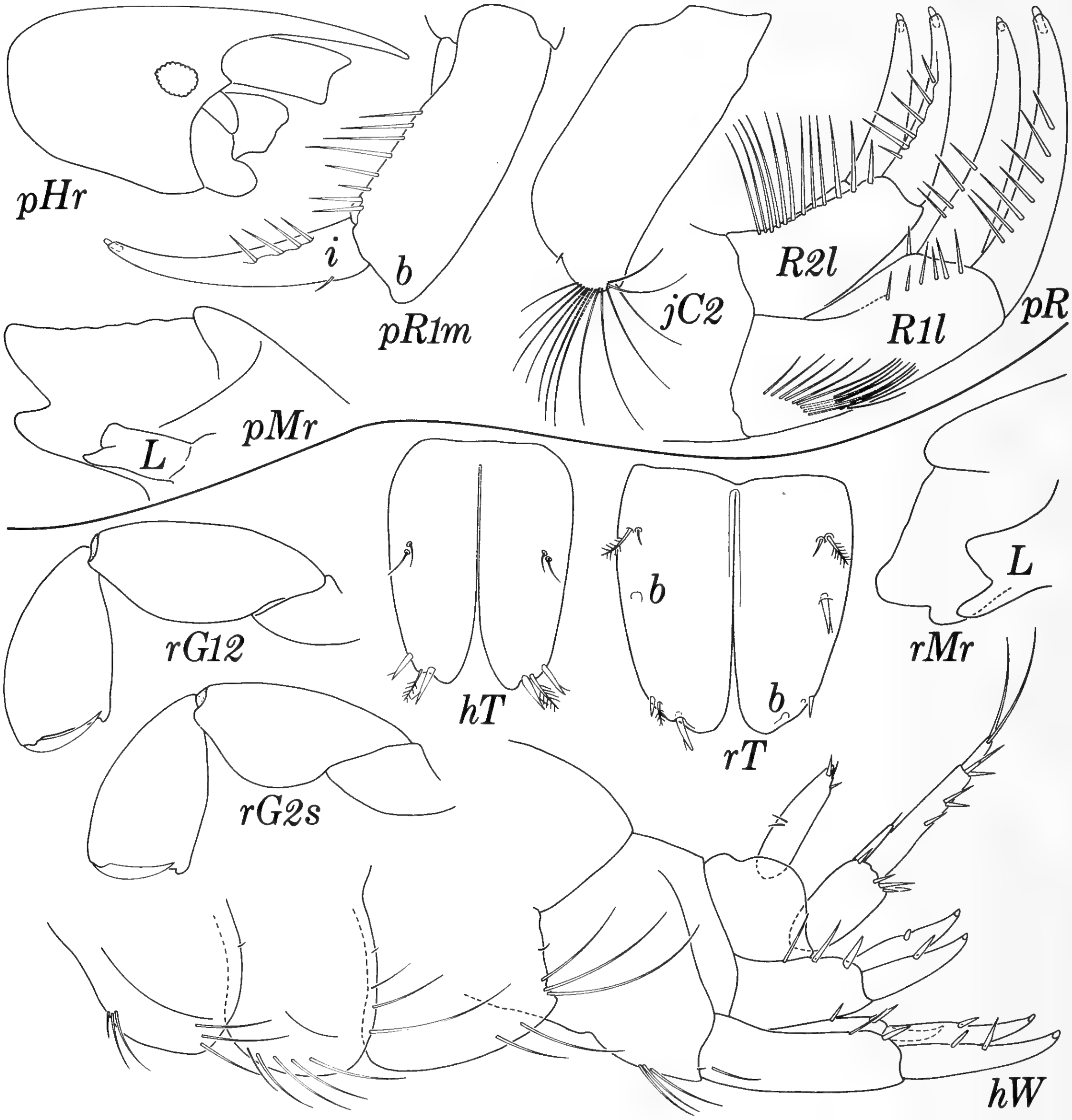

Fig. 2. UPPER, *Grandifoxus* sp. R: **j** = juvenile "j,"**p** = female "p." Lower, *Grandifoxus longirostris*: **h** = juvenile "h;" r = female "r."

Capital letters refer to parts; lower case letters to left of capitals refer to specimens cited in "Voucher Material" for each taxon; lower case letters to right of capitals refer to adjectives cited below: **C,** coxa; **E,** epimera; **F,** epistome, lateral; **G,** gnathopod; **H,** head; **L,** lacinia mobilis; **M,** mandible; **N,** molar; **P,** pereopod; **R,** uropod; **T,** telson; **U,** upper lip; **W,** pleon. **b,** broken; **d,** dorsal; **i,** inner; **l,** left; **m,** medial; **o,** outer; **r,** right; **s,** setae.

about 21 percent of total body length, greatest width almost 80 percent of length, rostrum constricted, narrow, elongate, not reaching middle of article 2 on antenna 1. Eyes not apparent. Article 1 of peduncle on antenna 1 about 1.3 times as long as wide, about 1.9 times as wide as article 2, ventral margin with about 5 setules, weakly produced dorsal apex with 2 setules, article 2 about 0.7 times as long as article 1, with midventral narrowly confined crescent of 7 setae, plus 3 apicolateral setae, primary flagellum with 6 articles, about 0.55 times as long as peduncle, bearing one short aesthetasc each on articles 3–5, accessory flagellum with 5 articles. Antenna 2 strongly ensiform, article 3 with 4 facial setae, spine formula of article 4 = 0-3-4-2, dorsal margin with 2 notches bearing 2 and 4 setae, ventral margin with 6 groups of 1–2 long to medium setae, one ventrodistal long spine, article 5 about 0.75 times as long as article 4, facial spine formula = 2, dorsal margin bearing one set of small setae, ventral margin with 5 sets of one long seta each, 3 ventrodistal long to medium spines set weakly facial; flagellum about 0.85 times as long as articles 4–5 of peduncle combined, with 6 articles.

Mandibles with weak palpar hump, right incisor with 3 teeth, left incisor with 3 humps in 2 branches, right lacinia mobilis scarcely bifid, moderately broad (damaged), left lacinia mobilis with 4 teeth, middle teeth not shortened, right and left rakers 8 plus one rudimentary, molars composed of short protrusions demarcated mainly by spines, right molar with 5 primarily medium spines plus one shorter and thick, serrate spine weakly disjunct, left molar with 7 primarily medium spines, no spine disjunct, each molar with plume, palp article 1 short, article 2 with one short inner apical seta and one other short basal inner seta, article 3 about as long as article 2, oblique apex with 10 spine-setae, basofacial formula = 0-1 (marginal). Lower lip with one cone on each outer lobe. Inner plate of maxilla 1 ordinary, bearing one medium apical pluseta, one similar apicomedial seta, 2 slightly shorter apicolateral setae, palp article 2 with one apical spine, one apicolateral, 2 medial and 2 submarginal setae. Inner plate of maxilla 2 shorter than outer, outer much broader than inner, outer with 2 apicolateral setae, inner with one medial seta. Inner plate of maxilliped with 2 large thick apical spines, 2 apicofacial setae, 5 medial setae, outer plate with 6 medial and apical spines, one apicolateral seta, palp article 1 with one apicolateral seta, article 2 with 2 groups of 2 apicolateral setae, medial margin of article 2 moderately setose, article 3 with 5 facial setae, 1–2 lateral setae, nail of article 4 short, moderately articulate, with unknown accessory setules (damaged).

Coxa 1 expanded apically, anterior margin weakly convex, main ventral setae of coxa 1–4 = 5-6-5-5, very narrowly constrained, posteriormost seta of coxae 1–3 slightly shortened, coxae 2–3 with weak ventral hump just anterior to setae, 1–2 setae of coxa 4 actually on posterior margin, anterior and posterior margins of coxa 4 almost parallel, posterior margin straight, posterodorsal corner rounded, posterodorsal margin short, V-shaped, undulate, width-length ratio of coxa 4 = 15:19. Gnathopods generally ordinary, width ratios on articles 5–6 of gnathopods 1–2 = 32:33 and 29:32, length ratios = 66:52 and 66:52, palmar humps small, palms weakly oblique, article 5 of gnathopods 1–2 elongate, ovate, posterior margin rounded.

Pereopod 4 slightly thinner than pereopod 3 especially on article 5, facial setae formula on article 4 = 4 and 3 parallel to apex, on article 5 = 2 and 3, main spine of article 5 extending to M. 80 on article 6, article 5 with no proximoposterior spines, spine formula of article 6 = 5 + 5 and 5 + 6, plus no middistal seta or spine, some spines especially long, acclivity on inner margin of dactyls of pereopods 3–4 sharp, produced as tooth, emergent setule amost fully immersed, midfacial pluseta absent. Coxae 5–7 posteroventral seta formula = 5-6-4. Articles 4–5 of pereopods 5–6 broad, facial spine rows dense, facial ridge formulas of article 2 on pereopods 5–7 = 0-0-1!, width ratios of articles 2,4,5,6 of pereopod 5 = 57:50:43:19, of pereopod 6 = 80:49:40:17, of pereopod 7 = 89:25:24:11, length ratios of pereopod 5 = 85:47:45:34, of pereopod 6 = 93:62:50:61, of pereopod 7 = 99:26:28:28, article 2 of pereopod 7 reaching apex of article 4, posterior margin with 5 small serrations, medial apex of article 6 not combed, bearing 2–3 weak digital processes.

Posteroventral corner of epimeron 1 rounded, posterior margin convex, anteroventral margin with 3 short to medium setae, posteroventral face with 3 long setae in vertical row. Posteroventral corner of epimeron 2 rounded, posterior margin convex, with 3 widespread long setae, facial setae = 5. Posteroventral corner of epimeron 3 weakly protuberant, posterior margin undulant, short, with 3 setae at corner, ventral margin with 2 setae. Epimera 1–3 with setule on posterodorsal margin set in weak notch.

Urosomite 1 with lateral setule at base of uropod 1 plus midventral brushes, articulation line incomplete, urosomite 3 slightly protuberant dorsally. Rami of uropods 1–2 with articulate but tightly fixed apical nails, no accessory nails, outer ramus of uropod 1 with 2 dorsal spines, inner with one, outer ramus of uropod 2 with one dorsal spine, inner with one dorsomedial spine, peduncle of uropod 1 with one basofacial seta and one apicolateral spine plus one seta, medially with 2 marginal spines plus enlarged displaced spine, peduncle of uropod 2 with 2 dorsal spines and one seta, medially with one small apical spine, apicolateral corners of peduncles on uropods 1–2 without comb. Peduncle of uropod 3 with 4 ventral spines, dorsally with one lateral spine, one medial setule, rami feminine, inner extending to M. 40 on article 1 of outer ramus, apex with one seta, medial and lateral margins naked, article 2 of outer ramus elongate, 0.33, bearing 2 long setae, apicomedial margin of article 1 with one seta, lateral margin with 3 acclivities, spine formula = 1-2-2-2 or 1-2-2, setal formula = 0. Telson especially long, length-width ratio = 18:13, almost fully cleft, each apex of medium width, protuberant medially, lateral acclivity broad, shallow, with widely spread lateral and medial spines separated by setule, all elements medium, midlateral setules subequal, of medium size.

Description of female "r."—Head about 19 percent of total body length, greatest width about 90 percent of length, rostrum constricted, narrow, short, reaching middle of article 2 on antenna 1. Eyes medium, clear of pigment, ommatidia ordinary. Article 1 of peduncle on antenna 1 about 1.4 times as long as wide, about 1.9 times as wide as article 2, ventral margin with about 19 setules, weakly produced dorsal apex with 2 setules, article 2 about 0.8 times as long as article 1, with proximoventral crescent of 18 setae, primary flagellum with 9 articles, about 0.5 times as long as peduncle, bearing short aesthetasc each on articles 3–8, accessory flagellum with unknown (at least 6, broken) articles. Antenna 2 moderately ensiform, article 3 with 5 large and one small facial setae, spine formula of article 4 = 0-10-9, dorsal margin with 5 notches bearing 1–3 setae and 0–1 spine, ventral margin with 12 groups of 1–5 long to short setae, one ventrodistal spine of unknown length, article 5 about 0.75 times as long as article 4, facial spine formula = 4–2 or 0–7 (variable on each side), dorsal margin bearing 4 groups of small setae, ventral margin with 14 sets of 2 long to short setae, 3 ventrodistal long to short spines set subdistally; flagellum about 0.66 times as long as articles 4–5 of peduncle combined, with 10 articles.

Mandibles with weak palpar hump, right incisor with 3 teeth, left incisor with 3 humps in 2 branches, right lacinia mobilis bifid, distal branch little shorter than proximal, broad, proximal branch simple, pointed, left lacinia mobilis with 5 teeth, right rakers 14 plus one rudimentary, left rakers 13 plus one rudimentary, molars composed of short cones demarcated mainly by spines, right molar with 7 primarily long spines plus one shorter spine weakly disjunct, left molar with 6 primarily long spines plus one shorter spine weakly disjunct, each molar with plume, palp article 1 short, article 2 with one short inner apical seta and 2 other short inner setae, article 3 about as long as article 2, oblique apex with 11 spine-setae, basofacial formula = 0–4 all in one deep notch. Lower lip with one cone on each outer lobe. Inner plate of maxilla 1 ordinary, bearing one medium apicofacial pluseta, one similar medial seta, 2 apicolateral much shorter setae, palp article 2 with one apical spine, 3 medial spines, one apicolateral and 5 submarginal setae. Inner plate of maxilla 2 shorter than outer, outer broader than inner, outer with 5 apicolateral setae, inner with 2 medial setae. Inner plate of maxilliped with 2 large thick apical spines, 4 apicofacial setae, 7 medial setae, outer plate with 6 medial and apical spines, 5 apicolateral setae, palp article 1 with one apicolateral seta, article 2 with 3 groups of 5 apicolateral setae, medial margin of article 2 strongly setose, article 3 with 9–10 facial setae scarcely strewn, 3 and 2 lateral setae, nail of article 4 short, moderately distinct, with one accessory setule.

Coxa 1 scarcely expanded apically, anterior margin weakly convex, main ventral setae of coxae 1–4 = 9-12-12-(11 ventral and 6 posterior), posteriormost seta of coxa 1 shortest, of coxae 2–3 scarcely shortened, coxae

2–3 with setose edge beveled, thus weakly similar to normal *longirostris* coxal form, anterior and posterior margins of coxa 4 divergent, posterior margin oblique, almost straight, posterodorsal corner rounded, posterodorsal margin ordinary, almost straight, width-length ratio of coxa 4 = 8:9.

Gnathopods generally ordinary, width ratios on articles 5–6 of gnathopods 1–2 = 28:28 and 28:30, length ratios = 65:54 and 60:49, palmar humps ordinary, palms weakly oblique to almost transverse, article 5 of gnathopods 1–2 elongate, ovate, posterior margin flat.

Pereopod 4 stouter than pereopod 3, especially on articles 4–5, both very stout, facial setae formula on article 4 = 11 and 10, on article 5 = 9 and 9, main spine of article 5 extending to M. 80 on article 6, article 5 with no proximoposterior spines, spine formula of article 6 = 9 + 10 and 9 + 11 plus no middistal seta, some spines especially long, acclivity on inner margin of dactyls on pereopods 3–4 bluntly produced as tooth, emergent setule very short, midfacial pluseta ordinary. Coxae 5–7 posteroventral seta formula = 19-21-15 (some setae facial on coxa 6). Articles 4-5 of pereopods 5–6 broad to ordinary in width, facial spine rows moderately developed, facial ridge formula of article 2 on pereopods 5–7 = 0-1-1, width ratios of articles 2, 4, 5, 6 on pereopod 5 = 49:46:46:19, of pereopod 6 = 69:44:38:15, of pereopod 7 = 78:21:22:10, length ratios of pereopod 5 = 82:42:47:40, of pereopod 6 = 88:63:56:53, of pereopod 7 = 96:22:27:32, article 2 of pereopod 7 reaching middle of article 5!, posterior margin with 8–9 small serrations, medial apex of article 6 not combed, bearing 3–4 weak digital processes.

Posteroventral corner of epimeron 1 rounded-quadrate, posterior margin weakly convex, serrate, setose (5), anteroventral margin and face with 7+ short to medium setae, posteroventral face with 4 scattered long setae, ventral margin with 11 setae, some in pairs. Posteroventral corner of epimeron 2 rounded-quadrate, posterior margin weakly convex, serrate, setose (10+), facial setae = 13 in ventral row and 5 scattered, posteriormost pair of ventrals set vertically. Posteroventral corner of epimeron 3 rounded-quadrate, posterior margin almost straight, serrate, setose (6), with one setule notch above, main setae confined mainly to ventral corner, ventral margin with 8 setae evenly spread.

Urosomite 1 without lateral or ventral setule at base of uropod 1, with ventral brush, articulation line incomplete, urosomite 3 unprotuberant dorsally. Rami of uropods 1–2 with articulate, enlarged apical nails tightly fixed, including inner ramus of uropod 1, outer ramus of uropod 1 with 6 ordinary dorsal spines, inner with 3 larger, outer ramus of uropod 2 with 3–4 dorsal spines, inner with 2 dorsomedial spines, peduncle of uropod 1 with 4 apicolateral but slightly spread spines, medially with 5 marginal setae and spines, proximalmost thin, apicalmost enlarged, plus large displaced spine, peduncle of uropod 2 with 8 short dorsal spines, medially with one apical spine same size as laterals, apicolateral corners of peduncles on uropods 1–2 without comb. Peduncle of uropod 3 with 10 ventral spines, dorsally with one lateral spine, 3 medial setules, rami feminine, inner extending to M. 63 on article 1 of outer ramus, apex with 2 setae, medial margin setose, article 2 of outer ramus short, 0.11, bearing 2 medium or longer setae (as judged by size of snapped bases), medial margin of article 1 with 7 setae, lateral margin with 6 acclivities, spine formula = 1-2-2-2-2-2-2, setal formula = 0-0-0-0-0-1-1. Telson ordinary, length-width ratio = 35:31, almost fully cleft, each apex wide, rounded, lateral acclivities weak, with short lateral and longer medial spines separated by short setule, each side with dorsofacial spine near M. 45, midlateral setules diverse, larger of medium size.

Remarks.—This juvenile identified by the describer of the species fits the original description adequately; the important character of displaced medial spine on the peduncle of uropod 1 is the critical feature separating the species from *G. grandis*; other characters such as the strange *grandis* (*milleri*) coxae might not be well developed in juveniles just as they are poorly developed in this juvenile. The giant specimen from Kyska differs from the juvenile in the enlarged and bifid right lacinia mobilis, the even more poorly developed humps on the coxae and the much stronger but expected armaments almost everywhere. The elongate article 2 on the outer ramus of uropod 3 in the juvenile is a normal feature of juvenile phoxocephalids.

Besides the displaced spine on uropod 1, the narrow spread of ventral setae on coxa 1 seems to be a good specific character of *longirostris*. Gurjanova's (1938:figs. 7–10) illustration of telson shows one apical and one lateral spine whereas juvenile "h" here has apical and no lateral spines. However, the giant female "r" from Kyska has the appropriate dorsolateral spine shown by Gurjanova. The large adult lacks facial setae on urosomite 1, unlike *grandis*.

Material.—Juvenile "h" 3.15 mm, Japan Sea near the Petrov I., 1/10/1934, det. E. Gurjanova; female "r" 10.4 mm, Kyska Harbor, Alaska, USA, sand 6–8 fms, W. H. Dall 165 (1002), U.S. Coast Survey Prof. B. Peirce, Supt.

Distribution.—Japan Sea into the Bering Sea and eastward to Kyska Island, Alaska, 10–15 m; if *lindbergi* is added, depth range possibly extending downward to 75 m.

Grandifoxus sp. R

Fig. 2, upper

Nomenclature.—This species may be *robustus* Gurjanova or *r. lindbergi* Gurjanova but until they are redescribed they must remain dubious. See center cuts of these species later.

Description of female "p."—Head about 20 percent of total body length, greatest width about 72 percent of length, rostrum weakly constricted, tapering almost evenly to narrow apex, exceeding middle of article 2 on antenna 1. Eyes small, clear of pigment, ommatidia especially small. Article 1 of peduncle on antenna 1 about 1.6 times as long as wide, about 2.1 times as wide as article 2, ventral margin with about 16 setules, weakly produced dorsal apex with 3 setules, article 2 about 0.7 times as long as article 1, with widely spread midventral cycle of 28 setae, primary flagellum with 11 articles, about 0.5 times as long as peduncle, bearing one short aesthetasc each on articles 5–10, accessory flagellum with 10 articles. Antenna 2 ensiform, article 3 with 11+ setae; spine formula of article 4 = 0-16-18, linearly aligned, dorsal margin with 5 notches bearing 1–4 setae, ventral margin with 18 groups of 1–5 long setae, one ventrodistal long spine, article 5 almost 0.8 times as long as article 4, facial spine formula = 8-7-4, linearly aligned, dorsal margin bearing 3 groups of small setae, ventral margin with 18 sets of 1–2 long to medium setae, 3 ventrodistal long to short spines set slightly facial; flagellum about 0.7 times as long as articles 4–5 of peduncle combined, with 15 articles.

Mandibles with weak palpar hump, right incisor with 3 teeth, left incisor with 3 humps in 2 branches, right lacinia mobilis scarcely bifid, moderately broad, left lacinia mobilis with 4 teeth, middle teeth not shortened, right and left rakers 13 plus 1–2 rudimentaries, molars composed of medium bulbous protrusions each with 11 primarily medium spines plus one short thick and serrate spine weakly disjunct, each molar with plume; palp article 1 short, article 2 with 4 medium inner apical setae and 1–2 other shorter inner setae, article 3 about 1.1 times as long as article 2, oblique apex with 17 spine-setae, basofacial formula = 4-2 plus 4–5 setae in marginal notch more distad. Each outer lobe of lower lip with one cone. Inner plate of maxilla 1 especially large, broad, bearing one long apical pluseta, one shorter but similar apicomedial seta, 3 apicolateral much shorter setae, palp article 2 with one apical and 3 medial spines, one apicolateral and 6 submarginal setae. Plates of maxilla 2 extending subequally, outer scarcely broader than inner, outer with 10 apicolateral setae, inner with one medial seta. Inner plate of maxilliped with 2 large thick apical spines, 4 apicofacial setae, 5 medial setae, outer plate with 9 medial spines, 8 apical and lateral setae, palp article 1 with 3 apicolateral setae in 2 groups, article 2 with 5 groups of 9 lateral setae, medial margin of article 2 strongly setose, article 3 with 16 slightly strewn facial setae, 5 lateral setae in 2 groups, nail of article 4 short, moderately articulate, with 2 accessory setules.

Coxa 1 not expanded apically, anterior margin weakly convex, main ventral setae of coxae 1–4 = 25-17-16-15 (and 36 posterior setae on coxa 4), posteriormost seta of coxae [broken, coxae 1–3 with ventral hump at anterior limit of setae, setae not widely spread on coxa 1, anterior and posterior margins of coxa 4 slightly divergent, posterior margin almost straight, posterodorsal corner sharp, posterodorsal margin short, concave, width length ratio = 3:4. Gnathopods generally ordinary, width ratios on articles 5–6 of gnathopods 1–2 = 27:27 and 25:28, length ratios = 65:52 and 65:52, palmar humps small, palms almost transverse, article 5 of gnathopods 1–2 elongate, oval, posterior margin flat, long.

Pereopod 4 stouter than 3, especially on articles 4–5, facial setae formula on article 4 = 13 and 12, almost parallel to apex, on article 5 = 13 and 14, main spine of article 5 extending to M. 90 on article 6, article 5 without proximoposterior spines, spine formula of article 6 = 10 + 11 and 11 + 12, plus no middistal seta, some spines especially long, acclivity on inner margin of dactyls of pereopods 3–4 sharp, produced as tooth, emergent setule amost fully immersed, midfacial pluseta ordinary. Coxae 5–7 posteroventral seta formula = 27+-35(2 rows)-20.

Articles 4–5 of pereopods 5–7 broad to ordinary in width, facial spine rows dense, facial ridge formula of article 2 = 0-1-1, width ratios of articles 2,4,5,6 of pereopod 5 = 60:60:48:19, of pereopod 6 = 94:62:49:19, of pereopod 7 = 101:24:27:12, length ratios of pereopod 5 = 105:50:50:39, of pereopod 6 = 105:65:66:72, of pereopod 7 = 106:28:32:44, article 2 of pereopod 7 almost reaching apex of article 4, posterior margin with 10 small to medium serrations, posteroventral margin either beveled or slightly oblique (not fully horizontal), medial apex of article 6 not combed, bearing 6–7 large digital processes.

Posteroventral corner of epimeron 1 rounded, posterior margin convex, serrate, setose (13), anteroventral margin and face with 20 long to short setae, ventral face with 3–4 pairs of long setae, plus 4 setae on or near lateral ridge. Posteroventral corner of epimeron 2 rounded, posterior margin convex, serratosinose, setose (17), anterior margin with cluster of 16 setae, facial setae = 27 strewn + 2 on lateral ridge, many pairs, triads and quartets set vertically. Posteroventral corner of epimeron 3 rounded, posterior margin almost straight, serratosinose, setose (6) + 4 setule notches, ventral margin with 20 setae, almost evenly spread and occasionally in vertical pairs or triads, face with 8 strewn setae, anterior margin with 11 setae in tandem.

Urosomite 1 with lateral setule at base of uropod 1 and 13 lateral setae and setal spines forming row but some setae in pairs, plus ventral brush, articulation line almost complete, urosomite 3 weakly protuberant dorsally. Rami of uropods 1–2 with articulate but tightly fixed apical nails, outer ramus of uropod 1 with 7 dorsal spines, inner with 4, outer ramus of uropod 2 with 6 dorsal spines, inner with none, peduncle of uropod 1 with 2 rows of 9 and 5 basofacial setae and 6 small apicolateral spines, medially with 8 marginal setal spines, apicalmost thin and scarcely displaced, peduncle of uropod 2 with 12 dorsal spines and setae, medially with 4 short spines spread halfway along margin, apicolateral corners of peduncles on uropods 1–2 without comb. Peduncle of uropod 3 with 15 ventral spines, dorsally with one lateral spine and one setule, one medial seta and 2 setules, rami feminine, inner extending to M. 65 on article 1 of outer ramus, apex with one seta, apicomedial margin with one seta, article 2 of outer ramus short, 0.06, bearing 2 setae [broken], medial margin of article 1 with 6 setae, lateral margin with 5 acclivities, spine formula = 1-3-3-3-3-3, spines short, setal formula = 0. Telson ordinary, length-width ratio = 8:7, almost fully cleft, each apex wide, rounded, with 1–2 narrow and weak lateral acclivities, spination variable on same specimen, either bearing 2 short lateral spines with medial similar setule or with short lateral and medial spines separated by similar setule, dorsolateral surface at M. 45 with 4 spines on each side, lateral setules at M. 30, diverse, larger of small size.

Juvenile "j."—Article 2 of antenna 1 with 20 setae in ventral crescent, primary flagellum with 9 articles, accessory with 7. Antenna 2 strongly ensiform, article 3 with 5 facial setae, spine count on article 4 = 0-10-7, on article 5 = 4-4. Article 5 of pereopod 7 as broad as in adult and *G. grandis*. Setae of epimeron 1, facial on ridge = 5, on posterior face = 4 strewn, posterior = 7; on epimeron 2 facial = 10, 3 of these posteriorly in vertical row ridge with 3, posterior with 10 strewn; on epimeron 3 ventral = 2 anterior and 7 posterior separated by large gap, posterior = 6 but dorsals spilling onto face, plus 2 posterior setules. Urosomite 1 with 5 facial setae. Armaments of uropod 1, basofacial peduncle = 3, apicolateral = 3 spines, medial = 4, none displaced, outer ramus with 5, inner with 2, all spines long as in adult; uropod 2 peduncle dorsolateral = 5 long (at least basal), outer ramus with 3, inner with 0; uropod 3 peduncle = 8 ventral spines, outer ramus lateral spine groups = 1-2-2-2, article 2 very short. Telson more elongate than in 16 mm adult, each apex with 2 medium spines separated by setule, dorsolateral spine present on each side.

Remarks.—Some adult specimens with 3 apical spines plus setule on each lobe of telson.

Posterior setae on epimera 1–2 usually strewn, or almost organized into 2 rows, or spilling onto face. Strong curve on rami of uropod 1 typical of all specimens.

Large specimens in poor condition, mushy, full illustrations to be reserved until better materials becoming available.

Relationship.—Differing from *G. grandis* in lack of spine on inner ramus of uropod 2; possibly this species and *grandis* form a pair of congruent subspecies. However, the setation of epimeron 3, even in juveniles, is much more widely scattered and more numerous in species R and this adds a second, albeit weak, difference between the two taxa.

Voucher material.—Female "p" 16.8 mm, Chirikoff Island, Alaska, Anchorage, 9–14 fms, sand, 1874, W. H. Dall; juvenile "j" 8.65 mm, Ins. Bering, USNM 13662, Accession No. 16878, 1884, N. Grebnitzky.

Other material.—Same Grebnitzky sample as above, 5 more specimens; another similar sample, USNM 13669, Accession No. 16878, 1884, N. Grebnitzky (1); St. Paul Id., Alaska, 6–9 fms, sand, 2 July 1874, W. H. Dall (1163) (1); Semidi Ids., Alaska, 12–18 fms, gravel, 1874, W. H. Dall (1152) (1); Alaska, 60-16 N, 167-41 W, 7 January 1884, Tag 25, [?Accession] No. 15688, Lieut. George M. Strong, U.S.N. (2); off Point Moller, Alaska, Bering Sea, 6 May 1941, King Crab Investigations C-108, Accession No. 161385 (1).

Distribution.—Japan Sea to western Alaska and into the Bering Sea, 8–16 m.

Grandifoxus sp. 51

Fig. 1, lower right

These specimens, like *Grandifoxus* sp. J, are characterized by jeweled spines on uropods 1–2 but resemble *Grandifoxus* sp. R in the absence of the spine on the inner ramus of uropod 2. On the other hand, they resemble *G. longirostris* in the presence of only pairs (not triads) of spines on uropod 3. This taxon is intermediate between *longirostris* and *grandis*-sp. R in the presence of short and poorly developed setae on the lateral face of urosomite 1; setae are absent in *longirostris* but well developed in *grandis*-sp. R. Unlike other taxa of *Grandifoxus* the coxal humps are almost undetectible.

Material.—Female "a" 14.9 mm (not of senile appearance) and female "g" 9.7 mm, Chichagoff Harbor, Attu, Alaska, 5–7 fms, gravel, sand, 1873, W. H. Dall (985).

Grandifoxus robustus (Gurjanova), revived

Pontharpinia robusta Gurjanova, 1938:262–263, 385, figs. 6, 6a; 1951:384–385, figs. 233, 234.
Pontharpinia robusta lindbergi Gurjanova, 1953:224–225, figs. 7, 8.
Paraphoxus milleri lindbergi.—J. L. Barnard, 1960:269.

Nomenclature.—This taxon was synonymized with *G. milleri* by J. L. Barnard (1960) and was also a homonym at that time. Modern practice allows removal from homonymy because the senior homonym is now distinct generically.

Now that species R, described above, is recognized as a species distinct from *longirostris* and *grandis* (=*milleri*) there is a possibility that the correct name for R must be either *robustus* (Gurjanova) or *lindbergi* (Gurjanova). Until they are redescribed the names cannot be assigned to any of my material.

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