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BIOLOGICAL SOCIETY OF WASHINGTON PROCEEDINGS

1042nd Meeting—16 February 1970

Ninety-First Annual Meeting

The 1042nd meeting and 91st Annual Meeting of the Society was called to order by President Joseph Rosewater at 2:35 p.m. in room 43 of the National Museum of Natural History. Twenty-three members were present.

The minutes of the previous annual meeting were read by the Secretary, and approved as read.

Treasurer Harald Rehder presented the financial report. Richard H. Manville reported that the auditing committee had found the Treasurer's books to be in order. Reports of the Treasurer and Auditing Committee were accepted.

The Secretary reported on membership changes in the past year, reading the names of five members whose deaths had been reported, and summarized actions of the Council.

Editor Roger Cressey reported that Volume 82 of the Proceedings consisted of 870 pages in 69 numbers, and included the symposium on Natural History Collections, amounting to 204 pages.

President Rosewater explained that the purpose of the proposed amendment to the bylaws, which had been distributed to members with the announcement of the meeting, was to avoid difficulties with the Internal Revenue Service. Robert Gibbs moved adoption of the amendment; the motion was seconded. After brief discussion to ensure that the proposed wording would serve the intended purpose, the motion was passed unanimously.

The Secretary reported on the results of the election of officers. All candidates were elected.

President-elect Meredith Jones reported on plans for a symposium, to be held in the fall of 1970, probably October. The symposium would concentrate on an examination of the state of knowledge of the region of Panama in which a sea-level canal is proposed, and on our ability to predict the biological consequences of such a canal. More than 20 potential speakers have been contacted.

Victor Springer expressed the opinion that the yield from the invested funds of the Society was not as great as might be expected, and moved that the investment policy of the Society be reviewed. Motion was seconded and passed. Richard Manville asked whether action would follow such review, and was assured by President-elect Jones that a Finance Committee would be formed.

There being no further business, the meeting was adjourned at 3:05 p.m.

Richard C. Banks
Secretary

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PROCEEDINGS
OF THE
BIOLOGICAL SOCIETY OF WASHINGTON

BIOLOGICAL INVESTIGATIONS OF THE DEEP SEA. 53. NEW SPECIES AND GENERA OF GONIASTERID SEA STARS[1]

By Jerald A. Halpern
Institute of Marine Sciences, University of Miami

Two new species of goniasterid sea stars were collected in the tropical Atlantic by the R/V *Pillsbury* and R/V *Gerda* of the Institute of Marine Sciences, University of Miami. They are the type-species of new genera. The R/V *Pillsbury* also collected the second known specimen of *Plinthaster productus* A. H. Clark. This species does not belong in the genus *Plinthaster* and is made the type-species of a new genus.

The type-species of *Aphroditaster, A. gracilis* Sladen, belongs in the genus *Pseudarchaster,* making *Aphroditaster* invalid. A new genus is erected to accomodate *Aphroditaster microceramus* Fisher.

This research was supported by National Science Foundation grant GB-4936. The operations of the R/V *Gerda* and R/V *Pillsbury* were supported by National Science Foundation grant GB-7082. The field work was part of the National Geographic Society-University of Miami Deep-Sea Biology Program. The author is grateful to these agencies.

Key to the Genera Discussed in This Paper

1.	Unpaired median spine at apex of each mouth plate pair	2
	Pair of median spines at apex of each mouth plate pair	3
2.	Adambulacral furrow margin straight	*Fisheraster* new genus
	Adambulacral furrow margin angular	*Pseudarchaster*
3.	Abactinal plates completely covered by granules	4
	Abactinal plates not completely covered by granules	6

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[1] Contribution No. 1181 from the Institute of Marine Sciences, University of Miami.

4. Adambulacral granulation very crowded; plate not visible .. *Peltaster*
   Adambulacral granulation spaced; plates visible between subambulacral granules 5
5. Irregular secondary abactinal plates present; abactinals covered only by spherical granules .... *Pillsburiaster* new genus
   No secondary abactinal plates; peripheral granules of radial abactinals angular .... *Ceramaster*
6. All abactinal plates surrounded by single row of granules; naked area bearing glassy bosses .... *Plinthaster*
   Some abactinal plates bearing more than single row of granules; naked areas smooth 7
7. Radial plates mainly naked. General form stellate; more than six superomarginals in contact medially .... *Diplasiaster* new genus
   Radial plates having only small naked area. General form pentagonal; less than three superomarginals in contact medially .... *Apollonaster* new genus

Fisheraster new genus

Diagnosis: Unpaired (but not recurved) median spine at apex of each mouth plate pair. No spines or spinules on actinal and inferomarginal plates. Adambulacral furrow margin straight.

Remarks: This genus belongs in the subfamily *Pseudarchasterinae* but it is closer to the *Goniasterinae* than any of the known genera of this subfamily.

Type-species: Aphroditaster microceramus Fisher.

Etymology: This genus is named after Walter K. Fisher, who described the type-species and was an excellent asteroid systematist.

Fisheraster microceramus (Fisher, 1913)

Aphroditaster microceramus Fisher, 1913, pp. 626–627; 1919, pp. 225–228, pl. 59, fig. 1, pl. 91, fig. 1.

Remarks: This species is well described and illustrated by Fisher (1919). Plate 70, figure 5 is not a photograph of *Fisheraster microceramus*, but of the type of *Paragonaster stenostichus.*

Type: U.S. National Museum cat. no. 30535.

Type-locality: Buton Strait, Celebes, 05°35′S, 122°20′E, 1023 m, *Albatross* sta. 5648.

Distribution: This species is known only from the type-locality.

Pillsburiaster new genus

Diagnosis: Abactinal plates tabulate, completely covered by spherical granules; loosely arranged into primary and secondary plates in radial area and center of disk. Papulae irregularly distributed between primary and secondary abactinal plates. Subambulacral spines very small, not crowded.

Remarks: The abactinal surface in this genus is similar to that of the species of *Peltaster*, but the secondary plates are not as regularly arranged and are not clearly delineated from the primary plates. The peripheral granules of the radial plates are not different from the central granules, as they are in *Ceramaster*. The actinal surface is similar to that of *Plinthaster* and *Ceramaster*.

This genus belongs in the subfamily Goniasterinae. It appears to be intermediate to *Ceramaster* and *Peltaster*.

Pentagonaster ernesti Ludwig, 1905, from the tropical eastern Pacific, belongs in this genus.

Type-species: Pillsburiaster geographicus new genus, new species.

Etymology: Pillsbury—after the R/V *John Elliot Pillsbury* of the Institute of Marine Sciences, University of Miami. Many species of sea stars new to science have been collected on this ship's expeditions; *aster*, Greek—a common ending for genera of sea stars.

Pillsburiaster geographicus new genus, new species

Figures 1, 2 (top)

Material studied: Holotype: $R = 75$ mm, $r = 30$ mm, $R/r = 2.8$; 04°36′N, 09°46′W, 1464–1556 m, R/V *Pillsbury* sta. 76, 4 June 1964, USNM E11258.—Paratypes: same location as holotype, 2 spec., USNM E11259.—03°50′N, 02°33′W, 1949–1986 m, R/V *Pillsbury* sta. 34, 29 May 1964, 1 spec., UMML 40.240.

Diagnosis: Abactinal granules coarse, spherical. Five or six adambulacral furrow spines. Ten or eleven mouth furrow spines.

Description: Five arms. $R = 75$ mm, $r = 30$ mm, $R/r = 2.8$. General form stellate.

Abactinal plates loosely arranged into primary and secondary plates in long, narrow radial areas and small center of disk. Primary plates only two to four times as large as secondary plates; secondary plates loosely arranged between primary plates. Abactinal plates tabulate, irregularly round; completely covered by very closely crowded, coarse, spherical granules. Many abactinal plates bearing two or three valved, spatulate sugar-tong pedicellariae with short, wide, thick jaws.

Papulae in center of disk and radial areas; papular pores irregularly distributed, each containing single papula.

Superomarginal and inferomarginal plates corresponding; thirty-two plates in each series. Lateral angle of marginals depressed; plates mainly in horizontal plane. Marginals more angular on distal third of arm.

Superomarginals slightly wider than long. In interbrachial arc, lower half of each plate completely covered by granules similar to those on abactinals. Upper half bordered by two to three rows of similar granules; center bare or with one to three scattered granules. Naked area becoming larger distally, so that last six plates surrounded by single row of granules. Last three or four pairs of superomarginals contiguous medially. Terminal plate moderately large; in shape of truncated cone

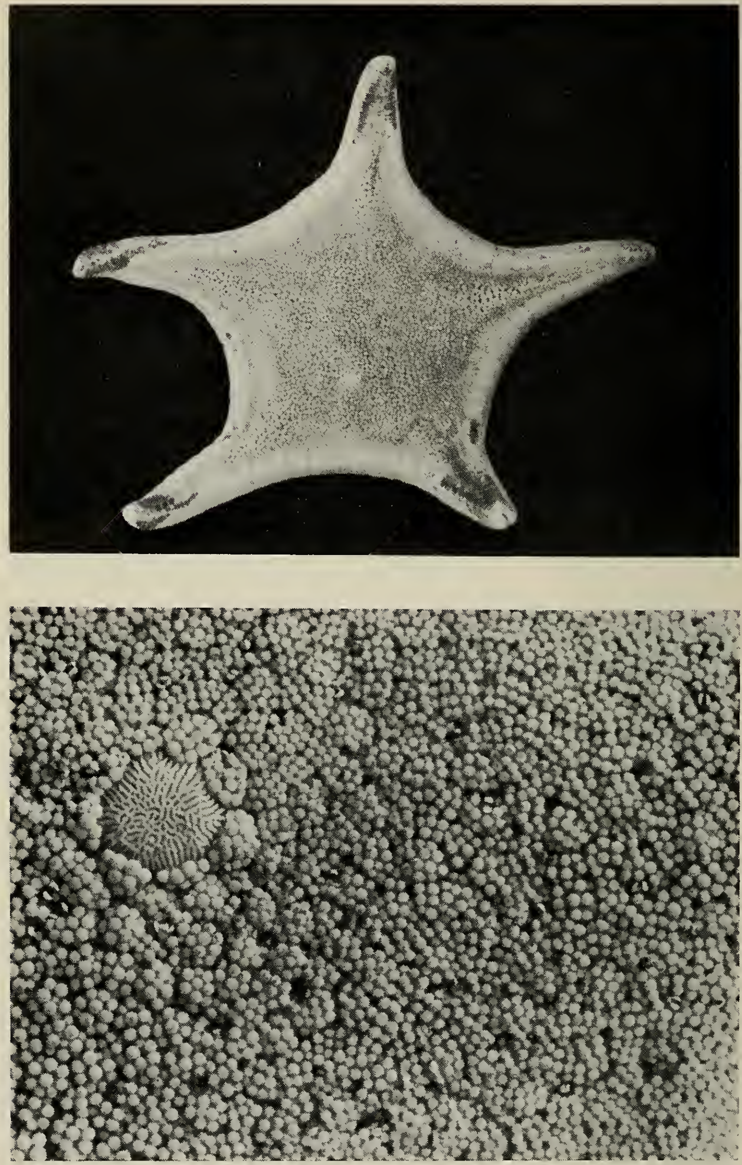


FIG. 1. *Pillsburiaster geographicus* new genus, new species, holotype: top, abactinal view, 0.8×.—bottom, abactinal view, 4.8×.

with apical depression bearing one large, short, wide, conical spine. Inferomarginal plates slightly wider than long; completely covered by granules similar to those of superomarginals.

Actinal plates moderately large, rhombic; extending about half way down arms. Each plate completely covered by coarse, rounded granules similar to those on inferomarginals.

Adambulacral plates approximately square with straight furrow margin bearing five or six short, subequal, compressed furrow spines. Three to four irregular rows of four to six very short, blunt subambulacral spinules, slightly taller than actinal granules. Many adambulacral plates bearing two or three valved, spatulate sugar-tong pedicellariae, similar to abactinal pedicellariae but not as thick.

Each mouth plate bearing ten or eleven furrow spines; first nine or ten spines subequal, slightly taller and thicker than adambulacral furrow spines. Median spine more strongly compressed and slightly taller than other mouth furrow spines. Rest of each mouth plate completely covered by 22–24 large, rounded granules, about twice as large as actinal granules.

Madreporite irregularly round, about five times as large as adjacent abactinal plates; located approximately one-third distance from center of disk to middle of interbrachial arc.

Type: United States National Museum, cat. no. E11258.

Type-locality: Gulf of Guinea, off Cape Palmas, 04°36′N, 09°46′W, 1464–1556 m, R/V *Pillsbury* sta. 76.

Distribution: This species is known from only two localities in the northern Gulf of Guinea; off Cape Three Points, 1949–1986 m and off Cape Palmas, 1464–1556 m.

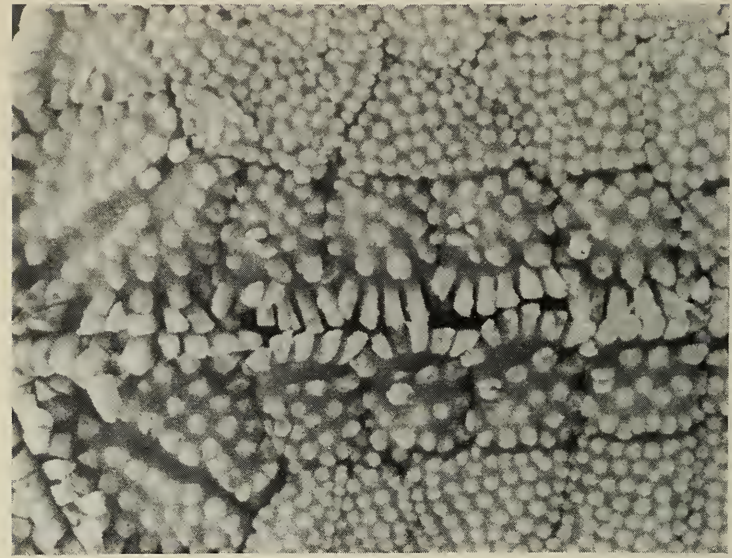
Discussion: Various characters of the paratypes are as follows:

Pillsbury station	R (mm)	r (mm)	R/r	Marginals	superomarginals in contact	adamb. furrow spines	mouth furrow spines
34	66	27	2.4	26	0–1	5–6	11–12
76	80	32	2.5	34	2–4	5–6	10
76	65	28	2.3	26	0–1	6	11

In the specimen measuring R = 80 mm, some of the superomarginals in the middle of the interbrachial arc are completely covered by granules.

Remarks: This species is very similar to *Pillsburiaster ernesti* and differs from it by having actinal pedicellariae and less stout subambulacral granules.

Etymology: geographicus—in reference to the National Geographic Society whose grant to the Institute of Marine Sciences, University of Miami for investigations of the deep-sea fauna helped make possible the discovery of many sea stars new to science.



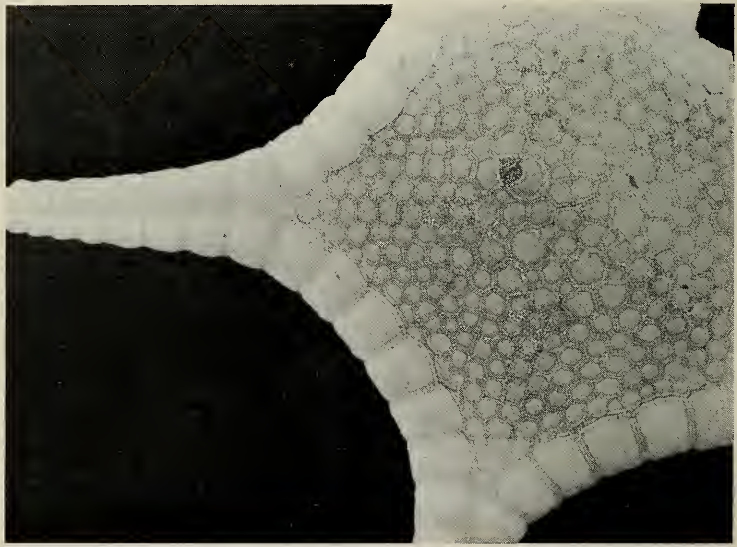


FIG. 2. Top, *Pillsburiaster geographicus* new genus, new species, holotype, actinal view, 6.8×.—bottom, *Diplasiaster productus* (A. H. Clark), specimen from R/V *Pillsbury* sta. 707, abactinal view, 2.9×.

Diplasiaster new genus

Diagnosis: Abactinal plates low-tabulate; surrounded by double row of granules in radial areas, single row elsewhere; no bosses. Superomarginals contiguous medially throughout length of arm. General form stellate.

Etymology: Diplasios, Greek—double; *aster*—a common ending for genera of sea stars; in reference to the double row of granules on the radial abactinal plates.

Remarks: This genus belongs in the subfamily Goniasterinae. It appears to be most closely related to *Apollonaster*. It differs from *Plinthaster* in the shape and granulation of its abactinal plates and in the large number of superomarginal plates in contact.

Type-species: Plinthaster productus A. H. Clark.

Diplasiaster productus (A. H. Clark, 1917)

Figures 2 (bottom) and 3

Plinthaster productus A. H. Clark, 1917. pp. 67–69; 1954, p. 375.

Material studied: Holotype: R = 27 mm, r = 12 mm, R/r = 2.3; 23°10′N, 82°23′W, 567 m, *Albatross* sta. 2154, 30 April 1884, USNM 36930.—11°22′N, 62°22′W, 78 m, R/V *Pillsbury* sta. 707, 19 July 1968, UMML 40.235.

Diagnosis: Four or five adambulacral furrow spines. Each mouth plate bearing eight furrow spines.

Description: Five arms. R = 29 mm, r = 13 mm; R/r = 2.2.

General form stellate, with broad, flat disk and narrow, strongly tapered arms. Interbrachial arcs wide, rounded.

Abactinal plates low-tabulate, restricted to disk. Plates smooth, naked in center; surrounded by single row of flattened granules except in radial areas, where some plates bearing second row of rounded granules inside peripheral row.

Twenty superomarginal plates naked except for one peripheral row of granules similar to those surrounding abactinals and U-shaped cluster of rounded granules adjacent to inferomarginals. Seven or eight pairs of superomarginals in contact medially. Terminal plate small, oval, surmounted by short spine. Twenty inferomarginal plates corresponding with superomarginals. Inferomarginals surrounded by two rows of rounded granules. Rest of each plate naked except for small area adjacent to superomarginals covered by closely crowded, rounded granules.

Actinal plates large, rhombic, completely covered by moderately large, rounded granules.

Adambulacral plates about half as big as adjacent actinals. Adambulacrals rectangular (about twice as wide as long) with straight furrow margin bearing four or five short, subequal, cylindrical furrow spines with rounded tips. First subambulacral row of two or three large, conical spines. Three to six rounded granules similar to those of actinals, in one or two irregular rows, covering rest of plate.

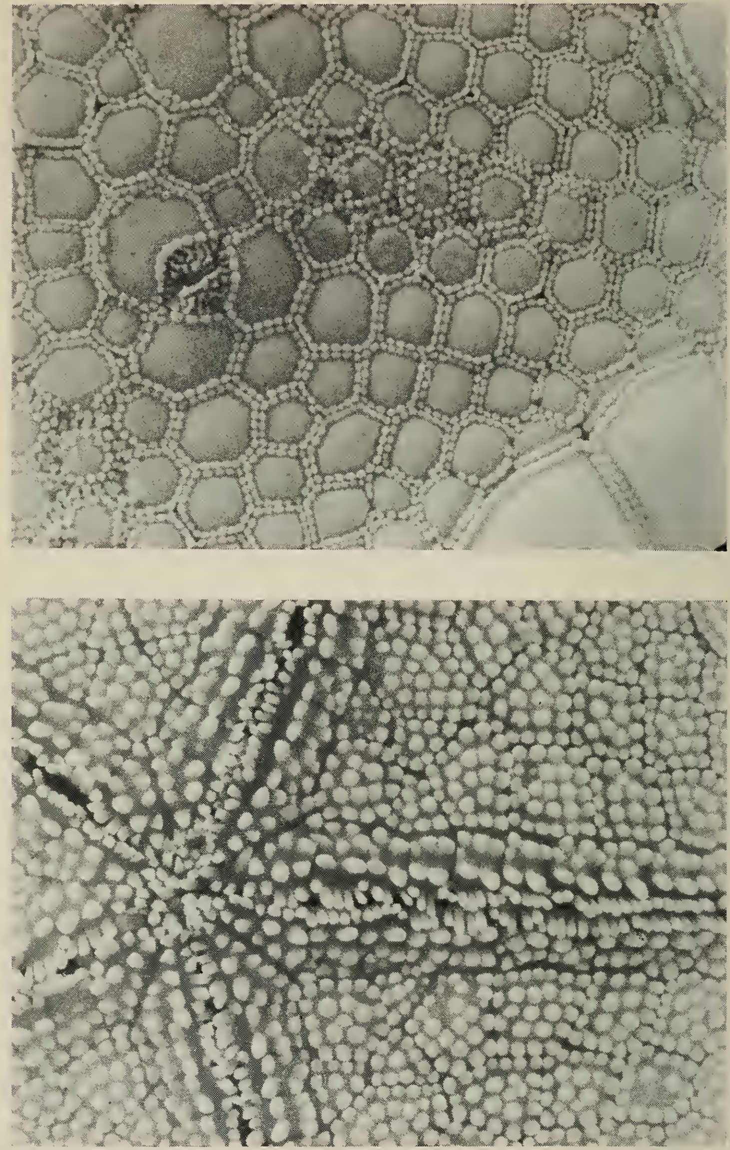


FIG. 3. *Diplasiaster productus* (A. H. Clark), specimen from R/V *Pillsbury* sta. 707: top, abactinal view, 8.5×.—bottom, actinal view, 7.3×.

Mouth plates relatively small. Each plate bearing eight furrow spines. First seven spines subequal, similar to adambulacral furrow spines; median spine slightly taller and stouter. Eight to ten scattered spines, grading actinally into granules similar to those of actinals, covering rest of plate.

Anus subcentral, inconspicuous. Madreporite irregularly round, slightly smaller than adpacent abactinals; located approximately one-third distance from center of disk to middle of interbrachial arc.

Type: United States National Museum, cat. no. 36930.

Type-locality: 23°10′N, 82°23′W, 567 m, *Albatross* sta. 2154.

Distribution: This species is known from only two localities: off Havana, Cuba, 567 m and off the Peninsula de Paria, Venezuela, 78 m.

Apollonaster new genus

Diagnosis: Abactinal plates of radial areas covered by peripheral row of large, flattened granules and one to three additional rows of rounded granules, leaving small, naked central area. Abactinal plates of interradial areas, center of disk and arms covered by peripheral row of small, flattened granules and zero to two additional rows of rounded granules, leaving large, naked central area. Central naked areas smooth.

Remarks: This genus belongs in the subfamily Goniasterinae. It appears to be intermediate between *Ceramaster* and *Diplasiaster.*

Type-species: Apollonaster yucatanensis new genus, new species.

Etymology: Apollo—in honor of the flight of Apollo 11, which landed the first men on the moon; *aster*, Greek—a common ending for genera of sea stars.

Apollonaster yucatanensis new genus, new species

Figures 4, 5

Material studied: Holotype: R = 36 mm, r = 24 mm, R/r = 1.5; 20°57′N, 86°34′W, 40–165 m, R/V *Gerda* sta. 899, 10 September 1967, USNM E11285.

Diagnosis: Six or seven subequal, strongly compressed adambulacral furrow spines. Thirteen mouth furrow spines.

Description: Five arms. R = 36 mm, r = 24 mm, R/r = 1.5. General form arcuate pentagonal.

Abactinal plates low-tabulate. Plates of radial areas covered by peripheral row of large, flattened granules and one to three additional rows of rounded granules, leaving small, naked area in center of plate. Plates of interradial areas, center of disk and very short arms covered by peripheral row of small, flattened granules and zero to two additional rows of rounded granules, leaving large naked area in center of plates. Central naked areas smooth. Some plates bearing small, excavate sugar-tong pedicellariae.

Fourteen superomarginal and sixteen inferomarginal plates corresponding, except at tip of arm, where two inferomarginals correspond with

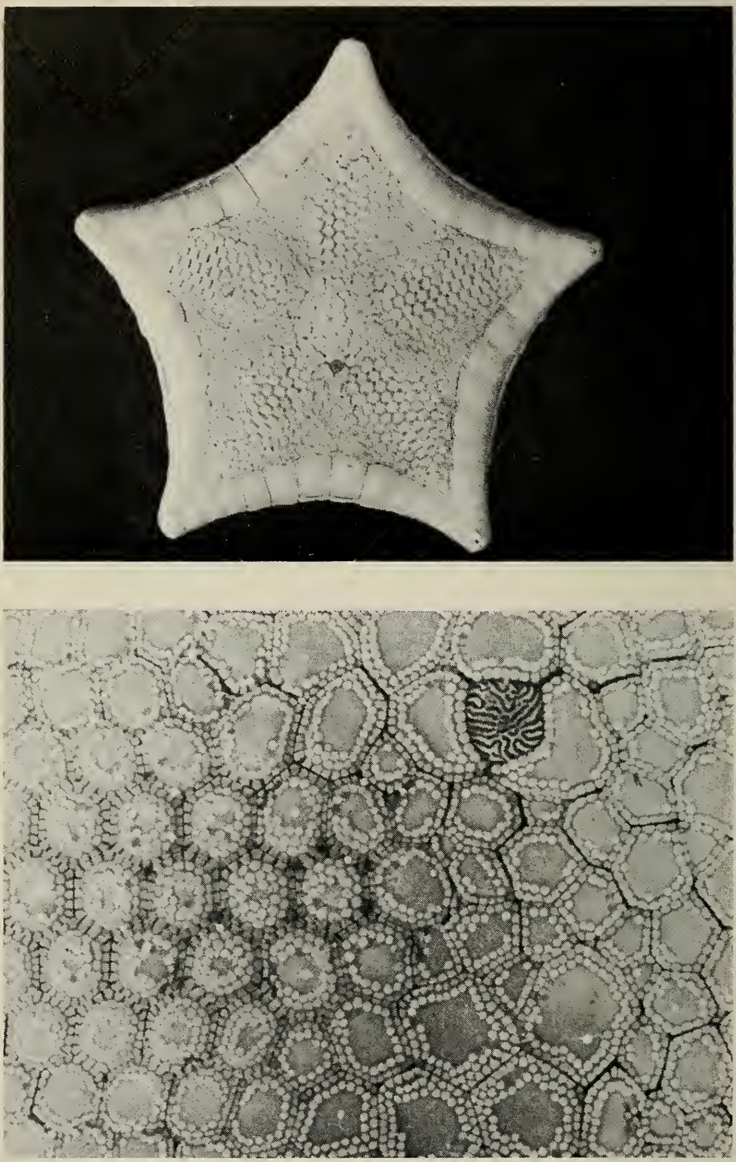


Fig. 4. *Apollonaster yucatanensis* new genus, new species, holotype, abactinal view; Top, actual size.—Botton, 6.9×.

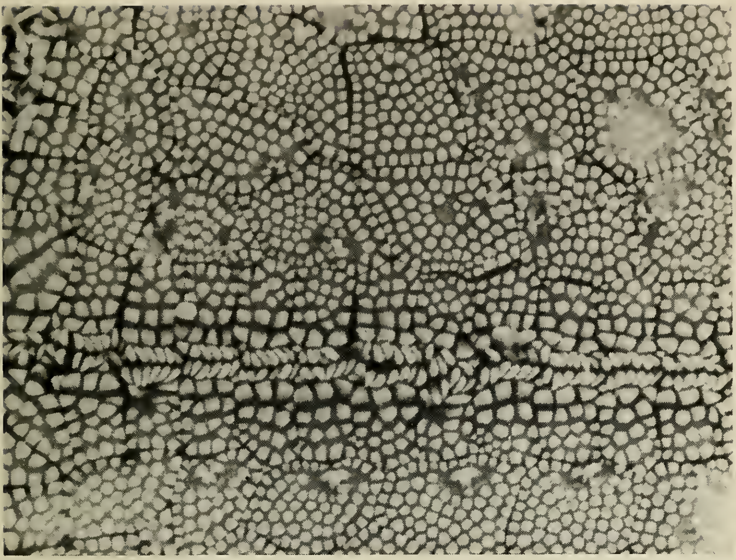


FIG. 5. *Apollonaster yucatanensis* new genus, new species, holotype, actinal view, 6.9×.

one superomarginal. Superomarginals slightly wider than long; surrounded by two rows of small, rounded granules, with several similar granules scattered about center. Some plates bearing small, excavate sugar-tong pedicellariae like those on abactinals. Terminal plate very small, oval. Inferomarginals slightly wider than long; surrounded by three to seven rows of small, rounded granules like those of superomarginals; several similar granules scattered about center of plate. Some plates bearing small, excavate sugar-tong pedicellariae.

Actinal plates large, rhombic, completely covered by moderately large, rounded granules. Some plates bearing excavate sugar-tong pedicellariae slightly larger than those on abactinals.

Adambulacral plates rectangular (about twice as wide as long) with straight furrow margin bearing six or seven subequal, strongly compressed furrow spines. First subambulacral row of three or four large, prismatic granules. Three or four more irregular subambulacral rows of three to five granules similar to those on actinals. Some plates bearing excavate sugar-tong pedicellariae.

Mouth plates long, narrow. Each plate bearing thirteen subequal furrow spines, similar to those on adambulacrals; median spine slightly enlarged. Rest of plate covered by 20–25 prismatic granules grading actinally into granules similar to those of actinals.

Madreporite irregularly round, about same size as adjacent abactinals;

located approximately one-quarter distance from center of disk to middle of interbrachial arc.

Type: United States National Museum cat. no. E11285.

Type-locality: Arrowsmith Bank, Yucatan, 20°57′N, 86°34′W, R/V *Gerda* sta. 899.

Remarks: The naked areas of the abactinal plates are not due to the granules being rubbed off. The granules are set in small, hemisperical pits in the plate which are readily apparent when the granules are rubbed off.

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PROCEEDINGS
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FRESHWATER TRICLADS (TURBELLARIA) OF NORTH AMERICA. II. NEW OR LITTLE KNOWN SPECIES OF *PHAGOCATA*.[1]

By Roman Kenk[2]
The George Washington University and Smithsonian Institution

During work on a revision of the North American fauna of freshwater triclads I studied planarian specimens from several states either collected on field trips or sent in by various collaborators. I wish to express my grateful appreciation to all who assisted me in the field or provided materials for study. Thanks are due particularly to Drs. Thomas E. Powell, Jr., R. O. Flagg, and Mr. Richard Whitten of the Carolina Biological Supply Company; and to Messrs. Timothy F. Hicks, Vernon M. Hawthorne, Phillip H. Baker, William F. Hart, Jerry H. Carpenter, and James F. Leser who in one way or another were instrumental in facilitating my access to the materials discussed in this paper.

Phagocata was established by Leidy (1847: 248) as a subgenus of *Planaria* O. F. Müller (1776) for the species *Planaria gracilis* described by Haldeman (1840). The chief characteristic distinguishing *Phagocata* from *Planaria* s. str., in Leidy's opinion, was the presence of multiple pharynges which at that time had not been observed in other species of freshwater triclads. Much later it was discovered that polypharyngy may occur in several genera of planarians (*Crenobia, Sphalloplana*) and that it has no generic taxonomic significance. The present definition of the genus *Phagocata* (synonym,

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[1] Supported by National Science Foundation Grant GB-6016 to the George Washington University.

[2] Author's address: Department of Invertebrate Zoology, Museum of Natural History, Smithsonian Institution, Washington, D.C. 20560.

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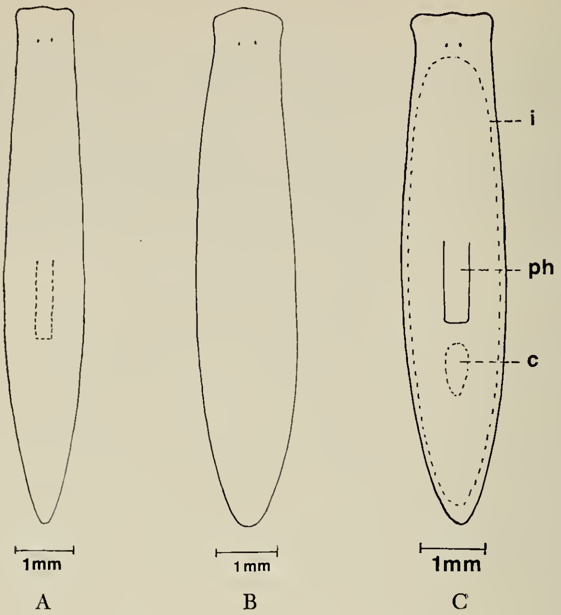

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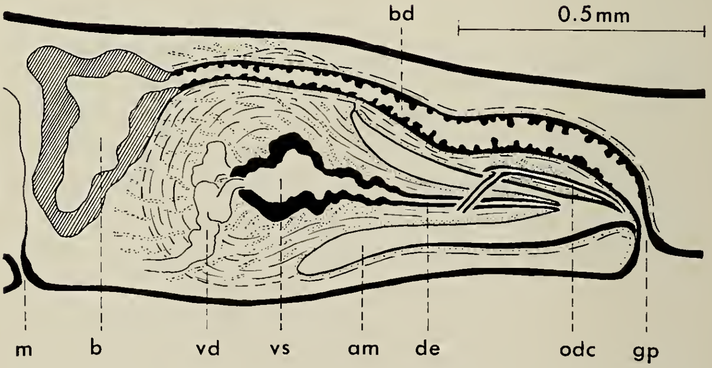

Fig. 1–2. 1. Outline sketches of species of *Phagocata*, from life. A, *P. bulbosa*; B, *P. crenophila*; C, *P. oregonensis*; *c.* copulatory complex; *i*, area occupied by intestinal branches; *ph*, pharynx. 2. *Phagocata bulbosa*, semidiagrammatic view of copulatory apparatus in sagittal section. *am*, male atrium; *b*, copulatory bursa; *bd*, bursa duct or stalk; *de*, ejaculatory duct; *gp*, genital aperture; *m*, mouth; *odc*, common oviduct; *vd*, vas deferens; *vs*, seminal vesicle.

Fonticola Komárek) is as follows (Kenk, 1935: 103, and Hyman, 1937: 302).

Planariidae whose oviducts—without embracing the stalk of the bursa copulatrix—unite in a common oviduct which opens into the genital atrium. Male atrium without radial muscle plates. Adenodactyls absent. Eyes usually two. Type of the genus, *Planaria gracilis* Haldeman (1840: 3).

Phagocata bulbosa new species[3]

Type material: Holotype, series of sagittal sections of posterior half of the body, on 2 slides, U.S. National Museum No. 40967. Paratypes in the author's collection.

External features (Fig. 1A): Mature animals are up to 12 mm long and 1.7 mm wide. The anterior end is truncate, with straight or centrally bulging frontal margin and rounded auricular edges. Behind the head there is no pronounced narrowing or neck, at most a very slight constriction behind the auricular lobes. The lateral margins diverge very gradually up to the middle of the body where the greatest width is attained. Behind the pharyngeal region the body tapers to a rather pointed posterior end.

There are usually two eyes, their distance from each other one-third or less of the width of the head at the level of the eyes. Each eye is farther removed from the frontal margin than from the lateral margin. The pharynx is inserted at about the middle of the body and measures in length approximately one-fifth of the body length. The copulatory organs occupy the anterior half of the post-pharyngeal region.

The animal is usually uniformly pigmented, the dorsal surface being a variable shade of gray, often presenting a mottled appearance. The ventral surface is somewhat lighter. The ocular specks on the dorsal side and a small area around the mouth opening ventrally are free of pigment, white.

As is seen from this description, the species resembles very closely a number of other American planariids from which it connot be distinguished in life by external characters: *Phagocata velata* (Stringer), *P. vernalis* Kenk, *P. crenophila* Carpenter, *Planaria dactyligera* Kenk, *Hymanella retenuova* Castle, and probably *Phagocata monopharyngea* Hyman (which has not been studied in life). I have not been able to separate the new species, with any degree of confidence, in mixed collections or cultures where it was associated with *Planaria* or *Hymanella*. Only the analysis of serial sections made it possible to identify the individual species.

Anatomy of the anterior end: There is no adhesive organ developed. The submarginal zone of adhesive gland openings, which parallels the

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[3] *bulbosus*, Latin, bulbous, referring to the size of the penis bulb.

body margins, continues into the head region along the frontal margin without interruption and without increase in width. There are no muscular differentiations such as are generally observed in adhesive organs. On either side of the head, along the auricular edges, the surface epithelium is modified, the cells bearing conspicuous cilia and containing very short rhabdites. It is highly probable that these two strips represent the auricular sense organs. On the ventral side of the head, immediately behind the adhesive gland zone, there is a small patch of ciliated epithelium approached by numerous gland ducts with a fine-grained, slightly eosinophilic secretion (as opposed to the deeply staining secretion of the adhesive glands). The cells of this epithelium generally lack rhabdite inclusions. The function of this organ is not clear.

Reproductive system: The numerous testes are predominantly ventral, occupying on either side a broad zone extending from a short distance behind the head to approximately the level of the mouth opening. Some testicular follicles may, however, have a more dorsal position or, at full maturity, individual large follicles may occupy the entire dorso-ventral depth of the body.

The two ovaries, accompanied laterally by large parovarial cell masses, lie, as is typical for freshwater triclads, on the medial side of each ventral nerve cord, generally behind the first lateral branch of the anterior intestinal ramus. The yolk glands or vitellaria occupy all available mesenchymal spaces both dorsally and ventrally in a zone extending from the ovaries to the posterior end of the body.

The copulatory apparatus (Fig. 2) conforms in every way with the definition of the genus *Phagocata* as proposed by Hyman (1937: 302). The genital aperture or gonopore (*gp*) lies at or a little behind the middle of the postpharyngeal region. There is no common genital atrium developed as the male atrium (*am*) and the bursa duct (*bd*) meet at the gonopore. The male atrium is conical, tapering posteriorly, and duplicating the shape of the penis papilla. It is lined with a flattened or cuboidal epithelium below which there are two muscle layers, a circular and a longitudinal one.

The penis consists of a large, spherical bulb and a finger- or cone-shaped papilla. The bulb is formed by strong muscle fibers running in various directions in a more or less concentric arrangement. It is traversed by many gland ducts with a faintly eosinophilic, fine-grained secretion, which enter it from the surrounding mesenchyme and open into its lumen. The papilla of the penis is covered with a flattened epithelium. Underlying this epithelium is a layer of very dense fine fibers which at the base of the papilla is continuous with the circular muscle layer of the male atrium; this fibrous layer may be of an elastic rather than muscular nature. In comparing the penis papilla in nine series of sagittal sections it was seen that the shape of this organ appeared quite uniform, straight, not showing any distortions or contractions such as are generally observed in soft muscular organs in planarians. Apparently the relative stiffness of the papilla is due to the fibrous layer.

The cavity of the penis bulb, the seminal vesicle (*vs*), is rather large, with an irregular outline. Its wall consists of a columnar epithelium of a glandular nature. Posteriorly the cavity narrows and continues into the papilla as a straight narrow canal, the ejaculatory duct (*de*), which opens at the point of the papilla. The seminal vesicle, particularly in its caudal portion, receives the gland ducts which have penetrated the tissue of the penis bulb.

The two vasa deferentia (*vd*), which at the level of the pharynx have assumed the shape of expanded, tortuous ducts (the false seminal vesicles or spermiductal vesicles), enter the penis bulb from either side antero-ventrally. They retain their expanded shape, form a few convolutions within the bulb, and finally empty separately through short narrow passages into the antero-lateral part of the seminal vesicle.

The two oviducts or ovovitelline ducts, which run from the ovaries posteriorly along the ventral nerve cords, ascend dorsally at the level of the copulatory complex and unite above the male atrium to form a common oviduct (*odc*). This then proceeds posteriorly along the atrial wall and connects with the atrial cavity quite close to the gonopore. The end parts of the paired oviducts and the common oviduct receive the highly eosinophilic "shell glands" as is the general rule in the genus *Phagocata*.

The copulatory bursa (*b*) is a large sac situated between the wall of the pharyngeal pouch and the penis bulb. It is highly lobate, with many diverticula extending mainly in a lateral direction. Its outlet, the bursal canal or duct (*bd*) runs from the bursa caudally, somewhat to the left of the penis bulb, then curves ventrally to connect with the gonopore. The duct shows no histologically distinct divisions. Some of the cells of its epitelial lining project villus-like into the lumen of the duct. The duct is surrounded by two muscle layers, an inner circular and an outer longitudinal layer.

Distribution and ecology: Phagocata bulbosa was collected on 13 June 1968 on the grounds of the Warren Laboratories of the Carolina Biological Supply Company (situated on highway U.S. 158, 3 miles east of Warrenton), Warren County, North Carolina. It was taken on liver bait in two localities, one (the type locality) on the side entrance road to the Laboratories in a seepage area with highly colored water, accompanied by *Hymanella retenuova* Castle; in the other locality, also on the side entrance road, it occurred together with *Planaria dactyligera musculosa* Kenk. Some of the specimens collected were sexually mature, others matured in laboratory cultures. I am indebted to Dr. Thomas E. Powell, Jr., and Dr. R. O. Flagg of the Carolina Biological Supply Company for kindly extending to me the hospitality of the Laboratories and aiding me in the collection of the specimens.

Laboratory cultures: Phagocata bulbosa was kept in the laboratory in spring water at about 14° C. and was fed beef liver and *Tubifex*. Young specimens became sexually mature after several weeks and deposited egg capsules (cocoons). As the cultures were mixed, containing also the other species present at the collecting sites (which in life could not be separated from *P. bulbosa*), only a few measurements of the egg capsules could be made for the individual species. All cocoons were unstalked, ellipsoidal, and attached to the substrate by a jellylike transparent substance. From one egg capsule, isolated from a mixed culture, three young emerged after 38 days. They matured, or at least developed parts of the reproductive system, in about four months and could then be assigned to *P. bulbosa* on the basis of their anatomy. Two specimens from a mixed culture (which were later identified as *P. bulbosa* on the basis of serial sections) laid two cocoons measuring 0.7 × 0.9 mm and 0.8 × 1.2 mm, respectively. These cocoons hatched 36 and 50 days after their deposition. No asexual reproduction (by fissioning or fragmentation) was observed in over one year of culturing.

Taxonomic position: The genus *Phagocata* in its broader sense (including also the forms frequently separated as *Fonticola, Atrioplanaria,* and *Penecurva*) comprises at present close to 50 species and subspecies widely distributed in the northern hemisphere (Eurasia and North America). The outstanding specific characters of *Phagocata bulbosa* are its pigmentation, the presence of a single pharynx, and the anatomy of its reproductive system: large, spherical penis bulb containing a seminal vesicle, conical penis papilla with narrow ejaculatory duct opening at its tip, far caudal opening of the common oviduct, and absence of a sphincter on the duct of the copulatory bursa. With regard to the anatomy of the penis it shows certain similarities with some widely scattered exotic species of the genus (in which, however, the zone of the testes reaches to the posterior end): three Japanese species, *P. kawakatsui* Okugawa (1956), which has a muscular sphincter in the posterior section of the bursal duct and a different course of the vasa deferentia entering the penis; *P. iwamai* Ichikawa and Kawakatsu (1962a), which has a wider ejaculatory duct; *P. teshirogii* Ichikawa and Kawakatsu (1962b), with a more flexable penis papilla; a species from Manchuria, *P. uenoi* Okugawa (1939), which has on each side a group of 4–8 eyes; and *P. altaica* Livanov and Zabusova (1940) from Lake Teletskoye in the Russian part of the Altai Mountains in Siberia, in which the penis papilla appears to be soft and easily distorted, coming back upon itself in the published illustrations. As far as the American planarians are concerned, the superficial similarity of the external features of *P. bulbosa* with those of other species and even genera has already been mentioned. The principal differences between our species and other pigmented American species of *Phagocata* are as follows: *P. gracilis* (Haldeman) and *P. woodworthi* Hyman are polypharyngeal; *P. velata* (Stringer) has predominantly dorsal testes and a diverticulum on the ejaculatory duct; *P. vernalis* Kenk is distinguished by a U-shaped

FIG. 3. *Phagocata crenophila*, photographs from life. A, specimen from Logan, Utah; *B*, specimen from Tahoe City, California. ×4.

copulatory bursa and lacks a well-developed penis bulb; in *P. crenophila* Carpenter the ejaculatory duct opens on the ventral side of the penis papilla; *P. tahoena* Kawakatsu, a small species with a different external habit, has the testicular zone extending to the posterior end; and *P. monopharyngea* (Hyman), originally described as a monopharyngeal subspecies of *P. gracilis*, seems to have a very weak penis bulb and a wide lumen of the ejaculatory duct.

Parasites: The majority of the specimens of *Phagocata bulbosa* examined on sections contained the holotrichous ciliate parasite, *Sieboldiellina planariarum* (Siebold) in the intestinal cavity and frequently in the lumen of the pharyngeal pouch. Several of the animals were infested also with a peritrichous epizoite, probably *Urceolaria mitra* (Siebold).

Phagocata crenophila Carpenter, 1969

The species was recently described by J. H. Carpenter (1969) who collected and studied it in Utah and deposited type material in the Smithsonian Institution (No. 38052-38054). The present discussion furnishes additional data on its morphology and distribution.

External features: (Fig. 1B and 3): *Phagocata crenophila* is another of the group of pigmented planarians which cannot be positively identified in life (see the remarks under the preceding species, *P. bulbosa*).

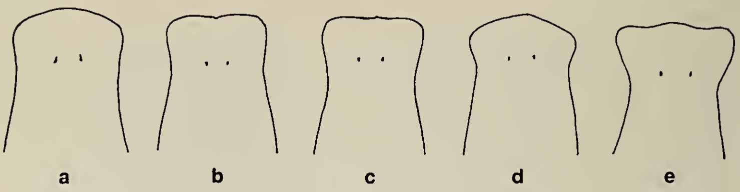

FIG. 4. *Phagocata crenophila*, outline drawings of anterior end.

According to Carpenter (1969: 276), mature specimens measure 12–22 mm in length and 1.5–2 mm in width. My specimens, when mature, were mostly about 17 mm long and 2 mm wide. The head is truncate but in detail may present various shapes when the animal is in motion. Generally the frontal margin bulges slightly in the center and the edges protrude very little laterally. In one population (from Tahoe City, California), however, the auricular edges protrude considerably so that a distinct narrowing or neck is formed behind them. Figure 4 shows the outlines of the head of specimens of various provenances in gliding locomotion. The dorsal surface is gray to black, the ventral side somewhat lighter. The distance between the two eyes amounts to about one-third the width of the head at the level of the eyes, and each eye is farther removed from the frontal margin than from the lateral margin.

Reproductive system: A general description of the gonads, gonoducts, and the copulatory organs has been given by Carpenter (1969). The zone of the testes, which are predominantly ventral, extends from the level of the ovaries to almost the posterior end of the body. I wish to supplement Carpenter's account of the copulatory complex, with particular regard to its muscular and glandular structures (Fig. 5). The genital aperture (*gp*) leads into two cavities: anteriorly the male atrium (*am*) and dorsally, somewhat to the left of the midline, the duct (*bd*) of the copulatory bursa (*b*). There is no common genital atrium discernible. The penis consists of a feebly muscular bulb and a well-developed plug-shaped papilla which bears at its distal end a characteristic lobelike appendage (*pp*). The two vasa deferentia (*vd*) enter the bulb antero-laterally, acquire a distinct coat of circular muscle fibers, and proceed transversally toward the midline where they unite. The common vas deferens thus formed runs posteriorly or postero-dorsally (depending on the state of contraction of the penis) for a short distance, then widens to a small cavity (*vs*) which we may consider to be the equivalent of a seminal vesicle. This cavity, which never assumes a conspicuous volume, is indicated by Carpenter (1969, fig. 12, *ed*) as the beginning of the ejaculatory duct. Actually the cavity continues into a straight canal, the ejaculatory duct (*de*) proper, running posteroventrally and opening into the male atrium on the ventral side of the penis papilla, its orifice generally being nearer to the base than to the lobular tip of the papilla.

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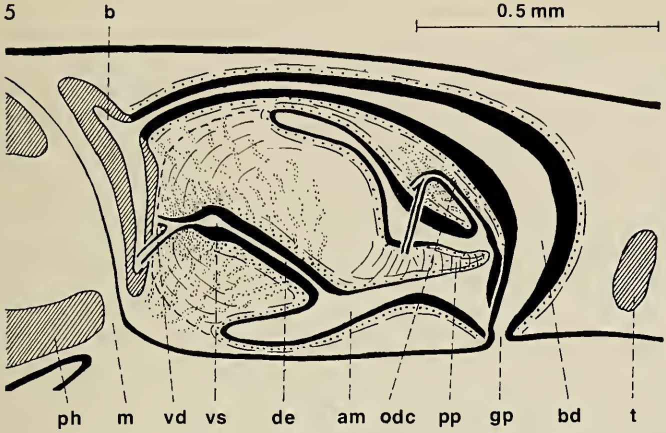

FIG. 5. *Phagocata crenophila*, semidiagrammatic view of copulatory complex in sagittal section. *am*, male atrium; *b*, copulatory bursa; *bd*, bursa duct; *de*, ejaculatory duct; *gp*, gonopore; *m*, mouth; *odc*, common oviduct; *ph*, pharynx; *pp*, lobe of penis papilla; *t*, testis; *vd*, vas deferens; *vs*, seminal vesicle.

The seminal vesicle and ejaculatory duct are lined with columnar epithelia, with little histological difference between them. The entire male tract from the common vas deferens to the mouth of the ejaculatory canal receives ducts of mesenchymal glands with a granular, faintly eosinophilic secretion. The gland ducts are particularly numerous at the level of the common vas deferens and the anterior part of the seminal vesicle. A coat of circular muscle fibers surrounds all canals and is very noticeable on the ejaculatory duct. The outer surface of the penis papilla is covered with a cuboidal epithelium which gradually diminishes in thickness toward the lobe of the papilla tip where it becomes thin and flattened. Below the epithelium are the usual layers of muscle fibers, a circular layer adjoining the epithelium and a deeper layer of longitudinal muscles. Only the lobe at the tip of the papilla is provided with dorsoventral muscle fibers.

The male atrium (*am*), which in general repeats the shape of the penis papilla, has a lining of cuboidal to columnar cells, with two muscle layers (circular and longitudinal) underlying it. The atrium opens to the outside at the genital pore (*gp*). On its dorsal side, a certain distance from the gonopore, the atrium receives the opening of the common oviduct (*odc*).

The two oviducts, which in the anterior part of the body accompany the ventral nerve cords, ascend at the level of the copulatory complex toward the dorsal side and unite in the space between the male atrium and the bursal canal, forming the common oviduct (*odc*). The end parts of the paired oviducts and the common oviduct connect with many ducts of mesenchymal glands with highly eosinophilic secretion, the so-called "shell glands."

The copulatory bursa (*b*) is a large sac lying between the pharyngeal pouch and the penis bulb, of variable size and shape and easily deformed by the pharynx in preserved specimens. Its outlet, the bursal canal or duct (*bd*) proceeds posteriorly above the atrium and behind it arches ventrally toward the gonopore. The diameter of its lumen gradually increases from the bursa posteriorly, then constricts again when approaching the gonopore. The cellular lining of the bursal duct consists of tall columnar cells, apparently of a glandular (apocrine) nature. There is no conspicuous histological difference between the narrow anterior and the wider posterior parts of the duct. Both parts are coated with two muscle layers, one with circular, the other with longitudinal fibers.

Distribution and ecology: Carpenter (1969: 280) collected *Phagocata crenophila* in five localities in Logan Canyon, Cache County, Utah, in cold mountain springs and streams. The species occurred in these localities together with *Polycelis coronata* (Girard). I observed sexually mature samples of *P. crenophila* in the following localities:

Visitors' Center of Eldorado National Forest, El Dorado County, California, located near the south shore of Lake Tahoe. Seepage springs on the grounds of the Center, with clear water, 7.8° C, pH 6.5. Current moderate, bottom mud with stones. Under stones and pieces of wood about 20 specimens, about half of them mature or semimature, taken 21 and 22 June 1967 and 11 July 1968.

Tahoe City, Placer County, California (near northwest shore of Lake Tahoe). Overflow of spring furnishing water to the local California Fish and Game facility. Water clear, current fast, bottom with stones and algal growth. Collected 6 specimens on 23 September 1967, one of them sexually mature (water temperature, 6.7° C, pH 6.8); many animals taken 10 July 1968, both mature nad immature ones (temperature 6.2° C, pH 6.6, oxygen 10 ppm). The population of this locality has the flared anterior end shown in figures 3B and 4e. Besides this species, *Polycelis* sp. occurred, in smaller numbers. Both *Phagocata* and *Polycelis* were also attracted to liver bait left in the stream over night.

At my visit to Logan, Utah, on 27 September 1967, Mr. Jerry H. Carpenter kindly took me to two of his collecting places where I could observe *P. crenophila* and *Polycelis coronata*: Ricks Spring, Cache County, Utah, on U.S. Highway 89, 16.6 road miles east of Utah State University in Logan; and Spring Hollow Stream, Cache County, off U.S. 89, about 5 miles east of Logan.

Immature planarians resembling *P. crenophila* were collected also in other localities under similar environmental conditions. Although no final identification could be made, they probably belonged to that species:

Sagehen Creek Biological Station of the University of California, Nevada County, California (north of Truckee, off State Road 89, close to the Sierra County line). Spring furnishing water to the Station, with clear, fast water, temperature 6.5° C, pH 7.5, oxygen 10 ppm. Under stones several specimens with wide heads, none mature, collected 10 July 1968. Besides these, more numerous *Polycelis* sp.

Charleston Park, Toiyabe National Forest, Clark County, Nevada (west-northwest of Las Vegas). Below waterfall at end of Little Falls Trail (off Kyle Canyon Road). Water clear, 8.2° C, pH 8.8. Under stones many immature specimens collected by Timothy F. Hicks and James F. Leser, 6 July 1967. Several animals were placed in a culture kept at 14° C but did not mature and gradually died off without any having fissioned or encysted. The last specimen disintegrated 31 October 1968 (after almost 16 months).

Phagocata crenophila seems to be widely distributed in the western mountains, both the Rocky Mountains and the Sierra Nevada, which have so far been little studied with regard to planarians. The species appears to be confined to cold springs and streams at high altitudes, often in the company of a species of *Polycelis*.

Phagocata tahoena Kawakatsu

Synonym: Phagocata nivea tahoena Kawakatsu, 1968: 6.

Phagocata tahoena was described by M. Kawakatsu (1968) from preserved specimens collected during 1962 and 1963 in the course of the Lake Tahoe Fisheries Study carried out by the California and Nevada Fish and Game Departments. The animals had been taken in bottom samples brought up by an Ekman dredge from depths of 15 to 1632 feet. Concerning the appearance of the species in life we have only the brief description given by one of the collectors (Mr. Ted C. Frantz), quoted by Kawakatsu (1968: 6, footnote), indicating that the color of the two species occurring in Lake Tahoe varied from dark brown to translucent pink. I visited Lake Tahoe in 1967 and attempted to collect the species with a trawling dredge at a depth of about 40 m off the south shore of the lake near Al Tahoe (El Dorado County, California) in the company of Mr. Phillip H. Baker. Two specimens were obtained, one sexually mature, the other immature. In 1968, with the able assistance of the California Fish and Game Warden William F. Hart, I tried baiting specimens with beef liver. The method proved to be very successful, as I was able to collect numerous specimens.

Baiting is often the most efficient method for the qualitative collecting of most species of freshwater triclads in both standing and running waters. The layout of the bait used in Lake Tahoe is illustrated in Figure 6. A small piece of beef liver was placed in a glass jar (*j*) which had a metal screw top with a number of perforations and a string attached to it. At a distance of several feet, the string was tied to a

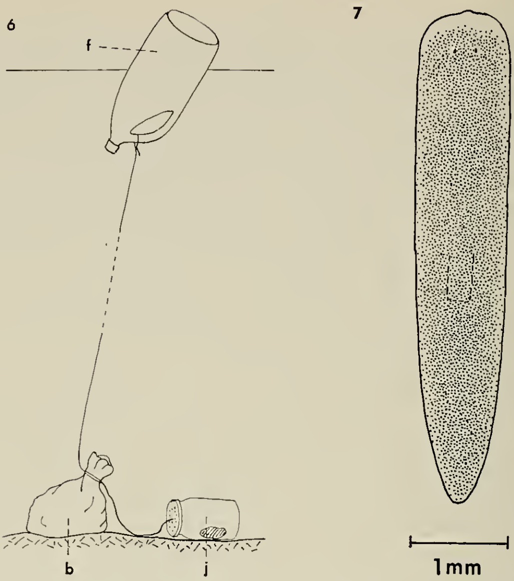

Fig. 6–7. 6. Baiting of planarians in deep water: *b*, canvas bag filled with stones to serve as anchor; *f*, float (plastic bottle); *j*, jar with perforated metal lid, containing bait. 7. *Phagocata tahoena*, from life.

canvas bag (*b*) filled with stones which served as an anchor. A nylon line connected the bag to a float (*f*), in this case an inverted plastic bottle. With this arrangement, baits were exposed in three places, at depths of 40, 69, and 89 m. When the jars were raised to the surface after 24 hours, two of them contained many animals which had remained in them after feeding on the liver.

The use of a perforated bait container for the collection of planarians had been recommended already by Sell (1916) but has hardly been in widespread practice. The effectiveness of this method was first demonstrated to me by the Powell Laboratories in Gladstone, Oregon. Liver, meat, pieces of fish, crushed snails, chopped-up earthworms, or other suitable food items may be used as bait. The perforations on the container keep larger predators or scavengers (*e.g.*, crayfish) from reaching the bait. There are, however, planarian species that are not attracted by chemical food stimuli, such as *Procotyla fluviatilis* Leidy and some subterranean species. For these species the common collecting methods must be employed, *i.e.*, individual searching in hiding places or the collection of debris, leaf litter, etc. in a large jar with water in which the animals will rise to the surface.

External features (Fig. 7): The general aspect of *Phagocata tahoena* in life has been fairly well preserved in some of the specimens studied by Kawakatsu (1968) and illustrated on his plate 1, figures A-C. Living specimens are generally 6 mm long and about 1 mm wide, although some of Kawakatsu's samples were considerably larger, measuring up to 12 mm in length in the preserved state. The animals are plump, with a large dorsoventral diameter. The head in life is rounded rather than truncate, lacking any lateral (auricular) protuberances. In the center of the head margin a small bluntly pointed projection may be seen when the animal is in gliding locomotion. There is no constriction or neck behind the head, as the lateral margins of the body run almost parallel up to the post-pharyngeal region where they begin to converge toward the more or less pointed posterior end. Eyes are two, separated from each other by a distance which amounts to about one-third, or slightly less, of the width of the head at the level of the eyes. The distance of each eye from the lateral margin is somewhat smaller than that from the frontal margin. The pharynx is inserted at the middle of the body and its length measures one-eighth to one-sixth the body length.

The color of the dorsal side is a light hue of grayish brown, diminishing in darkness toward the margins of the body. The two small areas adjoining the eyes and a crescent-shaped rim along the frontal border are free of pigment. The ventral surface is unpigmented, white.

In quiet gliding movement, the central part of the frontal margin is held somewhat elevated.

Anatomy: The distinctive anatomical characteristics of *Phagocata tahoena* have been described by Kawakatsu (1968). I wish to add here only some details concerning glandular and sensory structures of the species. The submarginal adhesive zone (Fig. 8, *az*) is remarkably feebly developed, consisting of a very narrow strip of epithelial cells paralleling the lateral margins of the body, infranucleate,[4] and lacking rhabdite inclusions. These cells are perforated by few gland ducts containing an eosinophilic secretion. In the head region, along the frontal margin, the adhesive zone widens moderately, without forming a distinct adhesive organ.

The auricular sense organs (Fig. 8, *au*) consist of a pair of bands of modified epithelium, one on each side of the head, extending along the very edge of the frontal margin and encroaching to some extent on the dorsal surface. The epithelium is ciliated, infranucleate, but contains rhabdites similar in size to those of the normal surface epithelium. Each organ is separated from the submarginal adhesive zone by a narrow strip of normal nucleated epithelium. There is a wide gap between the two

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[4] This term ("infranucléé") was first introduced by Codreanu (1943: 138) for epithelia, rather commonly observed in the various classes of the Platyhelminthes, in which the nuclei with some cytoplasm have descended into a deeper layer. Such epithelia are designated as "eingesenkt" by German authors, an expression which is frequently translated as "insunk." "Infranucleate" is a better descriptive term for this condition.

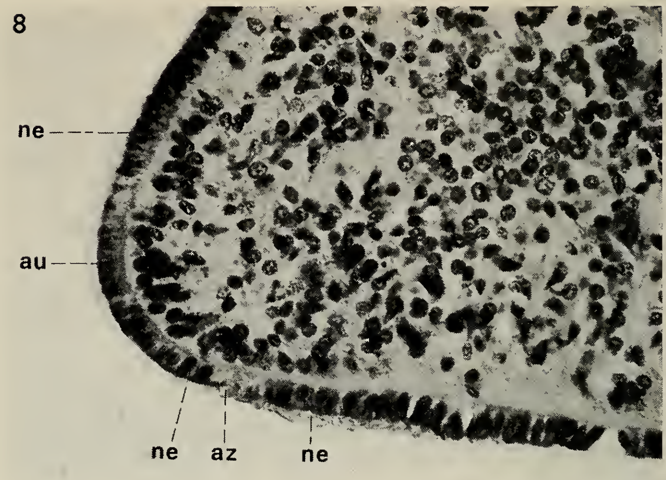

FIG. 8–9. *Phagocata tahoena*, sagittal sections through anterior end. 8. Auricular sense organ. 9. Subterminal organ. *au*. auricular sense organ (ciliated infranucleate epithelium, rhabdites present); *az*, submarginal adhesive zone; *cg*, cerebral ganglion; *ne*, normal surface epithelium; *so*, subterminal organ (infranucleate epithelium lacking rhabdites). ×300.

auricular organs in the center region of the frontal margin. Another small field of possibly sensory epithelium is seen in the very midline of the head on the ventral side immediately behind the adhesive zone (Fig. 9, *so*). This field, which we may call the subterminal organ, has a well-ciliated, infranucleate epithelium lacking rhabdite inclusions. It may be homologous with a similar organ described above in *Phagocata bulbosa.*

Regarding the anatomy of the reproductive system reference is made to Kawakatsu's (1968: 7–10) description and illustrations. The features distinguishing *P. tahoena* from other members of the genus *Phagocata* are as follows: Testes numerous, extending posteriorly almost to the tail end, predominantly ventral but with some testes ascending dorsally in the mesenchymatic spaces between the branches of the intestine; penis with well-developed bulb and conical or finger-shaped papilla; lumen of penis wide, not clearly differentiated into a seminal vesicle and an ejaculatory duct, receiving many glandular canals which have penetrated the penial tissues from the surrounding mesenchyme; penis lumen opening into the male atrium at the tip of the penis papilla; vasa deferentia opening into penial cavity separately from the antero-lateral sides; ovovitelline ducts ascending dorsally at the level of the copulatory complex, the left one passing through the space between the wall of the male atrium and the duct of the copulatory bursa, uniting with the right one above the atrium, the common oviduct thus formed opening into the posterior part of the male atrium (with regard to this situation, Kawakatsu's figure 2 is misleading); copulatory bursa and its duct both lined with a very thick epithelium, the bursal duct displaced to the left of the midline, showing no histological division into an anterior canal and a posterior "vagina."

Distribution: Kawakatsu's material was obtained from 40 bottom samples collected by an Ekman dredge at depths of 15 to 1632 feet in various sections of Lake Tahoe (Placer and El Dorado Counties, California; and Washoe and Douglas Counties, Nevada). My own collections were all made in the southern part of the lake:

Off south shore of Lake Tahoe, near Al Tahoe, El Dorado County, California. Two specimens collected by trawling dredge at about 40 m depth, one of them sexually mature, 23 September 1967.

Emerald Bay of Lake Tahoe, El Dorado County, California, on liver bait exposed for 24 hours at depth of about 40 m. About half a dozen specimens collected 12 July 1968.

Off Pope Beach, El Dorado County, California, on liver bait left 24 hours at a depth of 89 m, very many (certainly over 100) specimens, both sexually mature and young, 12 July 1968.

So far Lake Tahoe is the only known locality of *Phagocata tahoena.* However, the species may be more widely distributed in lakes of the Sierra Nevada mountain range which is still very little explored with regard to turbellarians.

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Fig. 10. *Phagocata tahoena*, part of transversal section. *g*, gregarine parasites in mesenchyme; *i*, intestine; *t*, testis. ×114.

Taxonomic position: *Phagocata tahoena* has been described by Kawakatsu as a subspecies of *P. nivea* Kenk (1953). There are, however, sufficient morphological differences between these two forms to justify giving *tahoena* the rank of a separate species. Of external characters, the plumpness of the body is quite remarkable, the rounded anterior end (truncate in *P. nivea*), the position of the eyes, and the presence of body pigment differ from the corresponding features observed in *P. nivea*. Among the anatomical characters, the structure of the penis, in particular the opening of the penis lumen at the tip of the penis papilla, separates *P. tahoena* from *P. nivea* (in which the penis lumen opens on the ventral side of the papilla). There is hardly any close taxonomic relationship between the two species. From an evolutionary standpoint it would also seem to be somewhat paradoxical to have an unpigmented surface species (*P. nivea*) closely related to a pigmented subspecies inhabiting the bottom of a deep lake. *P. tahoena* is, therefore, here considered to be a species separate from *P. nivea*.

Parasites: Some of the specimens of *Phagocata tahoena* examined in serial sections were infested with gregarines either encysted in the mesenchyme or more rarely free in the intestinal cavity. The cysts located in the mesenchyme were more or less spherical or ovoidal masses, each containing a pair of gametocytes (Fig. 10), similar to those described and illustrated by Holmquist (1967, fig. 7f-g) from *Dendro-*

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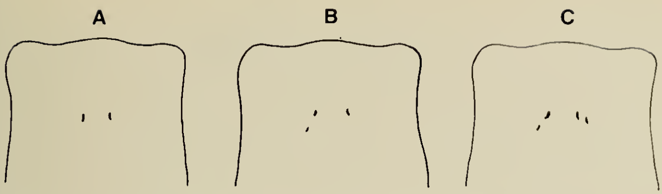

FIG. 11. *Phagocata oregonensis*, anterior end. A, normal two-eyed specimen; B and C, specimens with accessory eyes.

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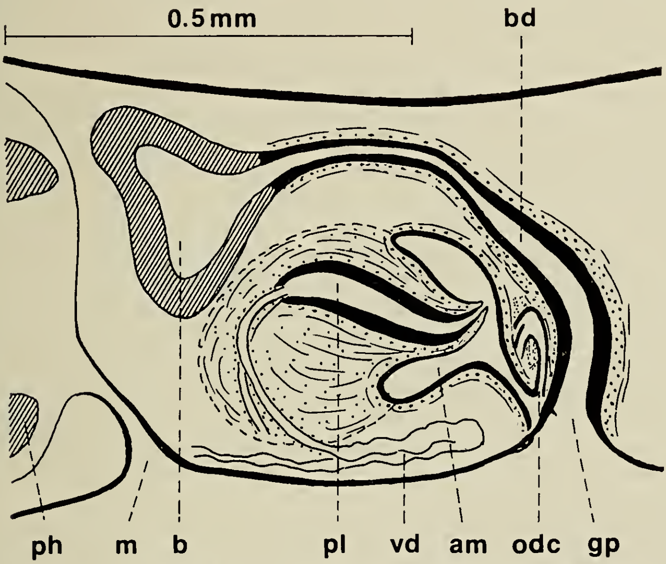

FIG. 12. *P. oregonensis*, copulatory apparatus in sagittal section. *am*, male atrium; *b*, copulatory bursa; *bd*, bursa duct; *gp*, gonopore; *m*, mouth; *odc*, common oviduct; *ph*, pharynx; *pl*, penis lumen; *vd*, vas deferens.

coelopsis piriformis. No stages of gamete or spore formation were observed.

Phagocata oregonensis Hyman, 1963

A brief description and rather sketchy illustrations of this species were given by Hyman (1963: 2–4), based mainly on the study of preserved specimens. No further mention has been made of the species in the literature, except for its inclusion in an analytical key to the American representatives of the genus *Phagocata* by Carpenter (1969: 281) and the presentation of an outline drawing of the anterior end in a recent paper (Kenk, 1969: 550).

External features (Fig. 1C and 11): This is an unpigmented, white, species. Mature specimens are up to 8 mm long and 1.5 mm wide. The head is truncate, with a somewhat waved frontal margin with slightly protuberant central and lateral portions (this condition is exaggerated in Hyman's figure, 1963: 3, fig. 1). The lateral or auricular edges of the head are rounded, protruding very gently laterally so that an indistinct necklike constriction appears behind them when the animal is in gliding motion. Behind the neck, the lateral margins of the body gradually widen up to the level of the pharynx, then converge again to meet at the more or less pointed posterior end. The root of the pharynx lies somewhat anterior to the middle of the body, and its length amounts to one-fifth the body length. The copulatory apparatus occupies less than half the length of the post-pharyngeal region.

The two principal eyes are situated close together, their distance from each other amounting to one-fifth to one-fourth the width of the head and the distance of each eye from the lateral margin being about equal that from the frontal margin. Supernumerary eyes are frequently observed, particularly in "old" individuals that have been kept in a culture for several months. Individual eyes may appear lateral or posterior to the principal eyes, either on one or on both sides (Fig. 11). It is well known that planarians with one pair of principal eyes frequently develop accessory eye spots and that the occurrence and number of these increases with the advancing age of the animals (Balázs, 1962).

The intestinal system begins a short distance behind the level of the eyes; there is no diverticulum or extension of the anterior intestinal ramus reaching forward between the eyes to a preocular level, such as is seen in some other white planarians with truncate head (*e.g. Planaria occulta*, see fig 1*a* in Kenk, 1969: 550). The anterior ramus bears 5–6 lateral branches, each posterior ramus 13–17 branches.

Reproductive system (Fig. 12): The zone of the ventrally located testes extends on either side from the level of the second intestinal side branch to the posterior end (it does not end in the region of the copulatory complex as Hyman indicates). The ovaries, ovovitelline ducts, and yolk glands present no peculiarities. The copulatory apparatus (Fig. 12) conforms with the design typical of the genus *Phagocata*. The genital aperture or gonopore (*gp*) leads dorsally into the duct of the copulatory bursa (*bd*) and anteriorly into the male atrium (*am*); there is no common atrium developed. The penis has a bulb of moderate size with generally concentrically arranged muscle fibers and a conical, pointed papilla. The lumen of the penis (*pl*), situated in the posterior part of the bulb and traversing the length of the papilla, is a uniform cavity not differentiated into a seminal vesicle and an ejaculatory duct. It gradually narrows posteriorly and opens at the tip of the papilla. This cavity is lined with an epithelium of tall cells of glandular nature and is at least partially filled with the secretion produced by these cells. The outer cover of the papilla and the lining of the atrial cavity consist of flattened to cuboidal cells, below which there is a layer of circular muscle fibers and a deeper layer of longitudinal muscles. The penial cavity also has a thin coating of circular and a more pronounced layer of longitudinal fibers.

The two sperm ducts or vasa deferentia (*vd*), which at the sides of the pharynx expand to form the tortuous spermiductal vesicles, proceed posteriorly to the level of the male atrium, then turn forward again, enter the penis bulb laterally, and open into the penis lumen separately but close together. Hyman's material on which she based her description of the anatomy of *P. oregonensis* was apparently defective since she states that she could not trace the sperm ducts into the penis bulb and assumed that they unite at the anterior margin of the bulb to form a common sperm duct which she interprets as an ejaculatory duct. My slides show clearly that each sperm duct, after forming the backward loop on the side of the atrium, enters the bulb and opens into the wide penis lumen independently. The lumen itself apparently corresponds to a combination of an anterior seminal vesicle and a distal ejaculatory duct without showing either a morphological or a histological differentiation into these two portions.

The two ovovitelline ducts unite in the usual way in the space between the dorsal wall of the atrium and the duct of the copulatory bursa. The common oviduct (*odc*) opens into the male atrium. Both the end parts of the paired oviducts and the common oviduct are provided with eosinophilic gland ducts which penetrate their epithelia from the surrounding mesenchyme.

The copulatory bursa (*b*) and its canal (*bd*) show no special differentiations. The canal or stalk gradually widens as it bends ventrally toward the gonopore, slightly left of the midline. The entire canal has two muscular coast, a circular and a longitudinal one. In the widened posterior part of the bursa stalk the circular layer gradually increases in thickness producing a terminal "vagina" without a sharp demarcation.

Distribution: Hyman's type material of *Phagocata oregonensis* was "from the vicinity of Crystal Springs in the Eastmoreland District of Portland," Oregon. I visited this area on 12 September 1967 in the company of Mr. Richard Whitten of the Powell Laboratories of Gladstone, Oregon, and collected numerous specimens on liver bait in Woodbury Spring (Eastmoreland District of Portland, Multnomah County), a small limnocrene with almost stagnant, clear water. The water temperature was 11.2° C, the pH 6.3. The species was accompanied by two other planarian species, *Dendrocoelopsis vaginata* Hyman and *Polycelis* sp.

Laboratory cultures: P. oregonensis was kept in an aquarium with spring water at 14° C for 13 months, fed alternately beef liver and live *Tubifex* worms (both were freely taken). Some specimens were sexually mature but did not deposit any egg capsules, nor did fission occur during the entire period.

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PROCEEDINGS
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THREE NEW SPECIES OF CALLIANASSID SHRIMP (DECAPODA, THALASSINIDEA) FROM THE WESTERN ATLANTIC[1]

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Three new species of *Callianassa* were discovered during a recent study of the callianassid fauna of South Florida. Since the comprehensive publication will not appear for some time, it was deemed best to publish the descriptions of the new species separately.

Specimens of the new species described below were first collected by the author in South Florida in 1967, but these specimens were later destroyed. Fortunately, additional material was available from other sources. I am most grateful to Mr. William Lyons of the Florida Board of Conservation Marine Laboratory, St. Petersburg (FBCML), for the loan of specimens of *Callianassa trilobata* dredged from Tampa Bay. I am indebted to Dr. Raymond B. Manning, Smithsonian Institution (USNM), for his assistance on a number of occasions and for the loans of specimens and to Dr. Herbert W. Levi of the Museum of Comparative Zoology (MCZ) for the loan of material containing specimens of all three new species.

The material at the National Museum of Natural History was examined during a trip sponsored by the Office of Academic Affairs of the Smithsonian Institution. During a

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portion of the study, the author was supported by a National Science Foundation traineeship.

Measurements given for specimens refer to total length. The term P3 is an abbreviation for third pereiopod. Other legs are referred to similarly.

Callianassa trilobata new species

Figure 1

Holotype: 1♂, 76 mm; Florida, Tampa Bay, off Pinellas Point; 18 January 1968; R. Stokes. EJ-68-2 (FBCML).

Paratypes: 1♀, 66 mm; Florida, Miami, Virginia Key, Bear Cut beach; 12 April 1959; R. Manning. USNM.

1 juvenile, 35.5 mm; Florida, Biscayne Bay; March–April 1937; H. L. Clark. MCZ 9697.

2♀♀, 77–80.5 mm; Florida, Tampa Bay, SW of Bayboro Harbor; 2–4 m; 16–17 January 1968; R. Stokes. EJ-68-1 (FBCML).

1 damaged ♀; Florida, Tampa Bay, off Bayboro Harbor; 2.5–3.5 m; 22 February 1968; Stokes and Lyons. EJ-68-7 (FBCML).

1♂, 60 mm, 1 damaged ♂, 8♀♀, 39.5–77.5 mm; Florida, Tampa Bay, off Pinellas Point; 2–3 m; 18 January 1968; R. Stokes. EJ-68-2 (FBCML).

Diagnosis: Front with three low, subtriangular projections. Telson trilobed laterally, much wider than long. Large cheliped with triangular ventral keel on merus. Eye of fresh specimen with white spot in center of pigmented area.

Description: Rostrum and lateral projections short rounded triangles. Rostrum 0.2 times length of eyestalks. Lateral projections situated between eyestalks and base of antennal peduncle. Eyestalks flattened, not reaching tip of first antennular segment, length 1.45–2.0 times width; lateral margins straight, directed slightly inward; distal margins straight, more obliquely directed, lacking distal projections; pigmented area central, slightly convex, elongate longitudinally, covering about 0.5 exposed dorsal surface of eyestalk; cornea small, subterminal, covering about 0.2 pigmented area. Dorsal carapace posterior to cervical groove with median prominence set off by oblique ridges.

Third segment of antennule 1–1.4 times length of second segment. Third antennular segment 0.6–0.9 times length of fourth antennal segment. Fourth antennal segment 1.25–1.85 times length of fifth segment. Antennal flagellum 2.5–4.3 times length of antennular. Second segment of antennule reaching 0.6 length of fourth antennal segment. Third antennular segment to 0.25 fifth antennal segment. Second and third segments of antennule with dense rows of elongate setae on their lateral surfaces. Third segment of antenna with numerous elongate setae laterally.

Incisor process of mandible with 16 acute teeth of varying sizes

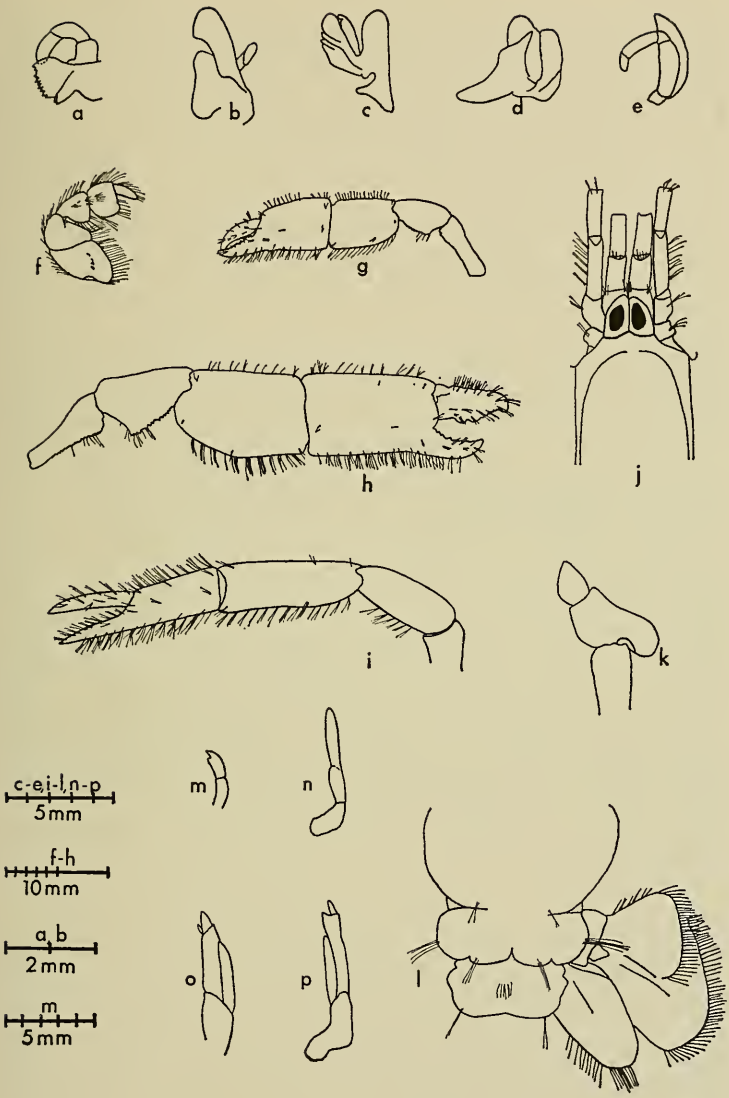

FIG. 1. *Callianassa trilobata*: a, mandible; b, first maxilla; c, second maxilla; d, first maxilliped; e, second maxilliped; f, third maxilliped; g, female large cheliped; h, male large cheliped; i, small cheliped; j, dorsum; k, P3; l, tail fan; m, male first pleopod; n, female first pleopod; o, male second pleopod; p, female second pleopod.

extending along entire margin, molar process bifurcate ventrally, tips acute, remainder of process entire. First maxilla with wide basal endite, slightly expanded distally, margin rounded; coxal endite with narrow, rounded distal lobe. Epipod of first maxilliped triangular, broadly rounded laterally; basal endite with straight lateral margins, rounded tip; exopod not distinctly bilobed, slight indentation on inner margin. Second maxilliped with exopod longer (1.5) than first segment of endopod. Merus and ischium of third maxilliped wide, length of both segments 1.5–2.0 times greatest width, ischium lacking spinous ridge on internal surface except for 3–4 proximally-directed free spines at proximal end; propodus expanded, width 0.73 times width of merus, with small rounded lobe distoventrally; width of dactylus 0.25 times width of propodus.

Ischium of large cheliped of male slightly expanded distoventrally, ventral margin with series of 23 rounded denticles, smallest proximally. Length of merus 1.6–1.8 times greatest width, proximal end of dorsal margin raised, with inconspicuous rounded denticles; ventral margin expanded, forming triangular keel, concave and entire proximally, remainder of margin with about 17 rounded serrations. Length of carpus 1–1.1 times length of merus, carpus width 0.75–0.95 times length, wider medially due to convex proximal margin; ventral margin of carpus inconspicuously serrate on inner surface, serrations separated by short fringes of setae. Length of palm 1.2–1.4 times length of carpus, palm length 1.35–1.6 times width, ventral margin weakly serrate on inner surface. Propodal finger blunt, curving slightly inward, cutting edge with three acute, triangular teeth proximally, two moderately strong rounded teeth medially, six low rounded teeth distally; series of blisters running along internal surface of finger. Length of dactylus 0.5 times length of palm, cutting edge with two irregular, truncate teeth proximally, series of 10 rounded teeth distally. Internal surface of dactylus with series of blisters interspersed with tufts of hair, dorsal margin similar, blisters more acute.

Large cheliped sexually dimorphic. Ventral margin of ischium of cheliped of female with several inconspicuous denticles. Length of merus 1.5–2.0 times width, dorsal margin convex, ventral keel present but not as strong as in male, fewer denticles on margin distally. Length of carpus 0.9–1.1 times length of merus, length of carpus 0.9–1.3 times width, ventral margin entire. Palm longer (1.05–1.55) than carpus, longer than wide (1.02–1.4), ventral margin entire. Propodal finger blistered on internal surface below cutting edge, cutting edge with proximal series of small triangular teeth, strong triangular tooth proximal to midpoint of edge, distal series of approximately 10 small rounded teeth decreasing in size toward tip. Small multilobed projection at base of notch between fingers. Dactylus narrow, curving inward, length 0.65–0.95 times length of palm, low serrate ridge running transversely across cutting edge proximally, remainder of edge straight, inconspicuously

TABLE 1. Branchial Formula of *Callianassa trilobata.*

	Maxillipeds			Walking legs				
Gill type	1	2	3	1	2	3	4	5
Pleurobranchs	–	–	–	–	–	–	–	–
Arthrobranchs	–	*	2	2	2	2	2	–
Podobranchs	–	–	–	–	–	–	–	–

* A single rudimentary gill may be present.

serrate; internal surface with scattered blisters, dorsal margin lacking blisters found in male.

Ischium of small cheliped lacking ventral serrations. Merus with simple convex dorsal margin, ventral margin lacking keel or denticles. Carpus narrow, length 2.5 times width. Palm shorter than carpus, narrowing distally. Propodal finger long and thin, cutting edge entire. Dactylus straight, narrow, cutting edge entire.

Propodus of third pereiopod (P3) bilobed, posterior lobe wide, rounded, ventral margin concave. P4 subchelate, P5 chelate. Branchial formula shown in Table 1, second maxilliped with rudimentary arthrobranch.

Abdomen elongate, well developed. First abdominal somite divided by transverse dorsal ridge, anterior 0.2 of somite narrow, rounded anteriorly, posterior area widening toward posterior margin. Well developed fringe of hair on posterolateral margins of third and fourth somites, length of fringes 0.25 times somite width. Fifth somite with similar fringe midlaterally. Lateral margin of sixth somite distinctly bilobed by strong transverse groove separating anterior three quarters from posterior quarter; lateral margin of anterior lobe inconspicuously bilobed with indentation occurring one-third length of lobe from anterior margin; posterior margin of somite indented.

Telson distinctly wider (1.14–1.6) than long, lateral margins trilobed; posterior margin concave centrally.

First pleopod of male uniramous, two-segmented, distal segment with acute tip, rounded prominence distolaterally. Second pleopod of male biramous, exopod bladelike, acute at tip, 0.78 times length of first segment of endopod. First segment of endopod bladelike, wider than exopod; second segment triangular with acute distal tip; third segment small, elongate, articulating laterally at junction of first and second segments. First pleopod of female uniramous, two-segmented, distal segment thick at base, bladelike distally. Second pleopod biramous, exopod bladelike, shorter than first segment of endopod. Endopod two-segmented, first segment bladelike, projecting slightly at distal tip and forming subchela with small, elongate second segment. *Appendix interna* of third through fifth pleopods subtriangular in outline, hooks located along lateral surface.

Endopod of uropod elongate oval, length 1.5–1.95 times width, narrowing distally, fringe of fine setae along distal half of posterior margin, denser fringe at distal tip. Exopod of uropod slightly longer than endopod, lower exopodal plate longest posteriorly, with dense fringe of setae. Single basal spine present. Suture distinct. Upper exopodal plate 0.6 times length of lower plate.

Color: Entire animal white. Eye of fresh specimen with white spot in center of pigmented area.

Dimensions of Holotype: EJ-68-2 (FBCML), ♂. Total length 76 mm, carapace length 17 mm. Telson width 5.0 mm, length 4.4 mm. Width of endopod of uropod 3.5 mm, length 5.9 mm. Large cheliped: width of merus 5.9 mm, length 10.6 mm; width of carpus 9.0 mm, length 11.9 mm; width of propodus 8.9 mm, length 14.2 mm; length of dactylus 7.25 mm.

Known Range: Miami and Tampa Bay, Florida.

Discussion: There are similarities between the cheliped of this species and that of *C. audax* de Man, but the species can be distinguished by the form of the telson, shape of the eyestalks and endopod of the uropod, and the keel on the merus of the large cheliped in *C. trilobata.*

Remarks: Two specimens are known which, because they exhibit characters usually associated with the male (form of the large cheliped and the pleopods), have been termed males and described as such. However, both specimens have male and female coxal apertures. The reason for this phenomenon is not yet apparent.

Etymology: The name is derived from the lateral contours of the telson.

Callianassa quadracuta new species
Figure 2

Holotype: 1♂, 68 mm; Venezuela, Cumaná; 1859; J. P. Couthouy. MCZ 760.

Paratypes: 1♂, 75 mm, 2♀♀, 27–39 mm, 1 ovigerous ♀, 62 mm; Venezuela, Cumaná; 1859; J. P. Couthouy. MCZ 760.

1♂, 69 mm, 1♀, 74.5 mm, 2 damaged ♀♀; Venezuela, Cumaná; 1859; J. P. Couthouy. MCZ 732.

1 ovigerous ♀, 70 mm; Venezuela, Cumaná; 1859; L. Agassiz. MCZ 12872.

Diagnosis: Chelipeds of first walking legs subequal, carpus with two acute distodorsal and two acute distoventral projections, distodorsal corner of palm an acute projection. Endopod of uropod triangular, extending well beyond distal margin of telson. Telson distinctly wider than long. Dactylus of third maxilliped expanded distally, width 0.75–0.9 times width of propodus.

Description: Carapace with two weak ridges dorsally, one on either side of midline running parallel to body axis, terminating before reaching front. Short median ridge narrowing anteriorly, continuous with rostrum.

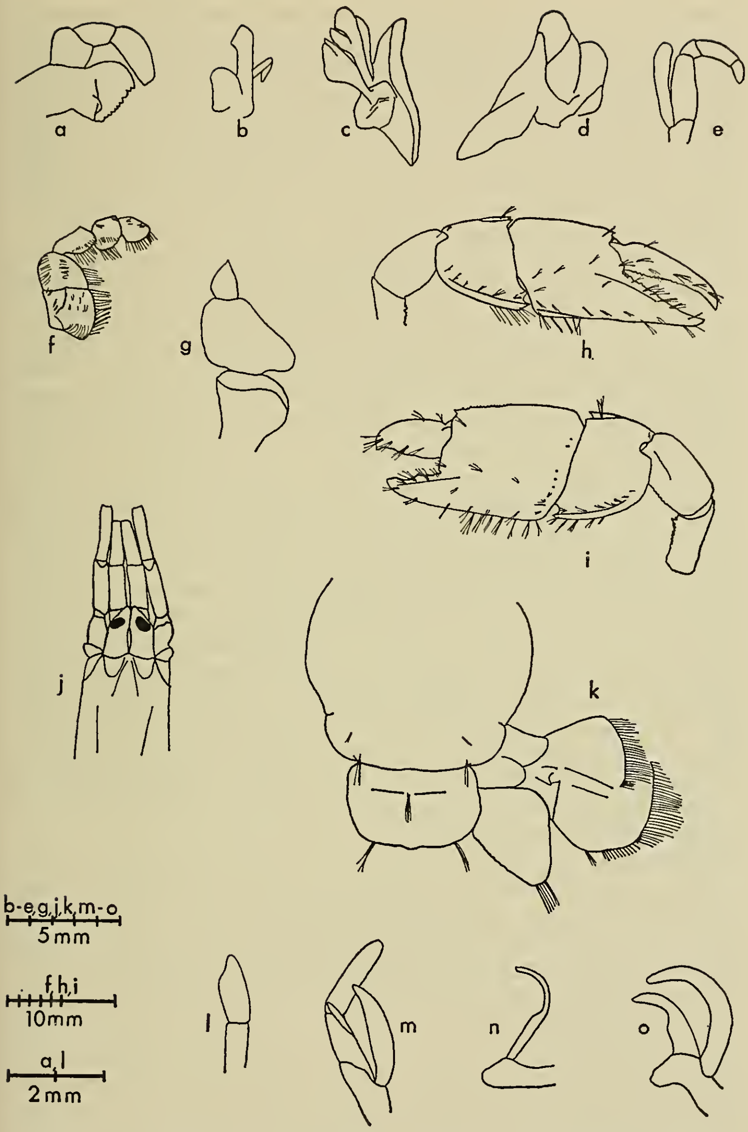

FIG. 2. *Callianassa quadracuta*: a, mandible; b, first maxilla; c, second maxilla; d, first maxilliped; e, second maxilliped; f, third maxilliped; g, P3; h, small cheliped; i, large cheliped; j, dorsum; k, tail fan; l, male first pleopod; m, male second pleopod; n, female first pleopod; o, female second pleopod.

Convex area as wide as eyestalk located over base of eye, narrowing posteriorly. Posterior area of carapace with ridge along dorsal midline.

Rostrum a low acute triangle extending 0.1–0.2 times length of eyestalks, slightly depressed. Lateral projections low rounded triangles at external margin of eyestalks. Eyestalks flattened, extending beyond distal margin of first antennular segment, length 1.8–2.8 times width; lateral margins indistinctly concave; distal margin straight, median projection denticulate at tip; cornea lateral, subterminal, covering about 0.1 exposed dorsal surface of eyestalks.

Length of third antennular segment 0.75–0.95 times length of second segment. Third antennular segment 0.6–0.8 times length of fourth antennal segment. Fourth antennal segment 1.06–1.5 times length of fifth segment. Antennal flagellum 2.5–4.35 times length of antennular. Second antennular segment extending to 0.9 length of fourth antennal segment. Third antennular segment to 0.75 fifth antennal segment. Second and third antennular segments with dense rows of elongate setae laterally.

Basis of mandible wide, first segment of palp shorter than second segment, incisor process with 10 truncate teeth, some inconspicuously serrate, molar process entire, bifurcate ventrally. Basal endite of first maxilla slightly expanded distally, distal margin straight; coxal endite with indication of distal lobe. Epipod of first maxilliped triangular, narrowly rounded distally; basal endite rounded; internal margin of exopod indented. Exopod of second maxilliped longer (1.3) than first segment of endopod. Merus and ischium of third maxilliped wide, length of both segments 1.55–1.85 times greatest width of either segment, spinous ridge on ischium with seven free spines distally, distal-most largest, remainder of ridge with about eight denticles; propodus not expanded, width 0.6–0.7 times width of ischium; width of dactylus measured proximally 0.35 times width of propodus, 0.75–0.9 times if width of dactylus measured distally.

Chelipeds of first pereiopods subequal. Ischium of left cheliped short, with 18 subacute denticles ventrally, longer spine near distal end. Merus with two inconspicuous denticles proximally on ventral margin, five denticles medially, length of merus 1.53–1.74 times width. Carpus shorter (0.8–0.9) than merus, length 0.65–0.85 times width, dorsal margin cristate proximally, divided on external surface distally forming two acute projections, one above the other, at distodorsal corner; ventral margin entire, secondary ridge just above margin on external surface, terminating distally as acute projection, second acute projection just above ventral-most articulation with palm. Palm longer (1–1.32) than wide, longer (1.6–1.96) than carpus; ventral margin of palm entire, rounded, dorsal margin cristate on proximal half, distal half with minute denticles, terminating distally as acute projection; distal margin of palm inconspicuously serrate along articulation with dactylus, slightly blistered behind notch between fingers. Series of raised tufts of hair on external surface of palm near proximoventral articulation. Propodal finger strong, blunt at tip, much shorter than dactylus, series of 15 rounded denticles proximally on cutting edge ending at median triangular tooth, remainder of cutting edge inconspicuously serrate. Weak ridge running along outer surface below cutting edge and for short distance on palm. Dactylus strong, length 0.6–0.75 times length of palm, blunt and curving inward distally; cutting edge entire on proximal third, serrate on remainder.

Ischium of right cheliped as in left, ventral margin with 16 irregular denticles and single spine near distal end. Merus as in left, length 1.45–1.8 times width. Carpus as in left with four acute projections distally, length 0.76 times width, length 0.85–0.95 times length of merus. Length of palm 1.17–1.52 times length of carpus, notably shorter and more oblique than palm of left cheliped, dorsal margin lacking distal serrations, ridge on propodal finger and palm more distinct. Propodal finger subacute distally, curving slightly inward, cutting edge with 10 irregular serrations. Dactylus slender, subacute distally, length 1.05–1.2 times length of palm, cutting edge with series of rounded denticles decreasing in size distally. For practical purposes, this cheliped termed small cheliped.

Propodus of P3 with narrow rounded lobe posteriorly, anterior margin slightly convex, segment about as long as broad. P4 simple, P5 chelate. Branchial formula as in *C. trilobata*, all gills well developed, gill of second maxilliped with lamellae.

First abdominal somite divided by transverse ridge; anterior quarter subrectangular, widening posteriorly; margins of posterior area diverging and continuing laterally almost to level of pleopod articulation before reaching posterior margin of somite. Third and fourth somites with well developed fringe of hair posterolaterally on dorsal surface. Fifth somite with well developed midlateral fringe. Lateral margin of sixth somite bilobed, anterior lobe distinctly wider than posterior, lateral margins convex; posterior lobe separated from anterior by lateral indentation, lacking well defined groove; posterior margin of somite with hint of indentation at midline, stronger indentation just beyond tufts of hair. Telson distinctly wider (1.46–1.76) than long; lateral margins with slight indentation in anterior third, remainder convex; posterior corners smoothly rounded, posterior margin with median convex projection. Dorsal surface of telson convex, distinct transverse ridge on proximal half interrupted medially by tuft of hair.

First pleopod of male uniramous, two-segmented, distal segment elongate, rounded distally, slight indentation on internal margin. Second pleopod of male biramous, exopod bladelike, subacute at tip. Endopod two-segmented, proximal segment with pliable flap running along distal half of lateral margin, distal segment bladelike, rounded at tip. First pleopod of female uniramous, two-segmented, proximal segment extending horizontally beyond level of articulation of second segment; distal segment bladelike, thicker proximally, rounded at tip. Second pleopod of female biramous, peduncle extending horizontally beyond level of articulation of endopod; exopod bladelike, curving inward, longer than endopod; endopod bladelike, thicker proximally, with only one segment. *Appendix interna* of third through fifth pleopods subtriangular with hooks along lateral surface.

Endopod of uropod triangular, length 1.2–1.7 times width, distal tip extending 2.1 times length of telson beyond posterior margin of telson; margins slightly irregular due to widely spaced setae, dense fringe of setae at distal tip. No median ridge. Exopod of uropod longer than endopod, upper exopodal plate with dense fringe of setae, posterodistal margin with two rows of approximately 14 strong setae. Suture distinct. Lower plate fringed with both hair and setae distally, strong short setae forming dorsal row; posterior corner with row of 12 strong spinelike setae. Ridge lacking, one strong basal spine present.

Color: Thorax and chelipeds white, remainder unknown in fresh material, entire animal beige when preserved in alcohol.

Dimensions of Holotype: MCZ 760, ♂. Total length 68 mm, carapace length 17 mm. Telson width 5.5 mm, length 3.75 mm. Width of endopod of uropod 2.75 mm, length 4.5 mm. Left cheliped: width of merus 4.25 mm, length 6.85 mm; width of carpus 8.4 mm, length 5.9 mm; width of propodus 9.5 mm, length 10.9 mm; length of dactylus 6.6 mm. Right cheliped: width of merus 4.0 mm, length 6.4 mm; width of carpus 8.0 mm, length 6.1 mm; width of propodus 8.4 mm, length 8.5 mm; length of dactylus 10.0 mm.

Known Range: SE Florida, Venezuela.

Discussion: This species appears to be closely related to *C. aequimana* Baker from Australia and to *C. novaebritanniae* Borradaile and its variety which was described by de Man (1928). De Man separated the two species and the variety based on the telson morphology, size, morphology, of the ischium of the large cheliped, and several less distinctive characters. As Sakai (1966) noted, for practical purposes, the ridge on the dorsal surface of the telson is most useful. *Callianassa quadracuta*, like *C. aequimana*, has a notched ridge, while *C. novaebritanniae* has a continuous weak ridge, and the variety lacks any ridge. In addition, the acute distal projections on the carpus of the cheliped and the convex posterior border of the telson separate *C. quadracuta* from all these Pacific forms.

Only one other species, *Callianassa laticauda* Otto, has been described as having a relatively well-developed gill on the second maxilliped (Gurney, 1944). The significance of the character is unknown since the branchial formula has been described for only a small number of species of *Callianassa*. No other characters relating *C. laticauda* and *C. quadracuta* are immediately apparent.

Etymology: The name of the species is derived from the acute projections on the carpus of the chelipeds.

Callianassa fragilis new species

Figure 3

Holotype: 1♂, 27 mm; Puerto Rico, Punta Arenas, sand flat; 12 June 1946; H. G. Hewatt. USNM 82367.

Paratypes: 1 damaged ♂; data as in holotype.

1♀, 16.5 mm; Antigua, Falmouth Bay, Black's Point; 30 April 1959; Smithsonian Bredin Expedition 112–59. USNM.

2♂♂, 39–40 mm; Venezuela, Cumaná; 1859; Capt. Couthouy. MCZ 760.

Additional specimens have been collected around Miami and have been deposited in the collection at the University of Miami Marine Institute.

Diagnosis: Total length less than 45 mm. Merus of large cheliped with proximal hook directed distally. Third segment of antennule extending beyond distal end of fifth antennal segment. Telson shield-shaped, with posteromedian concavity. Endopod of uropod wide oval, extending beyond posterior margin of telson.

Description: Rostrum and lateral projections rounded triangles. Rostrum extending only 0.07–0.23 times length of eyestalks. Lateral projections just beyond margin of eyestalks, not extending as far anteriorly as rostrum. Eyestalks elongate, extending almost to end of first antennular segment, length 2.2–2.7 times width; lateral margin more or less straight, directed at slight oblique angle inward; distal margin straight, more inwardly directed, with internal triangular projection; pigmented area central, subterminal, covering about 0.05 exposed dorsal surface of eyestalks, irregular in shape.

Length of third antennular segment 2.2–3.7 times length of second antennular segment. Third antennular segment 1.25–1.7 times length of fourth antennal segment. Fourth antennal segment 1.15–1.55 times length of fifth antennal segment. Antennal flagellum 2.75–4.2 times length of antennular. Second antennular segment extending to 0.55 length of fourth antennal segment. Third antennular segment to just beyond distal end of fifth antennal segment. Second and third antennular segments moderately fringed with setae on lateral surfaces.

Mandible with 12 teeth in incisor process, teeth progressively larger toward ventral end, molar process with two strong ventral teeth and four smaller teeth dorsally. Basal endite of first maxilla expanded distally, rounded; coxal endite narrow, with small rounded distal lobe. Basal endite of first maxilliped convex distally; exopod squared distally, with indentation on internal margin; epipod lacks distal acute projection, narrowly rounded laterally. Exopod of second maxilliped only 0.75 times length of first segment of endopod. Merus and ischium of third maxilliped wide, length of segments 1.4–1.6 times greatest width, internal surface of ischium with 16 weak denticles; merus subrectangular, disto-ventral area a rounded corner; propodus only slightly expanded proxi-

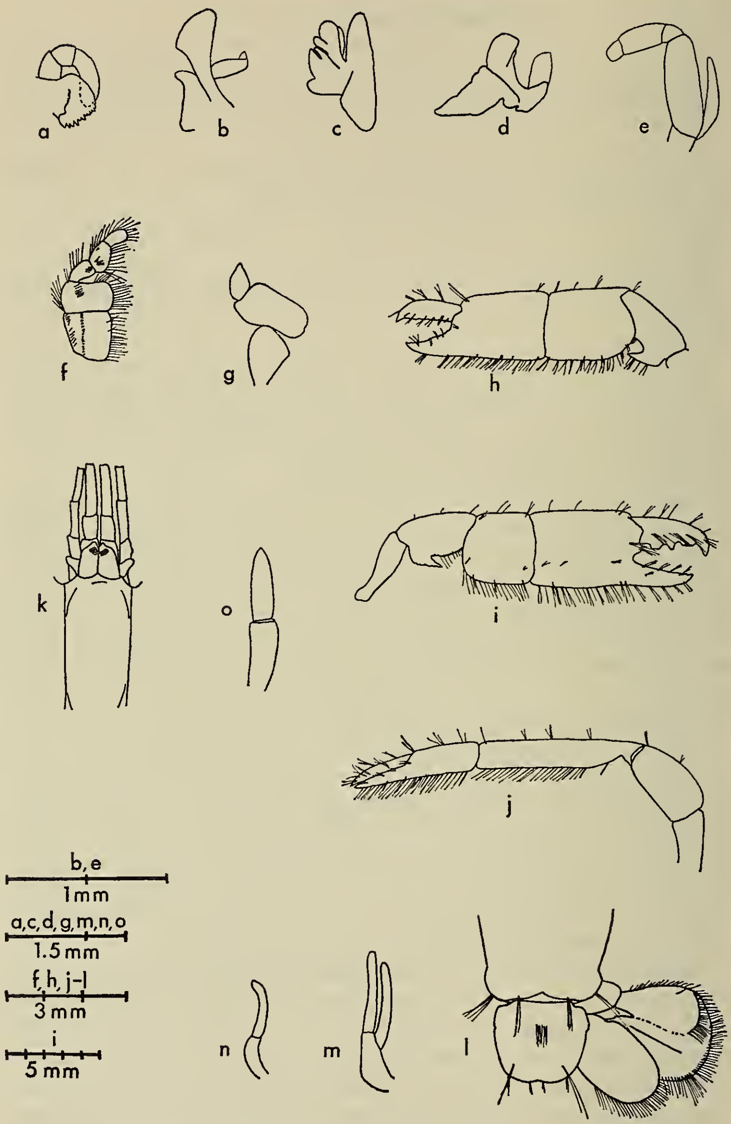

FIG. 3. *Callianassa fragilis*: a, mandible; b, first maxilla; c, second maxilla; d, first maxilliped; e, second maxilliped; f, third maxilliped; g, P3; h, female large cheliped; i, male large cheliped; j, small cheliped; k, dorsum; l, tail fan; m, female second pleopod; n, female first pleopod; o, male first pleopod.

mally, width 0.43 times width of merus; width of dactylus 0.4–0.67 times width of propodus.

Ischium of large cheliped of male with five broad, inconspicuous serrations ventrally. Merus more than twice (2–2.2) as long as wide, proximoventral margin produced into distally directed hook, hook with 3–4 strong serrations ventrally, acute tip; remainder of ventral margin with 11 denticles separated by tufts of hair. Length of carpus 0.68–0.9 times length of merus, longer medially due to convex proximal margin; width of carpus 1.1–1.4 times dorsal length, ventral margin entire. Palm longer (1.3–1.8) than carpus, length greater (1.15–1.3) than width, ventral margin entire. Propodal finger shorter than dactylus, cutting edge entire. Notch between fingers rounded, extending proximally for a short distance. Dactylus 0.6–0.82 times length of palm, truncate teeth proximally and distally with three or four rounded serrations on cutting edge of distal tooth, proximal tooth entire or serrate, triangular tooth medially. Tip of dactylus strongly curved, not hooked.

Ischium and merus of female cheliped like those of male. Carpus longer than wide (1.14–1.22), length equalling length of merus, almost (0.9–0.95) as long as palm. Palm narrowing distally, slightly narrower than carpus. Propodal finger serrate along cutting edge, notch between fingers not extending proximally. Dactylus slightly curved, lacking strong dentition, cutting edge serrate.

Ischium and merus of small cheliped lacking ventral denticles. Ventral margin of merus inconspicuously concave proximally, lacking hook. Carpus elongate, length 5–6 times width. Palm narrow, length 0.4 times length of carpus, notch not extending proximally. Propodal finger almost as long as dactylus, minute serrations on cutting edge. Dactylus straight, cutting edge entire.

Propodus of P3 bilobed, dactylus with acute tip. P4 simple, P5 chelate. Branchial formula as in *C. trilobata*, second maxilliped lacking rudimentary gill.

First abdominal somite short, lacking any transverse ridge. Third somite with tuft of hair in posterolateral corner. Fourth somite with midlateral tuft. Fifth somite with tuft of hair in anterior third of lateral margin. Lateral margin of sixth somite weakly bilobed, margins of anterior 0.75 slightly convex, fringed with fine hair, separated from posterior rounded lobes by indistinct groove; posterior margin indented medially.

Telson shield-shaped, width 1.16 times length, median concavity in posterior margin; lateral margins convex, slight notch 0.25 total length from proximal end, remainder of margin smoothly rounded; tuft of elongate setae on dorsal surface set back from each posterior corner.

First pleopod of female uniramous, two-segmented, distal segment bladelike, rounded at tip. Second pleopod biramous, exopod bladelike, rounded at tip, shorter than endopod (0.88); endopod similar, with transverse articulation 0.65 total length from proximal articulation. First

TABLE 2. Morphological Characteristics of *Callianassa atlantica* and *C. fragilis*.

Characteristic	*C. atlantica*	*C. fragilis*
Telson posterior border	acute median projection	median indentation
Eyestalk	beyond 1st antennular segment	shorter than 1st antennular segment
Eyestalk projection	slender, curving	short, rounded
3rd antennular segment / 2nd antennular segment	3.6–5.3	2.2–3.7
large cheliped fingers	about equal	dactylus longer
small cheliped carpus length/width	3.6–4.0	4.5–5.1
dactylus of 3rd maxilliped	slender	wide

pleopod of male uniramous, two-segmented, distal segment elongate, subacute at tip. No indication of second pleopod. (Holotype lacking pleopods on first and second abdominal somites.) *Appendix interna* of third through fifth pleopods subtriangular, hooks only on small area of lateral surface near apex.

Endopod of uropod wide oval, length 1.6 times width, extending 0.33 times length of telson beyond posterior margin of telson. Exopod of uropod extending just beyond endopod. Upper exopodal plate 0.8 times length of lower plate. Suture indistinct. Lower exopodal plate with dense distal fringe of setae, posterior corner with eight strong setae, anterior margin fringed with hair. No basal spine.

Color: Transparent except for subcutaneous yellow-orange on dorsal abdominal surface and white chelipeds.

Dimensions of Holotype: USNM 82367, ♂. Total length 27 mm, carapace length 6 mm. Telson width 2.25 mm, length 1.95 mm. Width of endopod of uropod 1.55 mm, length 2.5 mm. Large cheliped: width of merus 2.0 mm, length 4.25 mm; width of carpus 3.9 mm, length 2.9 mm; width of propodus 4.0 mm, length 5.25 mm; length of dactylus 4.3 mm.

Known Range: SE Florida, Puerto Rico, Antigua, Venezuela.

Discussion: Callianassa atlantica Rathbun is the only other western Atlantic species known which has a hook on the merus of the large cheliped. The two species appear to be closely related; both have an elongate third antennular segment, similar telson shapes, similar female pleopods, and both lack spinous frontal projections and male second pleopods. Table 2 shows several characters which can be used to separate the species.

Remarks: This species is found in shallow burrows in sand, mud, or clay, where it lives in close proximity to burrows of other species of *Callianassa* or *Upogebia*. When excavating around burrows of other species, it is not uncommon to find specimens of *C. fragilis* floating in water that has seeped into the hole. The animal apparently is affected by surface tension and can escape only after a prolonged struggle.

Etymology: The name reflects both the great ease with which the large cheliped becomes separated from the body and the small size of the species.

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PROCEEDINGS
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A REVIEW OF THE APHODIINE BEETLES OF THE GALAPAGOS ISLANDS (COLEOPTERA: SCARABAEIDAE)[1]

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The discovery of the genus *Diastictus* on Isla Wolf, confusion of names due to misidentification, and synonomy in the reported species of *Ataenius*, initiated the following brief review of the Aphodiinae found on the Galapagos Islands. The study was made possible by the generous loan of all of the many specimens in the California Academy of Sciences collection, by my good fortune in seeing many other specimens in American collections, and in Paris and London museums. Paratypes of all previously described species except *Ataenius atramentarius* (Erichson) have been examined. Of the latter I have seen a good series in the British Museum in London.

As might be surmised, since the Galapagos Islands are nearest the South American mainland, at least part of the coleopterous fauna has been derived from this continent. Linell, 1898, and Van Dyke, 1953, as well as other authors listed in the very comprehensive bibliography covering the insects of the Galapagos Islands by Linsley and Usinger, 1966, have pointed to South America as the original source of much of the fauna. Van Dyke believed, "The coleopterous fauna is definitely related to that of the barren grounds of western South America especially Ecuador and Peru, and no doubt derived from them at some period long ago." Hurd, 1958, in discussing carpenter bees expressed his belief that, "when the faunal relationships of the Galapagos Islands are considered

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in the light of those of continental areas, the faunal affinities are much closer with those of Central America. There is some evidence which suggests that the Galapagos Islands were at one time connected by a series of islands to Central America." Linsley and Chemsak, 1966, in two papers on the Cerambycidae of the Galapagos Islands, and of Cocos Island, also found affinities with mainland South America, Central America and the West Indies. Two Cocos Island species are found in the West Indies. One of them was described from Cuba.

Based on my limited knowledge of the Aphodiinae of South and Central America, and the West Indies, I believe two of the known species probably were derived from species originating in South America, one from Central America, one possibly from the West Indies and one from an endemic on another Galapagos Island. Such an assumption must be pure conjecture of course since it is impossible to be sure from which species and exact area the progenitors came. The only species of *Diastictus* is closely allied to a similar species from Colombia. *Ataenius atramentarius* (Erichson) was described from Peruvian specimens. *Ataenius arrowi* Hinton and *cavagnaroi* n. sp. are close to *nugator* Harold, 1880, which occurrs from southern United States, through Central America (Costa Rica) and into Argentina and Chile. *Ataenius aequatorialis* Petrovitz is similar to the West Indian species *A. vincentiae* Arrow. *Ataenius cavagnaroi*, thus far found only on Isla Fernandina, may have been derived from the more widely dispersed, very closely related endemic species *arrowi* which is known from Isla Santiago, Isla Santa Cruz, Isla Pinta, and Isla Isabella.

So far as we know at present all known Aphodiinae found on the Galapagos Islands are endemic except *Ataenius atramentarius*.

KEY TO GENERA AND SPECIES

1. Length less than 3 mm.; clypeus verrucose; first segment of hind tarsus equal to the length of the following segments combined .... *Diastictus darwini* n. sp.

Length usually more than 3 mm.; clypeus simply punctate, never verrucose; first segment of hind tarsus much longer than following two combined .... *Ataenius* spp. 2

2. Length 5.2 to 5.4 mm.; elytral intervals weakly convex over anterior disc, over apical third intervals carinate, laterally eroded and alutaceous .... *A. atramentarius* (Erichson)

Length less than 5.0 mm.; elytral intervals weakly to moderately convex or carinate over entire length 3

3. Length 4.4 to 4.6 mm.; clypeus rounded each side of median emargination; elytral intervals weakly evenly convex; sutural interval impunctate; male anterior spur hooked; tip of tibia and first tarsal segment densely clothed with long hair 4

Length 2.9 to 3.5 mm.; clypeus finely dentate each side; elytral intervals carinately convex entire length, sutural interval strongly punctate .... *aequatorialis* Petrovitz

4. Dull surface lustre; elytral striae fine, not noticeably crenate, punctures fine; intervals noticeably alutaceous, very weakly convex .... *cavagnaroi* n. sp.

Shining surface lustre; elytral striae moderately crenate-punctate; intervals shining, moderately convex .... *arrowi* Hinton

Diastictus darwini Cartwright new species

Holotype: Length 2.3 mm., width 1.0 mm. Shining, dark castaneous, convex, oblong-oval, widest at apical third. Antennae testaceous. Head strongly convex; clypeal margin evenly rounded each side of moderately deep median emargination, edge narrowly reflexed, surface moderately verrucose, genae sharply rounded, nearly right-angled, a sharply defined anteocular groove extending upward from gena around the eye; occiput with mixed fine and minute punctures.

Pronotum convex, one-fourth wider than long, anterior angles obtuse, posterior angles broadly rounded, sides nearly straight but due to convexity not visible from directly above except over anterior third; postapical groove deep in anterior angles causing the angles to appear explanate, the groove continued upward to disc in a series of closely placed moderate punctures leaving a smooth, minutely punctate anterior edge, a similar smooth area laterally outside fovea into the posterior angles, disc with moderately coarse scattered punctures generally separated by one or more times their diameters, longitudinal, vaguely impressed median line indicated by row of similar punctures; lateral and basal marginal line well defined.

Elytra one-third longer than wide, sides slightly divergent to apical third; striae strong, deep, crenately punctate; intervals weakly convex, smooth but with a row of very minute punctures and indistinct very minute alutaceous sculpture near striae, the latter more noticeable on the sutural interval.

Metasternum shining, disc smooth but with scattered minute punctures, median line weakly impressed, very finely alutaceous at sides, triangular area in front of posterior coxae merely flattened and indistinctly alutaceous. Abdominal segments shining very minutely alutaceous especially at sides, crenate along anterior margins, crenations of terminal segment much longer and deeper, at middle about one-third total length of segment. Pygidial transverse eroded area medially interrupted at base, eight pygidial setae.

Middle and posterior femora smooth, shining, posterior marginal line nearly half the length of femur inward from knee. Posterior tarsus more than half the length of the tibia. First segment of posterior tarsus shorter than long spur, apically as wide as length of second segment, as long as two following segments combined.

Holotype, California Academy of Sciences, and six paratypes collected on Isla Wolf, 1 February 1964, by D. Q. Cavagnaro; two paratypes from Isla Darwin, 29 January 1964, by D. Q. Cavagnaro. Paratypes in the California Academy of Sciences and Smithsonian Institution.

Paratypes vary in length from 2.2 to 2.7 mm., in color from dark castaenous to piceous. The coarse pronotal punctures are slightly more numerous and the median longitudinal line slightly deeper in some specimens. Pygidial setae number 6 or 8.

Diastictus darwini is nearest *D. gregalis* (Cartwright), new combination, from Colombia, South America. It differs in being noticeably broader, with less convex elytral intervals, a shallower less noticeable metasternal midline and in being uniform in color, not darker laterally than on disc of elytra.

Ataenius atramentarius (Erichson), 1847–110

Euparia atramentarius Erichson, 1847–110.
Ataenius atramentarius: Harold, 1869–1066.
Ataenius dampieri Petrovitz, 1961–356. (New synonymy)
Ataenius scutellaris: Van Dyke, 1953–123. (not Harold 1867–82)

Erichson placed *atramentarius* in *Euparia,* noting the species had been collected in Peru. I have examined nine specimens of *atramentarius* in the British Museum and compared paratypes of *dampieri* Petrovitz with one of them. I can find no differences. In the original description of *dampieri,* Petrovitz states his species is distinguished by the short hairs of the elytra and the shortened posterior marginal line of the hind femur. Since these characters are exactly duplicated in the Peruvian specimen of *atramentarius* and I can find no differences otherwise, it is unfortunately necessary to place *dampieri* in synonymy.

Van Dyke misidentified this species as *At. scutellaris* Harold. Among the specimens he listed was a single specimen from Isla Isabella (Albemarle Island) not now in the Academy Collection.

I have seen *A. atramentarius* (Erichson) from Isla Floreana (Charles Island), Isla Pinta (Abingdon Island), and Isla San Cristobal (Chatham Island).

Ataenius aequatorialis Petrovitz, 1961–355

Ataenius aequinoctialis Petrovitz, 1961–355. (Lapsus calami)

This species was described from Santa Cruz in 1961. It is the smallest of the Galapagos *Ataenius* and of the known species it is the only one with dentate clypeus. Except for the more evident short fine elytral pubescence and subcarinately convex elytral intervals, *aequatorialis* resembles *exiguus* Brown or a small *abditus* (Haldeman), as well as *vincentiae* Arrow as pointed out by Petrovitz. *At. vincentiae* differs in having the entire cariniform convex ridge of the elytral intervals broken by a median row of punctures and by having closer, shallower pronotal punctures.

All specimens examined were collected on Isla Santa Cruz (Indefatigable Island).

Ataenius arrowi Hinton, 1936–414

Fig. 1

Dr. Hinton described *arrowi* from James Island in 1936. The series before me were collected on the Horneman Ranch, Isla Santa Cruz, February and March 1964 and on Isla Darwin in January 1964.

The males of *arrowi* are much more shining than the females, the pronotal punctures are less dense and finer, the anterior tibial spur is bent inward at the tip, and the end of the posterior tibia and tarsus are quite hairy. The posterior tibial fringe of *arrowi* is usually composed of a group of five short close setae. The short accessory spine is close to the spurs without an intervening seta.

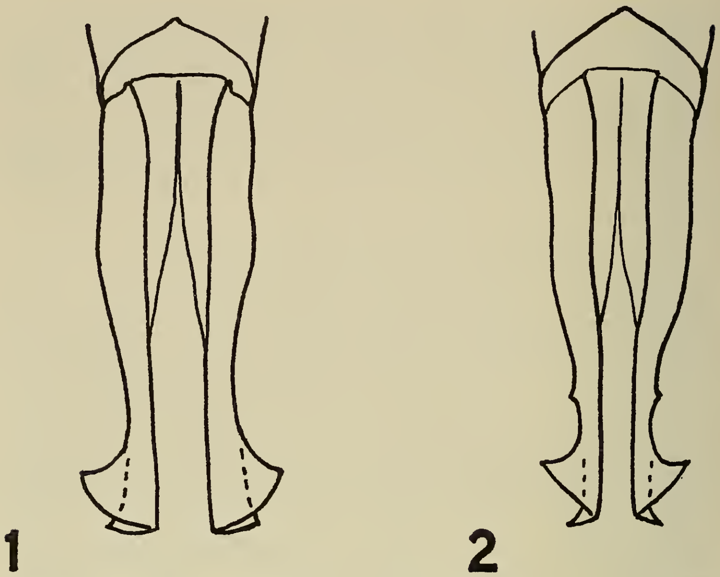
I have seen specimens of *arrowi* Hinton from Isla Santiago (James Island), Isla Santa Cruz (Indefatigable Island), Isla Pinta (Abingdon Island), and Isla Isabella (Albemarle Island).

The specimens from Isla Pinta frequently show slight differences such as having more uniform head punctures and the 10th elytral intervals slightly flatter than 9th but I can find no other differences.

Ataenius cavagnaroi Cartwright new species

Fig. 2

Holotype male.—Length 3.9 mm., width 1.8 mm. Piceous, finely alutaceous, weakly shining, elongate, moderately convex. Head moderately convex; genae nearly right angled; clypeus rounded each side of moderate median emargination, edge finely reflexed, surface very finely



Figs. 1, 2.—Dorso-caudal view of the lateral lobes of the male genitalia: 1—*Ataenius arrowi* Hinton, 2—*Ataenius cavagnaroi* n. sp.

punctate, the punctures generally separated by almost twice their diameters, band of frontal punctures coarse, about two to three times the diameter of the clypeal puncture and separated by less than half their diameter except in basal or occipital area where they are less dense. Parts of the clypeus have been broken away on each side of the median emargination but remainders of the sides are practically straight to angles of the genae.

Pronotum 1.6 mm. wide, 1.1 mm. long, very moderately convex; lateral and basal marginal line fine, edge barely broken by extremely short, fine setae, widely spaced laterally, more closely posteriorly around posterior angles, anterior angles obtusely rounded, posterior angles distinct but rather broadly rounded; surface densely punctate with mixed coarse and fine punctures throughout, the finer punctures usually half or more the diameter of the larger, usually separated by the diameter of the smaller or less, laterally, especially in the anterior angles the punctures are shallower and alutaceous within, surface between punctures very finely alutaceous.

Elytra 2.6 mm. long, 1.8 mm. wide, oblong oval, humeri finely dentate; striae fine, very weakly crenate with very fine punctures; intervals, all alike, weakly convex, the first three almost flat, surface alutaceous with scattered minute punctures separated by four or more times their diameters.

Metasternum concave lengthwise, shining and smooth over middle disc, a moderately strong and deep midline ending anteriorly in wider deeper pore, outer edges of disc very finely and closely punctate, with slightly larger punctures outward to sides, more strongly alutaceous at extreme sides, triangular depressed area in front of hind coxae deep and finely alutaceous. Abdominal segments alutaceous, with scattered moderately fine rather shallow punctures throughout, a trifle larger toward sides, separated by one or more times their diameters, segments finely crenate along anterior margin. Eroded area of pygidium strongly alutaceous and with very indistinct shallow punctures, shining margin noticeably widened apically.

Spur of anterior tibia bent inward at tip, tibial margin serrate above apical teeth, femur with perimarginal groove, surface closely, roughly, coarsely, shallowly punctate. Middle and hind femora with moderately fine punctures rather irregularly but closely spaced except along anterior margin and near knee; posterior marginal line half the length of the femur inward from knee. Posterior tibia with four closely spaced fimbriae, short accessory spine close to spurs without intervening seta, first tarsal segment a trifle longer than long spur. Remaining segments of hind tarsi missing.

Unique holotype, California Academy of Sciences, collected on Isla Fernandina, W. side, 1,100 ft., 5 February 1964, D. Q. Cavagnaro collector. The species is named after its collector.

This species is closely related to *Ataenius arrowi* Hinton but the pronotal punctures are much coarser and denser than in males of that species and they show less disparity in size than in females of *arrowi.* The strongly alutaceous elytral intervals are much flatter, the striae and their punctures are fine, and the crenations much less noticeable than in *arrowi.* The distinctly serrate anterior tibiae are noticeable. The parameres of the male aedeagus show a distinct lateral tooth, see fig. 2, which is lacking in *arrowi.*

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NORTH AMERICAN ORDOVICIAN OPHIUROIDEA THE GENUS *TAENIASTER* BILLINGS, 1858 (PROTASTERIDAE)

By Frederick H. C. Hotchkiss[1]

Thirteen species of ophiuroids have been described from the Ordovician strata of North America. Of these, *Stenaster obtusus* (Forbes) (Stenasteridae), *Taeniaster spinosus* (Billings) (Protasteridae), and *Hallaster cylindricus* (Billings) (Lapworthuridae) are discussed at great length in Spencer's Monograph of the British Palaeozoic Asterozoa. The remaining species are essentially known only from their first appearance in the literature.

The type species of the genus *Taeniaster* Billings is *Palaeocoma spinosa* Billings of which there are three syntypes, two of which were figured by Billings (1858). Spencer (1934) did not select a lectotype but regarded the three specimens as "co-types" and proceeded to base the greater part of his general account of the genus on the unfigured syntype and some other material which he was able to 'identify' through this third specimen. The unfigured syntype presents an aboral view of a protasterid brittle-star while the figured syntypes present oral views.

I have had the extraordinary opportunity of studying the type material of all of the North American Ordovician species of Protasteridae as well as other material housed in the Smithsonian Institution and latex casts of type material of relevant species from Great Britain. I find that the syntype presenting an aboral view is neither conspecific nor congeneric

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with the two syntypes which present an oral aspect. It being no longer possible to regard the three syntypes as "co-types" as done by Spencer, the first-figured individual is selected as the lectotype. Thus the generic diagnosis given by Spencer and Wright (1966) in the Treatise on Invertebrate Paleontology for this form cannot stand. It is interesting to note that *T. spinosus* is an index fossil (Shimer and Shrock, 1944) and also appears in textbooks of paleontology (Moore, Lallicker, and Fischer, 1952).

The following generic diagnosis, specific description, and synonomy is new. The generic diagnoses of Spencer (1934) and Billings (1858) are readily available, the latter being quoted in full in Schuchert (1915).

Acknowledgments.—I wish to thank Dr. Porter M. Kier of the Smithsonian Institution for making this study possible by allowing use of the collections, facilities and equipment under his care. Some of the Smithsonian material had been set aside for study by Dr. H. B. Fell of the Harvard Museum of Comparative Zoology and I thank him for releasing that material for my study. Many people assisted this study by loaning material and providing latex casts of specimens; for these kindnesses I wish to thank Dr. Bernhard Kummel of the Harvard Museum of Comparative Zoology, Dr. Thomas E. Bolton of the Geological Survey of Canada, Mr. Clinton F. Kilfoyle of the New York State Museum, Dr. D. H. Collins of the Royal Ontario Museum, Dr. R. V. Melville of the Institute of Geological Sciences (London), Dr. Murray Mitchell of the Institute of Geological Sciences (Leeds), Dr. R. P. S. Jefferies and Mr. H. G. Owen of the British Museum (Natural History), Dr. Colin Forbes and Dr. R. B. Rickards of the Sedgwick Museum, and Dr. E. C. Wilson of the Los Angeles County Museum of Natural History. I am obliged to Dr. Howard R. Cramer of Emory University for critically reading the manuscript in its original form and to Dr. Karl M. Waage of Yale University for reading the final draft.

Abbreviations.—The following abbreviations are employed:

United States National Museum (Smithsonian Institution) .... USNM

New York State Museum	NYSM
Harvard Museum of Comparative Zoology	MCZ
Geological Survey of Canada	GSC

SUBCLASS OPHIUROIDEA GRAY, 1840
Order Oegophiurida Matsumoto, 1915
Suborder Lysophiurina Gregory, 1896
Family Protasteridae S. A. Miller, 1889
Taeniaster Billings, 1858

Taeniaster Billings, 1858, Geol. Surv. Canada, Can. Org. Rem., dec. 3, p. 80 (in part). Type species *Palaeocoma spinosa* Billings by subsequent designation, Schuchert (1914, p. 42).—Chapman, 1861, Canadian Journ., n. ser., vol. 6, p. 517.—Wright, 1862, Mon. Brit. Foss. Echinod., Oolitic, vol. 2, pt. 1 (Palaeontogr. Soc. for 1861), pp. 24, 34.—Chapman, 1864, Expos. Min. Geol. Canada, p. 111.—Hall, 1868, 20th Rep. N. Y. State Cab. Nat. Hist., p. 300; also revised edition, 1868–1870, p. 338.—Zittel, 1879, Handb. Pal., vol. 1, p. 445.—Nicholson and Etheridge, 1880, Mon. Sil. Foss. Girvan Dist., p. 323.—Sturtz, 1886, Neues Jahrb. fur Min., Geol., Pal., vol. 2, p. 150.—Sturtz, 1886, Palaeontographica, vol. 32, pp. 78, 83.—Miller, 1889, N. Amer. Geol. Pal., p. 285 (in part).—Gregory, 1889, Geol. Mag., dec. 3, vol. 6, p. 26.—Gregory, 1897, Proc. Zool. Soc. London for 1896, p. 1035.—Gregory, 1900, Treat. Zool., vol. 3, Echinoderma, p. 251.—Cummings, 1908, 32d Ann. Rep. Dep. Geol. Nat. Res. Indiana, p. 715.—Schuchert, 1914, Fossilium Catalogus Animalia, pt. 3, p. 42.—Schuchert, 1915, USNM Bull. 88, p. 216 (in part).—Spencer, 1934, Mon. Brit. Pal. Asterozoa, pt. ix, p. 483 (in part).—Spencer and Wright, 1966, *in* Treatise on Invert. Paleont., pt. U, Echinodermata 3, p. U87 (in part).

Alepidaster Meek, 1872, Amer. Journ. Sci., ser. 3, vol. 4, p. 275.—Schuchert, 1915, USNM Bull. 88, p. 228 (in part).

Protaster Forbes.—Miller, 1889, N. Amer. Geol. Pal., p. 276 (in part).

Urosoma Spencer, 1930, Mon. Brit. Pal. Asterozoa, pt. viii, p. 433 (in part).

Drepanaster Whidborne.—Spencer, 1934, Mon. Brit. Pal. Asterozoa, pt. ix, p. 492 (in part).

(For further references see citations under species heading below).

Diagnosis: Interradial outline of disk generally straight or concave but may be convex; oral interradial areas of disk bear plates (of uncertain outline) and spines; aboral surface of disk invested with plates (of uncertain outline) and granules; margins of the disk perceptibly thickened in some material suggesting marginalia present; mouth angle plates short; first ambulacral short and stout; proximal ambulacrals only slightly excavated to accommodate the override of the first ambulacral; madreporite present. Arms taper uniformly; median suture between alternate ambulacrals straight, not sinuous. Ambulacral ossicles without

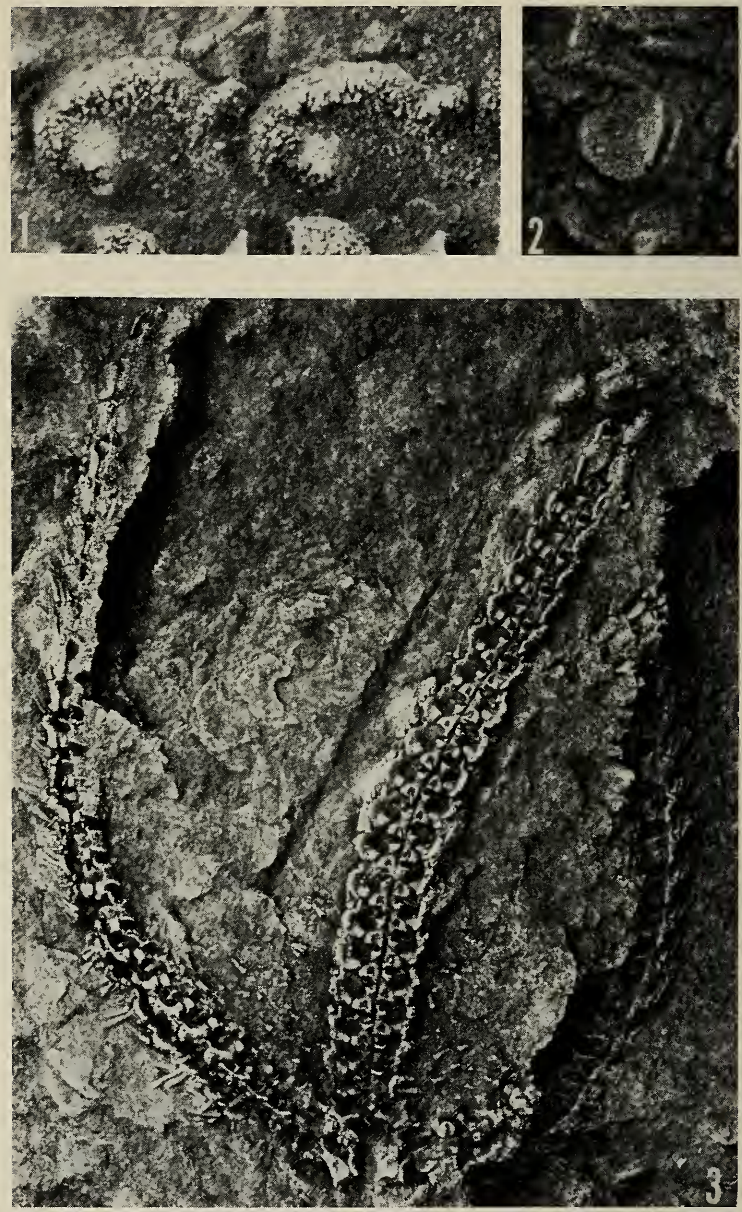

FIG. 1. *Taeniaster spinosus.* Lateral plates of an arm of USNM 92607 showing the characteristic ear-shape. ×30.

deep excavations for the insertion of dorsal longitudinal muscles; aboral outline of ambulacral ossicles therefore quadrate, not trapezoidal or triangular; oral surfaces of ambulacral ossicles ornamented at the ankle of the boot with a circular, subcircular or lemniscate depression; the waist of the boot is traversed by a groove leading from the median suture to the podial basin; the toe of the boot is variously pointed or blunt; proportions of the ambulacral boot vary along the arm; proximally the foot of the boot may be longer than the boot is tall. The laterals are generally ventral but there is great variation in the preserved attitude of the laterals relative to the ambulacral groove; from one view (fig. 1) the laterals are a diagnostic ear-shape; the laterals bear small proximal and distal fittings; both vertical and groove spines present.

Comparison with other genera: Taeniaster Billings closely resembles *Protaster* Forbes as described by Spencer (1934, p. 465) and further study may show these genera to have overlapping limits. A tentative difference is that *Protaster* as described by Spencer is not ornamented at the waist and ankle of the boot. The absence of deep excavations for the insertion of the dorsal longitudinal muscles in *Taeniaster* and *Protaster* distinguishes these genera from *Protasterina* Ulrich: type species by monotypy *Protasterina* (*Protaster* lapsus) *fimbriata* Ulrich (= *Protaster flexuosus* Miller and Dyer). *Drepanaster* Whidborne (type species by original designation *Protaster scabrosus* Whidborne) was diagnosed by Spencer (1934, p. 492) on the characters of *D. grayae* Spencer when, in fact, the genotype is vastly different; all that I am prepared to state at this time is that *D. grayae* is akin to *Protasterina.*

Remarks: I recognize but one species of *Taeniaster* in the material I have examined, the evidence for which is documented below under "Synonyms of *Taeniaster spinosus* (Billings)" and in the accompanying figures. In the description of the type species which follows, I have taken care to indicate those features which are noted in the lectotype and those which were noted from other specimens.

Range and distribution: Trentonian of Ontario and New York; Edenian of Kentucky; Maysvillian and Richmondian of Ohio; and the Richmondian of Indiana and Ontario.

Taeniaster spinosus (Billings)

Figures 1–9, 11

Palaeocoma spinosa Billings, 1857, Geol. Surv. Canada, Rep. Progr. for 1853–1856, p. 292.—Bolton, 1960, Cat. Type Invert. Foss. Geol. Surv., Canada, vol. 1, p. 91.

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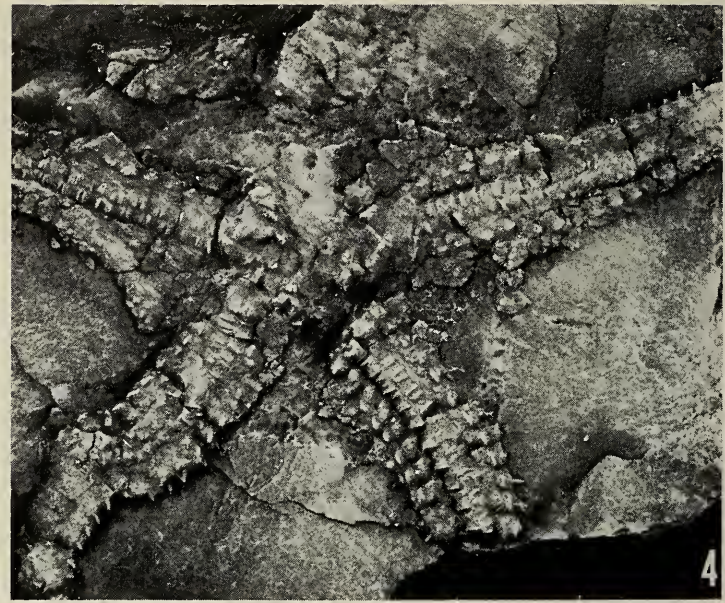
FIG. 2. *T. spinosus.* The madreporite of an individual from USNM 92617. ×30.

FIG. 3. *T. spinosus.* A latex cast made from the holotype of *T. schohariae* Ruedemann. NYSM 7784. ×8½.



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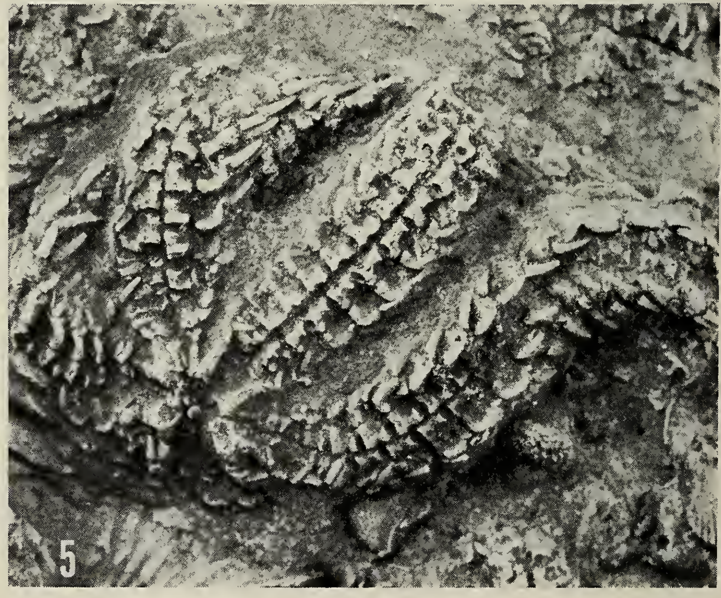

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Taeniaster spinosus (Billings).—Billings, 1858, Geol. Surv. Canada, dec. 3, p. 81, pl. x, figs. 3a–3d.—Wright, 1862, Mon. Brit. Foss. Echinod., Oolitic, vol. 2, pt. 1 (Palaeontogr. Soc. for 1861), p. 34.—Miller, 1889, N. Amer. Geol. Pal., p. 285, fig. 439.—Sturtz, 1893, Verh. naturh. Ver. preuss. Rheinl., etc., vol. 50, p. 20.—Parks, 1908, Trans. Canadian Inst., vol. 8, p. 363.—Ruedemann, 1912, Bull. N. Y. State Mus., No. 162, p. 89.—Schuchert, 1914, Fossilium Catalogus Animalia, pt. 3, p. 42.—Schuchert, 1915, USNM Bull. 88, p. 219, text fig. 17, pl. 36, fig. 1.—Bassler, 1915, USNM Bull. 92, vol. 2, p. 1256.—Spencer, 1934, Mon. Brit. Pal. Asterozoa, pt. ix, p. 488, text figs. 291c, 292, 293, 315–320, pl. xxxi, fig. 9 (in part).—Willard, 1937, Journ. Paleont., vol. 11, no. 7, p. 622.—Shimer and Shrock, 1944, Index Foss. N. Amer., p. 213.

Protaster? granuliferus Meek, 1872, Amer. Journ. Sci., ser. 3, vol. 4, p. 274 (*Alepidaster* at end of description).—Meek, 1873, Geol. Surv. Ohio, Paleont., vol. 1, p. 68, pl. 3 bis, figs. 8a, 8b (*Alepidaster* at end of description).—Lesley, 1889, Geol. Surv. Pennsylvania Rep., p. 4.—Miller, 1889, N. Amer. Geol. Pal., p. 276.—James, 1896, Journ. Cincinnati Soc. Nat. Hist., vol. 18, p. 138.—Parks, 1908, Trans. Canadian Inst., vol. 8, p. 368.

Taeniaster elegans Miller, 1882, Journ. Cincinnati Soc. Nat. Hist., vol. 5, p. 41, pl. i, figs. 6–6c.—Miller, 1889, N. Amer. Geol. Pal., p. 285.—James, 1896, Journ. Cincinnati Soc. Nat. Hist., vol. 18, p. 139.—Parks, 1908, Trans. Canadian Inst., vol. 8, p. 368.—Ruedemann, 1912, Bull. N. Y. State Mus., No. 162, p. 89.—Schuchert, 1914, Fossilium Catalogus Animalia, pt. 3, p. 42.—Foerste, 1914, Bull. Sci. Lab. Denison Univ., vol. 17, p. 328.—Schuchert, 1915, USNM Bull. 88, p. 221.—Bassler, 1915, USNM Bull. 92, vol. 2, p. 1255.—Spencer, 1934, Mon. Brit. Pal. Asterozoa, pt. ix, p. 491.—Willard, 1937, Journ. Paleont., vol. 11, no. 7, p. 622.

Protaster miamiensis Miller, 1882, Journ. Cincinnati Soc. Nat. Hist., vol. 5, p. 116, pl. 5, figs. 6, 6a, 6b.—Miller, 1889, N. Amer. Geol. Pal., p. 276.—James, 1896, Journ. Cincinnati Soc. Nat. Hist., vol. 18, p. 138.—Parks, 1908, Trans. Canadian Inst., vol. 8, p. 368.—Spencer, 1934, Mon. Brit. Pal. Asterozoa, pt. ix, p. 437.

Taeniaster granuliferus (Meek).—Cumings, 1908, 32d Ann. Rep. Dep. Geol. Nat. Res., Indiana, p. 733, pl. 3, fig. 7.

Taeniaster schohariae Ruedemann, 1912, Bull. N. Y. State Mus., No. 162, p. 88, pl. 3, fig. 1.—Schuchert, 1914, Fossilium Catalogus Animalia, pt. 3, p. 42.—Schuchert, 1915, USNM Bull. 88, p. 220.—Bassler, 1915,

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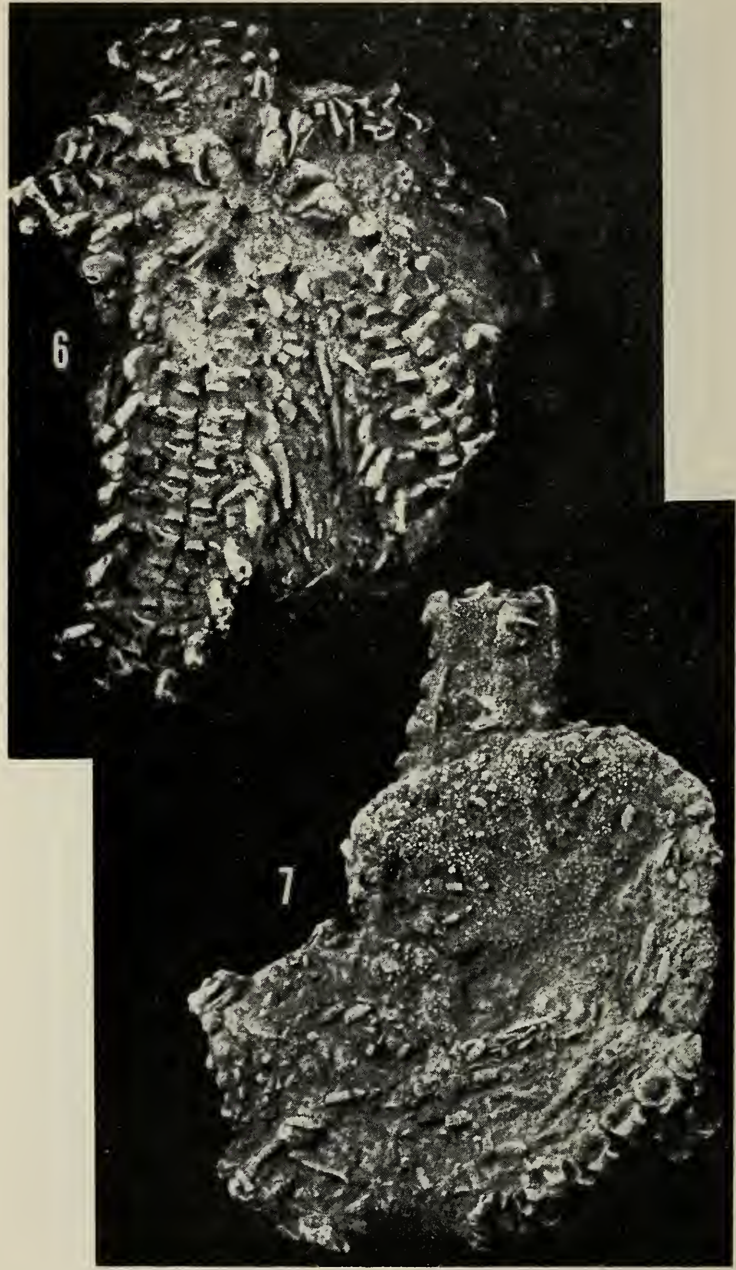
FIG. 4. *T. spinosus.* A view of the aboral surface as seen in USNM 92604. ×4½.

FIG. 5. *T. spinosus.* One of the syntypes of *T. elegans* Miller. USNM 40878. ×7.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USNM Bull. 92, vol. 2, p. 1255.—Willard, 1937, Journ. Paleont., vol. 11, no. 7, p. 622.

Alepidaster granuliferus (Meek).—Schuchert, 1914, Fossilium Catalogus Animalia, pt. 3, p. 11.—Schuchert, 1915, USNM Bull. 88, p. 230, fig. 26.—Bassler, 1915, USNM Bull. 92, vol. 1, p. 25.—Spencer, 1934, Mon. Brit. Pal. Asterozoa, pt. ix, p. 492.

Alepidaster miamiensis (Miller).—Schuchert, 1914, Fossilium Catalogus Animalia, pt. 3, p. 11.—Schuchert, 1915, USNM Bull. 88, p. 233.—Bassler, 1915, USNM Bull. 92, vol. 1, p. 25.

Taeniaster meafordensis Foerste, 1914, Bull. Sci. Lab. Denison Univ., vol. 17, p. 326, pl. 4, figs. 5–7.—Schuchert, 1915, USNM Bull. 88, p. 221.—Bassler, 1915, USNM Bull. 92, vol. 2, p. 1255.—Foerste, 1924, Geol. Surv., Canada, Mem. 138, p. 104, pl. 8, figs. 1–4.—Willard, 1937, Journ. Paleont., vol. 11, no. 7, p. 622.—Bolton, 1960, Cat. Type Invert. Foss. Geol. Surv., Canada, vol. 1, p. 93.

Taeniaster miamiensis (Miller).—Foerste, 1914, Bull. Sci. Lab. Denison Univ., vol. 17, p. 328.—Willard, 1937, Journ. Paleont., vol. 11, no. 7, p. 622.

Protaster (*Taeniaster*) *spinosus* (Billings).—Spencer, 1922, Mon. Brit. Pal. Asterozoa, pt. v, p. 201, text fig. 140.

Urosoma hirudo (Forbes).—Spencer, 1930 and 1934, Mon. Brit. Pal. Asterozoa, pt. vii, p. 434, text figs 278–280, pl. xxvii, figs. 3, 4, 5; pt. ix, p. 437, text figs. 281, 282, pl. xxix, figs. 1, 2, 3 (in part).

Drepanaster schohariae (Ruedemann).—Spencer, 1934 and 1940, Mon. Brit. Pal. Asterozoa, pt. ix, p. 493; pt. x, p. 500.

Diagnosis: As for the genus—monotypic.

Material: USNM 40878 (syntypes of *T. elegans*), USNM 40886 (syntypes of *Protaster miamiensis*), USNM 87166 (syntypes of *T. meafordensis*), USNM 92604, USNM 92607, USNM 92617, USNM 92627, USNM 92639, USNM 161520, NYSM 7784 (holotype of *T. schohariae*), MCZ 470 (holotype of *Protaster*? *granuliferus*; ex MCZ 21), GSC 1404 (herein selected as lectotype of *Palaeocoma spinosa*), GSC 1404a (paralectotype of *Palaeocoma spinosa*—herein referred to *Protasterina*), GSC 1404b (paralectotype of *Palaeocoma spinosa*), GSC 8580, a, b, c (syntypes of *T. meafordensis*).

Disk: Very few details of the disk have been discerned. The interradial margin of the disk is straight, concave, or, rarely, convex and in some individuals is slightly thickened (fig. 4) suggesting marginalia though the thickening could also be from the folding of the disk at this locus. USNM 40878 is notable for the seeming absence in oral view of

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FIG. 6. *T. spinosus*. The oral surface of the holotype of *Protaster*? *granuliferus* Meek. MCZ 470. ×9.

FIG. 7. *T. spinosus*. The aboral surface of the holotype of *Protaster*? *granuliferus* Meek. MCZ 470. ×9.

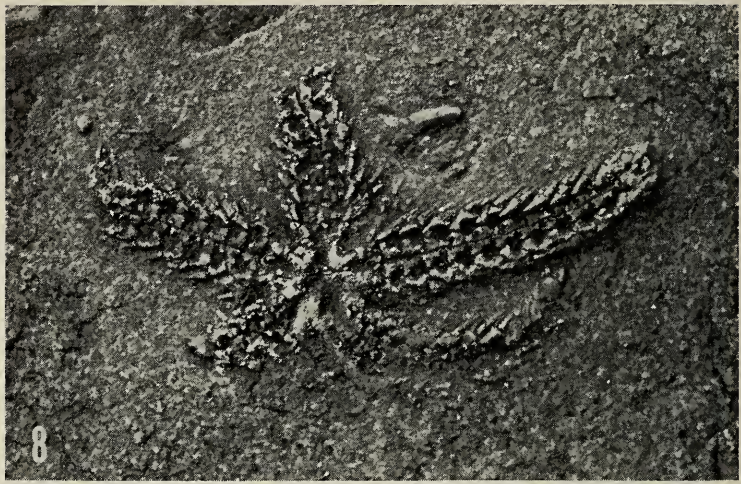

FIG. 8. *T. spinosus.* The lectotype. GSC 1404. ×7½.
FIG. 9. *T. spinosus.* A paralectotype. GSC 1404b. ×7½.

the disk (fig. 5) although very slight traces are to be found in the interradii of some individuals.

MCZ 470 (fig. 7), GSC 1404b (fig. 9), GSC 8580c, and USNM 92604 (fig. 4) present aboral views of the disk. The disk plates are highly ankylosed and overlain by fine granules.

The oral interradial aspect of the disk is invested with plates which are so ankylosed that it is impossible to determine their shape. Spines are found in the oral interradial areas of many individuals including the lectotype, however, some of these spines are dislodged vertical or groove spines. NYSM 7784 clearly demonstrates small disk spines unconfused with groove or vertical spines (fig. 3).

Mouth frame: The oral aspect of the mouth frame is well illustrated in the lectotype (fig. 8), MCZ 470 (fig. 6), USNM 40878 (fig. 5), NYSM 7784 (fig. 3), and GSC 8580 (fig. 11). The mouth angle plates form short V's; the oral wedge (*i. e.* the area included by the radial bow of the ambulacrals and virtually subtended by the proximal end of the syngnaths) is small as the first ambulacral is also short. The apophyses of the mouth angle plates seat the vertically elongated, oval torus seen clearly in MCZ 470 (fig. 6). No teeth have been observed. The cup for the first tube foot is not visible but probably lies within the radial bow apical to the proximal ridge bordering the cup for the second tube foot (Spencer: 1930, p. 403). The cup for the second tube foot is most clearly visible in NYSM 7784 (fig. 3) and is seen to be differentiated so as to assist in bringing food to the mouth.

The aboral aspect of the mouth frame is visible in USNM 92604 (fig. 4). The short, stout first ambulacral and the short, thin mouth angle plates are seen to be ornamented with a groove for the water-ring; the groove for the nerve-ring and the pseudohemal vessels was not separately identified. The proximal ambulacrals are only slightly excavated to accommodate the overriding action of the first ambulacral during opening of the mouth aperture.

Madreporite: The madreporite was found in MCZ 470 (fig. 6), GSC 9580 (fig. 11), USNM 92617 (fig. 2) and NYSM 7784 (fig. 3). It approximates a disk with a simple channel traversing approximately two-thirds of the rim, except in NYSM 7784 (fig. 3) where the madreporite is swollen, appearing subspherical with the channel showing as a wide crease. It is located to the right of the second lateral plate on the oral surface of the disk.

Arms: The arms taper uniformly. In aboral view usually only the double row of ambulacral plates is visible; USNM 92604 (fig. 4) is an exception with the laterals spread outward from the rays. The median suture separating the double row of ambulacral plates is straight. In oral view the lateral plates margin the ambulacral groove which is roofed over by the biserially arranged ambulacrals. (N. B. that the aboral aspect of the arms is not visible in the lectotype and is scarcely evident in paralectotype GSC 1404b.)

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FIG. 10. ? *Protasterina* sp. Technically, this specimen is a paralectotype of *T. spinosus*. The deep excavations for the insertion of the dorsal

Ambulacrals: The proximal ambulacral boots have short, stout boot-legs with the foot of the boot longer than the boot is tall; beyond the first few ambulacrals the foot of the boot shortens and the boot is taller and thinner.

The ambulacral boot is ornamented at the ankle with a depression to which Spencer (1925, p. 254) ascribes the function of seating tissues to support the radial nerve and pseudohemal canal; on the first few ambulacrals, however, it extends out into the foot; distally it becomes oval as the ambulacrals narrow.

The waist of the boot is traversed by a groove leading from the median suture to the podial basin. Spencer (1925, p. 254) deduced that this groove accommodated branches from the radial nerve and pseudohemal canal to the tube foot. The groove is transverse to the boot-leg except in NYSM 7784 (fig. 3) where it traverses the waist obliquely.

Several of the halves of vertebrae of the individual from USNM 40878 shown in figure 5 show the ventral muscle field excavating the sole of the ambulacral boot for the insertion of one end of the ventral longitudinal muscle; there is a corresponding excavation on the top of the ambulacral boot-leg. The ridge separating the dorsal and ventral muscle-fields and participating in the articulation between serial halves of vertebrae is visible in one of the arms of NYSM 7784 (fig. 3) where the laterals have fallen away and permit a lateral view of the ambulacrals.

Viewed aborally the proximal ambulacrals are approximately square in outline; the distal ambulacrals are rectangular in outline with the longer edge being along the axis of the arm. In MCZ 470 and USNM 92604 the ambulacrals bear a saddle-shaped depression extending to the lateral edge of the plate; in other material (notably USNM 92617, USNM 40878 and NYSM 7784) this saddle-shaped depression is not evident. The spacing between the ambulacrals for the dorsal longitudinal muscles is more evident in USNM 92604 (fig. 4) and NYSM 7784 (fig. 3) that in other material examined.

MCZ 470 (fig. 7) and USNM 92617 provide views of the ambulacral surface facing the median suture. It is found to be excavated to form a sinuous hollow canal within the arm for the radial water vessel.

Laterals: The laterals are a characteristic ear shape when viewed as shown in figure 1. From other viewpoints they are not especially distinctive except that the proximal and distal fittings are small.

Vertical spines are at least three in number, about as long as an arm segment, taper evenly to a point, and while essentially straight may curve slightly. The groove spines are also at least three in number, about

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longitudinal muscles are similar to those found in *Protasterina*. GSC 1404a. ×5.

FIG. 11. *T. spinosus*. The oral surface of one of the syntypes of *T. meafordensis*. GSC 8580. ×5.

as long as an arm segment, wider at the blunt tip than at the base, and essentially straight.

Measurements: Measurements were obtained using calipers. Irregularities in preservation and geometry of the individuals created some subjectivity in measurement; however, the data serves to illustrate the size range of the material. While the r/R ratio is generally smaller in specimens of larger disk size, USNM 92639 and USNM 92604 have disproportionately high ratios indicating great variation in this regard.

		r	*R*
GSC	1404	1.8 mm	6.3 mm
GSC	1404b	–	10.6 mm
GSC	8580	3.6 mm	13.5 mm
USNM	40878	–	16.8 mm
USNM	40886	4.7 mm	24.8 mm
USNM	92604	5.4 mm	13.9 mm
USNM	92617	3.1 mm	9.0 mm
USNM	92639	3.8 mm	11.7 mm
USNM	161520	3.9 mm	–
NYSM	7784	3.7 mm	15.5 mm
MCZ	470	4.7 mm	–

Formation and locality: Unless otherwise indicated, the data are taken from the label accompanying the specimen(s) and/or the data accompanying original description of the specimen(s).

Billings' material (GSC 1404 and GSC 1404b) is from the "Trenton," Middle Ordovician, Montmorency Falls, Quebec (Bolton, 1960). NYSM 7784, the holotype of *T. schohariae*, is from the Schenectady Formation near Schoharie Junction, New York.

USNM 92617 bears the labels "Eden (100′)" and "Covington, Kentucky" which suggest the locality given by Schuchert (1915) for the syntypes of *Protasterina fimbriata*, namely: "the lower Eden at about 100 feet above low-water mark in the Ohio River at Covington, Kentucky." USNM 161520 bears the label Eden, Covington, Kentucky. These specimens are regarded as from the Eden Group without specification of formation.

The labels of USNM 40878, USNM 92639 and USNM 92604 show these specimens to be from the Waynesville Formation of the Richmond Group; the first two are from Waynesville, Ohio and the third is from Oregonia, Ohio. Also from Oregonia, Ohio is USNM 92627 which is from the Richmond Group without specification of formation. The syntypes of *Protaster miamiensis* (USNM 40886) collected near Waynesville, Ohio are cited in Bassler (1915) as coming from possibly the Waynesville Formation or the Liberty Formation of the Richmond Group. The holotype of *Protaster*? *granuliferus* (MCZ 470) collected at Moore's Hill, Indiana is cited in Bassler (1915) as coming from the Richmond Group without specification of formation.

USNM 92607 bears a label indicating the material was collected from the Corryville Member of the McMillan Formation of the Maysville Group at Cincinnati, Ohio.

GSC 8580, a, b, c and USNM 87166, syntypes of *T. meafordensis*, were collected about 220 feet above Lake Huron, on Workman's Creek, three miles southeast of Meaford, Ontario, in the Meaford Formation (Upper Ordovician).

Location of type specimen: The lectotype of *Taeniaster spinosus* (Billings) (= *Palaeocoma spinosa* Billings) is No. 1404 in the collections of the Geological Survey of Canada.

Remarks: Specimens GSC 1404 and GSC 1404b were figured by Billings (1858, pl. x, figs. 3a–3d). Spencer (1934, p. 488) was the first to mention the third specimen (GSC 1404a) stating that "The third, which is not in such a good state of preservation, is important, because it is the only one of them which shows the apical surface of the arm. I am regarding the three as co-types of the species." Through GSC 1404a, Spencer was able to identify other Canadian material held in the British Museum (Natural History) and also the species *Protaster whiteavesianus* Parks with *Taeniaster spinosus*. If Spencer had seen the material that I have had access to, I feel sure that he too would have concluded that GSC 1404a (fig. 10) is not a specimen of *T. spinosus*. GSC 1404a, *Protasterina flexuosa* (Miller and Dyer), *Protaster whiteavesianus, T. maximus* Willard, *Drepanaster grayae*, and the material of "*T. spinosus*" described by Cramer (1957, p. 906) all possess ambulacrals which are deeply excavated for the insertion of the dorsal longitudinal muscles. Pending further study of these forms, they are all tentatively placed in the genus *Protasterina*.

I have examined MCZ 458 (formerly MCZ 28, MCZ 29, and MCZ 30) as Schuchert (1915, p. 230) thought this material represented a new species of *Alepidaster*. This examination has shown that the mouth frame and ambulacrals of this material are developed much as in *Protasterina*.

Synonyms of *Taeniaster spinosus* (Billings)

Protaster? *granuliferus* (*Alepidaster* at end of description) Meek, 1872 Amer. Journ. Sci., ser 3, vol. 4, p. 274.

Remarks: This species is based on a single specimen, MCZ 470, which provides excellent detail as may be seen from figures 6 and 7. Every feature found in the lectotype and paralectotype of *T. spinosus* is evident. It is one of the larger specimens available for study and bears a particularly well preserved madreporite.

Taeniaster elegans Miller, 1882, Journ. Cincinnati Soc. Nat., vol. 5 p. 41, pl. 1, figs. 6, 6a–6c.

Remarks: As stated by Miller, this species was founded upon more than thirty specimens occurring on a single slab (USNM 40878), but showing only the ventral side, with the exception of the ends of some of the rays. An individual is illustrated in figure 5. The disk is scarcely evident in the interradii. Miller correctly noted that only two rows of plates form the dorsal side of the ray, the laterals being ventral. As with other material that I am uniting with *T. spinosus*, the ambulacral boots are clearly ornamented at the ankle with a depression and at the waist of the boot by a groove leading from the median suture to the podial basin. While groove spines are largely missing in this material, vertical spines are exceedingly well preserved.

Protaster miamiensis Miller, 1882, Journ. Cincinnati Soc. Nat. Hist., vol. 5, p. 116, pl. 5, figs. 6, 6a, 6b.

Remarks: I have examined the five syntypes of this species (USNM 40886). Although much obscured by matrix, the proximal ambulacral ossicles are seen to have at the waist of the boot the groove leading from the median suture to the podial basin. The toes of the proximal boots are pointed as in the lectotype of *T. spinosus* and traces of a depression on the ankle of the boot further confirms the identity of this species with Billings'. Groove spines are particularly noticeable in this material, probably due to its lack of weathering. The specimens present the oral aspect.

Taeniaster schohariae Ruedemann, 1912, Bull. N. Y. State Mus., No. 162, p. 88, pl. 3, fig. 1.

Remarks: Ruedemann's description and figure contain many errors and do not adequately describe the single individual upon which the species is based (NYSM 7784). It is not surprising, therefore, that Spencer erroneously referred this species to *Drepanaster.* I provide here a photograph (fig. 3) of a cast made from the holotype which shows what a fine specimen it is. It is readily observed that the laterals are ear-shaped, with small proximal and distal fittings; that both groove and vertical spines are present; that the mouth angle plates are short and stout; that a madreporite is present; that the ambulacrals are not deeply excavated for the insertion of the dorsal longitudinal muscles; that the ambulacral boot is ornamented at the ankle with a subcircular depression and at the waist with a groove leading from the median suture to the podial basin; that the median suture is straight, not sinuous; and that small spines are scattered in the ventral interradial areas of the disk. The similarity of posture between NYSM 7784 and GSC 1404b is also worthy of note.

Taeniaster meafordensis Foerste, 1914, Bull. Sci. Lab. Denison Univ., vol. 17, p. 326, pl. 4, figs. 5–7.

Remarks: GSC 8580, a, b, c and USNM 87166 are the syntypes of this species. The individual from GSC 8580, illustrated in figure 11, shows that the mouth angle plates are short and stout; that a madreporite is present; that the ambulacral boot is ornamented at the ankle with subcircular depression and at the waist with a groove leading from the median suture to the podial basin; and that the median suture is straight, not sinuous. Other individuals, particularly from GSC 8580c, show that the ambulacrals are not deeply excavated for the insertion of the dorsal longitudinal muscles.

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PROCEEDINGS
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DRACHMASTER BULLISI NEW GENUS AND SPECIES OF OPHIDIASTERIDAE (ECHINODERMATA: ASTEROIDEA), WITH A KEY TO THE CARIBBEAN SPECIES OF THE FAMILY

By Maureen E. Downey
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Two specimens of a small starfish collected by the Bureau of Commercial Fisheries vessel M/V *Oregon*, one off Trinidad and the other off Martinique, represent another genus of the large family Ophidiasteridae. Of the 23 recognized genera in this family, at least six are represented in the Caribbean and the Gulf of Mexico. Eight or more species of Ophidiasteridae have been reported from this same area; however, in the course of a study of a very large collection of asteroids from this region, only six of the species (in addition to the new one) have been found. This essentially tropical family is principally a shallow water one, only three species in the family occurring at depths below 200 fathoms. Indeed, most species are found in very shallow water and they are usually reef-dwelling or reef-associated. They are remarkably abundant in the Indo-Pacific region and especially in the vicinity of Torres Strait. H. L. Clark (1921) has very thoroughly reviewed the family and described several new species from Australia. Two new monotypic genera have been added to the family since that time, one from the Indo-Pacific and one from Florida.

Drachmaster new genus

Arms with internal plates connecting the outer plates in transverse series.

Etymology: Generic name—masculine, from the Greek, drachme, target, and aster, star.

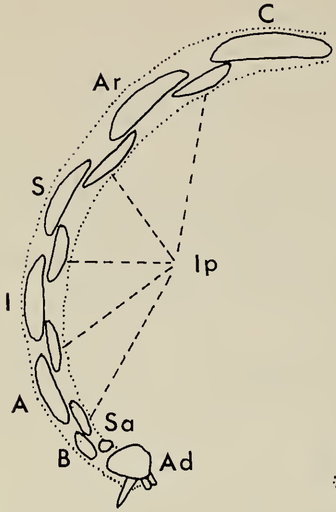

Fig. 1

Fig. 3

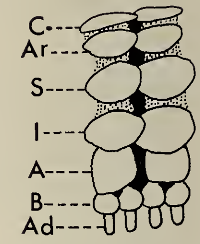

Fig. 2

Fig. 4

Figs. 1–4. 1, Cross-section of half a ray, showing arrangement of plates. 2, External view of transverse arrangement of plates. 3, Pedicellaria (erect). 4, Alveolus in which pedicellaria rests. Abbreviations: C = carinal plate; Ar = adradial plate; S = superomarginal; I = inferomarginal; A = first actinolateral; B = second actinolateral; Ad = adambulacral plates; Ip = internal plates.

Drachmaster bullisi new species
Figures 1–6

Disc small, rather flat. Anal pore central, surrounded by a number of enlarged spiniform granules; madreporite irregularly triangular or elliptical, sunken below general disc surface, and covered with deep gyri. Arms long, cylindrical, not much tapered, and terminate bluntly. All plates covered with moderately thick skin closely beset with small squamiform or minutely spinous granules of uniform size (because of this skin covering, it was not possible to determine the exact arrangement of the disc plates, but it seems to be quite like that of *Ophidiaster*). Plates on arms smooth, slightly tumid, in 11 very regular longitudinal rows (exclusive of adambulacral plates), and also in regular transverse rows. Plates in transverse series connected internally by small tumid plates (the principal feature by which *Drachmaster* is distinguished from all other genera of Ophidiasteridae) (Fig. 1). Eight longitudinal rows of conspicuous papular areas, with from one to three papulae per area. Viewed externally, from top of arm to adambulacrals, plates in transverse

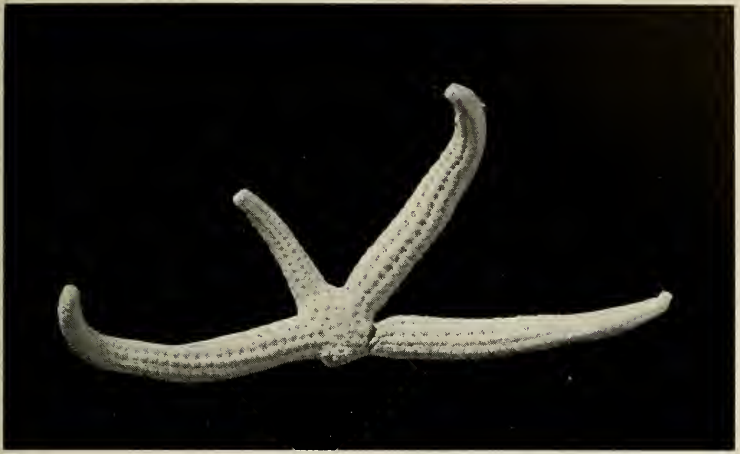

Fig. 5

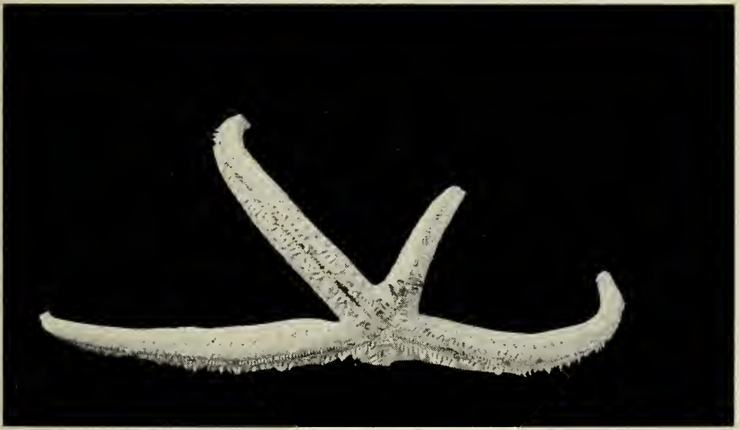

Fig. 6

Figs. 5–6. 5, *Drachmaster bullisi* (Holotype, USNM E11359). Aboral view. 6, Oral view, same specimen.

series are: (1) carinal, (2) adradial, (3) superomarginal, (4) inferomarginal, (5) first actinolateral, and (6) two second actinolaterals, side by side, each corresponding to an adambulacral plate (fig. 2).

Adambulacral armature of two short, blunt, somewhat flattened furrow spines, connected near their bases by skin, and a much longer, flat, more acute outer spine. Small spines around oral margin of jaw plates similar to and continuous with furrow spines; behind these, on actinal surface of jaw plates, two pairs of large spines, like outer adambulacral spines; distalmost pair accompanied each by a small spinelet between furrow spines and larger outer spine. Internally, a large flange on upper edge of ambulacral plates overlaps upper edge of ambulacral plate proximal to it. Superambulacral plates present.

On smaller specimen, but one pedicellaria, on abactinal surface in one interradial area; on rays, several incipient pedicellariae between adambulacrals and inferomarginals. Larger specimen abundantly provided with pedicellariae; one on upper edge of each superomarginal plate. Pedicellariae rare below inferomarginals, but occur frequently on abactinal surface. Valves of pedicellariae slender, elongate, minutely toothed, flattened laterally, and terminate in prominent hyaline hook which crosses hook of opposite valve when pedicellariae are erect (Fig. 3). Alveoli in which pedicellariae rest elongate-diamond-shaped, with raised lips (Fig. 4).

Ocular plates large, tumid; terminal portion of plate covered with large low rounded tubercles.

R/r—6/1. Holotype: R = 33 mm, r = 4.5 mm. Paratype: R = 14 mm, r = 4.5 mm.

The type material is in the U.S. National Museum.

Material examined: Holotype (USNM E11359), "Oregon" Station 5970, 11°13′N, 60°52′W, 34 fms., March 1966 (one arm missing, another regenerating). Paratype (USNM E11360), "Oregon" Station 5923, 15°36′N, 61°15′W, 40 fms., March 1966 (one arm removed for dissection).

Etymology: In honor of Harvey R. Bullis, Jr., Director, Exploratory Fishing and Gear Research Base, Bureau of Commercial Fisheries, Pascagoula, Mississippi.

Discussion

H. L. Clark's (1921) excellent review of the Ophidiasteridae renders unnecessary an extensive discussion of the other genera within this family. His very useful key need not be altered to accommodate *Drachmaster*, as the major character separating this new genus from the other genera in the family is the presence of the internal plates connecting the plates in transverse series.

A Key to the Caribbean Species of Ophidiasteridae

1\. With internal plates connecting the outer plates in transverse series .... *Drachmaster bullisi*
Without internal plates 2
2\. Complete covering of imbricating scales .... *Copidaster lymani*
Without covering of imbricating scales 3
3\. Abactinal plates in regular longitudinal series 4
Abactinal plates not in regular longitudinal series 7

4. Papular areas regularly present below inferomarginals 5
Papular areas not present below inferomarginals (isolated papulae sometimes present) .... *Tamaria floridae*

5. Papular areas in eight series 6
Papular areas in ten series .... *Hacelia superba*

6. Three rows of spines on adambulacrals .... *Ophidiaster bayeri*
Two rows of spines on adambulacrals .... *Ophidiaster guildingi*

7. Adambulacral armature spiniform, subprismatic; arms triangular in cross-section (in adult) .... *Narcissia trigonaria*
Adambulacral armature granuliform; arm cylindrical 8

8. Large tumid plates occurring randomly on disc and arms .... *Linckia nodosa*
No tumid plates .... *Linckia guildingi*

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I wish to thank Dr. Harvey R. Bullis and the Fish and Wildlife Service for providing the material on which this paper is based. I also appreciate the help of Dr. Mary Gardiner, whose knowledge of Greek was called upon to aid me with the etymology of *Drachmaster*. Dr. David. L. Pawson, of the Smithsonian Institution, was, as always, patient and helpful with suggestions during the preparation of the manuscript.

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PROCEEDINGS
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SUBSPECIES OF THE WESTERN ATLANTIC CAT SHARK, *SCYLIORHINUS RETIFER*

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The cat sharks of the genus *Scyliorhinus* (family Scyliorhinidae) in the western Atlantic are a morphologically homogeneous group readily separable into six categories by differences in color pattern. Five forms have been described. Our purpose in this report is to describe a sixth and to review the status of the group based on newly collected specimens from the West Indies and the coast of South America.

Of the six highly distinctive forms of *Scyliorhinus* we recognize two at the species level but divide one species into five subspecies. We follow Hubbs (1943) to differentiate subspecies from species. Thus, we regard incompleteness versus completeness of differentiation as the main test by which subspecies may be distinguished from species. We consider geographically contiguous but not greatly overlapping ranges as typical of subspecies. All except a few of our specimens in which color pattern remains after preservation are identifiable as one form or another by pattern but the pattern varies moderately in each species or subspecies. Intergradation of pattern is represented in our material only by the tendency for pattern elements of subspecies to blend in a few areas where ranges meet or possibly overlap. Such areas of intergradation are off the Colombia-Venezuela border and around oceanic banks of the northwestern Caribbean Sea. Our series of specimens is not large enough to demonstrate details

Table 1. Frequency of occurrence of various numbers of monospondylous vertebrae in species and subspecies of western Atlantic *Scyliorhinus*.

Species	Number of monospondylous vertebrae																			
	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49
Scyliorhinus torrei	1	3	2	3	2															
S. retifer retifer										4	13	14	9	5						
S. retifer meadi														1			1		2	1
S. retifer boa										2	4	2		1	1					
S. retifer haeckelii									1	1	7	1	1	1						
S. retifer besnardi								1	3											

of intergradation of pattern between all subspecies with contiguous ranges—if, in fact, it always does occur.

Scyliorhinus torrei Howell Rivero (1936) differs from *S. retifer retifer* and the other forms considered here to be subspecies of *S. retifer* in color and pattern. *S. torrei* is also much smaller than any of the subspecies of *retifer*. It differs without overlap in the number of monospondylous vertebrae from all the subspecies of *S. retifer* (see Table 1). The distance between a transverse line across the anterior ends of the nasal openings and the tip of the snout is less in our series of *S. torrei* than in any of the subspecies of *S. retifer*. Although our series show some overlap in other proportional measurements with one subspecies or another of *S. retifer, S. torrei* usually has a proportionally shorter snout, smaller pectoral fins, and smaller dorsal fins.

Characters other than color pattern separate many specimens of the five subspecies of *S. retifer* but variation within subspecies is substantial; we have found no morphological feature consistently present without overlap, at least between forms occupying contiguous geographical ranges. Since western Atlantic *Scyliorhinus* are demersal and probably non-migratory except for movements of short distances, an analysis of quantifiable characters should provide a good basis for estimates of relationships of populations. It does not appear likely, however, that either sufficient numbers of *Scyliorhinus* or samples properly comparable and representative for statistical treatment of populations can be assembled in the foreseeable future. Morphometrics as traditionally used in shark classification are of limited value as applied to scyliorhinid sharks for delineation of categories in which differences are small. Difficulties follow not only because of variability and allometry inherent in the scyliorhinids but also because unpredictable shrinkage or stretching in preservation and necessarily vague reference points make precise and reproducible measurement impractical.

Color pattern is the most practical character in western Atlantic *Scyliorhinus* identification and is the primary character used in the key that follows. Pattern is best described by

FIG. 1. Chart showing known distribution of western Atlantic *Scyliorhinus.* Details probably are biased because specimens have been collected only by trawling and because *Scyliorhinus* appears to occur most abundantly in areas of rough bottom that may preclude effective trawling. The range of *S. r. haeckelii* probably is continuous along the coast of Brazil between the mouth of the Amazon River and the offing of Rio de Janeiro, where little trawling has been done. The new subspecies, *S. r. besnardi* is to be expected off the coast of northern Argentina.

illustrations. Good drawings of all except the one newly described subspecies (Figure 2) are listed in references under each subspecies.

Key to Western Atlantic *SCYLIORHINUS*

1A Color pattern of randomly distributed, round or somewhat irregularly shaped, white or cream colored spots, about the size of the dark-adapted pupil or smaller, on brown or light tan ground color over all dorsal surfaces; ventral surfaces white; a series of seven or eight diffuse saddle-blotches of slightly darker brown which may be indistinct; size small, adults mature at about 29 cm and probably do not reach lengths greater than 32 cm .... *Scyliorhinus torrei* Howell-Rivero, 1936. (Note: Color patterns in *Scyliorhinus torrei* and *Schroederichthys maculatus* may be identical but *torrei* has a much shorter tail section. In *torrei* the distance from the anus to the tail tip is from 57 to 63 percent of total length whereas in *Schroederichthys* it is from 64 to 72 percent).

1B Color pattern various, but white or light-colored spots, if present, are either irregularly shaped flecks of white in melanistic specimens or are incorporated as parts of saddle-blotches and are not distributed over all of the dorsal surface; dorsal ground color usually gray in life but may become brown after preservation in alcohol; ventral surfaces usually white but may be irregularly suffused with darker color; size moderate, length at maturity 35 cm or more .... 2A or 2B.

2A Color pattern of dorsal surfaces a network of narrow and solid dark lines which are usually most prominent where they outline 7 or 8 dorsal saddlelike areas, dark lines frequently but not always reticulating along flanks .... *Scyliorhinus retifer retifer* (Garman, 1881).

2B No continuous, narrow and solid lines of darker color outlining saddle-blotches .... 3A or 3B.

3A Series of seven or eight saddle-blotches (including two on caudal fin) with indistinct edges; some blotches may be absent in the larger specimens; no small black or white spots present in color pattern .... *Scyliorhinus retifer meadi* Springer, 1966.

3B Small black spots, small white spots or both black and white spots present in color pattern .... 4A or 4B.

4A White spots usually present, usually but not exclusively incorporated in saddle-blotches; melanistic forms from off Colombia-Venezuela border may not have white spots ..... *Scyliorhinus retifer boa* Goode and Bean, 1896.

4B No white spots on dorsal surfaces .... 5A or 5B.

5A Pattern of numerous small black spots, most of them much smaller than the diameter of expanded pupil; some spots may outline a series of seven or eight saddle-blotches .... *Scyliorhinus retifer haeckelii* Miranda Ribeiro, 1907. (Note: Color patterns in *Scyliorhinus retifer haeckelii* and *Schroederichthys tenuis* may be identical but *Schroederichthys* differs in having a very long tail section, its length from anus about two times distance from anus to snout tip).

5B Pattern of moderately large black spots, most of them as large as expanded pupil or larger; spots arranged in approximate bilateral symmetry; some spots partly enclosing a center of lighter color or occurring as very closely adjacent pairs; distance between spots or spot-pairs usually greater than diameter of the smaller spot .... *Scyliorhinus retifer besnardi* new subspecies.

Scyliorhinus retifer retifer (Garman, 1881)

Scyllium retiferum Garman, 1881, p. 233 (type locality, 38°22′35″N, 73°33′40″W, off Delaware Bay in 89 fathoms).

Scylliorhinus retifer: Goode and Bean, 1896, part, pp. 16–17, figs. 14–15.

Scyliorhinus retifer: Regan, 1908, p. 457; Bigelow and Schroeder, 1948, pp. 207–211, fig. 33; Bigelow, Schroeder and Springer 1953, pp. 213–214; Springer, 1966, pp. 602–603, figs. 2, 6, 8.

Study material and records of capture: Museum of Comparative Zoology (MCZ) 825, holotype of *Scyllium retiferum*; USNM 187076 and more than 125 other specimens in United States National Museum (USNM) collection; records from 22 trawling stations (Springer and Bullis, 1956), from 49 trawling stations (Bullis and Thompson, 1965), and from additional trawling stations occupied after 1960 (unpublished data, Bureau of Commercial Fisheries).

Diagnosis: The reticulate pattern of narrow black lines sets this subspecies off from all other Atlantic sharks. The closest resemblance is to halfgrown specimens of *Cephaloscyllium fasciatum* from the vicinity of Hainan Island, China (see Chan, 1966, fig. 5). The reticulated pattern in S. *r. retifer* is well developed by the time the young leave the egg cases. It is remarkably persistent after preservation and in the very large series examined shows only moderate variation. Examples that show extremes in pattern variation are illustrated in Springer's review (1966) of western Atlantic cat sharks. The specimens we have seen fail to show either consistent pattern differences between small and large individuals or between samples from the northern and southern ends of the geographical range.

In S. *r. retifer* chromatophores in the skin produce some of the background color but pigment diffused within the hard material of dermal denticles is a major component of the dark reticulating lines. Excepting two specimens (USNM 75023, from R/V *Albatross* collections made off the coast of South Atlantic states in 1883–1885), all of the series that we have seen are easily and definitely identifiable by pattern. The two specimens have partly disintegrated and denticles are no longer in place.

Size: Males may reach sexual maturity at about 350 mm; the largest specimen seen, a female and probably not sexually mature, was 480 mm long. The length of the young at hatching is probably about 100 mm as indicated by young apparently newly hatched.

Distribution: S. *r. retifer* occurs along the continental shelf and slope from the southwestern edge of Georges Bank, Massachusetts, to Nicaragua. In the extreme northern part of its range it has been taken at depths of as little as 73 m but its habitat becomes deeper southward to 550 m off Nicaragua. The subspecies has not been recorded from the eastern or southern side of the Straits of Florida. Its range is either slightly overlapping or contiguous with the ranges of *Scyliorhinus torrei* and *Scyliorhinus retifer meadi* off the south-central and south-eastern coast of Florida. The geographical ranges of S. *r. retifer* and S. *r. boa* overlap on the continental slope of the northwestern Caribbean Sea but in this area S. *r. retifer* has been found usually at a greater depth than S. *r. boa.*

All of the specimens of western Atlantic *Scyliorhinus* that we find recorded were collected with otter trawls or dredges. Records of capture of S. *r. retifer* along the coast of the United States are especially concentrated off the Virginia Capes, off Dry Tortugas, Florida, and off Pensacola, Florida, in areas with considerable growth of sessile invertebrates of moderate size. Research vessels have collected less than two dozen mature specimens among more than a thousand taken in spite of continued efforts to collect large specimens of S. *r. retifer* over several years. Seventeen of the adults, eleven males, 365 to 410 mm, and five females, 360 to 420 mm long, were taken in a single net haul from about

180 m off North Carolina, July 19, 1960. Most of the locality records are based on captures of immature specimens taken singly. From fishing results we deduce that *S. r. retifer* adults prefer very rough bottom habitats that are generally considered untrawlable and that the immature sharks scatter to some extent over areas with fewer bulky obstructions.

Natural history notes: Several identifiable egg cases of *S. r. retifer* have been recovered that show cross bands similar to those illustrated by Springer (1966, fig. 8). One egg case measures 60 mm long between indented ends and 27 mm at the widest part.

Scyliorhinus retifer boa Goode and Bean, 1896

Scylliorhinus boa Goode and Bean, 1896, p. 17, fig. 6 (type locality, Barbados in 200 fathoms).

Scyliorhinus boa: Bigelow and Schroeder, 1948 (part, pertains only to type specimen), p. 204.—Springer, 1966 (part, reference only to type specimen), p. 601.

Scyliorhinus hesperius Springer, 1966, p. 603–604, fig. 15B.

Study material: MCZ 1335, holotype of *Scylliorhinus boa;* USNM 187732, holotype of *Scyliorhinus hesperius*; USNM 187728 and 26 other specimens.

Diagnosis: Scyliorhinus retifer boa is a subspecies in which differentiation appears to be far from complete, and, as defined here, probably includes several more or less distinct geographical races. The 26 specimens we have seen vary widely in color pattern. The subspecies is characterized by the presence of white or light-colored spots about the size of the dark-adapted pupil or smaller, the white spots usually scattered within dark dorsal saddle blotches. Specimens from the Antilles and the coast of eastern Colombia are darker than those from the coasts of Honduras, Nicaragua, and Panama. In the more melanistic specimens the dorsal pattern is irregular and obscure and dark color extends irregularly onto ventral surfaces. In *S. r. boa* the dorsal saddle areas or dorsal blotches of darker color are not outlined by continuous, reticulating narrow lines of black as they are in *S. r. retifer* and are usually not outlined by small black dots or interrupted series of black dashes as they are in *S. r. haeckelii.* Newly hatched specimens of *S. r. boa* and *S. r. haeckelii,* however, may not always be separable. The only very young ones available to us for examination are from the Lesser Antilles and the Guianas. Some have small, white spots as well as numerous small, black spots. Evidently, the white spots become more prominent with growth in *S. r. boa* but disappear in *S. r. haeckelii.*

The holotype of *Scylliorhinus boa,* a juvenile 6-inches long collected by the R/V *Blake* in about 365 m depth off Barbados, is now in poor condition (Bigelow and Schroeder, 1948). It was named and a diagnosis was given by Goode and Bean (1896) as a variant of *S. retifer.* A dual numbering system for some of the R/V *Blake* material accounts for the station number CVII given by Goode and Bean and number 291 given by Springer (1966). In this instance the two numbers refer to the same station (see Dick, 1969).

The holotype (MCZ 1335) now shows neither the scarcely visible reticulations noted by Goode and Bean nor the white spots which are apparently intended but not clearly shown in Goode and Bean's illustration (1896, fig. 6). Specimens recently collected off Barbados and off nearby St. Vincent are adults and do have white spots, although a reticulate pattern is not present. *Scyliorhinus* from other areas in the Lesser Antilles and the southern coasts of Hispaniola are also the white-spotted form. We conclude that the white-spotted form should be considered *Scyliorhinus retifer boa* and that *Scyliorhinus hesperius* Springer, 1966 described from the Caribbean off Panama is a junior synonym of *S. boa.*

One melanistic specimen, USNM 204378, from the Colombia-Venezuela zone of intergradation is the only example without white spots in our series that we refer to *S. r. boa.* It has relatively few black spots, larger than those of typical *S. r. haeckelii.* It might be identified as *S. r. besnardi* in the key given here except that the spots are slightly smaller than the dark-adapted pupil and have no light-colored centers.

Size: A sexually mature male from Barbados is 540 mm long. Although the specimens in our small series of *S. r. boa* are large in comparison with specimens in the very large series of *S. r. retifer*, we doubt that this size relation is significant. Because most of the slopes around the smaller islands of the West Indies are rough-bottom areas, exploratory fishing vessels were forced to attempt to get samples from or very near rocky or rough bottom if they were to get them at all. Thus, for *S. r. boa* we have a proportionally larger sample of the full grown specimens which, we postulate, prefer rough-bottom habitats.

Distribution: S. r. boa ranges from its type locality at Barbados northward through the Lesser Antilles, and along the southern coasts of Hispaniola and Jamaica. It occurs off the Central American coast southward from Honduras and is represented on the Caribbean coast of Colombia by melanistic variants. The specimens seen were trawled from depths of 274 to 676 m.

Natural history notes: One melanistic Colombia specimen of *S. r. boa* (USNM 204378) was alive when brought on the deck of the R/V *Oregon* and was placed in a drum of sea-water where it was observed to exhibit luminescence (Harvey R. Bullis, Jr., personal communication). He described the light as a diffuse glow from the ventral surfaces but noted two distinct light-producing spots on the dorsal midline between the tip of the snout and the origin of the first dorsal fin. Subsequent examination of this specimen in the laboratory failed to reveal photophores, which suggests that the luminescence may have been of bacterial origin. This appears to be the only report of bioluminescence from a galeoid shark.

Scyliorhinus retifer meadi Springer, 1966

Scyliorhinus meadi Springer, 1966, pp. 600–601, fig. 14B (type locality, off Cape Kennedy, Florida, 28°21′N, 79°51′W).

Study material: USNM 188049, the holotype, and five other specimens.

Diagnosis: Scyliorhinus retifer meadi has a color pattern of seven or eight dorsal saddles but no reticulating dark lines, no black spots, and no white spots, and thus differs from other subspecies of S. *retifer*. It has a greater average number of monospondylous vertebrae than other subspecies but overlaps S. *r. retifer* and S. *r. boa* (see Table 1). The six known specimens have appreciably longer denticle points than other subspecies of S. *retifer* of equal size.

Size: Mature and newly hatched specimens are not known.

Distribution: Specimens have been taken only at the type locality in 329 m depth off Cocoa Beach near Cape Kennedy, from the same depth off St. Augustine, in 457–622 m off Bimini, Bahamas, and in 549 m in the Santaren Channel between the Cay Sal and Bahama Banks. As shown in Figure 1, the known geographical range of S. *r. meadi* lies within and very near the range of S. *r. retifer*. This is in apparent conflict with an expected distribution of a subspecies as outlined earlier. The extent of the range of S. *r. meadi* cannot be well represented, however, by records of six immature specimens from four locations.

The contact between the two subspecies seems insubstantial. The area of geographical overlap lies off the Florida coast between St. Augustine and Fort Pierce. That both subspecies are rare in this area is shown by the capture of only four or five immature specimens of each subspecies in very thorough exploratory trawling operations carried out over several years.

Much less information is available from the side of the Gulf Stream adjacent to the Bahama Banks where less than two percent as much trawling effort has been made. The two records of capture of S. *r. meadi* on the Bahama side of the Gulf Stream thus seem more important and lead to the belief that it is primarily a Bahamian subspecies. In its color pattern S. *r. meadi* resembles some specimens of S. *r. boa* except for the absence of white spots but none of the six immature specimens show any trace of the reticulate pattern that characterizes S. *r. retifer*.

Scyliorhinus retifer haeckelii (Ribeiro, 1907)

Catulus haeckelii Ribeiro, 1907, pp. 163–165, pl. 8 (type locality off Rio de Janeiro in 80 m).

Scyliorhinus boa: Bigelow and Schroeder, 1948, (part, type of C. *haeckelii* depicted in illustration and incorporated in account of species, pp. 204–207, fig. 32).—Springer 1966, (part, except type of S. *boa*, pp. 601–602, fig. 15A).

Scyliorhinus fernandezi Weibezahn, 1953, pp. 3–7, fig. 1.

Study material: Museum Nacional Brasil (MNB) 494, the holotype; USNM 188060 and 20 other specimens.

Diagnosis: Scyliorhinus retifer haeckelii has a color pattern of very small black spots smaller than the dark-adapted pupil, the spots usually distributed generally over the dorsal surfaces and in many examples outlining the seven or eight dark colored dorsal saddles. In three of our specimens the dorsal saddles are only faintly represented and the black spots are smaller, more numerous, and more evenly distributed over the dorsal surfaces than in the more typical form.

None of the available specimens show any trace of reticulating narrow lines except as series of discrete black spots, but three newly hatched specimens have bands of slightly darker color (less strong than the color of dorsal saddles) that are similar to bands on anterior lateral surface of immature western Caribbean S. *r. boa*. The illustrations of the holotype and other illustrations noted in the synonymy above depict very well the color pattern that is characteristic of most of our specimens of S. *r. haeckelii.*

Size: S. *r. haeckelii* may be slightly smaller than S. *r. boa* or S. *r. retifer*, as previously suggested by Springer (1966, p. 602) because a 346-mm male S. *r. haeckelii* is apparently sexually mature.

Distribution: Our material indicates that S. *r. haeckelii* ranges along the continental slope of South America from western Venezuela to the vicinity of Rio de Janeiro, although the only specimen recorded from south of the equator is the holotype. Depths recorded for S. *r. haeckelii* are from 37 to 402 m. The holotype of *Catulus haeckelii* was taken off Rio de Janeiro from 80 m and the holotype of *Scyliorhinus fernandezi* was from 37 m. These records suggests the possibility that S. *r. haeckelii* frequents somewhat shallower water than S. *r. boa* and (in the tropical segment of its range) S. *r. retifer.*

Natural history notes: A series of 9 egg cases with 3 newly hatched young permits positive identification of the egg cases of S. *r. haeckelii.* The egg cases are light amber, transparent, and do not have transverse bands such as has been noted for egg cases of S. *r. retifer* that carry developing eggs. Each egg case has a pair of well-developed tendrils at each end. The upper and lower surfaces are smooth except for very faint longitudinal striae and the lateral edges are thickened and re-enforced much as in egg of *Scyliorhinus stellaris* and S. *r. retifer.* The egg cases of the series are 62 to 66 mm long measured along the axis (not including horns and tendrils) and are from 24 to 27 mm at their widest parts. The young obtained with, but not directly from, the egg cases are 100, 102, and 130 mm long. Seven of the cases contain yolk without indication of developing embryos. The series was collected by the UNDP/FAO vessel *Calamar* at its station 413 off Surinam in 137 m—(coral and "sea-fan" bottom) at 07°28'N; 56°24'W.

Fig. 2. Drawing of *Scyliorhinus retifer besnardi*, paratype, a 366-mm male, USNM 204377.

Scyliorhinus retifer besnardi new subspecies
(Figure 2)

Holotype: A 385-mm female (USNM 204376) trawled at station 419 the R/V *Prof. W. Besnard* of the Instituto Oceanográfico de la Universidade de São Paulo, from a depth of 190 m, temperature 15.67° C, salinity 35.726‰ at the trawling depth, at 33°26′S, 51°21′S, near the continental shelf edge off northern Uruguay, 2 November 1968.

Paratypes: A 470-mm adult male, Instituto Oceanográfico São Paulo (IOSP 81BS), partially dissected; a 338-mm female (IOSP 82BS); and a 366-mm male (USNM 304377); all from the same haul as the holotype.

Other Material: A 356-mm male (1OSP 83BS) from R/V *Prof. W. Besnard* station 436 from a depth of 140 m, temperature 15.77° C, salinity 35.702‰ at the trawling depth, at 30°15′S, 49°00′W, off Porto Alegre, Brazil.

Diagnosis: S. *r. besnardi* has the diagnostic characters of the genus *Scyliorhinus*; that is, chondrocranium with a supraorbital crest, lower labial furrow developed but upper labial furrow absent, and upper lip slightly overlapping lower lip near mouth corners.

The color pattern of *S. r. besnardi* is somewhat like the color pattern of *Halaelurus buergeri* of Japanese waters but *H. buergeri* lacks supraorbital crests. The color pattern of S. *r. besnardi* also resembles that of some specimens of *Scyliorhinus caniculus* and S. *stellaris* from the west coast of Africa but in the two latter species the nasal flaps extend nearly or quite to the upper lip and sometimes overlap it.

S. r. besnardi may be readily distinguished from other western Atlantic *Scyliorhinus* by the color pattern differences already set forth in the key. In addition, of the five specimens of *S. r. besnardi* for which we have vertebral counts, four have 38 monospondylous vertebrae and one has 37, whereas in 12 specimens of *S. r. haeckelii* only one has as few as 38. Other subspecies of *retifer* have somewhat higher counts, from 39 to 49 (see Table 1).

Description: Following are proportional measurements of the holotype in percentages of total length except as indicated. The range is given in parentheses for the holotype, two paratypes (excepting the 470-mm male), and the 356-mm specimen listed above. Measurements were made as outlined in Bigelow and Schroeder (1948).

Tip of snout to: front of mouth, 4.2 (4.1–5.4); eye, 4.2 (4.2–5.5); spiracle, 10.1 (9.6–10.6); first gill opening, 14.5 (14.5–15.6); last gill opening, 19.0 (18.9–19.2); origin pectoral, 18.2 (17.8–18.5); origin first dorsal, 48.1 (48.1–49.7); origin pelvics, 39.5 (39.5–41.6); origin second dorsal, 66.0 (66.0–67.2); origin anal, 58.5 (58.5–60.9); origin upper caudal lobe 79.2 (77.5–79.3); anterior end cloacal opening, 41.8 (41.8–45.2).

Greatest width of: head, 11.2 (11.2–11.5); trunk at pectorals, 8.6

(8.6–11.0); trunk at pelvics, 6.2 (6.0–6.4); trunk at caudal origin, 2.1 (2.1–2.8).

Greatest height of: head at spiracles 7.3 (6.1–7.3); trunk at pectorals, 9.9 (9.8–9.9); trunk at pelvics, 8.6 (8.4–8.7); trunk at caudal origin, 3.4 (3.3–3.6).

Eyes: horizontal diameter 3.6 (2.9–3.6); distance between supraorbital crests of chondrocranium 3.5 (3.5–3.8); distance between upper eyelids 6.2 (6.2–6.3).

Spiracles: greatest diameter 0.5 (0.5–0.7); least distance from eye, 0.8 (0.8–1.2); distance between, 7.5 (7.5–7.9).

Mouth: width, 6.5 (6.5–7.9); length, 3.9 (3.6–4.2); upper labial furrow absent; length lower labial furrow, 1.2 (1.2–1.7).

Nasal apertures: level of anterior ends to tip of snout, 2.5 (2.5–3.2); level of posterior ends to front of mouth, 0.6 (0.5–1.0).

Gill slits: height of first, 1.8 (1.5–1.9); height of fifth, 1.0 (1.0–1.2).

First dorsal fin: length base, 5.7 (5.7–6.9); length posterior tip (posterior inner margin), 2.6 (2.6–3.1); height, 4.4 (4.5–5.1); length anterior margin, 9.1 (9.1–10.7).

Second dorsal fin: length base, 5.2 (5.2–5.7); posterior tip (posterior inner margin), 2.6 (2.6–2.8); height, 2.9 (2.7–3.8); length anterior margin, 7.5 (7.5–8.2).

Pelvic fins: origin to posterior tip, 9.9 (7.4–10.2).

Caudal fin: upper margin, 20.8 (20.8–22.5); anterior margin lower lobe, 9.6 (9.6–10.4); tip to notch, 6.5 (6.5–7.1).

Distance between fin bases: first to second dorsal, 12.5 (10.4–12.5); pectoral to pelvic, 16.4 (16.1–18.2); pelvic to anal 11.7 (11.7–13.7); anal to lower caudal, 9.9 (7.9–9.9); second dorsal to upper caudal, 9.1 (4.8–9.1).

Teeth: number of upper, 23 plus 23 in holotype to 25 plus 26 in one paratype; number of lower 21 plus 1 plus 23 in holotype to 22 plus 3 plus 23 in one paratype.

Vertebrae: in holotype and in three paratypes from radiographs, in 470-mm male paratype from dissection, total number 125 (122–129); number monospondylous 38 (37–38).

Gill rakers: one about 1 mm high on each side of gill bars plus a second smaller gill raker on some gill bars of holotype; one paratype has only one on each side of gill bars without second smaller gill raker.

Color pattern of holotype (see fig. 2), gray above flecked with a few very small white specks which are incompletely formed replacement denticles; dorsal surface with seven or eight indistinct saddles only slightly darker than background color and marked with black, round or ovoid spots, some paired or double, some forming lunate or ocelluslike markings, most spots as large or larger than pupil, pairs or single spots separated from one another by distances greater than the diameter of spots, a series of eight spots on dorsal midline, three of which are double, spots present on dorsal surface of paired fins and on dorsals and caudal; ventral surfaces white but somewhat irregularly suffused with darker color.

Paratypes with a similar pattern of spots arranged in approximate bilateral symmetry, as in holotype.

Teeth of upper and lower jaws not differing greatly in size or shape; largest about 1 by 1 mm in holotype; typically with long central cusp flanked by one short cusp on each side but some with additional cusps, usually one extra on the inner side, but a few with extra cusps on both sides of central cusp; bases of teeth striate; symphysis of upper jaw distinct, without median tooth, but first tooth on each side of symphysis small; lower jaw without well-marked symphyseal separation and with 3 small medial teeth.

Dermal denticles 3-pointed on lateral surfaces, the central point longest, with three prominent ridges.

Pelvic fins of males united along inner margins for about two-thirds the distance to their tips, pelvic fins of females united by membrane only at base.

Claspers of the 470-mm male extend well beyond the tips of the pelvics, whereas claspers of the 366-mm paratype do not nearly reach the pelvic tip. This suggests that maturity in the male may be reached at lengths near 470 mm or less.

Etymology: The new subspecies is named in honor of Professor Wladimir Besnard, founder of the Oceanographic Institution of the University of São Paulo.

Acknowledgments: We thank Harvey R. Bullis, Jr., for permission to report his observation of luminescence from a specimen of S. *r. boa*, and Jules M. Crane for assistance in a laboratory search for photophores on the specimen.

Illustrations were prepared by Mildred M. Carrington.

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PROCEEDINGS
OF THE
BIOLOGICAL SOCIETY OF WASHINGTON

NINE NEW AMERICAN STOMATOPOD CRUSTACEANS

By Raymond B. Manning
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Since a revision on the western Atlantic stomatopods was submitted for publication in 1967, five species not included in that report have been sent to me by a number of individuals. In addition, four new species from the eastern Pacific region also have been discovered; inasmuch as a planned review of the eastern Pacific Stomatopoda has been further delayed those are characterized here.

I would like to thank the following individuals for providing me with the specimens reported here: Dorothy Bliss, American Museum of Natural History; E. E. Boschi, Instituto de Biologia Marina, Mar del Plata, Argentina; Harvey R. Bullis, Jr., U.S. Fish and Wildlife Service; C. E. Dawson, Gulf Coast Research Laboratory; L. McCloskey, then of Duke University Marine Laboratory; H. Rodrigues da Costa, Universidade Federal do Rio de Janeiro; Enrique M. del Solar, Instituto del Mar del Perú, Lima; and G. L. Voss, School of Marine and Atmospheric Sciences, University of Miami. The illustrations are by my wife Lilly.

Terms and measurements have been described in detail in an earlier paper (Manning, 1969). Types have been deposited in the American Museum of Natural History (AMNH), the Rijksmuseum van Natuurlijke Historie, Leiden (RMNH), and the Division of Crustacea, National Museum of Natural History, Smithsonian Institution (USNM), as indicated in the text.

Nannosquilla carolinensis new species
Figure 1

Holotype: 1♀, 18 mm; off North Carolina; 34°06.9′N, 76°11.5′W; 100 meters; *Eastward* station 5980; 7 October 1966; USNM.

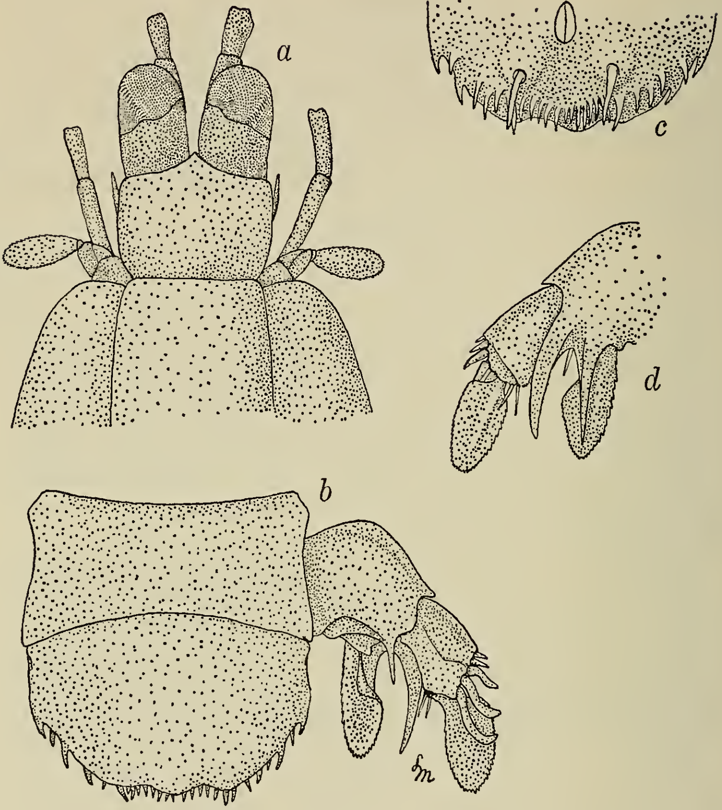

FIG. 1. *Nannosquilla carolinensis* new species. Female holotype, TL 18 mm, *Eastward* station 5980: *a*, anterior portion of body; *b*, sixth abdominal somite, telson, and uropod; *c*, telson, ventral view; *d*, uropod, ventral view. (Setae omitted).

Paratype: 1♂, 18 mm; data as in holotype; USNM.

Diagnosis: Cornea subglobular, set obliquely on stalk. Rostral plate flattened laterally, rounded anterolaterally, anterior margins converging on obtusely pointed apex. Dactylus of raptorial claw with 8 teeth. Mandibular palp absent; 4 epipods present. Abdomen flattened, smooth, unarmed. Telson broader than long, smooth dorsally, false eave with rounded median and lateral projections; marginal armature comprising, on either side of midline, 6 submedian denticles in a curved row, 1 movable submedian tooth, 6 fixed teeth and denticles, and 1 large fixed lateral tooth. Uropod with 2–3 stiff setae on inner margin and 4–5 spatulate spines on outer margin of proximal segment of exopod; spines of basal prolongation subequal in length.

Color: Background color light, appearing speckled with numerous dark stellate chromatophores.

Measurements: Male paratype and female holotype both 18 mm; other measurements of female: carapace length 3.1; cornea width 0.7; telson length 1.4, width 2.5.

Discussion: Nannosquilla carolinensis resembles *N. antillensis* (Manning) in having the spines of the basal prolongation subequal but differs in having the rostral plate rounded anterolaterally and in lacking the posterolateral spines of the sixth abdominal somite.

Etymology: The name alludes to the discovery of the species off North Carolina.

Nannosquilla dacostai new species

Figure 2

Holotype: 1 ♀, 19 mm; Brazil; 02°31'S, 40°22'W; 23 meters; Expediçao Norte Nordeste I, station 1720; H. Rodrigues da Costa; 29 October 1967; USNM.

Diagnosis: Cornea subglobular, set obliquely on stalk. Rostral plate broadly rounded laterally and anterolaterally, anterior margins converging on obtusely pointed apex. Dactylus of raptorial claw with 6 teeth. Mandibular palp and 4 epipods present. Abdomen flattened, smooth, with strong posterolateral spines on sixth somite. Telson broader than long, smooth dorsally, false eave rounded medially, median prominence flanked laterally by obtusely rounded lateral projection; marginal armature, on either side of midline, comprising 8 submedian denticles in transverse row, 1 movable submedian tooth, 4 fixed teeth and denticles, innermost set posterior to movable tooth, and 1 large fixed lateral tooth. Uropod with 3–4 stiff setae on inner margin and 5 spatulate spines on outer margin of proximal segment of exopod; inner spine of basal prolongation of uropod the longer.

Color: Faded.

Measurements: Unique female holotype, TL 19 mm; other measurements: carapace length 2.9; cornea width 0.8; telson length 1.3, width 2.0.

Discussion: Nannosquilla dacostai is similar to *N. antillensis* (Manning), differing in having only six teeth on the claw, broadly rounded anterolateral angles on the rostral plate, and four rather than five to eight fixed teeth and denticles on the telson lateral to the movable submedian tooth. With the exception of *N. carolinensis*, described above, and *N. antillensis*, all other western Atlantic species of *Nannosquilla* have the inner spine of the basal prolongation of the uropod longer than the outer.

Etymology: The species is named for H. Rodrigues da Costa who collected the holotype and made it available for study.

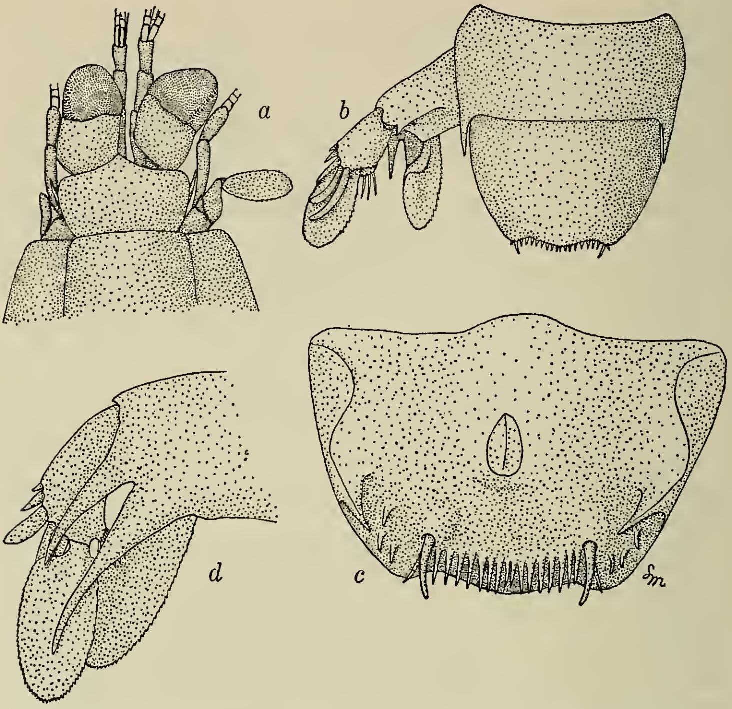

FIG. 2. *Nannosquilla dacostai* new species. Female holotype, TL 19 mm, Brazil: *a,* anterior portion of body; *b,* sixth abdominal somite, telson, and uropod; *c, telson,* ventral view, enlarged; *d,* uropod, ventral view, enlarged. (Setae omitted).

Meiosquilla dawsoni new species
Figure 3

Holotype: 1♂, 29.5 mm; Fort Amador Causeway, Pacific coast, Panama; chem-fish poison on sand pool and among rocks, small rock pile adjacent to causeway; 0.2 feet; C. E. Dawson, collector; 29 November 1966; USNM 124744.

Paratype: 1♂, 47 mm; taken by shrimp trawler out of Guaymas, Mexico; A. Sorenson; 1946; USNM.

Diagnosis: Eye large, triangular cornea bilobed, set obliquely on stalk. Ocular scales subtruncate. Anterior margin of ophthalmic somite with median tubercle. Rostral plate cordiform, longer than broad, apex rounded. Carapace smooth, lacking spines or carinae except for short reflected marginals and laterals on posterior portion. Dactylus of raptorial claw with 4 teeth; dorsal ridge of carpus of claw undivided. Mandibular palp absent; 4 epipods present. Exposed thoracic somites lacking sub-

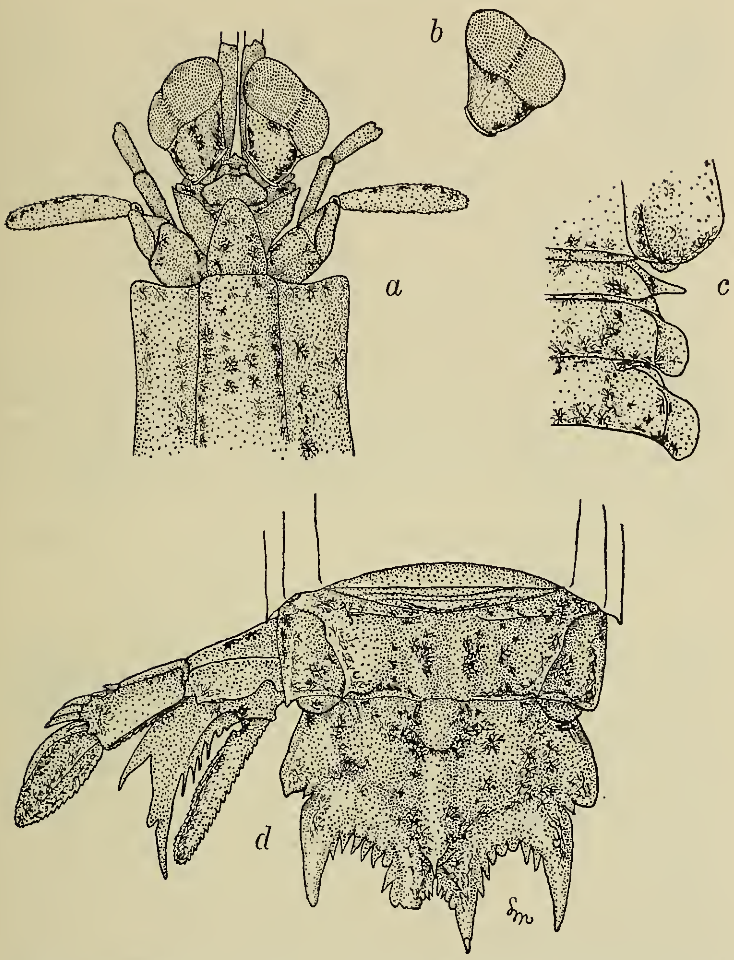

FIG. 3. *Meiosquilla dawsoni* new species. Male holotype, TL 29.5 mm, Panama: *a*, anterior portion of body; *b*, right eye; *c*, lateral processes of fifth, sixth, and seventh thoracic somites; *d*, fifth and sixth abdominal somites, telson, and uropod. (Setae omitted).

median carinae, intermediates present on sixth to eighth somites. Lateral process of fifth thoracic somite a rounded lobe, compressed anteroposteriorly, sharp ventral spine present on each side; lateral processes of sixth and seventh thoracic somites broadly rounded; ventral keel of eighth thoracic somite erect, apex rounded. Abdomen without submedian carinae on anterior 5 somites, abdominal carinae spined as follows: submedian 6, intermediate 6, lateral 6, marginal 5; carinae of sixth somite strongly inflated in male. Telson with 3 pairs of marginal teeth, submedians with movable apices; marginal carinae of telson short, dorsal surface lacking supplementary carinae; denticles sharp, 3–4, 7–8, 1; median carina and bases of marginal teeth inflated in males. Uropodal exopod with 6 movable spines on outer margin of proximal segment; basal prolongation of uropod with 4–6 fixed spines on inner margin.

Color: Background color light, body covered with numerous small black chromatophores.

Measurements: Males only examined, TL 29.5–47 mm; other measurements of male holotype: carapace length 6.9; cornea width 2.0; rostral plate length 1.2, width 1.0; telson length 4.0, width 5.3.

Discussion: Meiosquilla dawsoni is the eastern Pacific analog of *M. quadridens* (Bigelow); it differs from that species in having a slenderer rostral plate and in lacking posterior spines on the intermediate and lateral carinae of the fifth abdominal somite. The new species differs from the two known eastern Pacific species, *M. swetti* (Schmitt) and *M. oculinova* (Glassell), in lacking supplementary dorsal carinae on the telson.

Etymology: The species is named for the collector, C. E. Dawson.

Squilla decimdentata new species

Figure 4

Holotype: 1♂, 80 mm; Venezuela; 10°43.5′N, 64°16′W to 10°45.5′N, 64°15′W; 39–33 fathoms; *Pillsbury* station 723; 21 July 1968; USNM.

Paratypes: 1♀, 46 mm; Venezuela; 10°45′N, 62°00′W to 10°45.5′N, 62°02.5′W; 42–47 fathoms; *Pillsbury* station 705; 18 July 1968; USNM.—1♂, 28 mm; 2♀, 51–52 mm; Venezuela; 10°47.4′N, 62°55′W to 10°47.6′N, 62°56′W; 26–25 fathoms; *Pillsbury* station 710; 19 July 1968; USNM.—2♂, 22–55 mm; 4♀, 36–52 mm; Venezuela; 10°48′N, 63°13′W to 10°50′N, 63°13′W; 25–28 fathoms; *Pillsbury* station 711; 19 July 1968; RMNH.—5♂, 60–82 mm; 5♀, 59–73 mm; data as in holotype; RMNH.—9♂, 58–86 mm; 6♀, 48–77 mm; same data; USNM.—1♀, 68 mm; Venezuela; 10°20′N, 65°02′W; 35 fathoms; *Pillsbury* station 727; 21 July 1968; USNM.—1♀, 33 mm; Venezuela; 10°42.5′N, 66°21′W to 10°44′N, 66°20.4′W; 75–105 fathoms; *Pillsbury* station 738; 22 July 1968; USNM.—2♀, 35–53 mm; Venezuela; 10°54.7′N, 66°17.8′W to 10°57.6′N, 66°18′W; 128–153 fathoms; *Pillsbury* station 739; 23 July 1968; RMNH.—1♂, 35 mm; Venezuela; 11°39.6′N, 69°22.1′W to 11°42′N, 69°20′W; 88–102 fathoms; *Pillsbury* station 757; 27 July 1968; USNM.

Diagnosis: Eye large, cornea bilobed, set obliquely on stalk. Ocular scales subtruncate, inclined laterally. Rostral plate with short median carina, length and width of plate subequal, apex rounded. Median carina of carapace with anterior bifurcation; anterolateral spines of carapace strong but not extending to base of rostral plate; anterior margins of

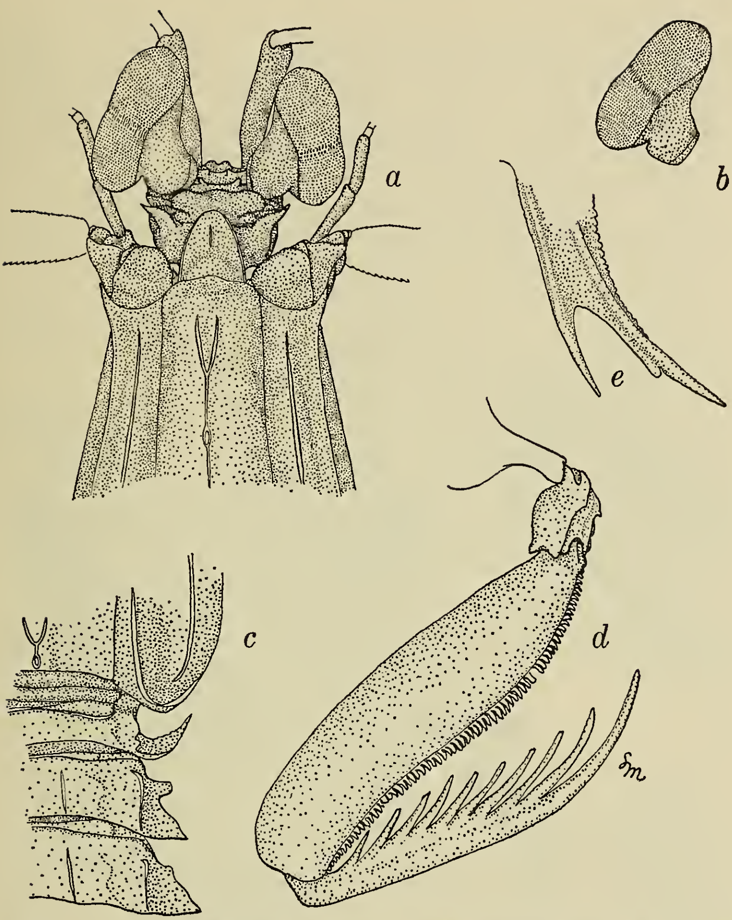

FIG. 4. *Squilla decimdentata* new species. Female paratype, TL 68 mm, *Pillsbury* station 727: *a*, anterior portion of body; *b*, left eye; *c*, lateral processes of fifth, sixth, and seventh thoracic somites; *d*, raptorial claw; *e*, basal prolongation of uropod. (Setae omitted).

lateral plates of carapace concave. Dactylus of raptorial claw with 10–11, usually 10, teeth, outer margin evenly rounded; dorsal ridge of carpus irregularly tuberculate. Mandibular palp and 5 epipods present. Lateral process of fifth thoracic somite a sharp, curved spine; lateral processes of next 2 somites bilobed, anterior lobes small, posterior lobes much larger, posterolateral apices sharp. Posterior 3 thoracic and all 6 abdominal somites with submedian and intermediate carinae, those on thoracic somites unarmed. Abdominal carinae spined as follows: submedian 5–6, intermediate (2)3–6, lateral (1)2–6, marginal 1–5. Telson broader than long with median carina and 3 pairs of marginal teeth, prelateral lobes present; median carina and margin of telson inflated in adult males; denticles 4–7, 10–14, 1; ventral surface of telson with short postanal keel. Uropodal exopod with 7–9 short movable spines on outer margin of proximal segment.

Color: Posterior 3 thoracic and anterior 5 abdominal somites with dark posterior line; second abdominal somite with obscure transverse dark patch middorsally; telson with pair of dark submedian crescents.

Measurements: Males, TL 22–86 mm; females, TL 33–77 mm; other measurements of male holotype, TL 80 mm: carapace length 15.8; anterior width of carapace 6.8; cornea width 5.3; rostral plate length 2.5, width 2.5; telson length 15.2, width 16.1.

Discussion: Squilla decimdentata can be distinguished from all known species of *Squilla* by the larger number of teeth on the dactylus of the raptorial claw, 10–11; the other species normally have six teeth on the claw, although S. *heptacantha* (Chace) always has seven. The new species closely resembles S. *lijdingi* Holthuis in color pattern and general facies, but can be distinguished from that species by the carina on the rostral plate and the well-formed anterior bifurcation of the median carina of the carapace in addition to the number of teeth on the claw.

Etymology: The name is from the Latin, decem, ten, and the Latin, dentatus, toothed, in reference to the number of teeth on the dactylus of the claw.

Eurysquilla solari new species

Figure 5

Holotype: 1♀, 47 mm; Peru; 09°24′S, 79°28′W; 160 meters; *Kaiyo Maru*; Enrique M. del Solar; 26 December 1968; USNM.

Diagnosis: Cornea strongly bilobed, set very obliquely on stalk. Ocular scales broad, flattened dorsally, inclined laterally. Antennal protopod with 1 ventral papilla. Rostral plate rounded laterally, strong apical spine present. Dactylus of raptorial claw with 7 teeth. Mandibular palp and 5 epipods present. Lateral processes of sixth and seventh thoracic somites rounded laterally and posterolaterally; eighth somite with carina above lateral margin. Abdominal carinae spined as follows: submedian 6, intermediate 5–6, lateral 5–6, marginal 4–5. Telson broader than long, with median carina and 3 pairs of dorsal carinae, dorsal carinae tuberculate, marginals entire; bases of intermediate and lateral teeth with patch or ridge of erect tubercles; inner intermediate denticle broad, triangular, outer intermediate denticle and lateral denticle slender, arising ventral to posterior margin. Uropodal exopod with 7 movable spines on proximal segment; basal prolongation slender, terminating in 2 spines, inner longer, inner margin of prolongation smooth.

Color: Body conspicuously marked with dark chromatophores; dark

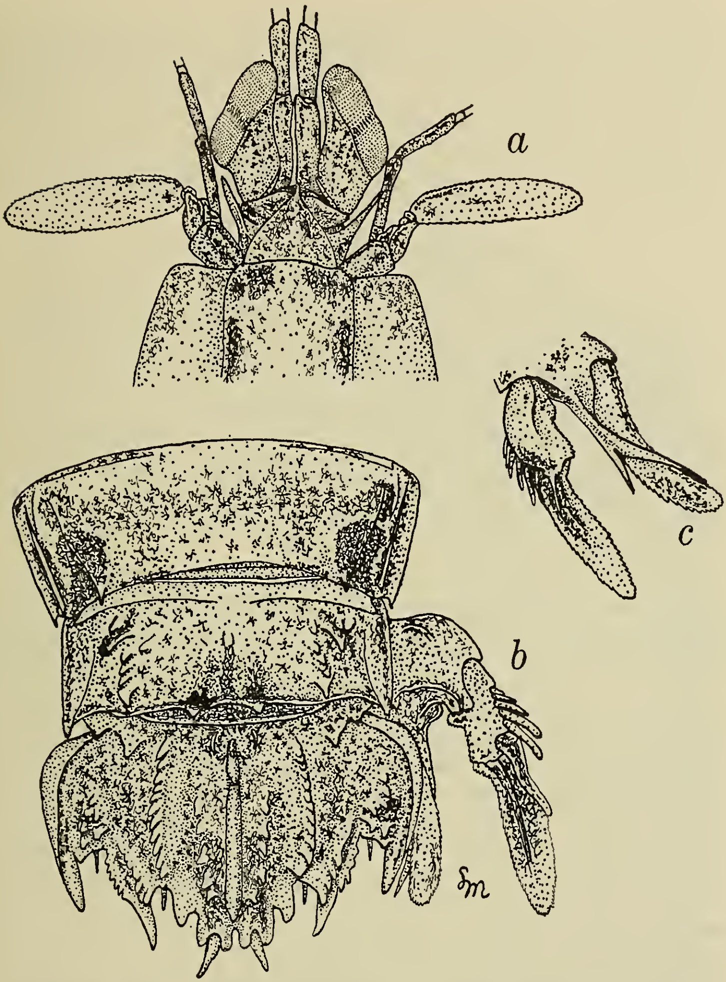

FIG. 5. *Eurysquilla solari* new species. Female holotype, TL 47 mm, Peru: *a*, anterior portion of body; *b*, fifth and sixth abdominal somites, telson, and uropod; *c*, uropod, ventral view. (Setae omitted).

lateral patches present on first and fifth abdominal somite; median portion of thoracic and abdominal somites and posterior portion of median carina of telson dark.

Measurements: Unique female holotype, TL 47 mm; other measurements: carapace length 8.0; cornea width 3.0; rostral plate length 2.2, width 2.2; telson length 5.8, width 9.9.

Discussion: Eurysquilla solari resembles both *E. veleronis* (Schmitt) from the eastern Pacific and *E. plumata* (Bigelow) from the western Atlantic, differing from both in having an apical spine on the rostral plate and in having posterior spines on the intermediate and lateral carinae of the fifth abdominal somite. All three species are marked by the dark spots on the fifth abdominal somite.

Etymology: The species is named for the collector, Enrique M. del Solar.

Gonodactylus petilus new species

Figure 6

Holotype: 1♂, 18 mm; southwestern Caribbean Sea, off Panama; 09°28.3′N, 78°20.7′W to 09°29.2′N, 78°21.7′W; 51–55 meters; *Pillsbury* station 419; 19 July 1966; USNM.

Paratypes: 1♂, 22 mm; same; 09°26.6′N, 78°16.3′W to 09°26.8′N, 78°17′W; 57–59 meters; *Pillsbury* station 418; 19 July 1966; RMNH.—2♀, each 22 mm; same; 09°30.5′N, 78°25.6′W to 09°30.7′N, 78°26′W; 51 meters; *Pillsbury* station 420; 19 July 1966; USNM.—1♀, 19 mm; same; 09°32.1′N, 78°33.5′W to 09°32.5′N, 78°34.3′W; 53–59 meters; *Pillsbury* station 421; 19 July 1966; RMNH.

Diagnosis: Anterolateral angles of rostral plate broadly rounded. Ocular scales erect, separate, rounded dorsally. Lateral process of sixth thoracic somite more rounded laterally and broader than process of seventh somite. Lower portion of posterior margin of pleura of anterior 4 abdominal somites concave dorsally, convex or straight ventrally. Anterior 5 abdominal somites unarmed posterolaterally. Sixth abdominal somite with 6 carinae, each usually with posterior spine, carinae inflated, unarmed in adult males. Abdomen slender, Abdominal Width-Carapace Length Index ranging from 704 to 731 in specimens with carapace lengths ranging between 3.4 and 4.5 mm. Telson broader than long, of Oerstedii-type, lacking dorsal tubercles on carinae; median carina flask-shaped, with rounded posterior tubercle, not noticeably inflated in males; accessory median carinae long, extending anteriorly for about one-third length of median carina, fusing posteriorly with median carina to form anchor; knob low; anterior submedian carinae with posterior tubercles or dimple; submedian, intermediate, accessory intermediate, and marginal carinae of telson sharp; low, swollen oblique ridge extending from base of each submedian tooth towards knob; submedian teeth very slender, movable apices usually present; intermediate teeth sharp, longitudinal axes subparallel with axes of submedians; apex of lateral tooth distinct; 13–14 submedian denticles and 2 anteriorly-recessed intermediate denticles, inner set on rounded lobe, present. Uropod slender, elongate; outer margin of proximal segment of exopod with 9–11 movable spines; endopod slender, rounded mesially and laterally, tapering to rounded apex.

Color: Dactylus of raptorial claw pink; merus with large proximal

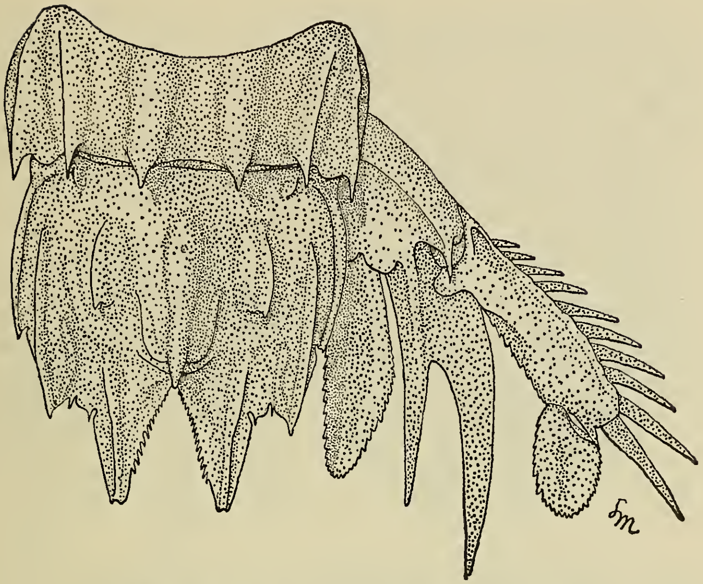

FIG. 6. *Gonodactylus petilus* new species. Male holotype, TL 18 mm, *Pillsbury* station 419: sixth abdominal somite, telson, and uropod (setae omitted).

and smaller distal spot on dorsal depression. Sixth thoracic and first abdominal somite with trace of median patch of dark chromatophores.

Measurements: Males, TL 18–22 mm; females, TL 19–22 mm. Other measurements of male, TL-22 mm: carapace length 4.5; fifth abdominal somite width 3.3; telson length 2.7, width 3.0.

Discussion: Gonodactylus petilus is the slenderest species to be described from the Americas; it differs from the known western Atlantic species lacking dorsal spines and tubercles on the telson in having very elongate accessory median carinae on the telson. The new species closely resembles *G. stanschi* Schmitt from the eastern Pacific region, but that species has some dorsal spinules on the telson.

Etymology: The specific name is from the Latin, petilus, thin.

Gonodactylus pumilus new species
Figure 7

Holotype: 1♂, 20 mm; Gardner Bay, Hood Island, Galapagos Islands; 01°22′S, 89°39′W; 15 feet, from coral heads; *Arcturus* station 54; 25–27 April 1925; AMNH.

Paratypes: 10♂, 8–16 mm; 9♀, 8–16 mm; data as in holotype; AMNH.—1♂, 15 mm; 1♀, 16 mm; data as in holotype; USNM.

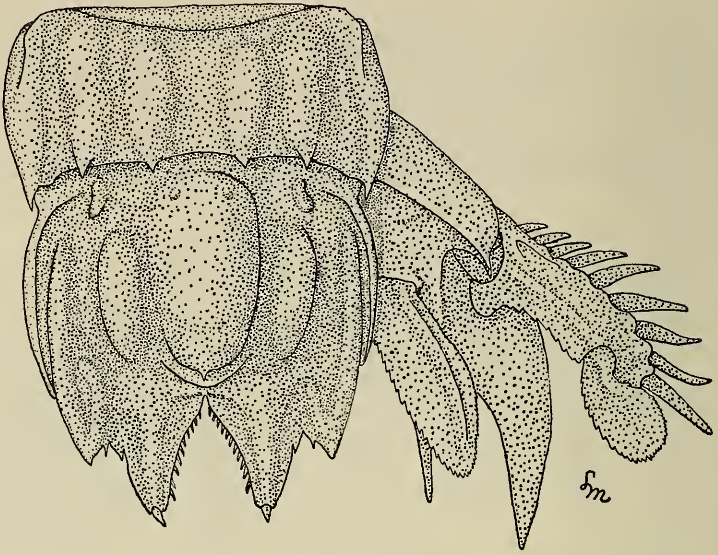

FIG. 7. *Gonodactylus pumilus* new species. Male holotype, TL 20 mm, *Arcturus* station 54: sixth abdominal somite, telson, and uropod (setae omitted).

Diagnosis: Anterolateral angles of rostral plate acute, sharp in some specimens but not spiniform. Ocular scales erect, separate, rounded or subtruncate dorsally. Lateral process of sixth thoracic somite more rounded laterally and broader than process of seventh somite. Lower portion of posterior margin of pleura of anterior 4 abdominal somites concave dorsally, slightly convex or flattened ventrally. Anterior 5 abdominal somites unarmed posterolaterally. Sixth abdominal somite with 6 carinae, submedians and intermediates slightly inflated, each usually with posterior spine; apical spines reduced or absent on submedian carinae of some males. Abdominal Width-Carapace Length Index ranging from 703 to 857 in specimens with carapace lengths ranging from 2.1 to 4.0 mm. Telson usually broader than long, of Oerstedii-type, lacking dorsal tubercles on carinae; median carina strongly arched dorsally, flask-shaped, with strong posterior spine (lacking in some males); accessory median carinae fusing posteriorly with median carina to form anchor, except in adult males in which inflation of median carina obliterates anchor; accessory medians armed posteriorly in some specimens, short, not extending anteriorly for one-fourth length of carina; knob low; anterior submedian carinae unarmed posteriorly; submedian, intermediate, accessory intermediate, and marginal carinae sharp; low, swollen oblique ridge extending from base of each submedian tooth towards knob; submedian teeth with movable apices; intermediate teeth sharp, apices slightly upturned, longitudinal axes subparallel with axes of submedians; apex of lateral tooth distinct; 9–11 submedian denticles and 2 anteriorly-recessed intermediate denticles, inner set on rounded lobe, present. Uropod not markedly slender; outer margin of proximal segment of exopod with 9–10 movable spines; endopod short, broad, inner margin and apex rounded.

Color: Faded.

Measurements: Males, TL 8–20 mm; females, TL 8–16 mm. Other measurements of male, TL 15 mm: carapace length 2.9; fifth abdominal somite width 2.3; telson length 1.8, width 2.1.

Discussion: Gonodactylus pumilus is the eastern Pacific counterpart of *G. torus* Manning; it differs from *G. torus* in having acute anterolateral angles on the rostral plate. The new species is also a dwarf species, like *G. torus*, which does not exceed 20 mm in total length; males 12 mm or more in total length exhibit the inflated median carina of the telson, a secondary sexual character. *Gonodactylus pumilus* is the smallest species recorded from the Americas.

Etymology: The specific name is from the Latin, pumilus, dwarf or pygmy.

Parasquilla (Parasquilla) boschii new species

Figure 8

Holotype: 1♀, 128 mm; east of Porto Alegre, Rio Grande do Sul, Brazil; 30°11'S, 48°34'W; *Walther Hervig* station 60; 27 February 1968; USNM 126072.

Paratypes: 1♀, 108 mm; Caribbean Sea, off Nicaragua; 12°21'N, 82°36.5'W; 105–108 fathoms; *Oregon* station 6448; 7 February 1967; USNM 125988.—1♂, CL23.2 mm; Brazil, off Rio de Janeiro; 22°59.6'S, 44°02.2'W; 21 meters; *Almirante Saldanha* station 1327; H. Rodrigues da Costa; 26 January 1966; USNM.

Diagnosis: Anterolateral angles of rostral plate rounded. Lateral processes of sixth and seventh thoracic somites rounded posterolaterally; eighth thoracic somite with median carina on posterior half of dorsal surface. Abdominal carinae spined as follows: submedian 6, intermediate 5–6, lateral 6, marginal 4–5; short accessory carina present on anterior half of each of anterior 5 abdominal somites above lateral carina. Telson with oblique interrupted carina on each side of dorsal surface extending towards intermediate marginal tooth; basal prolongation of uropod crenulate on inner margin.

Color: Largely faded, but lateral portions of body darker than dorsal surface; terminal spinules on walking legs crimson.

Measurements: Only male examined broken, CL 23.2 mm; females, TL 108–128 mm. Other measurements of female holotype, TL 128 mm: carapace length 30.4; cornea width 5.0; rostral plate length 3.0, width 6.1; fifth abdominal somite width 25.6; telson length 20.1, width 20.6.

Discussion: Parasquilla (Parasquilla) boschii closely resembles *P.* (*P.*)

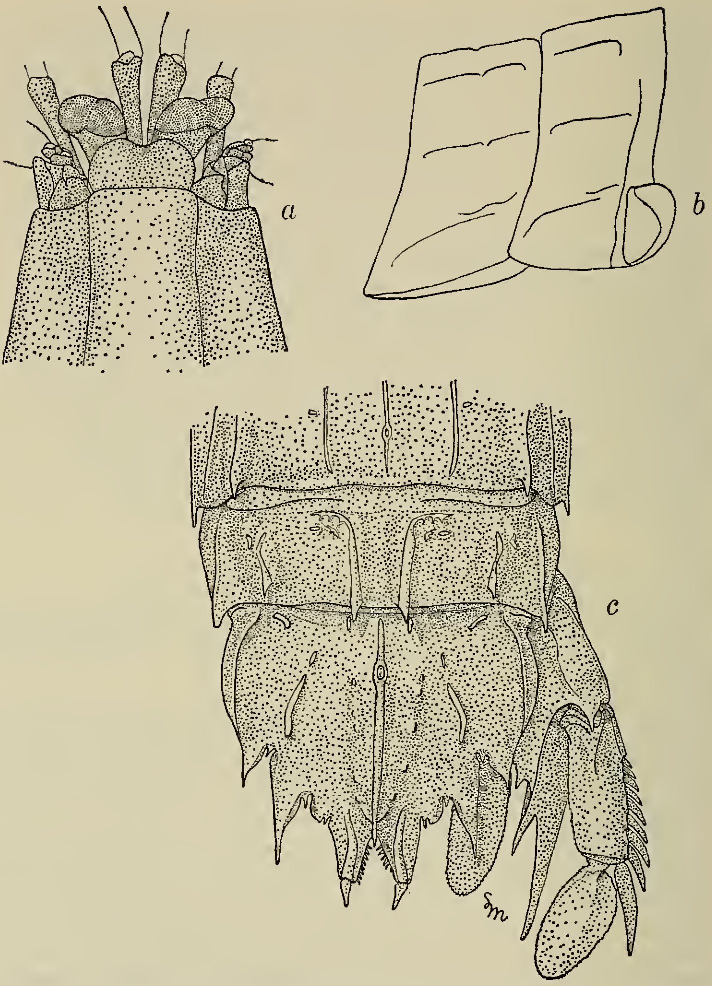

FIG. 8. *Parasquilla* (*Parasquilla*) *boschii* new species. Female paratype, TL 108 mm, *Oregon* station 6448: *a*, anterior portion of body; *b*, outline of first and second abdominal somites, right side, in lateral view; *c*, sixth abdominal somite, telson, and uropod. (Setae omitted).

ferussaci (Roux) from the eastern Atlantic region, differing in having short accessory carinae above the lateral carina on each of the anterior five abdominal somites. The new species differs from the three other American species in having a posterior spine on each intermediate carina of the sixth abdominal somite.

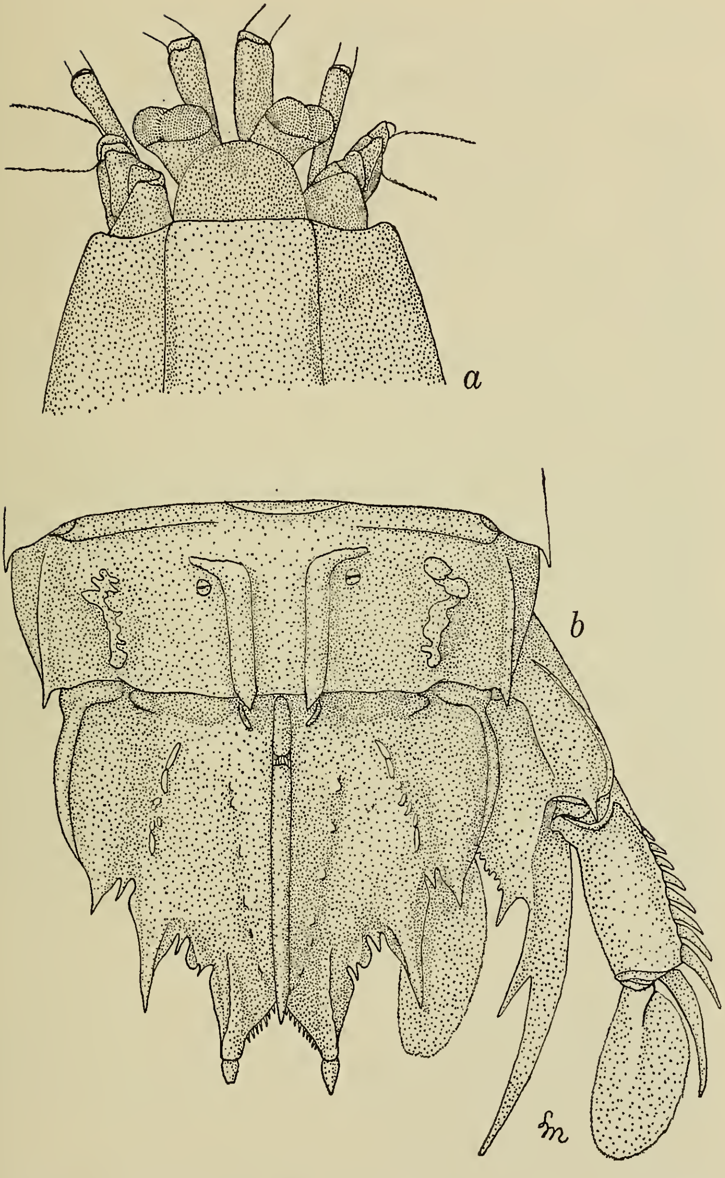

FIG. 9. *Parasquilla* (*Parasquilla*) *similis* new species. Female paratype, TL 128 mm, *Pillsbury* station 529: *a*, anterior portion of body; *b*, sixth abdominal somite, telson, and uropod. (Setae omitted).

Etymology: The species is named for Enrique E. Boschi who first made material of the species available for study.

Parasquilla (Parasquilla) similis new species

Figure 9

Holotype: 1♂, 160 mm; Gulf of Panama; 08°00.7′N, 79°11.8′W to 08°00.3′N, 79°12.8′W; 84 meters; *Pillsbury* station 529; 6 May 1967; USNM.

Paratypes: 1♂, 157 mm; 1♀, 128 mm; data as in holotype; USNM.—1♂, 151 mm; 1♀, 135 mm; data as in holotype; RMNH.—1♀, 125 mm; Caleta, La Cruz, Peru; 03°38′S; 23 April 1969; Enrique M. del Solar, collector; USNM.

Diagnosis: Anterolateral angles of rostral plate rounded. Lateral processes of sixth and seventh thoracic somites rounded posterolaterally; eighth thoracic somite lacking median carina on posterior half of dorsal surface. Abdominal carinae armed as follows: submedian 6, intermediate unarmed, lateral 6, marginal 5; accessory carina not present above each lateral carina of anterior five abdominal somites. Telson with oblique, interrupted carina on each side of dorsal surface extending toward intermediate tooth. Basal prolongation of uropod with 5–11 erect tubercles on inner margin.

Color: Pattern faded to overall bronze cast.

Measurements: Males, TL 151–160 mm; females, TL 125–135 mm. Other measurements of male holotype, TL 160 mm: carapace length 37.6; cornea width 4.8; rostral plate length 4.8, width 8.4; fifth abdominal somite width 35.1; telson length 26.4, width 29.5.

Discussion: Parasquilla (*Parasquilla*) *similis* is the first species of the genus to be described from the eastern Pacific region. It closely resembles *P. boschii* Manning and *P. meridionalis* Manning from the western Atlantic, differing from both in lacking a short median carina on the eighth thoracic somite. It agrees with *P. boschii, P. coccinea* Manning and *P. meridionalis* in lacking posterior spines on the intermediate carinae of the sixth abdominal somite and differs from the latter two species in having well developed dorsal carinae on the telson, a feature which it shares with *P. boschii.* None of the other species in the subgenus *Parasquilla* has erect tubercles on the inner margin of the basal prolongation of the uropod.

Large males of *P. similis* have the intermediate carinae of the sixth abdominal somite as well as the median carina and the bases of the marginal teeth of the telson noticeably inflated.

Etymology: The name is from the Latin, similis, similar, alluding to the resemblance to *P. meridionalis.*

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PROCEEDINGS
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TWO NEW NEOGENE SPECIES OF *TUBERCULODINIUM* AND ONE OF *XENICODINIUM* (PYRRHOPHYTA)

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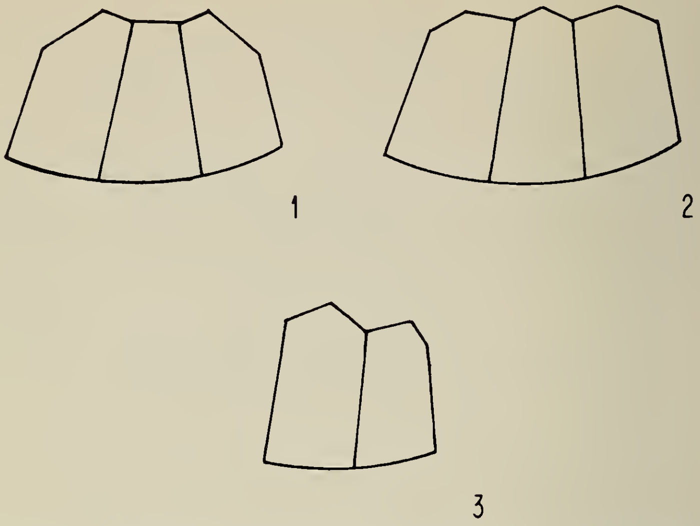
Two widely separated localities were the source of the material on which this paper is based. One is core hole 5 of the Joint Oceanographic Institution's Deep Earth Sampling Program (JOIDES). This core hole is located on the Florida-Hatteras Slope about 150 kilometers due east of Jacksonville, Florida. It was drilled by M/V Caldrill in April 1965. The age of the samples from this locality is Post-Miocene. The other location is north central Sumatra. Here the material is from two wells, one near Rumbai and the other on Rupat Island. The age of the sample from the Rumbai area is lower Miocene. The sample from the Rupat Island area is middle Miocene to Pliocene. Type specimens are deposited in the Helen Tappan Loeblich collection at the Department of Geology, University of California, Los Angeles, California.

Genus *Tuberculodinium* Wall, 1967

Tuberculodinium wallii new species

(Figs. 1, 4–6)

Description: Tract discoidal, with two wall layers. The endophragm is about 1 μ thick and forms a central body. The thin membranous periphragm is supported by processes arising from the central body. The periphragm is commonly damaged or missing due to its fragile nature. The spherical processes are closed distally and the cup-shaped processes are open distally. The processes are concentrated along the peripheral region and number from about 6 to 14. The dorsal and ventral areas of the central body (including the operculum) are ornamented by closely spaced small spherical "processes" which vary from 1 μ to 6 μ in diameter. The archeopyle reflects the position of three plates (see



FIGS. 1–3, diagrams to show types of opercula, 1, *Tuberculodinium wallii* n. sp.; 2, *T. vancampoae* (Rossignol) Wall; 3, *T. rossignolae* n. sp.

figure 1) which, judging by their size, shape, and location, are precingular. Using Evitt's (1967) study of the archeopyle as a guide, these plates most probably represent precingular plates 2″, 3″, and 4″.

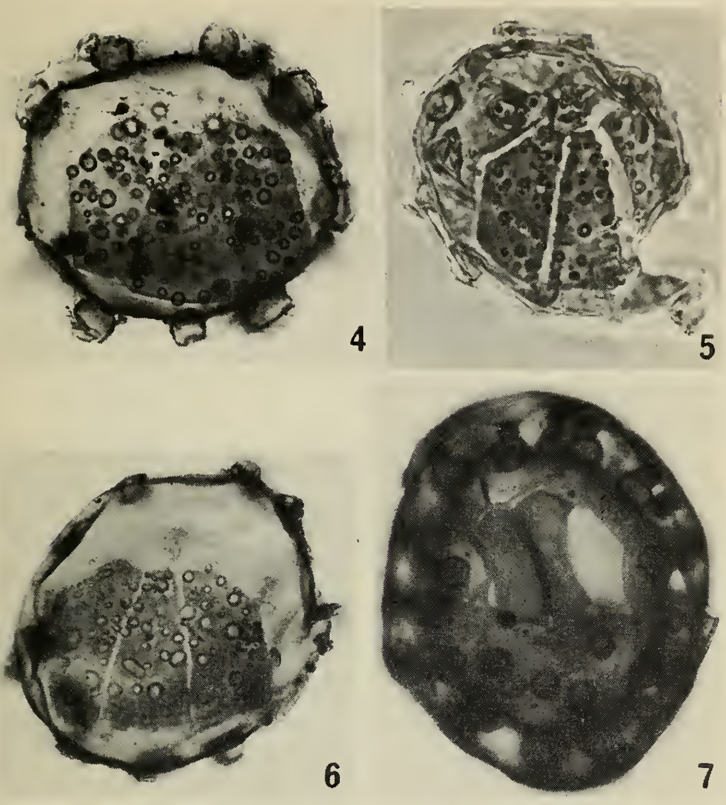
Dimensions: Body 87 μ to 117 μ. Central plate of the operculum is 35 μ to 74 μ high and 22 μ to 32 μ wide at the base.

Occurrence: JOIDES core hole 5, 105–179′ depth, Lat. 30°23′N, Long. 80°08′W, Post Miocene age.

Discussion: Tuberculodinium vancampoae (Rossignol) Wall also exhibits a three plate operculum (Figures 2, 7–9). The illustrated specimens are from JOIDES core hole 5, although, in addition, topotype material of *T. vancampoae* was kindly sent to me by Dr. Martine Rossignol. Although no opercula were visible on the topotype material, the size and shape of the archeopyle opening seem to be the same as those of the JOIDES specimens. *Tuberculodinium wallii* differs from *T. vancampoae* in exhibiting small spherical "processes" on the dorsal and ventral surfaces. The archeopyle of the former is also somewhat larger and slightly differs in shape from *T. vancampoae.*

Tuberculodinium rossignolae new species
(Figs. 3, 10, 11)

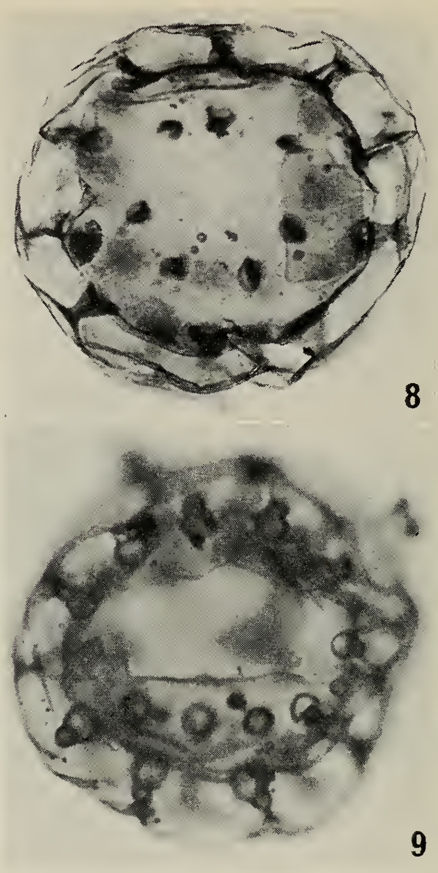
Description: Tract discoidal with two wall layers. The endophragm forms the central body of the tract and is about 2 μ thick. The central body bears from 9 to 14 tubular processes with rounded to flaring tips



Figs. 4–7; 4, *Tuberculodinium wallii* n. sp., holotype, JOIDES hole 5, 125′ depth, operculum fallen inside; 5, *T. wallii* n. sp., paratype, JOIDES hole 5, 179′3″ depth, operculum fallen inside; 6, *T. wallii* n. sp., paratype, JOIDES hole 5, 125′ depth; 7, *T. vancampoae* (Rossignol) Wall, JOIDES hole 5, 125′ depth, operculum in place with one lateral plate missing; all ×384.

which support an outer thin periphragm. Occasionally some of the processes are dumb-bell shaped. The processes are located peripherally and only rarely are found in a dorsal or ventral position. The archeopyle is seemingly precingular and usually consists of two reflected plates (Figure 3). Rarely there are three plates but in such cases one of the lateral plates commonly is somewhat deformed or only partially visible.

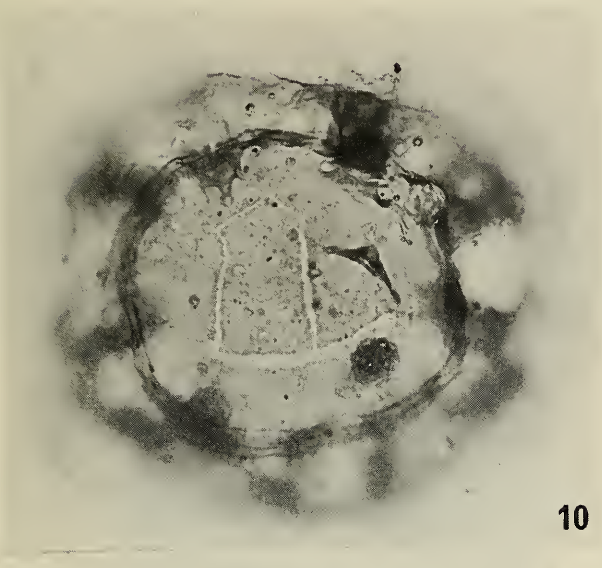
Dimensions: Central body 64 μ to 116 μ diameter. Overall diameter 90 μ to 145 μ. "Central" plate of operculum 26 μ to 42 μ high and 13 μ to 32 μ wide at the base.



Figs. 8, 9; 8, *Tuberculodinium vancampoae* (Rossignol) Wall, JOIDES hole 5, 105′ depth, operculum missing except for one lateral plate fallen inside; 9, *T. vancampoae* (Rossignol) Wall, JOIDES hole 5, 125′ depth, shows archeopyle; all ×384.

Occurrence: Lower Miocene, subsurface, near Rumbai, Sumatra.

Discussion: This species differs from *Tuberculodinium vancampoae* and *T. wallii* n. sp. in that it usually exhibits two opercular plates rather than three. In addition, the processes tend to be restricted to the peripheral areas rather than uniformly distributed as on *T. vancampoae.* The present species also lacks the small dorsal and ventral spherical "processes" of *T. wallii* n. sp.



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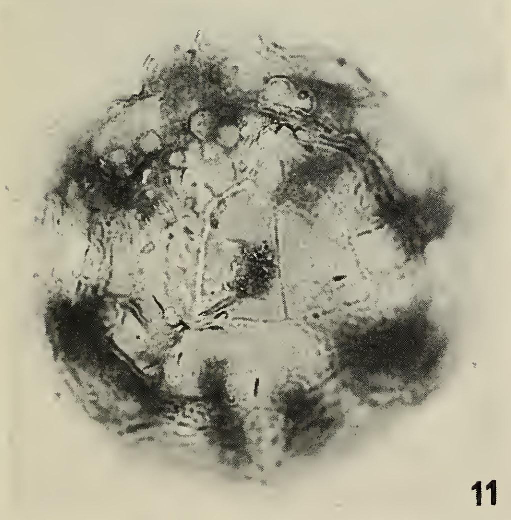

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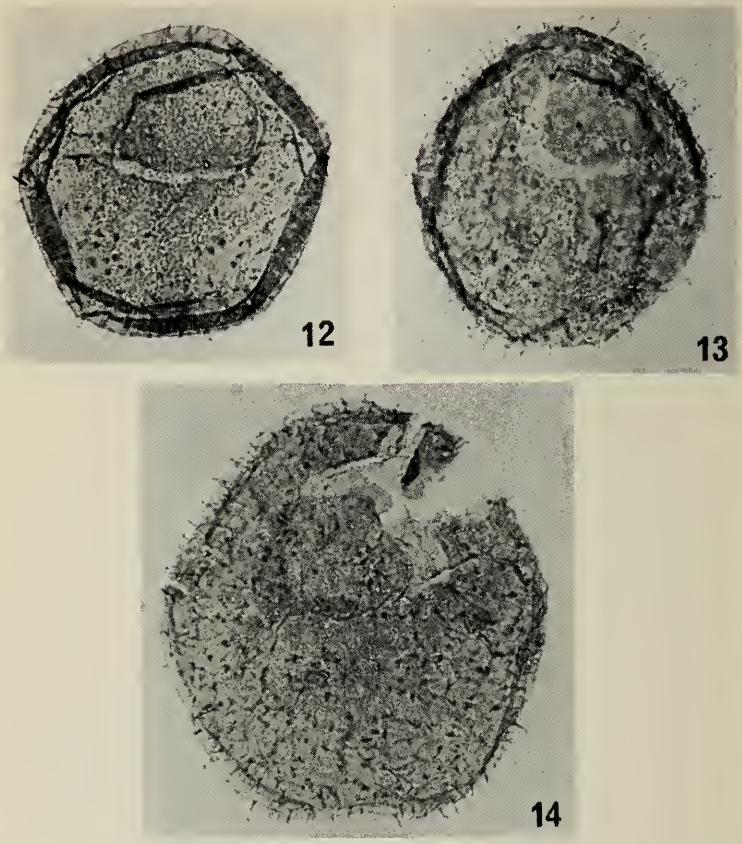
FIGS. 10, 11; 10, *Tuberculodinium rossignolae* n. sp., holotype; 11, *T. rossignolae* n. sp., paratype; both from subsurface near Rumbai; Sumatra; both ×518.



Figs. 12–14; 12, *Xenicodinium hispidum* n. sp., holotype; 13, *X. hispidum* n. sp., paratype; 14, *X. hispidum* n. sp., paratype, operculum dislodged showing shape of operculum; all from subsurface, Rupat Island, Sumatra; all ×518.

Genus *Xenicodinium* Klement, 1960

Xenicodinium hispidum new species

(Figs. 12–15)

Description: Tract flattened dorso-ventrally, rounded pentagonal in outline. Wall single layered, thin, finely granulate. Trapezoidal six-sided intercalary archeopyle on the dorsal epitract. The operculum separates first on the lower edges similar to the mode of opening of *Wetzeliella*. The tract is ornamented by processes 3 μ to 5 μ long. These are hollow and usually pointed distally but occasionally exhibiting blunt to slightly capitate morphology. The density of process distribution is variable with some specimens having fewer processes than the illustrated examples.

Dimensions: Tract 78 μ to 97 μ high, 72 μ to 87 μ wide.

Occurrence: Middle Miocene to Pliocene, subsurface, Rupat Island, Sumatra.

Discussion: This species differs from *Xenicodinium densispinosum* Klement in being flattened rather than egg-shaped and is slightly larger. In addition, the processes are less closely spaced. The affinity of this species is probably peridinioid in view of its general similarity to *Wetzeliella*.

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PROCEEDINGS
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DISPOSITION OF SPECIES OF TERRESTRIAL ISOPOD CRUSTACEANS OF THE GENERA *SYNUROPUS*, *SPHERARMADILLO*, *SPHAERONISCUS* AND *SCLEROPACTES* (ONISCOIDEA, SPHAERONISCIDAE)

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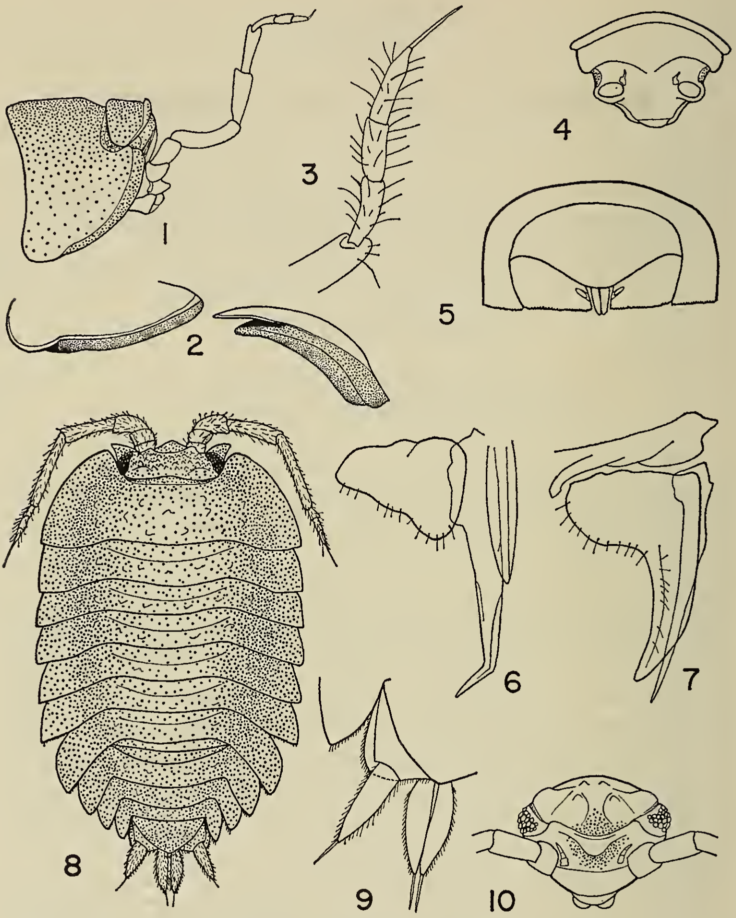
Specimens of two genera of terrestrial isopod crustaceans described by Richardson (*Synuropus* Richardson, 1901, and *Spherarmadillo* Richardson, 1907) are discussed here. *Synuropus* is found to be a junior synonym of *Scleropactes* Budde-Lund, and only minor differences (mainly lack of eyes) are found to separate *Spherarmadillo* from *Sphaeroniscus* Gerstaecker as redefined by Vandel (1963, 1964). Another species said by Mulaik (1960) to belong to the genus *Scleropactes* is transfered to *Armadilloniscus* Uljanin. Two species from Columbia described as *Sphaeroniscus* species by Pearse (1915) are also transfered to *Scleropactes*. All genera mentioned except *Armadilloniscus* are in the family Sphaeroniscidae as defined by Vandel (1964).

Spherarmadillo schwarzi was described by Richardson (1907) from a single female 18 mm long by 8.5 mm wide (*not* 50 × 22 mm as stated in the original description!) from Livingston, Guatemala. The type specimen (USNM 33471) and many other specimens from Trece Aquas, Guatemala (USNM 57379-80-81), were examined by the author and were found to be correctly placed in a separate genus by Richardson, and the new genus correctly placed near *Sphaeroniscus*.

The specimens of *Spherarmadillo* principally differ from specimens of *Sphaeroniscus* as defined by Vandel (1963, p. 88) in that they are without eyes. The coxapodal ridge is not developed along the entire length of the underside of peraeonal



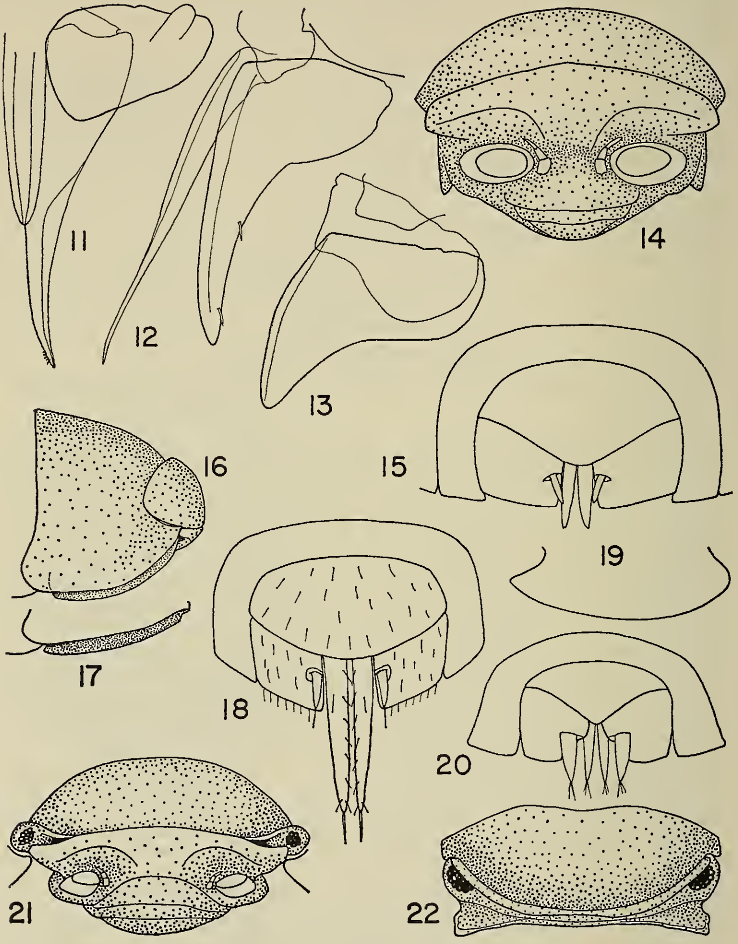
FIGS. 1–7. *Spherarmadillo schwarzi* Richardson (1907). 1. lateral view, peraeonal segment I and cephalon. 2. details, lateral margin of peraeonal segment I. 3. flagellum, antenna 2. 4. Cephalon, frontal view. 5. pleotelson. 6. pleopod 1, male. 7. pleopod 2, male. Figs. 8–10. *Scleropactes grandulatus* (Richardson) new combination, dorsal view female, holotype. 9. uropod. 10. cephalon, frontal view.

segment I as implied by Van Name (1936), but instead it is a sulcus or groove on the posterior portion of the margin. An angular border (a beveled edge) is found on the anterior and longest portion of the margin (see figs. 1 and 2 here—Richardson's figure "c" is misleading) and the notched portion is on the posterior part. The mouth parts include a maxilla, 1 which has two pencillate tufts of sensory setae.

The specimens from Trece Aquas (in three vials with three numbers; all collected in June 1907) were examined and consist of 11 females, the longest being 19 mm long, and one male 14 mm long. One female was gravid, but the marsupium had been disturbed so the embryos it contained were not counted. There is no doubt that the specimens are S. *schwarzi.* The first and second pleopods of the male (USNM 57381) were examined and are illustrated here (figs. 6 and 7). No pseudotracheae were found on either of the exopods, a further characteristic of the family Sphaeroniscidae. The correct name for the species is still *Spherarmadillo schwarzi* Richardson (1907).

Mulaik (1960) described two blind species from Mexico which he included the genus *Spherarmadillo*—S. *huatuscensis* and S. *cavernicola* (the latter from a cave). According to Mulaik there is a difference in the frontal margins of the cephalons, and in the lengths of the uropodal rami (cf. figs. 15 and 18). Both species are shorter than S. *schwarzi* (S. *hautuscensis*—7 mm; S. *cavernicola*—4 mm). S. *hautuscensis* (not well defined) differs from both species in possessing especialy long uropodal rami. No specimens of S. *hautuscensis* were examined by the author.

Specimens of S. *cavernicola* from a cave at Rancho de Cielo, Tamaulipas, Mexico, were examined (USNM 255216) and the species is illustrated here (figs. 11 to 17). None of the many specimens examined were much over 4 mm long and the species is remarkably like S. *schwarzi* differing mainly in the configuration of male pleopods (cf. figs. 6 and 7 and figs. 11 and 12) and in the average size of the specimens. There is also some difference in the types of lateral margins on peraeonal segment I—in S. *schwarzi* it is beveled or angular; in S. *cavernicola* it is more of a groove or "step" being slightly indented along most of the entire length. *Spherarmadillo* Richardson contains three species, two from Mexico and one from Guatemala.



FIGS. 11–17. *Spherarmadillo cavernicola* Mulaik (male). 11. pleopod 1. 12. pleopod 2. 13. pleopod 3. 14. cephalon. 15. pleotelson and uropods. 16. lateral view peraeonal segment I and cephalon. 17. detail, margin of peraeopod I. Fig. 18. *Spherarmadillo huatuscensis* Mulaik, pleotelson and uropods (after Mulaik). Figs. 19–22. *Scleropactes columbiensis* (Pearse) new combination. 19. detail, margin peraeopod I. 20. pleotelson and uropods. 21. cephalon, anterior view. 22. cephalon, dorsal view.

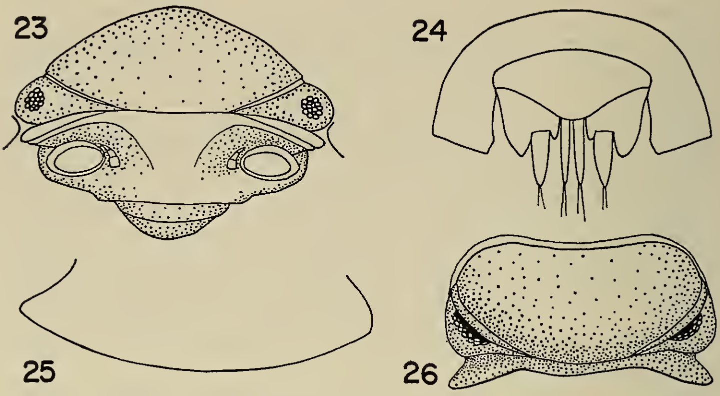
Synuropus grandulatus was described by Richardson (1901) from a single female 6.2 mm long from El Yunque, Puerto Rico at 2800 ft. altitude. Her illustration of the species lacked detail and her description was brief. In 1905 (p. 599) she repeated the description, and it was again repeated by Van Name (1936, p. 222). Since the species was not well described, it was placed by Van Name in the Oniscidae—"it would seem to be close to *Alloniscus*, if really separable from it," he stated. The author examined the type specimen of S. *grandulatus* (USNM 23912) and concluded that it is not a member of the Oniscidae, but rather belongs in the genus *Scleropactes* (Sphaeroniscidae).

Additions and corrections to Richardson's description of the species follow:

Body oval, not able to roll into a ball, with lateral parts of segments expanded and recurved. Dorsum of body covered with minute tubercles (Richardson's illustration exagerates the size and pattern of the tubercles) which are more apparent on the anterior part than on the posterior part of the body. Cephalon deeply set into peraeonal segment I, where rounded anterior angulations reach beyond compound eyes of many ocelli. Anterior margin of cephalon produced as obtusely pointed medial lobe. Lateral lobes well defined and acutely pointed. Ridge somewhat continuous with frontal line above eye and separating it from lateral cephalic bump. Flagellum of short antenna 2 with three subequal articles. Two pencillate setae on endopod of maxilla 1.

Peraeonal segment I wide and flared or slightly recurved. No marginal sulcus or coxal indications of any kind present on segment I. Other segments of subequal proportions with lateral margins of peraeon parallel for much of length. Pleon with margins continuous with peraeon; lateral margins of segments 1 and 2 hidden and 3, 4 and 5 recurved. Pleotelson with posterior border obtusely (somewhat angularly) rounded. Basis of uropod with sulcus along outer margin and with expanded lateral and posterior ventral edge of sulcus. Endopods close together and extended beyond subsimilar exopods. Richardson states that the color (now faded) is "brown, mottled with black."

The small female shares characters with species of the genus *Scleropactes* Budde-Lund. The cephalon is shaped much like that illustrated by Jackson (see Van Name, 1936, p. 292, fig. 270) in that there is a furrow or line above each eye. The configuration of the basis of the uropod also is like that of some species of *Scleropactes.* The lack of ability to roll into



Figs. 23–26. *Scleropactes gaigei* (Pearse) new combination. 23. cephalon, anterior view. 24. pleotelson and uropods. 25. detail, margin peraeopod I. 26. cephalon, dorsal view.

a ball is characteristic of several species which are also dorsoventrally flattened as in *S. grandulatus*. *S. estherae* Arcangeli (1930) is closest to *S. grandulatus* in many characters although there are many differences between the species. Neither species is able to roll into a ball and both are dorsoventrally flattened. The species of the genus are diverse and more work must be done to more properly define them, but it is clear that as now defined Richardson's specimen is really *Scleropactes grandulatus* (Richardson, 1901).

Pearse (1915) described two species of *Sphaeroniscus* from Columbia—*S. columbiensis* (USNM 98374) and *S. gaigei* (USNM 98378). The University of Michigan type specimens are now in the Smithsonian Institution. Both of the species were reexamined and some aspects of each are illustrated in figures 19–22 and 23–26, respectively. The specimens lack the particular ridge and notch on the lateral margin of peraeonal segment I peculiar to species of *Sphaeroniscus* as restricted by Vandel (1963, p. 88, footnote). Since the specimens of both species lack the notch, they are in the newly defined genus *Parsphaeroniscus* Vandel.

The specimens of both species, however, have a pronounced ridge on the cephalon just over the eye. There are no well defined cephalic bumps on either as is characteristic of *Scleropactes grandulatus* (fig. 10). The basis of the uropod in both species is produced on the lateral posterior margin with the exopod emerging from a notch in the medial posterior margin thus formed. Pearse's illustration of S. *columbiensis* (p. 548, fig. 8 u) shows the exopods attached at the medial corner of the basis, but they were not that way in the type specimen examined by the author (fig. 20). Unfortunately, because there were only a few specimens, the male pleopods were not examined. Adult specimens of S. *columbiensis* are large. The type measures 16 mm long and is from the Sierra Nevada de Santa Marta, Columbia, at 4800 ft. found "under leaves and logs" in a forest. S. *gaigei* is smaller (4.4 mm long) and from on San Lorenao, Sierra Nevada de Santa Marta, Columbia, at 7800 ft. found "under leaves in ground." These two species can no longer be retained in the genus *Sphaeroniscus*, but rather they must be placed in *Scleropactes* Budde-Lund, and their proper names are *Scleropactes columbiensis* (Pearse, 1915) and *Scleropactes gaigei* (Pearse, 1915).

Mulaik (1960) included the new species *Scleropactes cedrosensis* (p. 181) in the Eubelidae along with the species of *Spherarmadillo* mentioned above. It is obvious from his illustrations of this species (a single specimen 1.7 mm long) that it is of the genus *Armadilloniscus* Uljanin. Species of *Armadilloniscus* are always found on or near marine beaches. The specimen was most probably found on a beach on Isla Cedros, Baja California, Mexico, and Mulaik's illustration (pl. 17, fig. 342), especially that of the cephalon, is almost identical with Menzies's (1950, p. 479, fig. 19) illustration of the cephalon of *A. lindahli* (Richardson, 1905). Also Mulaik (pl. 17, fig. 346) illustrates a mass of "feathery" setae on the apex of the exopod of maxilla 1; it is comparable to the same structure found in *A. ellipticus* (see Van Name, 1936, p. 102, fig. 45) and is characteristic of species of *Armadilloniscus*, not *Scleropactes*. The large group of setae is also present on maxilla 1 on more obviously unrelated species of *Ligia*. The only difficulty encountered in acception the placement of Mulaik's species in *Armadilloniscus* is that the number of flagellar articles recorded (p. 182) and illustrated (pl. 17, fig. 342) by Mulaik is three and the number of articles in the flagellum of all known species of *Armadilloniscus* is four. Other than the article number, the general configuration of the antennae, a rather particular configuration, illustrated by both Menzies and Mulaik are in agreement. Blake (see Van Name, 1936, p. 102, fig. 45) erronously recorded the number of flagellar articles as five for *A. ellipticus* from New England, and the author working with *A. ellipticus* found it difficult to determine the correct article number without a compound microscope and with transmitted light. If the middle flagellar article as illustrated by Mulaik (pl. 17, fig. 342) is divided into two articles, then the flagellum would be composed of four articles each of slightly decreasing length. It would then be almost identical with the flagellum illustrated by Menzies (pl. 25, fig. 22), and strongly suggests that Mulaik's illustration is wrong. *Scleropactes cedrosensis* Mulaik (1960) clearly is a junior synonym of *Armadilloniscus lindahli* (Richardson, 1905), and the record by Mulaik extends the known range of the species from mid-California, to mid-Baja California which is not a improbable range extension.

The author wishes to thank the personnel of the Division of Crustacea, National Museum of Natural History, Smithsonian Institution, for aid in studying the type specimens used in the study.

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A NEW OPHIDIOID FISH (GENUS *LUCIFUGA*) FROM A LIMESTONE SINK, NEW PROVIDENCE ISLAND, BAHAMAS[1]

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The ophidioid fish described here was collected in Mermaid's Pool, a little-known limestone sink near Nassau on New Providence Island in the Bahamas. Proper placement of this species required study of its closest known relatives, the two species of Cuban cave brotulids. We refer all three species to the genus *Lucifuga*, which is diagnosed below.

We are indebted to Dr. Carleton Ray, Johns Hopkins University, who collected specimens during a dive in Mermaid's Pool, and made them available to us. Research for this paper was supported by a grant from the National Science Foundation (GB-7015) to C. R. Robins. We also thank Dr. and Mrs. James E. Böhlke, Academy of Natural Sciences of Philadelphia, who made it possible for Robins to visit Mermaid's Pool during August, 1969; Dr. Isabel Canet and Luis R. Rivas, Bureau of Commercial Fisheries; and Dr. Salvatore Carfi, Università di Firenze, who helped us in various ways. Curators at the California Academy of Sciences (CAS), The University of Michigan Museum of Zoology (UMMZ) and the Smithsonian Institution (USNM) allowed us to utilize their collections.

Lucifuga Poey

Diagnosis: Chin barbel absent. Gill membranes separate. Livebearing; male genitalia well-developed, lacking ossified parts. Ventral

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[1] Contribution No. 1179 from the Institute of Marine and Atmospheric Sciences, University of Miami.

fins each with a single ray, immediately adjacent to each other, originating well behind the symphysis of the cleithra; the pelvic girdle not extending anteriorly to the symphysis of the cleithra. Connection between dorsal and anal and caudal fins variable in extent; caudal fin exserted, rays 8–11. Pectoral fin entire, without separate, elongated rays; not on an elongated peduncle. Dorsal-fin origin over centrum 8, 9 or 10, usually 9; a single predorsal rayless pterygiophore. Head partly naked, bearing prominent canals with large chambers. Head pores: 1 in lateral canal; 2 in supraorbital; 6 in suborbital; 7 in preoperculo-mandibular. Anterior nostril directly above the upper lip. Developed gill rakers 3; tongue with an anterior prowlike extension. Spine on opercle flattened, weak, not visible exteriorly. Branchiostegal rays 7, 4 attached to outer surface of epihyal and enlarged distal portion of ceratohyal, 3 attached ventrally along shaft of ceratohyal. Body compressed; tail section not greatly elongated; snout depressed. Lateral line interrupted, the shorter, anterior part above midline of body, the posterior part in midline. Teeth present on premaxillary, vomer, and dentary; present or absent on palatine. Maxillary vertically expanded posteriorly, a small ventrally directed process near posteroventral angle. Eyes poorly developed, not externally visible in many preserved specimens. Body completely covered with small, imbricate scales.

First neural spine shorter than those following. Ribs apparently present on first centrum; centra 2 to 6 or 7 bearing ribs, the following abdominal centra with pleural ribs at the ends of parapophyses, with exception of last centrum which usually lacks them. Total vertebrae 46 to 53.

Relationships: We agree with Eigenmann (1909) and Hubbs (1938) that *Lucifuga* belongs in the large assemblage of viviparous ophidioid genera called Brosmophycinae by some ichthyologists. The dermatopsin genera (Cohen, 1966) and the *Dinematichthys-Ogilbia* assemblage (including the Mexican cave genus *Typhliasina* Whitley = *Typhlias* Hubbs) can be dismissed as close relatives because of their ossified genital claspers. Among the many remaining genera, *Lucifuga* seems closest to some of the deep water species with depressed snouts, presently placed in *Cataetyx* and *Diplacanthopoma*. Both of these genera are in the process of revision, hence detailed comparisons are not possible at present. Susceptible of brief mention, however, are similarities in body and head shape, copulatory apparatus, and ventral fin placement. Among shallow water genera, *Lucifuga* may have its closest known relative in *Calamopteryx* Böhlke and Cohen (1966), a small, secretive coral reef fish living in the tropical western Atlantic. Because it is a small fish with elongate pectoral radials, it is unlikely that *Calamopteryx* gave rise directly to *Lucifuga*. The common ancestor of both may await discovery, hidden in the crevices of a tropical Atlantic reef.

Subgenera: Poey (1858–1860) placed both species of Cuban cave brotulids in *Lucifuga*. Gill (1863) erected *Stygicola* for *L. dentatus* because of the presence of palatine teeth. This character notwithstanding, the species of *Lucifuga* are very similar indeed and obviously are much more closely related to each other than to any other known brotulid. We believe that classification will be better served by referring all three species to a single genus, *Lucifuga*, which contains two subgenera. Hubbs (1938), in discussing *Typhliasina, Lucifuga* and *Stygicola* wrote, "All three genera are sharply differentiated by the detailed structure of the penis." It seems to us that differences between *Lucifuga* and *Stygicola* are of degree rather than kind.

Subgenus *Lucifuga*

Lucifuga Poey 1858, type species *L. subterraneus* Poey, by subsequent designation of Jordan and Evermann (1896).

Diagnosis: Palatine teeth absent. Pectoral fin rays 12 to 14, usually 12 or 13.

Species: L. subterraneus.

Study Material: USNM 204452 (2); USNM 126697 (1); UMMZ 157178 (54).

Subgenus *Stygicola*

Stygicola Gill 1863, type species *Lucifuga dentatus* Poey, by monotypy.

Diagnosis: Palatine teeth present. Pectoral fin rays 15 to 20.

Lucifuga (*Stygicola*) *dentatus* (Poey)

Diagnosis: Pectoral fin rays 15 to 17. Vertebrae 46 to 48. Scales absent on the area between lateral canal and preopercular canal.

Study Material: USNM 5334 (1); USNM 34632 (3); USNM 63992 (1); USNM 102160 (1); CAS 6714 (7).

Lucifuga (*Stygicola*) **spelaeotes** new species

Figs. 1, 2

Diagnosis: Pectoral fin rays 18 to 20. Vertebrae 52 to 53. Scales present on the area between lateral canal and preopercular canal.

Description: Measurements of the types of *L. spelaeotes* and of a representative series of *L. subterraneus* and *L. dentatus* are given in Table 1; frequency distributions of fin-ray and vertebral counts are presented in Table 2. In the account below, an asterisk indicates the condition in the holotype.

The dorsal profile is strongly arched, the highest point being at or slightly in advance of the dorsal-fin origin. The dorsum is broad and flattened from the dorsal fin to the snout tip with only a slight depression in the interorbital region. The sides are very flat and converge ventrally so that a cross section through the nape would be bluntly V-shaped. In dorsal view the snout is broadly rounded with the upper jaw somewhat projecting. The mouth is subterminal with the lower jaw only slightly shorter than the upper. The ventral profile is

Fig. 1. *Lucifuga spelaeotes.* USNM 204603; holotype; 109 mm SL. Drawn by Mildred H. Carrington.

Fig. 2. *Lucifuga spelaeotes.* USNM 204603; holotype; 109 mm SL. Detail of ♂ genital area; ventral view; anterior to the left; papilla proper and median 1 pushed forward, lobes spread apart; see text for explanation. Drawn by Mildred H. Carrington.

nearly straight with only a slight upturn to the caudal base. Posteriorly the body is compressed, elongate and evenly tapered to the tail.

The anterior nostril opens through a short tube positioned laterally on the anterior rim of the snout. The much larger posterior nostril is a triangular opening without raised margins, located about midway between the anterior nostril and the clear window in the skin covering the eye.

The eye is relatively well-developed though small and has a protruding lens which is easily seen through an elongate, clear window, several times larger than the eye. The horizontal diameter of this window is 3.5 or 3.6* per cent of standard length, and the snout as measured to the forward edge of the window is 5.7 or 6.9* per cent.

The vertical fins are confluent, though the caudal fin is exserted and

Table 1. Measurements in millimeters on the three species of *Lucifuga*.

	spelaeotes		subterraneus									
	USNM 204604	USNM* 204603	USNM 102160	UMMZ 157178	UMMZ 157178	UMMZ 157178	UMMZ 157178	USNM 102160	UMMZ 157178	UMMZ 157178	USNM 126697	UMMZ 157178
Sex	♀	♂	?	♀	♂	♀	♂	♀	♀	♂	♂	?
Standard length	76.5	109	40.0	60.2	67.5	70.9	72.5	72.8	74.6	76.0	80.2	81.5
Head length	21.2	33.1	11.1	–	18.7	18.6	19.7	18.3	20.5	20.9	22.4	22.1
Body depth[1]	15.3	23.8	6.5	–	14.3	14.1	16.3	12.0	15.4	17.1	16.0	–
Jaw length[2]	10.1	17.9	5.0	7.8	8.3	9.1	9.2	8.4	9.3	9.2	10.5	10.6
Depth of maxilla[3]	3.4	6.2	1.6	2.4	3.3	2.9	3.1	2.8	3.6	3.6	3.5	3.6
Snout to dorsal-fin origin	27.6	43.9	–	24.4	27.5	28.9	29.0	28.7	30.6	29.8	33.8	32.2
Snout to anal-fin origin	37.6	61.5	–	31.1	35.8	35.9	36.5	37.6	37.9	38.8	40.5	–
Pectoral-fin length	9.7	13.2	–	–	8.0	8.2	–	7.5	–	–	–	–
Ventral-fin length	7.3	14.3	–	3.8	6.2	4.0	3.6	–	–	4.3	4.8	–
Cleithrum to ventral fin[4]	3.5	5.0	1.4	2.9	3.0	3.5	3.6	3.2	4.0	4.9	3.1	4.8

[1] Greatest depth.
[2] Snout tip to posterior edge of maxilla.
[3] Greatest distance across expanded posterior end of maxilla.
[4] Symphysis of cleithra to origin of ventral fin.
* Holotype.

TABLE 1. (*Continued*)

	dentatus									
	CAS 6714	CAS 6714	CAS 6714	USNM 63992	CAS 6714	USNM 5334	CAS 6714	CAS 6714	CAS 6714	USNM 102160
Sex	♂	♂	♂	♂	♂	♂	♂	♂	♂	♂
Standard length	76.1	87.0	88.3	95.7	98.9	99.1	100	101	106	118
Head length	21.9	24.4	25.2	27.8	27.9	27.4	26.8	28.6	29.2	31.5
Body depth[1]	15.3	17.2	21.3	21.1	22.4	20.9	21.8	22.5	22.8	24.8
Jaw length[2]	10.6	13.0	13.6	15.5	15.2	15.0	14.5	16.4	15.9	18.4
Depth of maxilla[3]	4.1	4.6	5.1	5.8	5.3	5.3	5.3	5.7	5.3	7.1
Snout to dorsal-fin origin	29.8	34.5	34.7	39.2	38.8	39.2	40.6	41.2	41.7	46.9
Snout to anal-fin origin	39.0	47.0	46.4	52.3	52.8	53.5	53.1	53.6	55.4	62.6
Pectoral-fin length	9.3	9.7	11.5	–	12.5	10.4	–	–	–	15.0
Ventral-fin length	5.3	6.1	8.0	5.3	–	7.0	–	9.1	7.3	7.0
Cleithrum to ventral fin[4]	4.0	5.5	4.8	–	5.9	5.5	5.5	5.1	6.1	6.1

[1] Greatest depth.
[2] Snout tip to posterior edge of maxilla.
[3] Greatest distance across expanded posterior end of maxilla.
[4] Symphysis of cleithra to origin of ventral fin.
* Holotype.

Table 2. Frequency distributions of numbers of fin-rays and vertebral centra in *Lucifuga*.

	Dorsal rays																		
	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98
subterraneus	1	2	3	1	2	–	21	–	–	–	–	–	–	–	–	–	–	–	–
dentatus	–	–	–	2	1	1	–	–	–	1	1	1	1	1	2	1	–	–	–
spelaeotes	–	–	–	–	–	–	–	–	–	–	–	–	1*	–	–	–	–	–	1

	Anal rays																	
	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78
subterraneus	1	1	–	–	1	2	–	–	2	1	–	1	–	–	–	–	–	–
dentatus	–	–	–	–	–	–	–	–	1	2	1	2	2	1	1	2	–	1
spelaeotes	–	–	–	–	–	–	–	–	–	–	1*	1	–	–	–	–	–	–

	Pectoral rays										Vertebrae[2]							
	12	13	14	15	16	17	18	19	20		46	47	48	49	50	51	52	53
subterraneus	9	4	1	–	–	–	–	–	–		4	9	1	–	–	–	–	–
dentatus	–	–	–	2	7	4	–	–	–		4	6	3	–	–	–	–	–
spelaeotes[1]	–	–	–	–	–	–	2*	1	1		–	–	–	–	–	–	1*	1

* Holotype.

[1] Both sides counted.

[2] Ural centra not counted.

easily distinguished. The dorsal fin is highest posteriorly, the anal fin of about equal height throughout. The pectoral fin is elongate and pointed, its central rays longest. Its base is vertical and mounted on a broad fleshy pad. The branchiostegal and opercular membranes cover most of the fin base, and reach nearly to the rays themselves. Most pectoral rays, all anal rays except the anterior 1 or 2, and all dorsal rays except a few anteriorly, are branched once. The single pelvic ray is undivided and filamentous, though short, reaching about half way to the anus.

The entire body, including the isthmus and the pectoral-fin base is covered with small, rounded cycloid scales. There are about 23 rows in a series across the body above the anal-fin origin. The branchiostegal membranes, the entire underside of the head, the jaws, the snout, the interorbital areas, the entire course of the cavernous cephalic lateralis system and the sides of the head forward of the posterior edge of the maxilla, are naked. The naked area over the preopercular canal is disjunct from the naked area along the lateral canal, with the intervening area bearing scales; thus the scaly area of the opercle is continuous dorsally with the scaly area anterior to the preopercle. The opercle, the sides of the head from the preopercular margin to the maxilla and the occiput bear scales, except for those portions over the head canals. Except for a few scales at the base of the pectoral rays, all fins are naked.

There is no pored lateral canal on the body, but the sensory papillae are well-developed and in two series. The upper and anterior series of 14 papillae extends caudally from the head to a point about midway between the dorsal- and anal-fin origins. The lower row of about 38* to 42 papillae extends along the mid side from the caudal base to a point under and slightly in advance of the end of the upper series. The head canals are cavernous and the openings are large. There are 7 pores in the preoperculomandibular series: the first and largest at the angle of the preopercle, the second to fourth open ventrally along the mandibular ramus, the fifth is directed mesially at the anterior end of the mandibular ramus and the sixth is at the side of the jaw tip on the lower lip; the last pore is hidden in the fold of skin between the lip and the mandibular ramus and opens from the ramus into this fold. The two canals do not join anteriorly. There are 6 pores in the suborbital series. The first 5, slitlike, along the edge of suborbital rim, the last, circular, between and slightly below the two nasal openings. The posterior of the two pores in the supraorbital canal opens between and mesiad to the nasal openings, the anterior at the snout rim. The single pore in the lateral canal is at the posterior end of the tube above the opercle.

The lower jaw in the holotype is abnormal in that it bears a fleshy, multidigitate growth on the lower lip near the symphysis of the dentary. There is also a large fleshy pad (absent in the female) on the outside of the mouth at the tip of the lower jaw.

The naked skin covering many of the mucous chambers on the head is an almost iridescent white. This is particularly striking on the dorsalmost chamber of the preopercular canal and the posterior chambers of the lateral canals.

The opening behind the fourth gill arch is restricted to a slit along the lower arm of the arch. There are 3 short rakers on the upper part of the lower limb of the first arch plus 13 low dentigerious pads, the upper 2 of which are between the developed rakers. Four similar pads are present on the upper limb. A pseudobranch is absent. The tongue is free and elongated anteriorly, its tip fitting into a median groove in the vomer when the mouth is closed.

Teeth are present on the premaxillae, dentaries, vomer and palatine. Those in the jaws are short, villiform, and in broad patches. The vomerine tooth patch is nearly divided by a median groove and the teeth are somewhat elongate, needlelike and arranged in a whorl. The palatine teeth are similar and are restricted to the anterior end of the bone.

There is a rounded ethmoid projection and a single, flattened opercle spine, neither of which is visible externally.

Ribs are present on centra 1 to 7; subsequent abdominal centra except the last have pleural ribs at the ends of parapophyses. Epipleural ribs are presently; however, our x-ray photographs do not allow precise description of their distribution.

There are 13 precaudal and 39* or 40 caudal vertebrae, total 52* or 53, exclusive of the ural centrum.

Of the 7 branchiostegals, the posterior 4 attach to the outer surface of the epihyal and enlarged distal portion of the ceratohyal; the anterior three attach ventrally to the shaft of the ceratohyal.

The posterior end of the maxilla is vertically expanded and unsheathed dorsally; its posterior edge is convex, ending below in a distinct projection or hook.

The male copulatory apparatus is well-developed and lacks ossification. It is borne on a broad, fleshy lobe (the "papilla proper" of Hubbs, 1938) which projects posteriorly beyond the vent. A fleshy conical papilla (here called median 1) projects posteriorly from the middle of the distal margin of the lobe. Anterodorsal to median 1 is another, small papilla, the "median process" (Hubbs, 1938), which is enclosed by prominent, earlike lobes. These lobes are partly divided into a larger section ("secondary lobe" of Hubbs, 1938), immediately dorsal to median 1, and a smaller section ("basal lobe" of Hubbs, 1938) which is slightly dorsal and medial to the first section and which extends anteriorly and meets its mate in the midline anterior to the median process. Although better developed, the entire copulatory apparatus is basically similar to that in mature males of *L. dentatus* and *subterraneus* which we have examined. We can not readily reconcile our observations with the figure of *dentatus* presented by Hubbs (1938, pl. 3) and suggest that his specimen was immature.

There are two, short pyloric caeca.

Color: Except as noted below the entire fish is a rich walnut brown, the color in preservative differing but little from life colors according to Dr. Ray. The margins of the vertical fins are whitish, this light-colored border widest posteriorly and in the smaller female. The pectoral fins, the ventral ray, the lips and the skin over the cephalic lateralis system, are all unmarked or distinctly whitish. The branchiostegal membranes are whitish posteriorly but dark along the isthmus. The orobranchial chamber, the gut and the peritoneum are all unmarked.

Etymology: From the masculine Greek noun, *spelaeotes*, a cave or cavern dweller, in reference to its habitat.

Material examined: Holotype, USNM 204603, an adult male, 109 mm SL Bahamas, New Providence Island, Mermaid's Pool, depth 5 meters, 24 October 1967, collected by Carleton Ray. Paratype, USNM 204604, a female, 76.5 mm SL, collected with the holotype.

Habitat: Mermaid's Pool is a small sink in the limestone area SW of Nassau. The vegetation, where not cleared for a housing development, is predominantly pine and scrub growth. The main pool is about 75 feet across, and several small openings are nearby. Grapsoid crabs live on the steep walls. The water level is several feet below the surface and represents the exposed water table. Salinity of a water sample taken by Dr. Ray just below the surface (ca. 1 meter), tested at the Institute of Marine and Atmospheric Sciences, was 4.6 ppt.

The area of Mermaid's Pool is in a large tract of land already largely cleared for a housing development; the future of the Pool and its water quality is uncertain.

Discussion: L. spelaeotes appears to be the most primitive of the three known species of the genus. Of particular significance are the presence of palatine teeth, a greater number of caudal fin rays (10 to 11 instead of 8 as in the other two species), relatively well-developed eyes in the adult and a distinctly dark coloration. *L. dentatus* is surely closest to *spelaeotes*, sharing with it the possession of palatine teeth. *L. dentatus* is usually, although not always, a paler fish. Eigenmann (1909) described the color as varying "from pinkish lilac to steel-blue, with transparent edges to the fins." He mentioned, however that dark specimens are also found, and illustrated them (pl. 13). Color photographs of live specimens published as the result of a recent Italian Expedition to Cuba (A.O. 1968) show an almost white fish with a dark blotch on one of the vertical fins near the tail and pale brown pigmentation on the dorsum and part of the head. We have seen no specimens of *dentatus* or *subterraneus* with developed eyes, although Eigenmann mentioned that the eye is variable in size and smaller in older individuals. *L. subterraneus* is surely the most specialized species with its lack of palatine teeth, smaller size, generally pale color ("faint pink to lilac pink and lilac." according to Eigenmann) and marked depression above the orbits—the last character shared with *dentatus*. A direct phyletic line is unlikely, for several disjunct characters are also present. For example, *spelaeotes* and *subterraneus* have the area between preopercular and lateral canals covered with scales; in *dentatus* this area is naked. Also, both *spelaeotes* and *subterraneus* have a scaly patch on the occiput (though the scales are imbedded and difficult to see in the latter); *dentatus* has a naked occiput.

Reports are extant of still other populations of blind cave fishes in the West Indies, one on Eleuthera in the Bahamas and another at Jamaica. Collections from these islands will surely add to knowledge of the phylogeny of the species of *Lucifuga* and may well contribute significant data to zoogeography and to the study of speciation and evolution in cavelike environments.

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PROCEEDINGS
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TWO NEW MITES OF THE GENUS *KLINCKOWSTROEMIA* FROM MEXICO (ACARINA: KLINCKOWSTROEMIIDAE)[1]

By Neil Chernoff and Robert Pope
Department of Biology, University of Miami

The genus *Klinckowstroemia* Tragardh contains three species collected in Costa Rica and Surinam. As with the other species in the family Klinckowstroemiidae they have all been found in association with passalid beetles. This paper describes two new species which have been collected in Mexico.

Klinckowstroemia grabowskii new species
(Figs. 1 and 2)

Female holotype: General body shape oval. Idiosoma 1140 μ long, 900 μ wide. DORSUM. Dorsum covered by single plate which extends over gnathosoma. Numerous setae and pores on plate: pores often in pairs and triads. Pair of large barbed setae on anterior margin of plate. Dorsal shield grooved behind each seta. VENTRUM. Jugular plate has pair of large, simple setae at anterior margin and pair of pores at base. Plate 140 μ wide, 40 μ long. Sternal plate with 3 pairs of simple setae and one pair of pores. First pair of setae at anterior portion of plate lateral to pores. Second and third pairs of setae in close proximity to basal margin of plate. All measurements were made at the widest and longest portions of the plate, unless otherwise indicated. Sternal plate 95 μ long, 290 μ wide. Sternogynial plate bears single pair of pores at anterior margin, plate 70 μ long, 205 μ wide. Latigynial plates truncate and separate sternogynial and mesogynial plates for distance of 30 μ. Number of setae on latigynial plates varied both within the population and between populations. Most specimens collected at Oaxaca had 5 setae on each plate although occasional specimens had 6. Mites which were collected at Omilteme generally had 4 setae, but as at Oaxaca, the pattern of setae between latigynial plates differed greatly between individuals and in many cases on a single individual. Each plate with single pair of pores. Latigynial plates 160 μ long, 85 μ wide. Mesogynial

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[1] This research was aided by N.I.H. grant GM 12300–02.

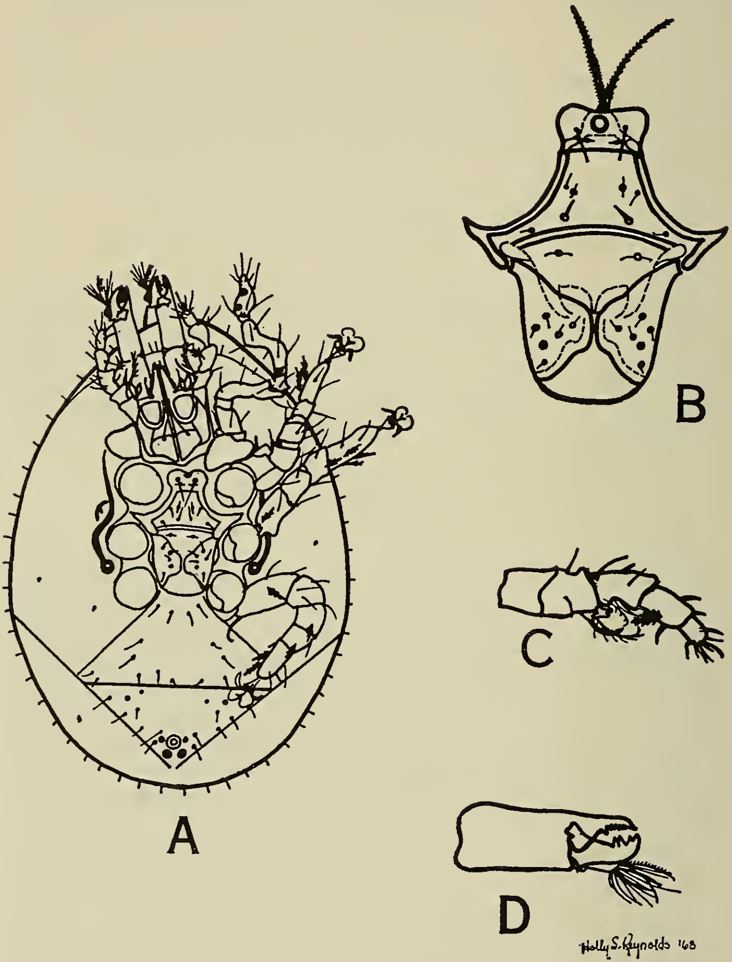

FIG. 1. *Klinckowstroemia grabowskii* n. sp. Female: A, ventrum; B, genital area; C, palp; D, chelicerae.

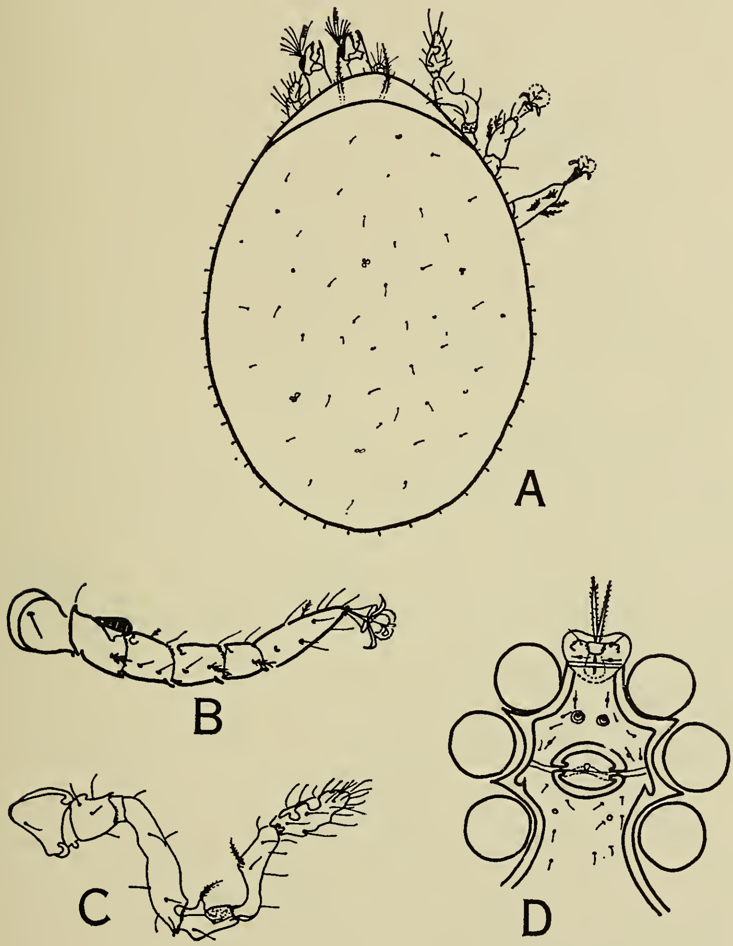

FIG. 2. *Klinckowstroemia grabowskii* n. sp. Female: A, dorsum; B, leg IV; C, leg I. Male: D, genital area.

plate broadly triangular, 70 μ long, 125 μ wide. Ventral plate with numerous setae and pores, plate 300 μ long, 580 μ wide at its widest point, 150 μ wide at level of coxae IV. Anal plate has 6 pairs of simple setae, 3 pair of pores. The two pairs of setae closest to anal opening considerably larger than others. One pair of pores beneath anal opening, other two pairs near anterior margin of plate. Anal plate 480 μ wide, 190 μ long. GNATHOSOMA. Palpi five-segmented. Some simple setae on tarsi, tibia, and genu. Tarsi have bifid apoteles. Genu has large, thick, barbed seta. The medial, distal portions of trochanters extended, bifid setae of trochanter arise immediately beneath it. Portions of distal borders of femur and genu serrated. Corniculi bifid, one branch blunt, other sharp. Chelicerae toothed and chelate. The fixed digit with 5 small teeth followed by one large one. Movable digit with 4 teeth, distal 2 minute, proximal 2 larger. Excrescence on movable digit. LEGS. Legs II, III, and IV have caruncles and claws. Distal portions of the genu and femurs of legs II, III, and IV serrated. Some barbed setae present on all segments except coxae of legs II, III, and IV. Stigmata lateral to, and between coxae III and IV. Peritreme winds around coxa III and continues anteriorly parallel to coxa, ending opposite coxa I.

Male: Body shape similar to female. Dorsum as in female. Jugular plate has different shape from that of female. Arrangement and numbers of pores and setae on plate similar to female. Jugular plate 42 μ long, 144 μ wide. The sternal plate has 3 pairs of setae, 2 pairs of pores, plate 180 μ long, 200 μ wide. Genital plates at level of coxae III. Each is an ovular plate hinged to either sternal or ventral plate. Genital plates 80 μ long, 120 μ wide. Ventral plate with numerous simple setae and pores, plate 400 μ long, 150 μ wide at level of coxae IV, 625 μ wide at its widest part. Anal plate has 13 setae, 7 on one side, 6 on the other. From comparison with other paratypes it is apparent that the usual number is six pairs. Anal plate with 3 pairs of pores, plate 190 μ long, 500 μ wide. Gnathosoma as in female. Legs, peritreme, and stigmata generally as in female. Legs II, III, and IV have single barbed seta on all segments except coxae; other leg setae simple.

The species was described from 24 females and 16 males. The holotype data is 14.5 mi. northeast of Oaxaca, Cerro San Felipe, 9000′, Oaxaca State, Mexico, 12 July 1966 (collected by Neil Chernoff). The mites were in an alcohol vial with *Undilifer incisus* Truqui the host beetle. Additional specimens of *K. grabowskii* were collected 5.5 mi. east southeast of Omilteme, 7000′, Guerrero State, Mexico, 29 June 1966, from *Oileus rimator* Truqui.

Klinckowstroemia tapachulensis new species

(Figs. 3 and 4)

Female holotype: Body shape oval, posterior more blunt than anterior. Idiosoma 970 μ long, 740 μ wide. DORSUM. Dorsal shield entire with numerous small setae and pores. Pores often in pairs and triads. Lateral

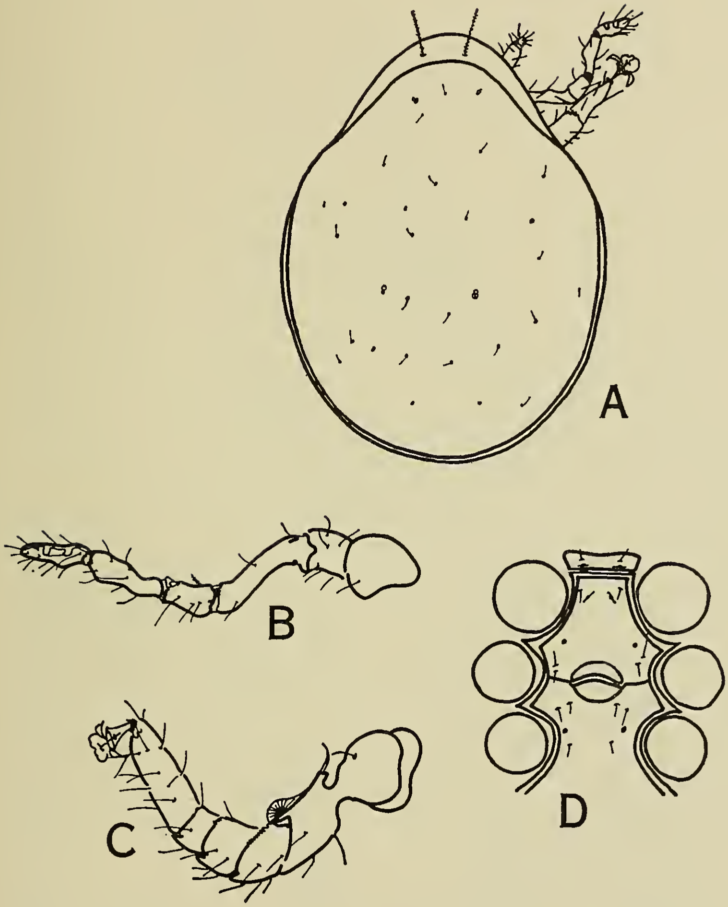

FIG. 3. *Klinckowstroemia tapachulensis* n. sp. Female: A, dorsum; B, leg I; C, leg IV. Male: D, genital area.

borders marked by presence of small simple setae. Anteriorly dorsal shield extends over gnathosoma. Two large barbed setae on anterior portion of dorsal shield. Dorsal shield grooved behind setae. VENTRUM. Jugular plate has pair of long, barbed setae (60 μ +). Setae positioned below anterior margin of plate, each on an ovular, delineated portion of plate. Jugular plates coalesced, and reticulations of plate indicate this line of fusion. Pair of pores at posterior margin of plate. Plate 120 μ wide, 42 μ long. Sternal plate with 3 pairs of setae, 1 pair of pores. Setae I on anterior portion of plate posterior to pores. Setae II are largest of sternal setae, lie on posterior margin of sternal plate. Setae III lateral to setae II. Sternal plate 210 μ wide, 84 μ long. Sternogynial plate with single pair of pores at anterior margin. Plate triangular, 192 μ wide, 92 μ long. Latigynial plates triangular, apposed at midline. They separate sternogynial and mesogynial plates for a distance of 6 μ. Holotype with 5 setae on right plate, 4 setae on left. Single pore on lateral borders of each plate. Latigynial plates 132 μ long, 84 μ wide. Epigynial plate triangular, 90 μ long, 120 μ wide. Ventral plate with numerous small, simple setae and pores. Pair of large pores at level of coxae IV. Ventral plate 310 μ long, 100 μ wide at level of coxae IV, 530 μ wide at widest part. Anal plate with 5 pairs of setae, 2 pairs of pores. One pair of pores lateral and posterior to anal opening, other pair in anterior lateral portion of plate. Anal plate 150 μ long, 430 μ wide. GNATHOSOMA. Palpi five-segmented. Simple setae on tarsi, tibia, genu, and femur. Tarsus has bifid apotele. Genu with large simple setae. Genu, femur, and trochanter each with one barbed setae. Trochanter has large plumose setae. Distal portion of trochanter extended and bifid. Distal borders of genu and femur serrated. Chelicerae toothed and chelate. Fixed digit with 5 small teeth followed by one large tooth, then one small one. Movable digit with 2 large teeth followed distally by 2 small ones. Dense group of simple setae attached to distal portion of movable digit. LEGS. Legs II, III, and IV have claws and caruncles. Most setae on legs are simple, but barbed setae noted on tibia and femur of leg I, and on trochanter of legs III and IV. Serrations noted on distal borders of genu and femur of all legs. Stigmata lateral to, and between coxae III and IV. Peritreme runs at slight angle to coxae and reaches lateral border of body above level of coxae I at juncture of anterior hood and lateral margin.

Male: Body shape similar to female. Dorsum similar to female. Jugular plate not clearly seen. Pores similar to those of female. Sternal plate has 3 pairs of setae and 2 pairs of pores. Anterior pair of setae parallel and lateral to pores. Remaining pores and setae lie on posterior lateral borders of plate. Sternal plate 135 μ long, 156 μ wide. Genital opening at level of coxae III. Plates ovular and hinged to either sternal or ventral plate. Genital plates 60 μ long, 75 μ wide. Ventral plate with numerous simple setae and pores. Pair of large oval pores medial to coxae IV. Ventral plate 270 μ long, 450 μ wide at widest part. Anal

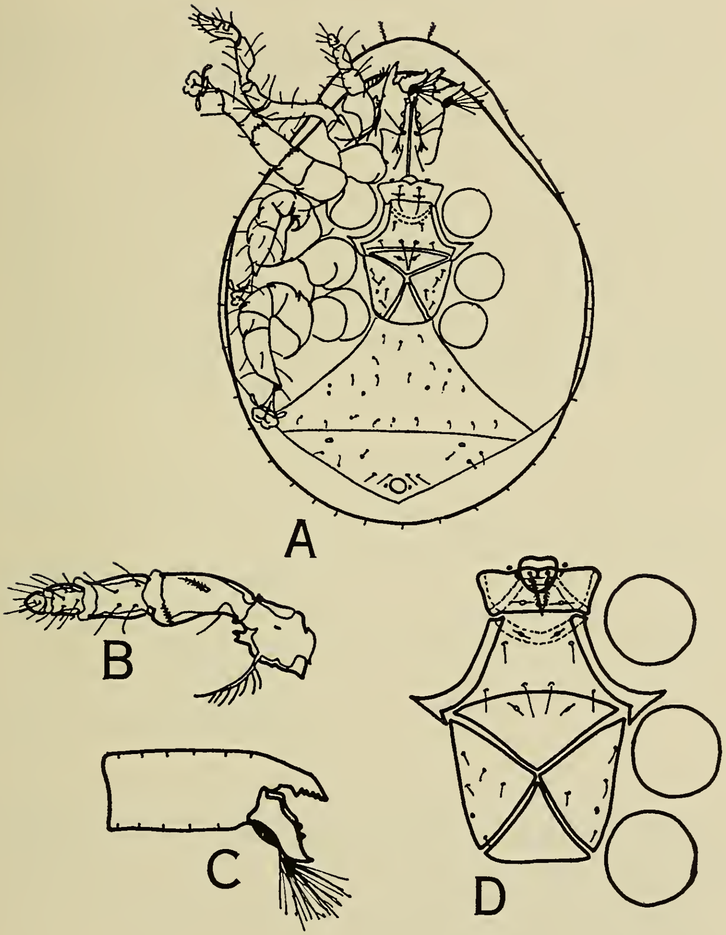

FIG. 4. *Klinckowstroemia tapachulensis* n. sp. Female: A, ventrum; B, palp; C, chelicerae; D, genital area.

plate has 11 setae (6 on one side, 5 on the other) and 3 pairs of pores. One pair of pores posterior to anal plate, other two pair at anterior border. Pair of large setae anterior to anal opening. Anal plate 145 μ long, 420 μ wide. Gnathosoma was obscured. Legs, peritreme, and stigmata as in female.

The species was described on the basis of one female and one male. The collection data for both specimens is 8.5 mi. north of Tapachula, 1750′, Chiapas State, Mexico, 22 July 1966 (collected by Donna Thompson). The specimens were taken from an alcohol vial which contained both *Passalus interruptus* Linnaeus and *Popilius eclipticus* Truqui.

The genus *Klinckowstroemia* contains three previously named species. *K. tragardhi* Baker and Wharton has never been properly described. The mite to which this species refers was mentioned by Tragardh (1938) but he did not designate a genotype at that time. Baker and Wharton (1952) validated the genus by naming the species *K. tragardhi* but they did not make any attempt to further describe the species. Attempts by the present authors to locate the type species in the Tragardh collection have been fruitless. Hunter and Butler (1966) described two additional species from Costa Rica. A key to the females of the species described by Hunter and Butler, and those described in this paper follows:

1 —latigynial plates triangular, not apposed ....
.... *K. concava* Hunter and Butler
1′—latigynial plates truncate, apposed 2
2 —distal portion of peritreme lateral to coxa I ....
.... *K. grabowskii* Chernoff and Pope
2′—distal portion of peritreme anterior to coxa I 3
3 —6 pair of anal plate setae, 6 teeth on fixed chelicera ....
.... *K. truncata* Hunter and Butler
3′—5 pair of anal plate setae, 7 teeth on fixed chelicera ....
.... *K. tapachulensis* Chernoff and Pope

It should be noted that the critical specific characters of these mites are not really known. Three of the four species have been described on the basis of a total of only 5 specimens. Until the variability within large numbers of mites of the same species is known, the significance of such characters as those used above are open to conjecture.

The holotypes of *K. grabowskii* and *K. tapachulensis* have been deposited in the Smithsonian Institution.

The authors would like to acknowledge the assistance of Mrs. Donna Thompson for collecting the host beetle of *K. tapachulensis*; to extend their thanks to Dr. H. F. Strohecker for his invaluable assistance during this project; to Dr. O. L. Cartwright, Curator, Division of Coleoptera, Smithsonian Institution, for the identification of the host beetles; and to Miss Holly Reynolds for the illustrations.

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PROCEEDINGS
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ON AN INTERESTING PHILIPPINE SPECIES OF THE EARTHWORM GENUS *PHERETIMA* KINBERG, 1866 (OLIGOCHAETA, ANNELIDA)[1]

By G. E. Gates
Zoology Department, University of Maine, Orono

Earthworm faunas of a few areas have been more or less thoroughly surveyed. Our knowledge of the megadriles of so many other parts of the world is fortuitous, a result of one or more accidental finds. The interest of a Peace Corps Volunteer was aroused by a bright blue earthworm of a size that to him seemed unusually large. As a result, several specimens became available from a small Philippine island.

The identifiable species was known hitherto only from an Italian description of the holotype. Although that account is better than many of the period, confirmation of some characters and information about others then ignored has been needed.

Megascolecidae
Pheretima Kinberg, 1866
Pheretima mazarredoi Rosa, 1894

Pheretima "mazarredi" Rosa, 1894. Atti Acad. Sci. Torino, 29, p. 765. (Type locality, Marinduque Island, Philippines. Holotype, originally in the Madrid Natural History Museum. No other information now available.)

Material examined: Marinduque I. Bathala, Santa Cruz, found on surface of ground near some caves, 2 March 1965, 2–5–0. Halford Jones.

External characteristics: Size, 250–325 by 15 mm (aclitellates), of juveniles 60 by 5 mm. Segments, 114, 116, 120 (2 specimens), 122, 124, 131. Prostomium, epilobous, tongue closed. Color, very dark, almost midnight blue but with an obvious greenish tinge. Setae, small, numerous,

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[1] From research financed by the National Science Foundation.

deeply retracted, not certainly recognizable in much of the dorsum. First dorsal pore, at 12/13 (7).

Octothecal, pores at 5/6–8/9. Male pores, minute, superficial, equatorial and rather widely separated, in xviii. Genital markings, paired, represented by whitish transverse depressions about in line with the male porophores and so rather widely separated, at 17/18, 18/19, or 18/19, 19/20, 20/21.

Internal anatomy: Septa, all present and complete from 5/6 posteriorly. Special longitudinal muscle band at mD, recognizable only from 12/13 posteriorly. Pigment, very dark, of a greenish blue appearance. Lymph glands (unrecognizable in the two small juveniles), present from xvi posteriorly. Brown bodies, numerous under the peritoneum.

Gizzard, in viii, *ca.* 6 mm long and 7 mm thick, the wall only *ca.* 1 mm thick, with a wider flange either in vii or adherent to 7/8. Esophagus, widened in x–xiii, valvular in xiv–xvi. Intestinal origin, in xvii (4). Intestine, deeply and variously sacculated, especially anteriorly but acaecal and atyphlosolate.

Dorsal blood vessel, unrecognized in front of 5/6, possibly because of absence of blood therein. Ventral trunk, complete, bifurcating over subpharyngeal ganglion, the branches passing up along the circumpharyngeal nervous connectives (presumably to dorsal trunk?). Extraesophageals, median to segmental vascular arches, passing onto ventral face of gut in x, unrecognizable behind xiii (3), empty continuations of the vessels in one specimen seemingly passing into xvi (and then to the ventral trunk?). Supra-esophageal trunks, rather widely separated, in x–xiii, usually empty, connected with each other transversely at least once, just in front of 12/13. Subneural trunk, no trace recognized from one end of body to the other (1 completely dissected specimen). Hearts, of vi–ix slender, lateral (*i.e.*, connecting dorsal and ventral trunks only in each of those segments), of x–xiii lateroesophageal.

Holandric. Testis sacs, none (testes and male funnels obviously free in coelomic cavities). Male funnels, polyplicate. Male ducts, not seen, presumably intraparietal behind funnel septa. Seminal vesicles, two pairs, in xi, xii, vertically placed, *ca.* 10 mm long by 1 mm thick, with densely spongelike texture. Prostates, compact, confined to xviii, seemingly sessile. Ducts, 5 mm long, mostly within the parietes, recognizable only after dissecting prostates away from the body wall.

Spermathecae, size increasing posteriorly. Ducts, almost confined to the body wall. Diverticulum, small, heart-shaped to spheroidal, or very shortly ellipsoidal, on anterior face of duct just at, partly or wholly within parietes. Ovaries, vertically placed, *ca.* 2 mm long. Ovisacs and pseudovesicles, unrecognized.

GM glands, none visible in coelom, on or in body wall.

Reproduction: Specimens were too immature to provide any macroscopically recognizable evidence as to mode of reproduction. Texture of seminal vesicles is not like that of mature specimens of many amphimictic species of the genus. Genital aberrations, such as are so often present in male sterile morphs, are lacking. Perhaps biparental reproduction should be anticipated.

Remarks: Many natives, according to Mr. Jones (*in lit.* to author), believe these worms to be snakes. Noteworthy, in that connection is the fact that *Pheretima ophioides* Michaelsen, 1930, has a similar blue color. *In vivo*, the pigment of *P. mazarredoi* probably was confined, except perhaps at the anterior end, to connective tissue between the epidermis and the circular muscle layer. Presumably then, after preservation, epidermis, brown bodies, spermathecal and prostatic ducts were selectively stained by the dissolved pigment. Alcohol in which the worms were received had a bright yellow color.

The parietal musculature was studied in microtome sections by Prof. W. J. Harman who has reported on its structure as follows (*in lit.* May 7, 1969). "The circular muscle is composed of 10–12 fibers each clearly separated from the others by abundant connective tissue. Individual fibers are 23 μ wide. The separating connective tissue is 33 μ thick. In the longitudinal musculature 8–20 fibers are enclosed in each thin connective tissue sheath. The Kastchen are not as clearly formed as in other pheretimas or any other earthworm that I have ever seen but the differences are only quantitative. I would have identified the slides as coming from a *pheretima* had I not known beforehand."

Coelomic fluid can be ejected from the dorsal pores of *P. ophioides* to a height of 1½ m. The fluid, according to native collectors, is corrosive and especially dangerous if gotten into the eyes. One of Mr. Jones letters indicates he had received similar warnings about his specimens of *P. mazarredoi*.

Systematics: Immaturity of each specimen obviates mention of several characters likely to be of systematic importance: Location and shape of clitellum. Presence or absence of ovisacs, pseudovesicles, GM glands. Spermathecal diverticula seem to have reached the same stage as in the clitellate holotype. Perhaps then, GM glands should not be expected.

Absence of intestinal caeca, typhlosoles, and testis sacs, completeness of septa 8/9–9/10, presence of a pair of complete lateral hearts in each of viii and ix, in the genus *Pheretima* are regarded as primitive characters. If a subneural trunk is lacking (the vessel often is unrecognizable when empty), that condition also will be considered primitive. Too little information is available to warrant a statement as to the duplex condition of the supra-esophageal trunk. Paired female pores, in *Pheretima* also is a character that seems primitive but the original account of the type indicates presence of a single, median aperture as in most species of the genus.

Absence of testis sacs in *Pheretima* has been recorded hitherto only from male sterile morphs and from juveniles of amphimictic forms.

Whether sacs would later have been developed by the Marinduque worms of course is unknown but now seems unlikely.

The clitellum, according to the original account of *P. mazarredoi,* extends through xiii, in addition to the usual three segments. That character was formerly regarded as primitive, but mainly because *Pheretima* was believed to be directly descended from *Megascolex* in which the clitellum often included more than segments xiv–xvi.

Presence of hearts in xiii, in *Pheretima,* now certainly seems to be an advanced rather than a primitive character.

A subgenus *Archipheretima* was erected by Michaelsen (1928) for holandric species with the following characteristics: Clitellum extending through more than segments xiv–xvi. Copulatory chambers and intestinal caeca lacking. Neither of those characters is diagnostic nor is the combination. Subsequent addition (Michaelsen, 1934) of two more characters added nothing of value to the definition. The only really important character in the definition is, "intestinal caeca absent," and that is shared with various species in other classical subgenera of *Pheretima.* Michaelsen did not put *P. mazarredoi* in his *Archipheretima* though it now seems more primitive than some that were included. All species of *Archipheretima* are too inadequately characterized for present needs.

Pheretima mazarredoi seems likely to be closely related to *P. iris* and *P. margaritacea* (Michaelsen, 1892) from the island of Samar and *P. ophioides* from Luzon.

Each species referred to *Archipheretima* is known today only from the original materials. Beyond the Philippines the only records are for Borneo.

Immature specimens, from a cave in the region where *P. mazarredoi* was secured, differ from that species in characters that often have been found to distinguish closely related taxa from each other. A short description is appended.

Pheretima sp.

Material: Marinduque Island. Bathala, Santa Cruz, cave, August 13, 1964, 0-2-0. Halford Jones.

External characteristics: Size, 235–385 by 20 mm. Segments, 120, 126. Body, shortly and transversely elliptical in cross section. Color, slate, uniform in ventrum as well as dorsum.

Spermathecal pores, very small transverse slits about 6–7 mm apart from each other. Female pores, nearly 2 mm apart (1 specimen). Male pores, very small transverse slits, equatorial in xviii, 9+ mm apart from each other ventrally, each at center of a circular area slightly protuberant from middle of a slightly depressed, longitudinally elliptical area of epidermal translucence about 2 mm wide that crosses slightly into xvii and xix.

A single preclitellar marking, about 7 mm wide and 2½ mm long, obliterates 9/10. A central translucent portion is distinctly demarcated from a peripheral opaque band. Postclitellar markings, widely paired, nearly circular areas (of slight tumescence?), slightly median to male pore levels, *ca.* 2 mm wide, separated from each other mesially by a distance about equal to 4 mm, two pairs obliterating 19/20 and 20/21.

Internal anatomy: Pigment, slate-colored, in a layer between epidermis and circular muscle layer.

Esophagus, in x–xiii with low, thin, lamelliform, closely crowded ridges on inner wall. Esophageal valve, in region of 14/15. Intestinal origin, in xv.

Seminal chambers, in two vertical rows protruding slightly from anterior face of spermathecal duct.

Ingesta: Mostly organic matter, including one bit of wood 18 mm. long. A small tick-like arachnid also was found.

Parasites: Slate-colored brown-bodies in the coelom contained nematode eggs, pseudonavicella spores, variously shaped but poorly preserved bodies that may be gregarines, also organisms of unknown relationships, as well as numerous small setae and corpuscles of various sorts.

Remarks: Intersegmental furrows of the clitellar region were almost obliterated but no tumescence was externally recognized and dorsal pores still were functional.

Alcohol in which these specimens were preserved had become a dark and rather greenish color. Dissolved pigment may have stained the ventrum (to produce an appearance of uniform coloration) as it presumably did the brown-bodies (some subperitoneal) and prostatic ducts.

Fine diagonal ridges on inner wall of intestine run through several consecutive segments.

Nephridia, of the intestinal region, seem to be more numerous on posterior than on anterior faces of the septa and especially so ventrally.

Significance of certain differences from other Marinduque specimens, such as in the spermathecae and the intestinal origin, remains to be determined. A sufficiently long isolation of cave from exterior populations could have enabled specific distinctness for each.

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A NEW CRAYFISH FROM THE NASHVILLE BASIN, TENNESSEE

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The new burrowing crayfish described below was first collected from a "tributary of Stone River, 20 miles from Columbia, Tennessee" in November during the last decade of the past century by a Mr. Von Baer. The three specimens collected by him were transferred to the Smithsonian Institution from the United States Fish Commission. Thus, the existence of this crayfish has been known for approximately 75 years. There seems to be some error in the data cited above, for I have been unable to locate a "Stone River" within a 20 mile radius of Columbia. Tributaries of Stones River in Rutherford County are 30 to 35 miles east-northeast of Columbia, and it seems probable that one of them is the source from which Mr. Von Baer obtained his specimens. The original label in the container has been damaged, and the last figure in the date has been lost.

The species was rediscovered by Dr. Glenn Gentry in a boggy area along a small tributary to the Harpeth River in Cheatham County, Tennessee in April, 1968. Subsequently, he has obtained additional specimens from the area, and during April 1969, Jean E. Pugh, Daniel J. Peters, Dr. Gentry, and I obtained a series of 27 specimens in the type-locality. Additional material has been made available to me by Harold N. Mullican of the Tennessee Game and Fish Commission and by Raymond W. Bouchard.

I should like to thank Messrs. Bouchard, Gentry, Mullican, and Peters and Miss Pugh for their assistance in amassing the specimens on which this description is based. I am also

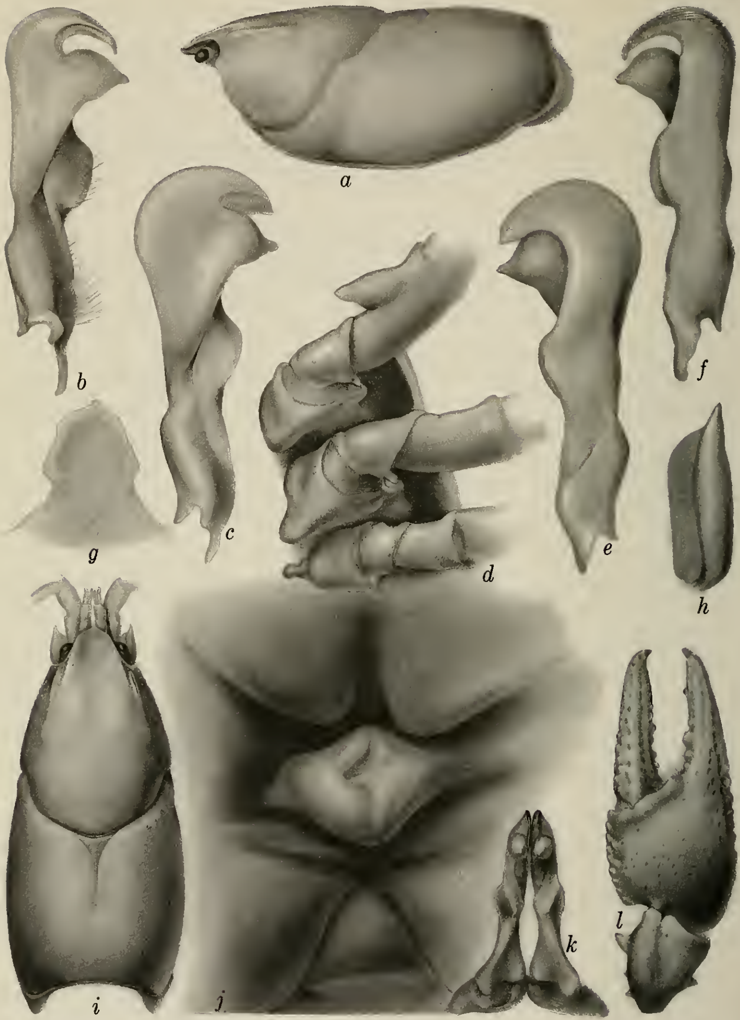

FIG. 1. *Cambarus gentryi* new species (pubescence removed from all structures illustrated except Fig. 1a). a, Lateral view of carapace of holotype. b, Mesial view of first pleopod of holotype. c, Mesial view of first pleopod of morphotype. d, Basal podomeres of third, fourth, and fifth pereiopods of holotype. e, Lateral view of first pleopod of

Table 1. Measurements (mm) *Cambarus gentryi.*

	Holotype	Allotype	Morphotype
Carapace:			
Height	11.7	11.3	13.1
Width	13.1	13.2	14.2
Length	27.6	26.9	30.1
Areola:			
Width	—	—	—
Length	11.5	11.2	12.8
Rostrum:			
Width	4.4	4.6	4.8
Length	4.2	3.8	5.0
Chela:			
Length of inner margin of palm	7.3	5.6	7.0
Width of palm	9.7	8.1	9.9
Length of outer margin of chela	22.1	16.8	19.7
Length of dactyl	13.2	10.0	11.6

grateful to Carolyn B. Gast for the excellent illustrations and to Fenner A. Chace, Jr. and H. H. Hobbs III for their criticisms of the manuscript.

Cambarus (*Jugicambarus*) *gentryi* new species

Diagnosis: Body pigmented, eyes small but well-developed. Rostrum with convergent margins devoid of marginal spines or tubercles, acumen very short and indistinctly delimited. Areola sublinear, comprising 40 to 44.5 percent of entire length of carapace, and bearing one or no punctations in narrowest part. Carapace without cervical tubercles or spines. Suborbital angle rounded. Postorbital ridge prominent with conspicuous swelling caudally and subtruncate cephalically. Antennal scale approximately three times longer than broad. Chela with single row of five to eight tubercles on mesial margin of palm and one to three above marginal row; lateral surface with middle half subcostate and both fingers with moderately well-developed longitudinal ridges on upper surfaces. First pleopods (Fig. 1b, f, k) of first form male with

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←

morphotype. f, Lateral view of first pleopod of holotype. g, Cephalic portion of epistome of holotype. h, Antennal scale of holotype. i, Dorsal view of carapace of holotype. j, Annulus ventralis of allotype. k, Caudal view of first pleopods of holotype. l, Distal podomeres of cheliped of holotype.

corneous central projection recurved approximately 120°, tapering distally, lacking subterminal notch, and not extending so far caudad as mesial process but its tip usually reaching proximally beyond distal (morphological cephalic) margin of latter; mesial process non-corneous, submammillate, with simple or spinose tip directed caudally but lying lateral to tip of central projection. Annulus ventralis (Fig. 1j) deeply embedded in sternum, and with short cephalomedian trough separated from broad caudal wall by asymmetrical median depression. Color cobalt blue with orange or yellow and yellowish green markings.

Holotypic Male, Form I: Body subcylindrical. Abdomen narrower than thorax (10.3 and 13.1 mm). Greatest width of carapace greater than depth at caudodorsal margin of cervical groove (13.1 and 11.7 mm). Areola almost linear (approximately 50 times longer than broad) with room for one punctation in narrowest part. Cephalic section of carapace 1.4 times longer than areola (length of areola 41.6 percent of entire length of carapace). Rostrum broad basally, basal width slightly greater than length, with convergent margins and short, broad, poorly-defined acumen, tip of which reaching slightly beyond midlength of penultimate podomere of antennular peduncle; margins thickened and continuous to slightly upturned tip and lacking tubercles or spines; sub-marginal row of tubercles large and deep basally but becoming smaller and shallow toward acumen; upper surface concave with few punctations basally; subrostral ridges strong and evident in lateral aspect to base of acumen. Postorbital ridges prominent although not strongly elevated, grooved dorsolaterally, with swollen prominences caudally and rounded apically. Branchiostegal spine almost obsolete, represented by very small ridge. Carapace punctate dorsally and granulate laterally; cephalic portion of hepatic region and ventral margin of cephalic portion of cervical groove with number of moderately large tubercles; cervical spines absent, represented by one or two very small squamous tubercles; gastric area with submedian pair of prominent knobs approximately midway between caudal ends of post-orbital ridges and cervical groove. Abdomen shorter and narrower than carapace (24.6 and 27.6 mm; 10.3 and 13.1 mm). Cephalic section of telson with single fixed spine in each caudolateral corner. Upper surface of telson and uropods setose. Basal podomeres and inner ramus of uropod without spines; outer ramus with row of short spines on distal margin of proximal segment, otherwise spineless.

Cephalomedian projecting portion of epistome (Fig. 1g) narrower than long, subrhomboidal, with cephalic margin arched and bearing small cephalomedian projection; basal area with fovea almost obsolete and with thickened caudal margin bearing broad concavity. Basal segment of peduncle of dextral antennule with small spine near distal margin, sinistral member without such spine. Antennae broken but probably reaching no farther caudad than midlength of abdomen. Antennal scale (Fig. 1h) almost three times longer than broad, broadest near midlength with broadest lamellar area subequal in width to thickened lateral portion, latter terminating in heavy spine reaching end of penultimate podomere of antennular peduncle. Third maxillipeds reaching midlength of penultimate podomere of antenna.

Right chela (Fig. 1l) subrectangular, somewhat depressed but with inflated palm and with lateral margin subcostate. Upper surface of palm punctate, mesial margin with subcristiform row of eight tubercles and two above row (left chela with row of six and three above); lateral margin undulating because of large punctations; lower surface punctate but with two prominent tubercles opposite articulation with dactyl. Upper surfaces of both fingers with moderately well-defined longitudinal ridges flanked by tubercles; lower surfaces punctate without distinct ridges; opposable margin of immovable finger with row of five tubercles along proximal three-fifths (third from base largest) and one on lower level at base of distal fourth, single row of minute denticles extending between fourth tubercle and corneous tip of finger; lateral surface of finger broadly rounded, polished, and with scattered punctations; opposable margin of dactyl with eight tubercles along proximal three-fourths of finger, fourth from base largest, and with single interrupted row of minute denticles extending between fifth tubercle from base and corneous tip of finger; mesial margin of dactyl tuberculate along proximal half and punctate along distal half.

Carpus of right cheliped longer than broad with deep oblique longitudinal furrow dorsally; dorsal surface punctate; mesial surface with one large acute tubercle and smaller one proximal to it; ventral surface with single prominent tubercle lateral to major tubercle on mesial surface (no prominent tubercle on ventral surface of left carpus).

Merus of right cheliped with mesial and lateral surfaces sparsely punctate; dorsodistal surface with two prominent tubercles, ventrolateral surface with row of four tubercles and ventromesial with row of eight. Only three small tubercles on ventral surface of ischium.

Hooks on ischia of third pereiopods (Fig. 1d) strong, simple, not opposed by tubercle on basis, and projecting proximally beyond distal end of latter. Coxa of fourth pereiopods with prominent, vertically disposed caudomesial protuberance and broad shelflike flange cephalic to protuberance; coxa of fifth pereiopods without prominences. Sternum deep between third, fourth, and fifth pereiopods and with prominent tufts of setae borne on ventrolateral margins.

First pleopods (Fig. 1b, f, k) symmetrical and reaching coxa of third pereiopods when abdomen is flexed. (See diagnosis for description.)

Morphotypic Male, Form II: Differs from holotype in following respects: cephalic section of telson with two spines in each caudolateral corner, mesial ones movable; mesial ramus of uropod with median ridge bearing small spine almost at distal margin of ramus; mesial margin of palm of chela with row of six tubercles and two above row; mesial surface of carpus of right cheliped with two tubercles proximal to major one;

dorsal surface of merus with only one well-developed tubercle, and ventromesial margin with row of 10 tubercles on right cheliped; hooks on ischia of third pereiopods and protuberances on coxae of fourth much reduced in size. First pleopod (Figs. 1c, e) with neither terminal element corneous and mesial process as in holotype; central projection much heavier, inflated, and contiguous with mesial process for proximal half of its length; shaft with distinct oblique suture in proximal half. (see measurements.)

Allotypic Female: Differs from holotype in following respects: telson and uropods as in morphotype; mesial margin of right chela with row of six tubercles and two above it, left with row of five and three above; carpus of right chela as in morphotype; merus of both chelae with single well-developed tubercle dorsally, ventrolateral margin with row of five on dextral cheliped and ventromesial margin with row of nine on dextral and 10 on sinistral cheliped. (See measurements.)

Annulus ventralis (Fig. 1j) about 1.4 times broader than long, deeply embedded in sternum, and firmly fused to V-shaped sternal plate immediately cephalic to it, but with caudal half movable; cephalic portion with short median longitudinal trough broadening caudally to form broad asymmetrical submedian depression; sinus originating along caudodextral wall of latter, curving to median line, then caudally, and terminating on broad caudal wall. Sternite between fifth pereiopods subtriangular and about 1.3 times broader than long.

Color Notes: Carapace with hepatic and branchiostegal areas cobalt blue; gastric region also blue but suffused with greenish tan. Margins of rostrum, postorbital ridges, pair of subcircular prominences at caudolateral ends of postorbital ridges, and paired tubercles in gastric area orange tan; pair of faint cephalomesially-directed pale tan lines extending from base of rostrum. Subrostral ridges pale cream tan; lower marginal portions of branchiostegites and lower hepatic area almost white. Cephalic terga of abdomen almost as blue as branchiostegites but fading caudally, assuming greenish suffusion; uropods and telson pale greenish blue. Caudal margin of each tergum and margins of uropods and telson with fringe of orange tan setae. Antennae cream with orange tan setae. Dorsal surface of cheliped bluish green from distal portion of merus to orange tan tips of fingers, progressively paler distally; distal articular surface of basis and ischium with orange knobs and margins; distal margin of merus, dorsal articular area of carpus, and articular surface of propodus at base of dactyl orange; all tubercles on chela yellowish cream; spines on dorsodistal portion of merus, spine on mesial surface of carpus, and mesial row of tubercles on propodus conspicuously orange-yellow; lower surface of chelipeds pinkish cream except for blue mesial and proximomesial area of propodus. Upper surfaces of legs pinkish cream basally; merus suffused with pale green; carpus olive green; remaining podomeres fading distally to pinkish cream; joints between ischium and merus and merus and carpus marked with bright orange, as are hooks on ischiopodites of third pereiopods. Third maxilliped and lower surfaces of legs mostly cream; epistome largely cobalt blue but with cream splotches and margins. Ventral surfaces of abdomen, uropods, and telson pale blue; pleopods pinkish cream except for longitudinal cobalt blue bar on caudal surface of shaft of endopodite of second.

Type-locality: Boggy area below seepage along a small tributary to Turnbull Creek (Harpeth-Cumberland drainage system), one mile west of Kingston Springs, Cheatham County, Tennessee. There, along a shaded area adjacent to the stream, the watertable is virtually at the surface, and the ground, literally riddled with crayfish burrows, is almost covered with mats of liverworts and mosses. A shallow layer of soil, small rocks, and gravel overlies almost horizontally bedded rock, making it unnecessary, and probably impossible, for the crayfish to construct burrows to a depth greater than 1.5 feet.

Disposition of Types: The holotypic male, form I, the allotypic female, and morphotypic male, form II, are deposited in the Smithsonian Institution (nos. 130283, 130284, and 130285, respectively) as are the paratypes, which consist of 2♂, form I; 7♂, form II, 22♀; and 1 juvenile♂.

Size: The largest specimen, a male, form I, has a carapace length of 48.3 mm, the largest female, 43.4 mm, and the smallest first form male, 30.8 mm. The former two specimens were collected from the Concord Creek, Rutherford County locality, and the latter from the type-locality.

Specimens Examined: TENNESSEE—Cheatham County: Type-locality, 1♀, G. Gentry, IV/1968; 1♂I, 2♂II, 3♀, G.G., XI/8/1968; 2♂II, 2♀, G.G., XII/22/1968; 2♂I, 6♂II, 18♀, 1j♂, G.G., D.J.P., J.E.P., H.H.H., IV/8/1969. Davidson County: Along creek adjacent to Park Office in Montgomery Bell State Park, 2j♀, D.J.P., J.E.P., H.H.H., IV/10/1969. Houston County: Along Yellow Creek at Dickson County line on Tenn. Rte. 49, 1♂II, D.J.P., J.E.P., H.H.H., IV/10/1969. Maury County: Near Mt. Pleasant, 1♂I, 1♀, Bruce Cole, V/13/1969. Rutherford County: Along Concord Creek, off Tenn. Rte. 99 between Rockvale and Eagleville, 1♂I, 3♀, H.N.M., V/1969; (?)"Tributary of Stone River, 20 miles from Columbia, 3♂I, V.B., XI/189?." Williamson County: Camp Mary Mount, 22 miles W. of Nashville, 0.5 mile off Tenn. Rte. 100, 1♂I, G.G., X/4/1969.

Thus the known range of the species encompasses portions of the basins of the Cumberland (Stones River, Harpeth River, and Yellow Creek) and Duck rivers in Middle Tennessee.

Variations: The only variations observed that are worthy of note exist in the specimens from the Concord Creek and "Stone River" localities in Rutherford County. The four individuals from the former are larger than those from the other localities, having carapace lengths of 40.7 to 48.3 mm of which the areolae constitute 43.5 to 44.5 percent, whereas, elsewhere the largest individual is a male from Stone River with a carapace length of 37.8 mm, and the largest from the type-locality is a female measuring 35.3 mm. The areolae of the specimens from the latter two localities range from 42.4 to 44.0 and 40.4 to 43.2 percent of the carapace length, respectively.

The first pleopods of the male from the Concord Creek locality also differ from those in other localities in that the central projection is not so strongly recurved, the mesial process terminates in three or four small spines, and its distal portion is more strongly arched laterally than in the other males. Whether or not these variations in the pleopod are peculiar to the single male cannot be ascertained until additional specimens from the area become available. That the population of which it was a part attains a greater size than does that in the type-locality seems highly probable, for among the 37 specimens from the latter, none is as large as the smallest of the four specimens from the Concord Creek area.

Among the specimens from "Stone River," the constricted distal portion of the mesial process of the first pleopod is longer and more flattened than that of specimens from the vicinity of the type-locality, and the distal portion of the pleopod is almost as strongly arched laterally as it is in the single male from Concord Creek; however, the central projection is disposed more nearly like that in individuals from the type-locality.

Life History Notes: First form males have been collected in April, May, and November. Neither ovigerous females nor ones carrying young have been observed.

Relationships: Cambarus gentryi has its closest affinities with the members of the subgenus *Jugicambarus* (see Hobbs, 1969), and both in its morphology and habits seems to be more closely allied to *Cambarus carolinus* Erichson (1846:96) than to any other described species. Its most distinctive features are the linear areola and the cobalt blue carapace with orange or yellow markings.

Etymology: It is a pleasure to name this crayfish in honor of my good friend, Dr. Glenn Gentry, who has aided me on many occasions in my study of the crayfishes in Tennessee.

Remarks: In the type-locality, the crayfishes are deterred in their vertical burrowing by the shallow soil overlying bed rock, and as Dr. Gentry pointed out to us, the animals were more easily secured by utilizing a garden rake than a shovel. In other localities, they were either collected with the aid of a flashlight at night when they were at the mouths of their burrows or were walking on the surface of the ground, dug from complex burrows, or supposedly taken in a stream (by Von Baer).

In the type-locality, the burrows consisted of shallow, mostly horizontal passages, some six or eight feet in length, that branched and had two or three openings to the surface. Elsewhere, the burrows, while branching and having at least two openings to the surface, were more nearly vertical, with one passageway descending to a depth of about three feet. Heavy rains had fallen shortly before the burrows were excavated, and the water table was within one foot of the surface.

Perhaps, like *Cambarus diogenes diogenes* Girard (1852: 88), the first form males occasionally leave their burrows and wander into streams. This possibility seems probable if we may assume that Von Baer collected his specimens from the stream bed, and the fact that all three specimens are first form males again lends further support to such a conclusion.

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NEW ENTOCYTHERID OSTRACODS OF THE GENUS *ORNITHOCYTHERE* AND THE DESCRIPTION OF A NEW GENUS

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Three new species of entocytherid ostracods, belonging to the genus *Ornithocythere* Hobbs, 1967:2, are described from Kentucky and Mississippi. *Ornithocythere aetodes* (see below) and *O. popi* (see below) were collected from the burrowing crayfish *Cambarus diogenes* in Mississippi. The third species, *O. rhea* (see below), was obtained from the same host species in Kentucky. With the descriptions of these additional forms, the genus now consists of five members, the combined ranges of which appear to be discontinuous, one species occurring in the coastal plain of Maryland and Virginia and the others in Kentucky, Alabama and Mississippi.

Not only have females of all the described members of the genus *Ornithocythere* been correlated with the males but also peculiarities of the genital areas permit the recognition of each, and consequently keys are provided for both sexes. Because the key to the females is based on genital structures, a description of its basic plan and a limited terminology are needed. The genital structures, collectively called the *genital complex*, are situated posterodorsally in the shell of the females. All species of the genus *Ornithocythere* possess a heavily sclerotized *genital papilla*, which appears as a simple cone or cylinder. In addition to the papilla, *O. aetodes* possesses two *alate processes* (wings) which extend ventrally from the level of the papilla. *O. waltonae* Hobbs, 1967:2 and *O. popi* possess a genital complex composed of a papilla and a *campanula.* The latter is somewhat bell-like, with the papilla, analogous to a clapper, hanging pendant within it. Surrounding the genital structures, regardless of its form, is an amorphous mass on which detritus accumulates.

The genus *Hartocythere* (see below) is erected to receive a disjunct species from Alabama, Florida, and Georgia, which was formerly assigned to the genus *Geocythere* Hart, 1962: 134. When additional species were discovered, it became an orphan in the genus, thus necessitating the proposal of the new genus *Hartocythere.*

I wish to thank Dr. J. F. Fitzpatrick, Jr. and Dr. Horton H. Hobbs, Jr. for their assistance in the preparation of this manuscript and Dr. David G. Frey for his criticisms of it.

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Genus *Ornithocythere* Hobbs, 1967

Diagnosis: Terminal tooth of mandible pectinate. Male copulatory complex lacking finger guard and accessory groove; peniferum extending ventrally beyond clasping apparatus; acute, sclerotized, beaklike prominence (resembling inverted head of a bird) directed anterodorsally, its ventral base arising from ventral border of peniferum rather than from anterior surface. Corneous penis large, directed anterodorsally with prostatic and spermatic elements propinquant throughout length; clasping apparatus well-developed, may or may not be divisible into horizontal and vertical rami; vertical ramus with margins entire; horizontal ramus with or without entire borders, ramus terminating in three to five apical denticles. Triunguis females without J-shaped rod or amiculum, but possessing sclerified genital papilla; campanula present or absent; no pectinate process on distal podomere of second antenna.

Type species: Ornithocythere waltonae Hobbs, 1967:2.

KEY TO MALES

1 External border of clasping apparatus entire .... *waltonae* Hobbs, 1967:2

1′ External border of clasping apparatus annulate or with rounded prominences 2

2(1′) Clasping apparatus L-shaped and divisible into horizontal and vertical rami .... *rhea* new species

2′ Clasping apparatus with sinuous or simple curve, not divisible into horizontal and vertical rami 3

3(2′) Clasping apparatus S-shaped, with three rounded prominences on external border, terminating in four apical denticles ...... *aetodes* new species

3′ Clasping apparatus with simple curve, mesiodistal surface bearing linear series of four small tubercles, terminating in three to five apical denticles 4

4(3′) Beaklike projection on anteroventral portion of peniferum subacute; two tubercles situated on proximoventral angle of beaklike prominence, third one on ventral margin near apex; clasping apparatus with four mesial prominences proximal to five apical denticles ...... *gypodes* Hobbs III, 1969:169

4′ Beaklike projection on anteroventral portion of peniferum acute, without tubercles; clasping apparatus possessing four annulations proximal to apical denticles ...... *popi* new species

KEY TO TRIUNGUIS FEMALES

1 Genital complex consisting of dorsally situated papilla enclosed within campanula 2

1′ Genital complex consisting of dorsally situated papilla not enclosed within campanula 3

2(1) Genital papilla directed posteroventrally and enclosed within posteroventrally directed campanula ...... *waltonae*

2′ Genital papilla directed ventrally, enclosed within ventrally directed campanula ...... *popi* new species

3(1′) Genital complex consisting of genital papilla and two alate processes ...... *aetodes* new species

3′ Genital complex consisting of genital papilla and lacking alate processes 4

4(3′) Genital papilla directed anteroventrally and possessing saclike extension posterodorsally ...... *rhea* new species

4′ Genital papilla directed posteroventrally and lacking posterodorsal extension ...... *gypodes*

Ornithocythere aetodes new species
(Fig. 1a–e)

Male: Eyes pigmented, located approximately one-fourth shell length from anterior margin. Shell (Fig. 1b) subovate, highest posterior to midlength; margins entire; submarginal setae scarce, absent dorsally, present anteriorly, posteriorly, and ventrally. Range of shell size recorded in Table 1.

Copulatory complex (Fig. 1a, d) with peniferum extending ventrally beyond clasping apparatus, its ventral portion highly sclerotized, beaklike prominence directed anterodorsally with swelling on proximoventral angle; penis large, U-shaped, situated in distal one-fifth of peniferum,

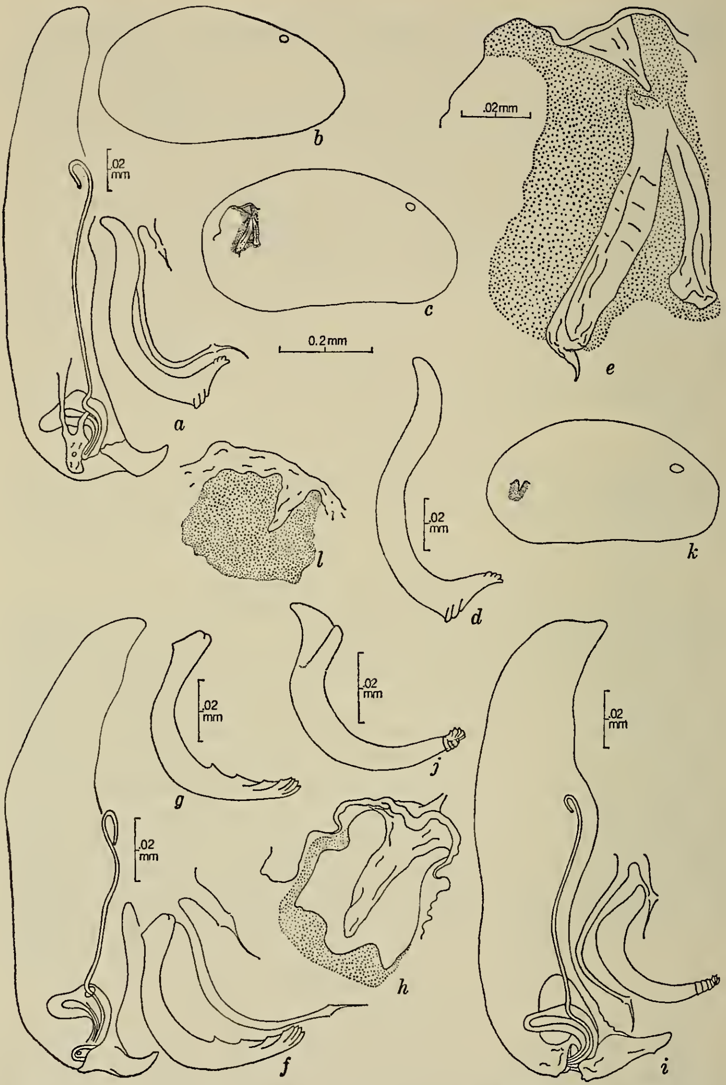

FIG. 1a–e. *Ornithocythere aetodes* new species; Fig. 1f–g. *Ornithocythere waltonae* Hobbs, 1967; Fig. 1i–l. *Ornithocythere gypodes* Hobbs III, 1969. Fig. 1a, f, i. Mesial views of entire male copulatory complexes; Fig. 1b. Lateral view of right valve of male; Fig. 1c, k. Lateral views of right valve of females (b, c, k, to scale indicated below c); Fig. 1d, g, j. Clasping apparatus of males; Fig. 1e, h, l. Female genitalia (to scale indicated by e).

and supported by sclerotized penis guide, latter extending dorsally beyond level of penis. Clasping apparatus S-shaped, not clearly divisible into horizontal and vertical rami; external and internal borders entire except external border bearing three smooth prominences at distal one-fifth and distalmost portion terminating in four apical denticles; ventral finger four times length of dorsal finger—former slender, L-shaped, paralleling clasping apparatus, latter slender and directed ventrally.

Triunguis female: Eyes pigmented; shell (Fig. 1c) subovate with concavity slightly anterior to midlength; margins entire; submarginal setae like those of male; genital complex consisting of sclerified conical, acute papilla (Fig. 1e) directed anteroventrally, bordered by two alate processes, anteriormost directed ventrally, posterior ala directed posteroventrally and terminating distally in recurved spine; both papilla and alae enclosed in amorphous mass. Range of shell size recorded in Table 1.

Type-locality: Burrow from ditch along St. Rte. 28, 0.5 mi. W. of jct. St. Rtes. 28 and 35, Smith County, Mississippi (Leaf River drainage). This species has been collected from no other locality.

Disposition of types: The holotypic male, allotype and male paratype are deposited in the National Museum of Natural History (Smithsonian Institution), nos. 126264 and 126265, respectively. Paratypes are in the collections of C. W. Hart, Jr. (1 ♂), the Smithsonian Institution (1 ♂), and the author (1 ♂).

Host: Cambarus d. diogenes Girard.

Entocytherid associate: Ankylocythere harmani Hobbs, 1966:71.

Relationships: Ornithocythere aetodes has its closest affinities with *O. waltonae* (Fig. 1f–h). The penifera of both are quite similar in shape and structure, particularly in the ventral portion. *O. aetodes*, however, possesses an S-shaped clasping apparatus, the external border of which bears three smooth prominences, whereas *O. waltonae* supports a C-shaped clasping apparatus in which the external border is entire. *O. gypodes* and *O. popi* are similar in that they share with *O. aetodes* the "bird-head" peniferum. *O. aetodes* demonstrates the close relationship that exists between the genera *Ornithocythere* and *Geocythere.*

The structure of the male copulatory complex of *O. aetodes* provides some insight into a probable common origin of the genera *Geocythere, Hartocythere* (see below), *Okriocythere*, and *Ornithocythere.* Like the members of the genus *Geocythere, O. aetodes* possesses excrescences on the external border of the clasping apparatus as does the monotypic *Okriocythere* Hart, 1964: 243; also, the length of the peniferum from the dorsalmost level of the clasping apparatus to its ventral extremity approaches that of the members of the genus *Geocythere.* Its affinities to *Hartocythere* are most obviously indicated in the alate process of the female genital complex (c.f. Figs. 1e and 2n).

Etymology: Aëtos (Greek) = eagle + oides = like—referring to the

TABLE 1. Measurements (in millimeters).

	holotype	males	allotype	females
Ornithocythere aetodes				
number of specimens		5		5
length (range)	0.55	0.52–0.55	0.54	0.53–0.58
mean		0.54		0.54
height (range)	0.31	0.29–0.32	0.32	0.30–0.34
mean		0.30		0.32
Ornithocythere gypodes				
number of specimens		7		7
length (range)	0.50	0.45–0.50	–	0.48–0.50
mean		0.46		0.48
height (range)	0.25	0.23–0.29	–	0.25–0.29
mean		0.26		0.27
Ornithocythere popi				
number of specimens		10		6
length (range)	0.43	0.37–0.45	0.41	0.40–0.44
mean		0.43		0.42
height (range)	0.22	0.22–0.25	0.22	0.22–0.25
mean		0.23		0.24
Ornithocythere rhea				
number of specimens		5		4
length (range)	0.46	0.46–0.50	0.48	0.48–0.49
mean		0.48		0.48
height (range)	0.25	0.25–0.28	0.29	0.29–0.30
mean		0.27		0.30
Ornithocythere waltonae				
number of specimens		10		10
length (range)	0.49	0.47–0.50	0.52	0.49–0.52
mean		0.49		0.51
height (range)	0.27	0.25–0.27	0.30	0.28–0.31
mean		0.27		0.30
Hartocythere torreya				
number of specimens		10		5
length (range)	0.48	0.43–0.48	–	0.48–0.51
mean		0.46		0.50
height (range)	0.27	0.25–0.34	–	0.26–0.28
mean		0.27		0.27

ventral portion of the peniferum of the male resembling the inverted head of an eagle.

Ornithocythere gypodes Hobbs III, 1969
(Fig. 1j, k, l)

At the time of the original description, the holotype was the only known representative of this species. Subsequently, many specimens (both male and female) have been obtained from the burrowing crayfish *Cambarus diogenes* in two additional localities in Pickens County, Alabama and from two localities in Noxubee County, Mississippi. The acquisition of these specimens permits a description of the triunguis female of the species and a more accurate account of the clasping apparatus (Fig. 1i, j) of the male.

Triunguis Female: Eyes pigmented; shell (Fig. 1k) subovate with greatest height slightly posterior to midlength; margins entire; submarginal setae present except dorsally; genital complex consisting of sclerified, conical papilla (Fig. 1l) directed posteroventrally and surrounded by amorphous mass. Range of shell size recorded in Table 1.

Male: Clasping apparatus (Fig. 1j) not divisible into horizontal and vertical rami; internal and external borders entire; except at distal portion where mesiodistal surface with linear series of four small tubercles; clasping apparatus terminating in three to five apical denticles. Range of shell size recorded in Table 1.

Ornithocythere popi new species
(Fig. 2g–k)

Male: Eyes pigmented, located approximately one-fourth shell length from anterior margin; shell (Fig. 2i) subovate with posterior region higher than anterior; greatest height slightly posterior to mid-length; margins entire; submarginal setae scarce, but occurring ventrally and along the anterior and posterior margins. Range of shell size recorded in Table 1.

Copulatory complex (Fig. 2g, h) with peniferum extending ventrally beyond clasping apparatus, ventral portion sclerified and terminating anteroventrally in beaklike prominence; penis large, U-shaped, and situated approximately in distal one-fourth of peniferum; clasping apparatus not clearly divisible into horizontal and vertical rami, but gently curved; external border of distal half with four annulations; distalmost portion terminating in three apical denticles; dorsal and ventral fingers slender, latter three times length of former; ventral finger curved parallel to clasping apparatus; both terminating in single spines.

Female: Eyes pigmented, located one-fourth shell length from anterior margin; shell (Fig. 2j) subovate with greatest height slightly posterior to midlength; margins entire; genital complex (Fig. 2k), situated posterodorsally, with sclerotized genital papilla directed ventrally, enclosed in ventrally tapering campanula with orifice at ventral extremity. Range of shell size recorded in Table 1.

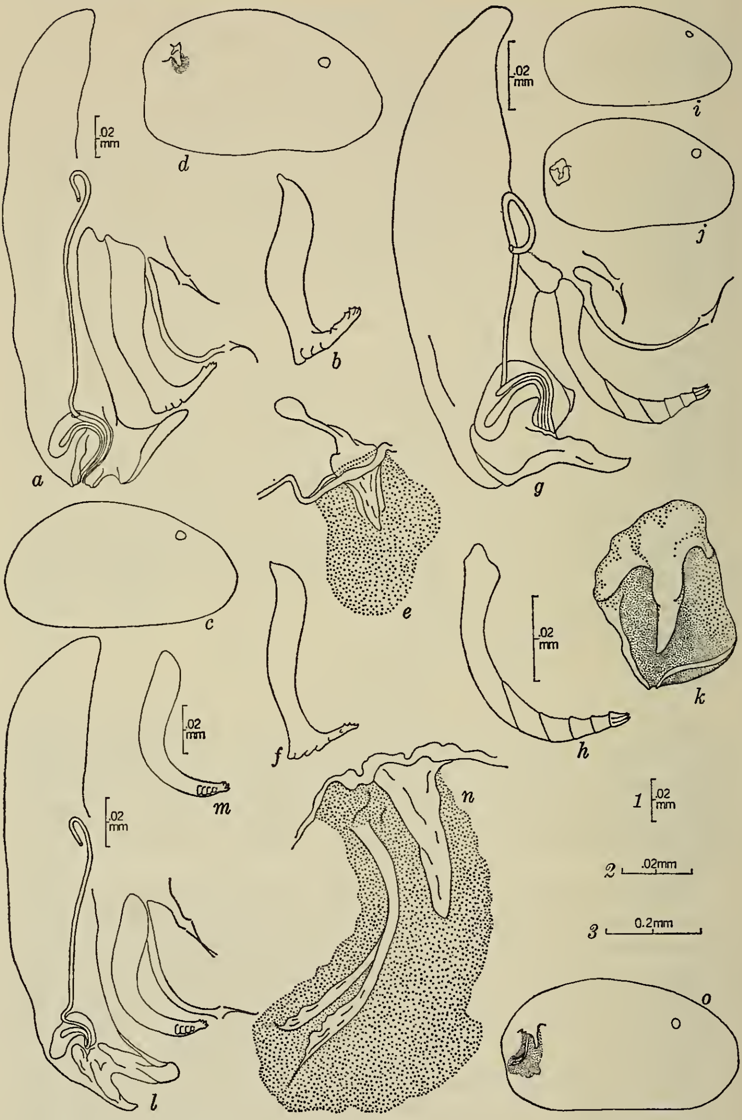

FIG. 2a–f. *Ornithocythere rhea* new species; Fig. 2g–k. *Ornithocythere popi* new species; Fig. 2l–o. *Hartocythere torreya* (Hart, 1959). Fig. 2a, g, l. Mesial views of entire male copulatory complexes; Fig. 2b, f, h, m. Clasping apparatus of males (b, f to scale 1); Fig. 2c, i. Lateral views of right valve of male (scale 3); Fig. 2d, j, o. Lateral views of right valve of female (scale 3); Fig. 2e, k, n. Female genitalia (scale 2).

Type-locality: Burrow in drainage ditch on U.S. Hwy. 49, 0.7 mi. N. of Stone-Harrison County line, Stone County, Mississippi (Biloxi River drainage).

Disposition of types: The holotypic male, allotype, and dissected male paratype are deposited in the National Museum of Natural History (Smithsonian Institution), nos. 126266 and 126267, respectively. Paratypes are in the collections of C. W. Hart, Jr. (2♂), the Smithsonian Institution (2♂), and the author (8♂, 3♀).

Hosts: Cambarus d. diogenes Girard and *C. d. ludovicianus* Faxon.

Entocytherid associates: Ankylocythere harmani Hobbs and an undescribed species of each of the genera *Ankylocythere* and *Geocythere*.

Range: In addition to the type locality, *O. popi* has been collected from burrows in the bank of a small creek on U.S. Hwy. 11, 8.8 mi. SW of jct. U.S. Hwy. 11 and St. Rte. 26, Pearl River County, Mississippi (Pearl River drainage).

Relationships: Ornithocythere popi is most closely related to *O. gypodes*. The penifera of both species resemble the head of a bird and the penes are U-shaped. The clasping apparatus are markedly similar in that both possess annulations and terminate in three apical denticles; the annulations of *O. popi* are larger and extend further proximally. This species is also closely related to *O. waltonae* and *O. aetodes* having the characteristic beaklike prominence on the anteroventral portions of the peniferum. Like *O. waltonae*, the genital complex of the triunguis female of *O. popi* is composed of a papilla which is enclosed in a campanula.

Etymology: I am pleased to name this species in honor of my father, Horton H. Hobbs, Jr., to whom I affectionately refer as "Pop."

Ornithocythere rhea new species
(Fig. 2a–f)

Male: Eyes pigmented, located approximately one-fourth shell length from anterior margin. Shell (Fig. 2c) subovate with greatest height slightly posterior to midlength; margins entire; submarginal setae evenly spaced anteriorly, ventrally, and posteriorly, but absent dorsally. Range of shell size recorded in Table 1.

Copulatory complex (Fig. 2a, b, f) with peniferum elongate, slender, and extending well beyond clasping apparatus; projection on anteroventral portion of peniferum beaklike, subacute, and extending anterodorsally; penis large, U-shaped, and extending slightly beyond ventral margin of peniferum; penis resting in groove bordered by sclerified penis guide; clasping apparatus (Figs. 2a, b, f) variable but always clearly divisible into horizontal and vertical rami; vertical ramus 2.5 times length of horizontal ramus; two rami forming angle less than 90°; external and internal borders of vertical ramus entire; mesial internal border with or without single tooth; mesial external border with row of three to five rounded prominences; apical portion with four denticles;

dorsal and ventral fingers slender each terminating in single spine; dorsal finger straight, directed anteroventrally; ventral finger gently curved anteriorly.

Triunguis female: Eyes pigmented, located approximately one-fourth shell length from anterior margin; shell (Fig. 2d) subovate with truncate posterior margin, slightly larger than male; margins entire; submarginal setae as in male; genital complex (Fig. 2e) consisting of small sclerotized papilla directed anteroventrally and surrounded by amorphous mass; sclerotized prominence with saclike extension directed posterodorsally from base of papilla. Range of shell size recorded in Table 1.

Type-locality: Trammel Creek, 1.4 mi. from jct. U.S. Hwy. 231 and 31W at Alvaton, Allen County, Kentucky (Barren River drainage). This is the only locality from which *O. rhea* has been collected.

Disposition of types: The holotypic male and allotype are deposited in the National Museum of Natural History (Smithsonian Institution), no. 126269. Paratypes are in the collections of C. W. Hart, Jr. (1♂, 1♀), the Smithsonian Institution (1♂, 1♀), and the author (2♂, 1♀).

Host: Cambarus diogenes subsp.?

Entocytherid associate: Ankylocythere hyba Hobbs and Walton, 1963.

Relationships: The male of *Ornithocythere rhea,* like all the members of the genus *Ornithocythere*, possesses a peniferum which resembles the inverted head of a bird, however it is most closely allied to *O. aetodes.* Both species possess a relatively long clasping apparatus, the mesial external borders of which bear a row of rounded prominences. The clasping apparatus of *O. rhea,* however, has an angular bend resulting in the horizontal and vertical rami being disposed at less than a right angle whereas in all other members of the genus, the clasping apparatus is never clearly divisible into two rami. *O. rhea* is also distinct in that the penis is very long and slender in comparison with the other members of the genus.

The triunguis female also shows unique characters which suggest that this species is the most remote member of the genus. Among them is the possession of a saclike extension directed posterodorsally from the base of the papilla of the genital complex (Fig. 2e).

Etymology: Rhea—a genus of ostrichlike birds—so named since the peniferum resembles the inverted head and neck of an ostrich.

Hartocythere new genus
(Fig. 2l–o)

Diagnosis: Terminal tooth of mandible pectinate. Male copulatory complex lacking finger guard and accessory groove; ventral portion of peniferum heavily sclerotized, angled anteroventrally, and deeply cleft, extending ventrally much beyond clasping apparatus; corneous penis large and curved anteroventrally, with prostatic and spermatic elements contiguous throughout their lengths. Clasping apparatus curved approximately at right angle but not distinctly divisible into vertical and horizontal rami, mesiodistal surface bearing linear series of small tubercles and apex of apparatus with four denticles. Triunguis female without J-shaped rod or amiculum but possessing heavy, sclerotized genital papilla.

Gender: Feminine.

Type-species: Entocythere torreya Hart, 1959; here designated.

The genus *Hartocythere* is here proposed to receive a single somewhat disjunct species described by Hart, which in his generic revision (1962) he assigned to the genus *Geocythere*. With the discovery of additional species of the latter and the erection of the closely allied genus *Ornithocythere* Hobbs, 1967, of which five species are now known, uncertainty has arisen as to the limits of variation in the two genera. The removal of Hart's *G. torreya* from the genus makes *Geocythere* a more unified assemblage and permits rather concise definitions of the three genera.

Hartocythere torreya (Hart, 1959)
(Fig. 2l–o)

Entocythere torreya Hart, 1959: 198–200, figs. 7–11.

Geocythere torreya.—Hart, 1962: 135.

Male: Eyes pigmented, situated one-fourth shell length from anterior margin. Shell subelliptical with greatest height slightly posterior to midlength; margins entire. Submarginal setae few in number but evenly spaced anteriorly, posteriorly, and ventrally. Range of shell size recorded in Table 1.

Copulatory complex (Fig. 2l, m) described in diagnosis of genus.

Triunguis female: Eyes as in male. Shell (Fig. 2o) similarly shaped but slightly larger than that of male and with shallow ventral concavity slightly anterior to midlength. Submarginal setae, although sparse, evenly spaced around entire margin. Range of shell size recorded in Table 1.

Genital complex (Fig. 2n) consisting of long, slender sclerotized papilla directed slightly anteroventrally; two posteroventrally curved alate processes situated dorsal to papilla; all of these structures surrounded by amorphous mass with adhering detritus.

Type-locality: Near Blue Springs, Torreya State Park, Liberty County, Florida.

Host: Cambarus diogenes diogenes Girard.

Entocytherid associates: Three undescribed species of the genus *Ankylocythere* and *Uncinocythere simondsi* (Hobbs and Walton, 1960: 17).

Range: Hartocythere torreya has been collected in the Alabama, Escambia, Choctawhatchee, and Appalachicola drainage systems in the following: ALABAMA—Bullock, Clark, Conecuh, and Geneva counties;

FLORIDA—Escambia and Liberty counties; and GEORGIA—Randolph County.

Relationships: This species has its closest affinities with the members of the genera *Geocythere* and *Ornithocythere* but may be readily distinguished from all of them by the highly sclerotized, deeply bifid ventral portion of the peniferum.

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PROCEEDINGS
OF THE
BIOLOGICAL SOCIETY OF WASHINGTON

STUDIES ON SPIROSTREPTOID MILLIPEDS. IX. THE STATUS OF THE INDIAN GENUS *LEIOTELUS* CHAMBERLIN[1]

By Richard L. Hoffman
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One of the most intriguing of R. V. Chamberlin's legion of enigmatic generic names is *Leiotelus*, proposed in 1921 as a taxon of the family Odontopygidae and comprising the type genus of a monotypic new subfamily Leiotelinae.

Inasmuch as the description of *Leiotelus* and its type species *L. amballae* were not accompanied by illustrations of the male genitalia, these names fell promptly into a state of neglect and insofar as I know have never subsequently been mentioned in the literature. This is a remarkable situation in itself since the family Odontopygidae is of course strictly endemic to Africa, and the asserted existence of an Indian member of the group should have excited the greatest interest. Since 1921, however, the diplopod fauna of India was surveyed by Attems in 1936, and the family Odontopygidae subjected to careful revision by Dr. Otto Kraus (1960, 1966) without any account whatever being taken of *Leiotelus* by either author.

The type specimen of *L. amballae* is an adult male, taken at Ambala in Punjab, and is still preserved in the collection of the Museum of Comparative Zoology, Harvard University. Through the cooperation of Dr. H. W. Levi, I was recently enabled to restudy this specimen, and am glad to be able to dispose of the long-standing enigma concerning its taxonomic status. The species belongs not to the Odontopygidae but in

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[1] A contribution from studies supported by grants GB 7936 and GB 3098 from the National Science Foundation. Parts I–VI appeared in *Lloydia*, vols. 16–24, 1953–1961, parts VII and VIII in *Papeis Avulsos de Zoologia*, vol. 21, 1968–1969.

fact is a member of the characteristically Indian family Harpagophoridae as might easily have been guessed both from its locality and the fairly explicit verbal account of the taxonomic characters!

FAMILY HARPAGOPHORIDAE ATTEMS, 1909

SUBFAMILY HARPAGOPHORINAE DEMANGE 1961

(= LEIOTELINAE CHAMBERLIN, 1921; NEW SYNONYMY)

The Harpagophoridae has been rendered by M. Demange into three subfamilies on the basis of the gonopod sternum. Without going into the internal classification of the family at the present time, I can only note that on the basis of gonopod characters, *Leiotelus amballae* clearly falls into any subfamilial, or even tribal, ensemble that might include *Harpagophora* itself, and Chamberlin's subfamily name is thus regarded as a subjective synonym of Demange's nominate subfamily which although many years younger, is based upon the type genus of the family.

It is difficult to imagine how *L. amballae* was ever identified as an odontopygid to begin with. The paraprocts lack the typical dorsal spination of that family, the epiproct is elongate and curved upward, and the gonopods are of perfectly normal harpagophorid pattern. Moreover, Chamberlin had described three new harpagophorids in the pages immediately preceding the proposal of *Leiotelus*.

As a point of fact, *L. amballae* is referable to a genus proposed by Carl several years prior to *Leiotelus*, and based upon a quite well-known Indian species.

Phyllogonostreptus Carl

Phyllogonostreptus Carl, 1918, Rev. Suisse Zool., vol. 26, p. 424. Type species, *Spirostreptus nigrolabiatus* Newport, 1844, by monotypy and original designation.

Leiotelus Chamberlin, 1921, Ann. & Mag. Nat. Hist., ser. 9, vol. 7, p. 67. Type species, *L. amballae* Chamberlin, 1921, by monotypy and original designation. New Synonymy!

This genus has experienced a somewhat variegated taxonomic history. Originally monotypic, it was justified by its author with the statement "Ce genre se distingue de tous les Harpagophoridae par l'absence complète d'épine ou autre saillie coxale aux gonopodes postériors [= telopodite] et par l'état réduit des pectinations du télopodite." *Phyllogonostreptus* was recognized on these bases by Attems in 1926, but later he (1936: 257) withdrew Carl's name into the synonymy of *Thyropygus* in the belief that the absence of a femoral spine was scarcely a generic character. In his 1936 key to species of *Thyropygus*, however, Attems took *nigrolabiatus* out at the first couplet, along with *serpentinus* Att., *broelemanni* Att., and *melinopus* Att., because of the lack of said spine. In his own work on Indian diplopods published in 1941, J. Carl continued to recognize *Phyllogonostreptus* as a valid genus, and in the following year Attems (1942: 90) reverted to the same opinion. He moreover brought additional species into the genus: *uniserialis* from Indochina, *segmentatus* from the Phillippines, and the four taxa supposedly from Borneo: *serpentinus, melinopus, broelemanni,* and *bicornis.*[2]

The recent monographic account by M. Demange (1963) again reduced *Phyllogonostreptus* to monotypic status by relocating the above mentioned species to other genera (except for *bicornis,* which was not mentioned). Although the absence of a femoral spine is not *per se* a generic character (the spine being suppressed randomly among various other groups), when taken into account with the overall form of the gonopods it does contribute to the diagnostic appearance of those appendages *en suite.* I concur with Demange that *Phyllogonostreptus* is a valid genus containing up to the present only the South Indian species *nigrolabiatus.*

Phyllogonostreptus nigrolabiatus (Newport)

Spirostreptus nigrolabiatus Newport, 1844, Ann. & Mag. Nat. Hist., ser. 1, vol. 13, p. 269 (Holotype, Brit. Mus., from "India").—Pocock, 1892, Journ. Bombay Nat. Hist. Soc., vol. 7, p. 159.

Phyllogonostreptus nigrolabiatus: Carl, 1918, Rev. Suisse Zool., vol. 26, p. 426.—Attems, 1942, Ann. Naturh. Mus. Wien, vol. 52, p. 91.—Demange, 1961, Mem. Mus. Nat. d'Hist. Natur., n. s., Ser. A, vol. 24, p. 190.

Thyropygus nigrolabiatus: Attems, 1936, Mem. Indian Mus., vol. 11, p. 259.

Notes: Thanks to the work of Carl, Attems, and especially Demange, this species is now well-known as regards its identity and gonopod structure. I can only add the verification, based upon the study of Newport's original type specimen in 1960, that Pocock's identification of his material (upon which later concepts of the species are founded) was entirely correct.

The distribution of *nigrolabiatus* remains very incompletely known. It has been recorded by Pocock from Madras (presumably the city) and by Carl from "Ceylon" without further particulars. Attems saw material from Madras and Rambha. Demange records specimens from the Sheveroy Hills, in Madras, from Pondichery (the French enclave), and

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[2] It is perhaps unnecessary to allude to the utter unreliability of locality labels attached to the material taken in the East Indies by several collectors during the past century. As more cohesive and limited generic groups emerge from the great catch-all "genera" of Attems and others, distributional anomalies are easy to detect, such as the records for Borneo for taxa otherwise known only from Java and Sumatra. In particular, diplopods taken by Ida Pfeiffer supposedly in Borneo appear to be chiefly Sumatran in origin; those (such as *Thyropygus brevicaudatus* Att.) collected by Plason and labeled "Borneo or Celebes" doubtless came from neither of those islands but from Sumatra or Malaya instead. Borneo has in fact an impressive harpagophorid fauna of its own, the genera largely endemic once the spurious records have been eliminated.

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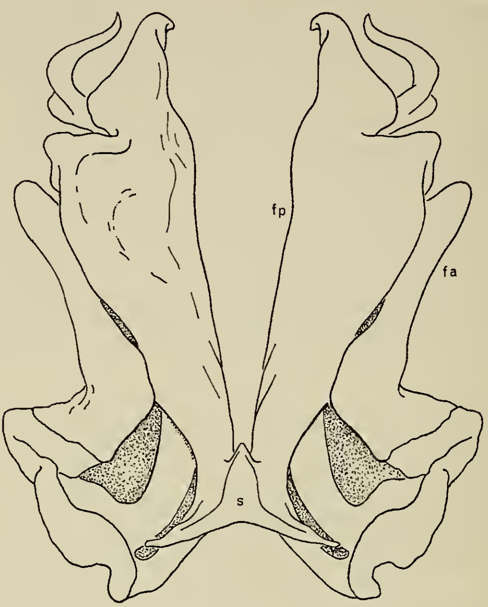

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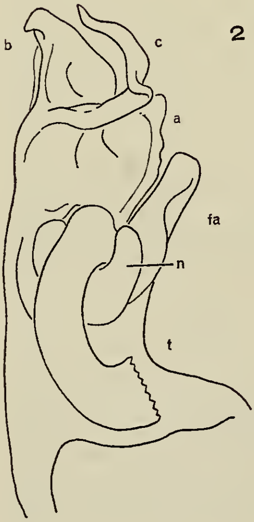

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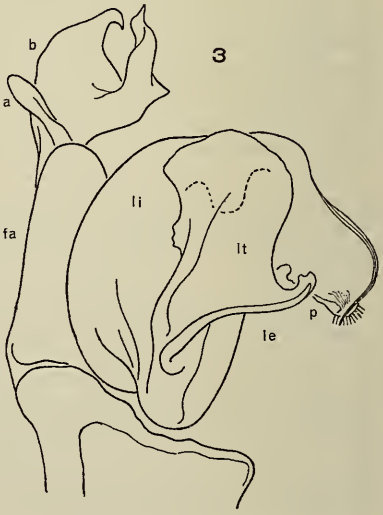

from Asansol, West Bengal. Interestingly, it was not encountered by Carl in his extensive collecting in Nilgiris, Palnis, and Anaimalais, suggesting perhaps a coastal distribution.

The presence of the species in Ceylon has not been confirmed, to the best of my knowledge. Demange's record for Asansol is of considerable interest as being far-removed from the Madras localities, and perhaps a restudy of the specimens will show subspecific differences in structure.

Phyllogonostreptus amballae (Chamberlin) new combination

Figures 1–4

Leiotelus amballae Chamberlin, 1921, Ann. & Mag. Nat. Hist., ser. 9, vol. 7, p. 67. (Holotype from "Amballa" [= Ambala, Punjab], India.)

Holotype: M.C.Z. 4856, adult male, fragmented, maximum diameter 8 mm. 57 segments.

Coloration altered by long preservation, at present light gray with the metasomites, legs, and antennae ferruginous brown, anal segment and paraprocts darker.

Head relatively small, of normal appearance, the epicranium finely striated, lower part of clypeus and labrum vertically rugulose, remainder of head smooth and polished. Mandibular stipes inflated laterally, produced ventrally into a prominent triangular, medially incurved lobe similar to that figured by Demange (1963: fig. 275–76) for *Fageostreptus hyatti.* Distal third of gnathochilarial stipes with a prominent subterminal oval nodosity. Antennae moderately long, basal articles glabrous, 2nd article longest; 4th and 5th short and nearly triangular in outline, 6th almost rectangular; 5th and 6th with prominent transversely reniform sensory area on the outer surface; 7th small, subhemispherical, its distal edge inturned between the four small sensory cones, and with a single small rounded sensory knob on its outer side.

Collum much wider than head, strongly narrowed down the sides behind level of mandibles but terminally enlarged and a prominent ventrally produced anterior corner present, surface of collum smooth and polished.

Body segments divided by a fine but sharply defined suture into a broad prozonite with numerous fine transverse striations and a shorter

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Figs. 1–3. *Phyllogonostreptus amballae* (Chamberlin). 1, gonopods (telopodites not shown), oral aspect. 2, left gonopod coxa, with basal part of telopodite, aboral aspect. 3, right gonopod, lateral aspect. Abbreviations: a, b, c, distal lobes and processes of the posterior coxal fold (inner paragonocoel); fa, anterior coxal fold (outer paragonocoel); fp, posterior coxal fold; le, external lamella of telopodite; li, internal lamella; lt, transparent lamella; n, coxal nodosity at end of gonocoel; p, distal process of external lamella; s, sternum; t, telopodite.

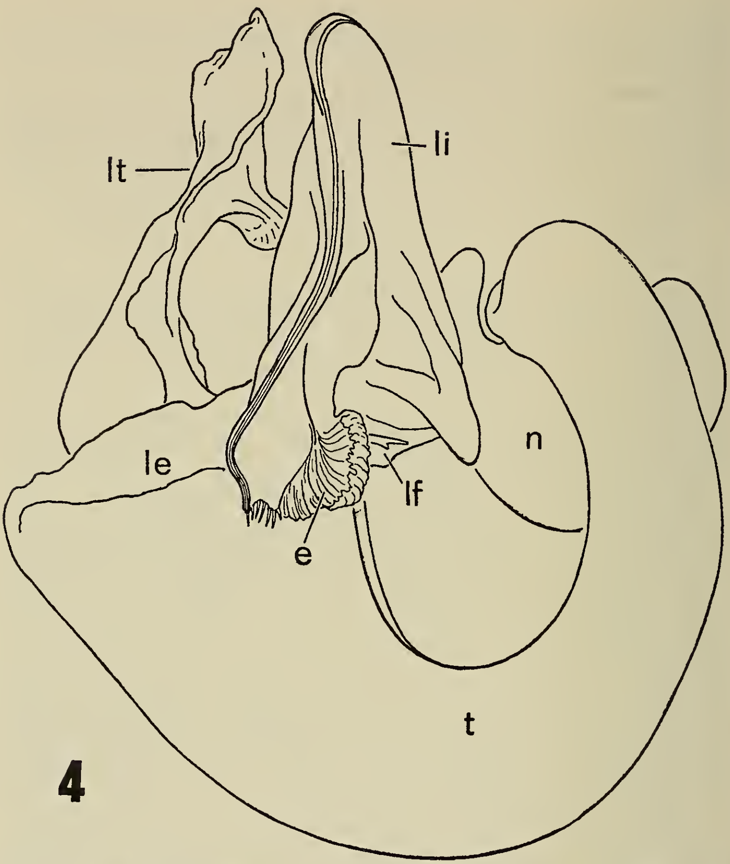

FIG. 4. *Phyllogonostreptus amballae* (Chamberlin), telopodite of right gonopod, aboral aspect. Abbreviations: e, hyaline cupulate lobe of internal lamella; lf, apical projection of intermediate distal process of the internal lamella; other abbreviations as in Figures 1–3.

metazonite, dorsally smooth, without punctations, becoming longitudinally striate below level of ozopores. Latter small, located in the metazonite, not in contact with the transverse suture.

Terminal segment produced into a short, upturned epiproct about equal in length to free edge of paraprocts, latter convex, smooth, without distinct free margination; hypoproct small, transverse, smooth, not fused with preceding segment.

Sterna smooth. Stigmata small, triangular, not extending laterally beyond level of distal end of coxae. Legs moderately long, the two distal podomeres visible beyond sides of body from above, coxae of posterior pair of legs of each segment somewhat enlarged, their mesial surfaces strongly flattened, the distocaudal region produced into a low blunt conical process. Legs virtually glabrous, ventral macrosetae 1-1-1-0-0-5 (tarsal setae usually 3 on the anterior side and 2 on the posterior), a prominent macroseta above the base of each tarsal claw. Ventral pads present on the postfemora and tibiae of all legs.

First and second pairs of legs removed (presumably by Chamberlin) and no longer with the specimen.

Gonopods (Figs. 1–4) generally similar to those of *P. nigrolabiatus* as illustrated by Demange (1961). Coxae fused basally with a small triangular sternal remnant (s). Anterior fold (fa) of coxa displaced laterally, exposing base of telopodite. Posterior fold (fp) enlarging distally from point of fusion with sternum, the apical fourth abruptly narrowed and set off as a subtriangular, hamate, caudally curved process (b); aboral side of distal third with an elongate, slender, sinuously flexed branch (c) considerably better-developed than that of *nigrolabiatus*. Aboral face of gonopod with a prominent subreniform nodosity (n) subtending the point of exit of the telopodite. Latter relatively short and massive (figs. 3, 4), the femoral division without trace of spine, the more distal extent curving proximad and thence laterad, laterally forming a broad semicircular blade divided into two major regions as in *nigrolabiatus*. Internal lamella (li) the larger and more prominent, and carrying the seminal groove; latter running out terminally on a small thin plate with six or seven small marginal spines, laterad to which is a cupulate, hyaline lobe (e); mesad to these structures the internal lamella is produced into an acute projecting lobe (d) and a small acuminate process (lf), the latter visible only in aboral aspect. External lamella smaller, ending in a truncate lobe (p), and produced ventrally into a prominent spatulate transparent lamella (lt) which carries a smaller retrorse secondary lobe on its median side.

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PROCEEDINGS
OF THE
BIOLOGICAL SOCIETY OF WASHINGTON

NOVAQUESTA TRIFURCATA, A NEW GENUS AND SPECIES OF THE FAMILY QUESTIDAE (ANNELIDA, POLYCHAETA) FROM CAPE COD BAY, MASSACHUSETTS[1]

By Katharine D. Hobson
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The little-known family Questidae Hartman (1966) has been known for only one genus and species, *Questa caudicirra* Hartman (1966), from Southern California. Polychaetes belonging to this family were found in some samples collected in Cape Cod Bay by the Biotic Census of the Systematics-Ecology Program. The specimens represent a new genus and species and are described below. I am grateful to Dr. Olga Hartman for the loan of specimens from the type lot of *Q. caudicirra* and for critically reading the manuscript. Discussions with Dr. D. G. Cook have been very helpful.

The family Questidae includes small slender worms that superficially resemble oligochaetes. Specimens of both of the presently known species have been collected from coarse sediments at shelf depths. The following characters are found both in *Questa* Hartman (1966) and *Novaquesta* new genus, and may represent family characters: Prostomium lacks appendages; peristomial segment achaetous; inconspicuous biramous parapodia, provided at least with a few thick bifid hooks and a few serrated capillary setae; pygidium slightly bilobed, anal cirri present or absent; reproductive structures

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[1] Contribution No. 197 from the Systematics-Ecology Program. This study was aided by Contract Nonr 3070(03) between the Office of Naval Research, Department of the Navy, and the Systematics-Ecology Program, Marine Biological Laboratory.

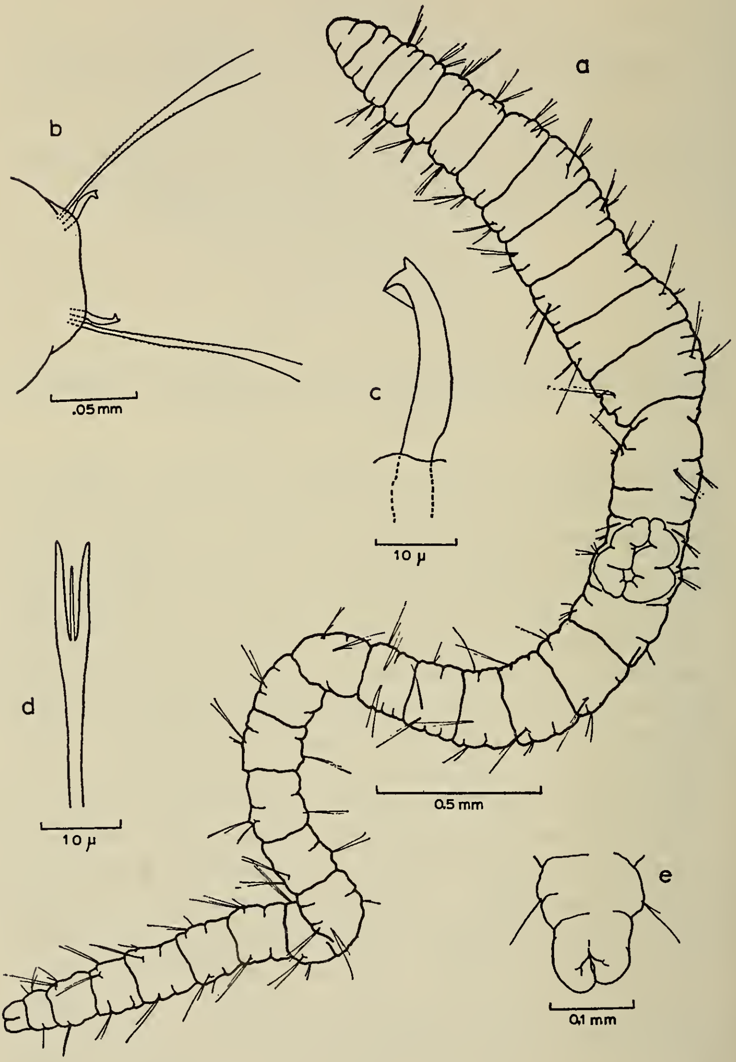

FIG. 1. *Novaquesta trifurcata* new species: a, dorsal view of male; b, posterior parapodium; c, bidentate seta from a median setiger; d, trifurcate seta from notopodium of third setiger; e, postero-ventral view of pygidium.

confined to a few segments. There is a ventral buccal organ. This structure has some phylogenetic value, so it is likely that the Questidae are allied to other Sedentaria possessing a ventral buccal organ (see Dales, 1962).

Novaquesta new genus

Type species: N. trifurcata new species. Gender: feminine.

Diagnosis: Small slender worms. First segment achaetous and biannulate; the remaining segments with inconspicuous biramous parapodia. Three kinds of simple setae: (1) serrated capillary setae; (2) thick bifid hooks; and (3) modified setae. Pygidium bilobed, without cirri.

Remarks: The presence of three kinds of setae and the absence of anal cirri distinguish *Novaquesta* from *Questa* Hartman.

Novaquesta trifurcata new species

Figs. 1a–e

Type material: This species is based on 100 specimens collected from sandy sediment in Cape Cod Bay. The holotype ♂, (USNM 40460), and 15 paratypes ♂ and ♀ (USNM 40461) come from station 1412-E4 (41°54.0′N, 70°8.6′W; 17 m depth; 11 June 1968) and are deposited in the Smithsonian Institution. Additional paratypes are deposited in the Gray Museum of the Systematics- Ecology Program (51; ♂ and ♀) and in the collections of the Allan Hancock Foundation of the University of Southern California (3; ♂ and ♀) and the collections of D. G. Cook (15; ♂) and of the author (15; ♂ and ♀). Seventy-two of these paratypes come from station 1412-E4, four from station 1412-Ep, two from station 1514-E1 (41°53.5′N, 70°10.7′W; 18 m depth; 19 January 1967), one from station 1530-E3 (41°53.0′N, 70°31.4′W; 12 m depth, 21 November 1967), and five from station 2130-E2 (41°48.0′N, 70°31.4′W; 7 m depth; 21 November 1967).

Etymology: The name refers to the nature of the modified setae.

Description: Mature worms are about 4–6 mm long and 0.3–0.4 mm wide (without setae), colorless (preserved in alcohol) and have about 30 setigers. Except for the inconspicuous parapodia, the body lacks appendages (Fig. 1a). The prostomium and first segment are somewhat biannulate. All parapodia, except occasionally the last one or two pairs, are biramous and have at least two kinds of setae (Fig. 1b). There are usually two serrated capillary setae and one thick bifid hook in each ramus. Occasionally there may be three or four capillaries or two bifid hooks in a ramus. The bifid hooks begin on the first setiger and consist of a main tooth at right angles to the shaft, a small apical tooth, and a faint connection between the shaft and the tip of the main tooth (Fig. 1c). There are one or two trifurcate setae in each of the first five to eight notopodia. The trifurcate setae consist of two well-defined prongs and a shorter, fainter, and more slender middle prong (Fig. 1d).

The anus is surrounded by two lateral lobes and lacks anal cirri (Fig. 1e).

The 12th and 13th segments of mature females contain several yolky eggs of various sizes. Usually the largest egg in a female is about 200 μ in diameter. The 13th and 14th segments of mature males are somewhat shortened and there is a dorsal folding of the body wall (Fig. 1a) in the region of the genitalia. This and other aspects of the anatomy of *N. trifurcata* are being studied by Dr. David G. Cook.

Distribution: Known only from Cape Cod Bay.

Remarks: The genitalia of the two specimens of *Q. caudicirra* that I have studied are also concentrated on a few segments. The female has a few large eggs in the 12th and 13th segments. The segments bearing the "dorsal fold" of the male are achaetous, and it appears that the "dorsal fold" is located on the 13th and 14th segments.

Questa caudicirra and *Novaquesta trifurcata* are distinguished by the following:

	Q. caudicirra	*N. trifurcata*
modified setae:	absent	trifurcate setae in anterior notopodia
branchiae:	dorsal cirriform branchiae in posterior setigers	absent
anal cirri:	2 pairs	absent
segments bearing "dorsal fold" of male:	setae absent	setae present

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PROCEEDINGS
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THE CORRECT NAME FOR THE LEAST SHORT-TAILED SHREW (*CRYPTOTIS PARVA*) OF GUATEMALA (MAMMALIA: INSECTIVORA)

By Charles O. Handley, Jr., and Jerry R. Choate
Smithsonian Institution, Washington, D.C., and Museum of Natural History, The University of Kansas, Lawrence

The nomenclatorial history of the least short-tailed shrew of Guatemala (a subspecies of *Cryptotis parva* Say) is complicated, and the name currently used for that animal is invalid. To summarize briefly, Gray (1843 and 1862) used a *nomen nudum, Corsira tropicalis,* for a shrew from Cobán, Guatemala. Tomes (1862) described a shrew from Dueñas (later corrected by Alston to Cobán), Guatemala, as *Sorex micrurus.* Alston (1877) observed that the names *Corsira tropicalis* Gray and *Sorex micrurus* Tomes represented the same taxon, and on Coues' advice placed them in the genus *Blarina. Sorex micrurus* Tomes 1862 thus became a secondary homonym of *Galemys micrurus* Pomel 1848 (= *Sorex talpoides,* now *Blarina brevicauda talpoides,* Gapper), a fact noted by Merriam (1895) when he revised the genus *Blarina.* After being validated by Merriam's description, *Blarina tropicalis* (later *Cryptotis tropicalis*) was used for the Guatemalan least short-tailed shrew until Miller (1924) disregarded the rule "once a homonym, always a homonym" and resurrected the name *Sorex micrurus* Tomes. This name has continued to be used to the present time in violation of the International Code of Zoological Nomenclature.

The nomenclatorial history of the Guatemalan least short-tailed shrew began with the publication of the following unsigned notice in the Proceedings of the Zoological Society of London (1843:79): "Various species of *Mammalia* from

Coban [*sic*], in Central America, were exhibited. These specimens were from Mr. J. Gray, who in a letter which accompanied them addressed to the Curator, observes that the collection contains the following species: viz. *Mustela frenata*, Licht., *Didelphys Quica, Heteromys Desmarestiana, Corsira tropicalis, Corsira Temlyas, Saccophorus Quachil, Mus Tazamaca,* and *Mus Teguina*; all of which species, with exception of the first two, are new to science."

Gray was correct in his assumption that most of his specimens represented unrecognized species, but he neglected to provide descriptions and the names he applied thus were *nomina nuda*. Subsequently, Gray and others described all the species that he initially had indicated were new.

As late as 1862 Gray (p. 115) continued to use the *nomen nudum, Corsira tropicalis*, for a skin and skull representing a least short-tailed shrew from Cobán, "S. America" [= Guatemala]. In the same year, Tomes (1862:279), reporting on a collection of mammals from Dueñas, Guatemala, described as new a least short-tailed shrew that he named *Sorex micrurus*. His material consisted of a skin with skull and two specimens in spirits. Regarding those specimens, R. W. Hayman (*in litt.*, 24 April 1958) reported: "We have the skin and skull here as B. M. 7.1.1.33. Thomas marked this number in the margin of our PZS in Tomes' description, and labelled the specimen co-type and lectotype. The main label on the skin is written by Thomas and gives Dueñas as the locality, no doubt on the strength of Tomes' statement in the heading on p. 278 ('Report of a collection of mammals made by Osbert Salvin, Esq., F.Z.S., at Dueñas, Guatemala; with notes on some of the species, by Mr. Fraser'). The collectors are named on this label as O. Salvin and L. Fraser. In addition to the label provided and written by Thomas, the skin also has a small round card label bearing the following, 'Guatemala 2778 Fraser 1859' on one side, and on the reverse 'S. microurus. Skull.' We should not think this is likely to be the original collector's label, but probably one put on by Tomes. The skull is also labelled as the skin, with Thomas' handwriting.

"There are two more skins in the Tomes collection, nos.

7.1.1.34 and 35, both labelled Cobán. Neither has any collector's name on the label but according to the register [both] were received from Leadbeater, a dealer. Thomas labelled one of these 'Corsira tropicalis—one of the original series—on a B. M. stand [indicating that the specimen had been mounted for exhibit]. Received with Tomes' Collection.'"

Alston (1877:446) finally began to unravel the mounting, but as yet relatively unnoticed, confusion: "I may here observe that the Shrew named *Corsira tropicalis* by Gray, at the same time as the above [*Corsira temlyas* Gray = *Sorex veraepacis* Alston], seems to be the same as that subsequently described as *Sorex micrurus* by Mr. Tomes (P. Z. S., 1861 [*sic*], p. 279). Dr. Coues informs me that it proves to belong to the division of *Blarina*, which have thirty-two [*sic*] teeth; but whether it is distinct from some of the described North-American species remains to be ascertained. . . .

"*Corsira tropicalis* [Gray] = *Blarina micrura* (Tomes). . . ."

A note by Coues (1877:638) clarified Alston's remarks:

"This [*Blarina micrura*] is a 30-toothed *Blarina* (subg. *Soriciscus*), very closely related to United States species like *B. cinerea*, *B. exilipes*, and *B. berlandieri*, if really distinct.

"A short time ago I sent a number of Shrews to my valued correspondent Mr. E. R. Alston, of London, begging him to compare them with the types of certain species preserved in the British Museum.

"Among the Shrews sent to him was a specimen [*Cryptotis orophila*, USNM 38474] from Costa Rica (coll. J. Carmiol), of which he states:—'I have little or no doubt that it is the same as *Sorex micrurus* Tomes. . . I have not access to Mr. Tomes's types, but I have examined another of Mr. Salvin's specimens, in spirits, and have no doubt your animal is the same. I also believe that Gray's *Corsira tropicalis* is the same, though the types look darker from dirt.'"

Next, Alston (1879:56) corrected the type locality of Tomes' *Sorex micrurus*: "the species was described by Mr. Tomes from specimens collected by Mr. Salvin near Coban [*sic*] (not Dueñas as stated by Mr. Tomes), one of which was picked up dead in a forest path." Commenting on this statement, R.

W. Hayman (*in litt.*, 24 April 1958) noted that: "since Alston was presumably in touch with Salvin sufficiently to be able to quote the circumstances of the finding of one of the specimens, it seems likely that his reference to Cobán rather than Dueñas is the correct one."

From 1877 until 1911, *Sorex micrurus* Tomes was included in the genus *Blarina* as a secondary homonym of *Galemys micrurus* Pomel, in turn a subjective synonym of *Sorex talpoides* [currently *Blarina brevicauda talpoides*] Gapper. The homonymy was detected by Merriam (1895:21):

"When *Sorex micrurus* Tomes (1861 [*sic*]) was transferred to the genus *Blarina* it became preoccupied by *Galemys* (*Brachysorex*) *micrurus* Pomel (1848), which is a synonym of *Blarina brevicauda* (Say), and therefore is not available. No other name seems to have been proposed for the species except *tropicalis* Gray, which is a *nomen nudum.* The name, however, is peculiarly appropriate, the species being closely restricted to tropical America; hence I here reinstate it to replace *micrurus*, but it will have to date from the present paper."

Merriam, in redescribing *tropicalis*, listed Cobán, Guatemala, as the type locality and referred to two specimens measured by Tomes (*loc. cit.*) as the "original type specimens."

In their early checklists, Miller and Rehn (1901:247) and Miller (1912:25) regarded *Blarina tropicalis* Merriam as the proper name for the Guatemalan least short-tailed shrew. However, in his 1924 checklist Miller (p. 32), by *lapsus* or perhaps because of the removal of 30-toothed shrews from the genus *Blarina*, reverted without comment to *Sorex micrurus* Tomes as the valid name for this shrew. All subsequent authors [see particularly Cabrera (1925:134), Hall and Kelson (1959:62), and Goodwin (1969:41)] have used *Cryptotis micrura* as the name for the Guatemalan least short-tailed shrew.

Such usage, however, is contrary to both the International Rules of Zoological Nomenclature, 1905, and the International Code of Zoological Nomenclature, 1961. Article 57 of the Code states: "The Law of Homonymy applies to species-group names originally published in (primary homonyms), or later brought together in (secondary homonyms) the same genus or collective group, except as noted in Article 59c." Article 59c states: "A name rejected after 1960 as a secondary homonym is to be restored as the valid name whenever a zoologist believes that the two species-group taxa in question are not congeneric, unless it is invalid for other reasons." The only potential problem of interpretation of Article 59c in this instance involves whether rejection of the name *micrura* as a secondary homonym dates from 1895 (Merriam, *loc. cit.*) or, as a consequence of its erroneous revival, from the present paper. But, as we have clearly shown, rejection of the name *micrura* dates beyond any reasonable doubt from Merriam's precise statement to that effect, and Article 59c thus does not apply.

In accordance with the Code, the name *micrura* must be rejected if it was a homonym when it was included in the genus *Blarina.* It appears to us, therefore, that the fundamental question as to the fate of the name *micrura* relates to the correct generic identity of G[*alemys*]. *micrurus* Pomel.

The problem of the identity of G[*alemys*]. *micrurus* traces back to 1842, when De Kay (p. 17) redescribed *Sorex dekayi* Bachman, erroneously attributing to it four upper unicuspids and a total of 30 teeth. He stated (p. 18) that:

"The specimens from which our description is taken, were obtained from Queens county, and were described and exhibited before the Lyceum of Natural History nearly fifteen years ago. I then gave it the name of *concolor*, but the description was never published. Dr. Bachman [1837:377], who examined the same specimen, gave the present name [*Sorex dekayi*], which, by the just and rigid rule of priority, must be preserved."

Pomel (1848:249) included *Sorex dekayi* De Kay and *Brachysorex harlani* Duvernoy in section *Brachysorex* of his genus *Galemys*, which was characterized in part by four upper unicuspids and a total of 30 teeth. Presumably he would have included *Sorex dekayi* Bachman, with five upper unicuspids and a total of 32 teeth, in the genus *Sorex*. Owing to De Kay's faulty description, Pomel therefore seemingly believed that the names *Sorex dekayi* Bachman and *Sorex dekayi* De Kay applied to two different kinds of shrews (and not to the same shrew, as we have shown). Because of this conflict, he renamed *Sorex dekayi* De Kay as *Galemys micrurus.*

It thus appears certain to us that the names *Sorex dekayi* Bachman, *Sorex dekayi* De Kay, and *Galemys micrurus* Pomel were applied not only to the same kind of shrew but to the same specimens, and that all are synonymous with *Sorex talpoides* Gapper. Merriam's (*loc. cit.*) contentions that *Sorex micrurus* Tomes was preoccupied and that the proper name for the Guatemalan least short-tailed shrew was *Blarina tropicalis* Merriam were valid statements of fact. Inasmuch as there is no other available name for *tropicalis*, Article 23b concerning *nomina oblita* does not apply in this instance, and the pertinent synonymy of this shrew therefore should stand as follows:

Cryptotis tropicalis Merriam

1843. *Corsira tropicalis* Gray, Proc. Zool. Soc. London, p. 79, *nomen nudum.*

1862. *Sorex micrurus* Tomes, Proc. Zool. Soc. London, 1861: 279. Lectotype—British Museum (Natural History) no. 7.1.1.33; skin and skull; obtained in 1859 by O. Salvin and L. Fraser; Cobán, Alta Verapaz, Guatemala. Not *G*[*alemys*]. *micrurus* Pomel, Arch. Sci. Phys. Nat. (Geneva), 9:249, 1848 (= *Sorex talpoides* Gapper).

1877. *Blarina micrura*, Alston, Proc. Zool. Soc. London, p. 445.

1895. *Blarina tropicalis* Merriam, North American Fauna, 10:21, a renaming of *Sorex micrurus* Tomes, preoccupied.

1911. *C*[*ryptotis*]. *tropicalis*, Miller, Proc. Biol. Soc. Washington, 24:221.

1924. *Cryptotis micrura*, Miller, U.S. Nat. Mus. Bull. 128, p. 32.

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A REVISION OF THE RED-RUMPED CACIQUE, *CACICUS HAEMORRHOUS* (AVES: ICTERIDAE)

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The Red-rumped Cacique (*Cacicus haemorrhous*) is a moderately large, colonial, arboreal icterid, and type species of a Neotropical genus currently considered to include nine species (Meyer de Schauensee, 1966). It is widely distributed in northern South America east of the Andes, from Colombia south to northern Argentina. Its nearest relative is apparently the Scarlet-rumped Cacique (*C. uropygialis*), with which it is (almost?) completely allopatric, and which it resembles to the extent that the two species have occasionally been confused in the literature. The only locality from which both species have been reported, as far as I can discover, is Baeza, eastern Ecuador (*C. "affinis" = haemorrhous*, Goodfellow, 1901: 478; *C. uropygialis*, Chapman, 1926: 694). As stated by Hellmayr (1937: 32), it remains to be seen whether both forms are found together in the same altitudinal zone; collections from "Baeza" may have originated from anywhere within an altitudinal range of one to two thousand feet and possibly more (Chapman, 1926: 704).

Zimmer (1930: 433) and Hellmayr (1937: 32) have listed several characters useful in separating *Cacicus haemorrhous* and *C. uropygialis,* involving bill shape, plumage color, and wing formula. There is an additional character overlooked by both of these authors. In *uropygialis* the crown feathers are elongated into an incipient crest; even in the small subspecies *C. u. pacificus* the crown feathers are actually longer than in the much larger *C. haemorrhous.* In view of these morphological differences and the uncertainty as to possible sympatry, I prefer to keep *haemorrhous* and *uropygialis* as separate species for the time being.

Hellmayr (1937) and other modern authors have unanimously recognized two subspecies of *Cacicus haemorrhous.* For the northern race, Hellmayr gives the ranges as "French, Dutch, and British Guiana; southern Venezuela (Orinoco Valley and its tributaries); southeastern Colombia (Caquetá); eastern Ecuador; northeastern Brazil, south to the Pará region and (?) west to the Rio Madeira (Humaytá)." The queried Rio Madeira record will be discussed beyond. The second subspecies, according to Hellmayr, inhabits "Wooded region of eastern Brazil, from Pernambuco, Bahia, and Minas Geraes south to Santa Catharina; Paraguay and the adjoining parts of Argentina (Chaco and Misiones)."

Although, as indicated above, there has been general agreement that there are two subspecies of *C. haemorrhous*, there has been a long history of confusion as to the characters distinguishing these, and the correct names each should bear. The species name is based on *Oriolus haemorrhous* Linnaeus, 1766, from "Brasilia, Cayana." The next oldest name for this species is *Cassicus affinis* Swainson, 1834, from "Brazil." Cassin (1867: 64) applied Linnaeus' name to the birds of southeastern Brazil and Swainson's name to those of Cayenne, without discussing type localities. Cassin considered *affinis* Swainson to be "but a doubtful species," but recognized it provisionally, chiefly on the authority of Bonaparte (1853). Bonaparte's description is quite clearly based, not on the population of Cayenne, but on that of the Amazonian region, to be discussed beyond.[1] Sclater (1883: 161; 1886; 324) followed Cassin in using the name *haemorrhous* for the birds of southeastern Brazil and the name *affinis* for those of "Guiana,

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[1] Bonaparte clearly misapplied the Linnaean name *haemorrhous* as well, but *not* to the "east-Brazilian form" as stated by Zimmer (1930: 433). Bonaparte specifically stated that he was using the name *haemorrhous* for the species of *Cacicus* (then spelled *Cassicus*) represented in the collection upon which he was reporting, namely, that of Delattre from Mexico and Nicaragua. He further states that, of the three species he recognized (*haemorrhous, affinis,* and *uropygialis* from "Nouvelle Grenade"), the first was "l'espèce la plus petite. . ." Bonaparte's reference to *C. haemorrhous* should thus be transferred to the synonymy of the small red-rumped cacique found in Nicaragua, now known as *C. uropygialis microrhynchus* (Sclater and Salvin).

Cayenne, and Lower and Upper Amazonia." Sclater was less uncertain than Cassin about the *characters* of the two "species," describing (1886: 324) *haemorrhous* as "dull brownish black" and *affinis* as "glossy black." He further alluded to the "larger and thicker bill" of adult males of *affinis*, pointing out that Bonaparte had also mentioned this character. Six of the nine specimens of "*affinis*" then in the British Museum came from the Guianas, one from Pará (Brazil), one from Sarayacu (eastern Ecuador), and one from "Western Ecuador," a locality generally conceded by later authors to be erroneous. Thus Sclater's allocation of "*affinis*" to "Lower and Upper Amazonia" in the "Catalogue of Birds in the British Museum" (1886) would have been based on his one male from Pará and one from Sarayacu, although he had presumably also seen the specimens from Chamicuros, Amazonian Peru, in the Bartlett Collection (Sclater and Salvin, 1873). Sclater mentioned no difference between Guianan and Amazonian specimens.

The next step in the nomenclatorial progression was taken by Berlepsch (1889: 300), who stated flatly that the species of Cayenne and Guiana must take the name *C. haemorrhous* Linnaeus, with *affinis* Swainson as a synonym. No reason for this change was given. Sclater (1883: 161) had considered "Brazil" the type locality of *haemorrhous* because Linnaeus had mentioned this locality first, and he had therefore used *affinis* Swainson for the "Guianan form" in spite of the fact that Swainson's bird had also come from "Brazil." Berlepsch's synonymizing of *affinis* with *haemorrhous* left, by his reckoning, the bird of southeastern Brazil without a name. He therefore supplied the new name *C*[*assicus*] *aphanes*, with the type locality Santa Catharina, Brazil.

In this same paper, Berlepsch described as a new species *Cassicus pachyrhynchus*, based on two specimens from "Tarapoto (Cumbase)," Río Huallaga, Peru. He compared these birds with Guianan specimens of *haemorrhous*, and with *C. uropygialis* from unspecified localities. Hellmayr (1937: 33), without specifying whether he had examined the types of *pachyrhynchus*, placed this name in the synonymy of *C. u.*

uropygialis. One might think from the wording of his footnote on p. 32 that Hellmayr did *not* see the types, since he makes much of the fact that an examined specimen from Cueva Seca, Río Tocache, was "almost topotypical *pachyrhynchus*" in the course of a discussion as to whether *uropygialis* could be divided into northern (*uropygialis*) and southern (*pachyrhynchus*) races (an idea he rejects). Yet he *also* mentions "an immature bird from Tarapoto (Cumbase)" without stating whether this was one of the cotypes of *pachyrhynchus,* and calls attention to the fact that this Tarapoto bird "resembles *C. h. affinis* in wing formula, though otherwise it is a typical *uropygialis.*" We will return later to a discussion of the name *pachyrhynchus* Berlepsch.

Berlepsch's application of *haemorrhous* Linnaeus to the form of the Guianas was stabilized and justified by Hellmayr (1937: 30), who stated that the type specimen, in the Réaumur collection, came from Cayenne. For the cacique of southeastern Brazil, Hellmayr followed the suggestion of Zimmer (1930: 433) that this population should bear the name *affinis* Swainson (formerly applied to the Guianan bird in spite of the type locality "Brazil"). Zimmer reasoned that, although Swainson's plate was "somewhat equivocal," Swainson had visited those parts of Brazil where "*aphanes*" occurs, but *not* "those parts of the same country inhabited by '*haemorrhous*' which, at that time, were rather inaccessible." Hellmayr (1937: 29), after an unsuccessful attempt to locate the type specimen of *affinis,* decided that Swainson's plate, poor as it is, "agrees much better with the Brazilian than with the Guianan form." Hellmayr therefore adopted Zimmer's usage of *affinis* for the "dull-colored form of eastern Brazil," with *aphanes* Berlepsch as a synonym. Hellmayr cited simply "Brazil" as the type locality of *affinis*; the name was finally fixed as the correct name for the birds of southeastern Brazil when Pinto (1944: 554) restricted the type locality to eastern Baía.

As of Hellmayr (1937), therefore, two subspecies of *Cacicus haemorrhous* were recognized, with names finally stabilized as *C. h. haemorrhous* (Linnaeus), type locality Cayenne, and *C. h. affinis* (Swainson), type locality eastern Baía, Brazil.

This has been the accepted treatment in the standard literature since Hellmayr (see, for example, Blake, 1968: 145).

As long ago as Bonaparte (1853), descriptions of a cacique had appeared, matching neither the Guianan nor the southeast Brazilian population of *haemorrhous.* Bonaparte's description was as follows: "Grande; la couleur rouge étendue; le bec droit, mais très-dilaté, énorme à la base." This description appears under the heading "*C. affinis*, Sw. (crassirostris, *Aliq.*)" (slightly mistranscribed in Hellmayr's [1937: 30] synonymy of *haemorrhous*).

I am not certain what Bonaparte meant in his use of the term "*Aliq.*" I would deduce, from related words in Latin dictionaries, that the intended meaning was "of some," "of others," "sometimes known as," or the like. However, I can find no earlier usage of the name *crassirostris.* If this interpretation of "*Aliq.*" is correct, then the name *crassirostris* Bonaparte, having been first published as a synonym and never adopted as the name of a taxon, is unavailable under article 11 (d) of the International Code of Zoological Nomenclature (1964). If, on the other hand, "*Aliq.*" had some such implication as "or, more properly. . ." or "a better name would be. . ." then Bonaparte's *crassirostris* is a substitute name for, and a pure synonym of, *affinis* Swainson, *even though* Bonaparte's *description* was not of the bird called *affinis* by Swainson, according to article 72 (d) of the Code. In short, the name *crassirostris* Bonaparte is not available except as a junior objective synonym of *affinis* Swainson. Hellmayr was therefore in error in placing the reference to Bonaparte in the synonymy of *haemorrhous* Linnaeus.

Attention was called earlier in the present paper to Hellmayr's tentative allocation to *C. h. haemorrhous* of a specimen from Humaytá, Rio Madeira, Brazil. The wording of Hellmayr's footnote (p. 31) is as follows: "Birds from the Pará region agree with a Guianan series. A single adult male from the Rio Madeira (Humaytá), however, is much larger (wing, 209; tail, 125; bill, 40), and has a much stronger, more powerful bill. While the significance of this divergency remains to be determined by additional material, it seems well to state that the bird is quite different from *C. u. uropygialis*, having another wing formula, more glossy plumage, the red of the rump deeper in tone, as well as much more extended toward the back, and the culminal ridge slightly flattened in the middle."

Comparison of Bonaparte's description with that of Hellmayr immediately raises the suspicion that Bonaparte had before him, misidentified as *affinis*, a specimen similar to that from the Rio Madeira.

The "additional material" to solve the problem of the Rio Madeira bird, called for by Hellmayr, is not only available now but was available when Hellmayr wrote. Specimens in Carnegie Museum and elsewhere show clearly that a third, highly distinctive subspecies of *Cacicus haemorrhous* inhabits the Amazonian region of Brazil and Peru. This subspecies differs in several ways from either *C. h. haemorrhous* or *C. h. affinis*, but its principal character is its massive bill, swollen at the base of the culmen—or, in Bonaparte's apt words, "le bec droit, mais très-dilaté, énorme à la base."

We have already seen that the name *crassirostris* Bonaparte, although probably intended for a specimen of this Amazonian race, cannot be used for it because of nomenclatural technicalities. No other name listed in Hellmayr's synonymies for the species *Cacicus haemorrhous* is applicable, and it would appear at first sight that a new name is needed for the Amazonian subspecies. This is not, in fact, the case.

In reading the original description of *Cassicus pachyrhynchus* Berlepsch (placed by Hellmayr, as noted earlier, in the synonymy of *Cacicus u. uropygialis*), I was struck by wording that did not, to me, appear descriptive of *uropygialis* but rather of a bird similar to the large-billed Amazonian population of *haemorrhous*. Berlepsch stated that the two specimens of his new species differed from specimens of *haemorrhous* "durch auffallend starken, breiten und hohen Schnabel. Derselbe ist fast um ein Drittel stärker als bei Guiana-Vögeln. . ." He went on to say that the dull color and restricted size of the red rump patch were reminiscent of *C. uropygialis*, whereas Hellmayr had called attention to the *deeper* red and more *extended* rump patch of the Rio Madeira specimen. Berlepsch suspected that the "synonym" *crassirostris* cited by Bonaparte might apply to his new species, but rejected this name as not provably applicable.

The measurements cited by Berlepsch for his two unsexed specimens indicated that his types were almost certainly a male and a female, these caciques being strongly sexually dimorphic in size. The wing length of the presumed male, 177½ mm., seemed too great for *uropygialis* (for which Hellmayr had given wing measurements of males as 153, 157, 160, 160, and 165 mm.), but yet too small to match the Rio Madeira specimen with a wing length of 209 mm.

I was permitted to borrow the cotypes of *pachyrhynchus* from the Senckenberg Museum in Frankfurt am Main. It took no more than a glance to tell that these specimens do, indeed, represent the Amazonian population of *Cacicus haemorrhous,* and are not *C. uropygialis.* Their bills exactly match specimens from Amazonian Brazil in Carnegie Museum. The color and size discrepancies alluded to above are explained by the fact that both specimens are first-year birds, as suspected by Berlepsch when he characterized his types as "Zwei anscheinend nicht ganz ausgefärbte Vögel." First-year birds of this species are not only duller in color, but often markedly smaller than older birds.

The three subspecies of *Cacicus haemorrhous* are summarized below.

Cacicus haemorrhous haemorrhous (Linnaeus)

Figs. 1 and 2, right

Oriolus haemorrhous Linnaeus, Systema Naturae, 12th ed., 1, 1766: 161 ("Brasilia, Cayana"; type from Cayenne, *fide* Hellmayr, 1937: 30).

Highly iridescent with blue reflections, both above and below; bill slender, culmen not swollen at base, but tending to be ridged.

Measurements: 28 adult males, wing (flat) 168–187.5 (175.8); tail 100–115 (105.9); culmen from base 34–41 (38.2); width of bill at posterior end of nostril 7–10.5 (8.5). 3 adult females, wing 134–142 (138.0); tail 83–92 (87.5); culmen 32–34.5 (33.7); width of bill 8–9 (8.5).

Range: The Guianas, northeasternmost Brazil in Amapá, southeastern Venezuela in Bolívar and Amazonas, and the Orinoco drainage of east-

Fig. 1. Adult males of *Cacicus haemorrhous*, dorsal view. Left to right: *C. h. affinis*, Arroyo Urugua-i, Misiones, Argentina; *C. h. pachyrhynchus*, Villa Braga, Rio Tapajos, Brazil; *C. h. haemorrhous*, Pied Saut, French Guiana.

ern Colombia. The specimen from the Sierra Macarena, Meta, Colombia (FMNH: see acknowledgements for explanation of abbreviations) listed by Blake (1962: 107), a first-year male, matches specimens of the same age class from Venezuela and Cayenne. It is the southwesternmost example I have seen of typical *haemorrhous*. Intergradation with *pachyrhynchus* is discussed below, under that subspecies.

Cacicus haemorrhous pachyrhynchus (Berlepsch)

Figs. 1 and 2, center

Cassicus pachyrhynchus Berlepsch, Journal für Ornithologie, 37, 1889: 299 ("Tarapoto [Cumbase]" = San Pedro de Cumbase, near Tarapoto, San Martín, Peru).

Large, with culmen conspicuously swollen at base; color very deep bluish black, but not conspicuously glossy as in *haemorrhous*, and having, in good light, a faintly purplish sheen; scarlet rump patch extending, on the average, more anteriorly than in other races.

Measurements: 13 adult males, wing 183–210 (193.5); tail 107–125.5 (116.5); culmen 38–42 (40.4); width of bill 11–14 (12.7). 6 adult

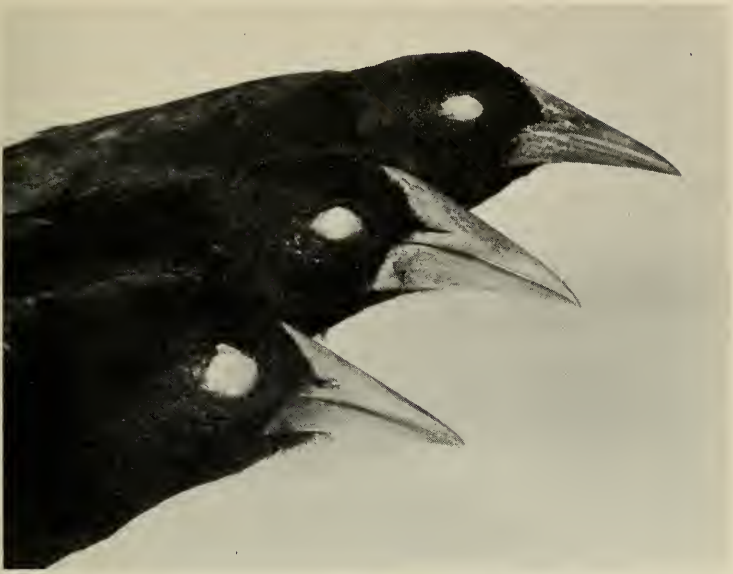

FIG. 2. Same specimens as figure 1, lateral view.

females, wing 139.5–149 (146.6); tail 89–98 (95.2); culmen 33–35.5 (34.4); width of bill 10–12 (11.4).

Range: The Amazon and its southern tributaries in Brazil and Peru. As Meyer de Schauensee (1966) omits Peru from the range of *Cacicus haemorrhous*, it would be well to place on record here the Peruvian localities from which this species has been taken. Typical specimens of *pachyrhynchus* have been examined from: the type locality, San Pedro de Cumbase, San Martín (NMS); Oroza (below Iquitos on the Amazon), Loreto (AMNH); Santa Rosa, upper Ucayali, Loreto (AMNH); Balta, Río Curanja, Loreto (LSU—see Lowery and O'Neill, 1965, for details of this locality, which is also the type locality for a newly described species of the same genus, *Cacicus koepckeae*). The record from Chamicuros, Loreto, listed under *C. haemorrhous* by Sclater and Salvin (1873) and under *C. affinis* by Sclater (1883) was placed in the synonymy of *C. uropygialis* by Hellmayr, with no indication as to whether he had examined the specimens. Judging from the locality, they were almost certainly *C. h. pachyrhynchus*. Hellmayr's listing of this reference under *C. uropygialis*, as well as his synonymizing of *pachyrhynchus* with the latter species, appears to have been based on nothing more than the assumption that no form of *C. haemorrhous* occurred in Peru, and that therefore all caciques from that country must be referred to *C. uropygialis*. I have been unable to verify the identity of the Chamicuros specimens;

the Bartlett collection is not in the British Museum (Natural History), nor is there any record there of what became of Bartlett's specimens.

Specimens from Peru north of the Amazon and Marañon (confluence of the Ríos Napo and Curaray [AMNH]; and Huachi, Río Pastaza [MLZ]) are intermediate between *haemorrhous* and *pachyrhynchus*. These two Peruvian localities were in Ecuador prior to the settlement in 1942 of the Oriente border dispute. Also intermediate between *haemorrhous* and *pachyrhynchus* are specimens from the Amazon drainage of southeastern Colombia in Caquetá and Vaupes (AMNH). Also probably intermediate, on geographic grounds, is the specimen from Sarayacu, Ecuador, in the British Museum (Natural History).

Specimens from eastern Pará, Brazil (CM, AMNH) tend to have the iridescence of *haemorrhous*, but, like the northern Peruvian specimens, are larger and have the base of the culmen more swollen, approaching *pachyrhynchus*. Measurements of Pará specimens are as follows: 6 adult males, wing 186–195 (191); tail 108.5–115 (111.6); culmen 37–39.5 (38.3); width of bill 10.5–11.5 (10.8). 4 adult females, wing 136–140 (138.3); tail 86.5–99 (90.9); culmen 31.5–33 (32.3); width of bill 9–11 (9.8).

No specimens have been examined from Brazil north of the Rio Solimões (Amazonas) and south of the Guianas; this is probably a zone of intergradation between *haemorrhous* and *pachyrhynchus*. Specimens from the Amazon drainage of northern Bolivia (a country also omitted from the range of this species by Meyer de Schauensee [1966]) are nearest true *pachyrhynchus*, but show some approach to *affinis* in their somewhat dull color (upper Río Beni, Beni [YPM]; Río Yapacani, Santa Cruz [CM]).

Cacicus haemorrhous affinis (Swainson)

Figs. 1 and 2, left

Cassicus affinis Swainson, Ornithological Drawings, pt. 1, 1834: pl. 2 [not seen] ("Brazil," restricted to eastern Baía by Pinto, 1944: 544).

C[*assicus*] *affinis*, Sw. (crassirostris, *Aliq.*) Bonaparte, Comptes Rendus Acad. Sci. Paris, 37, 1853: 833 (no locality given).

C[*assicus*] *aphanes* Berlepsch, Journal für Ornithologie, 37, 1889: 300 ("Sta. Catharina" = Santa Catharina, Brazil).

Similar to *C. h. haemorrhous* in wing length; tail longer, more like *C. h. pachyrhynchus*; base of culmen not swollen, culmen not ridged; plumage moderately iridescent, with blue gloss, above, but dull and brownish below with no gloss or sheen of any kind; rump patch averaging more restricted than in *haemorrhous*, and more orange, less reddish scarlet; adult females apparently relatively seldom develop the full brightness of the rump patch as exemplified by AMNH 775573, Arroyo Urugua-i, Misiones, Argentina.

Measurements: 20 adult males, wing 165–185 (175.2); tail 109.5–

122 (115.9); culmen 34–39 (36.3); width of bill 7–8.5 (8). 11 adult females, wing 137–142 (139.8); tail 97.5–101 (99.9); culmen 29.5–32 (30.9); width of bill 7–8 (7.5).

Range: Blake (1968: 145) gives the range of this form as follows: "Eastern and south-central Brazil (Pernambuco, Bahia, Goiás, and southeastern Mato Grosso south to Santa Catharina, Paraguay, and northeastern Argentina (Chaco, Misiones)." Pinto (1944: 554) considered as "muito duvidosa" the locality "Pelotas, Rio Grande do Sul, Brazil" as published by Sclater (1886: 324). Pelotas is in southeastern Rio Grande do Sul, an area from which *Cacicus haemorrhous* is, indeed, probably absent. That the species almost certainly occurs in *western* Rio Grande do Sul is indicated by a specimen taken at Garruchos, Corrientes, Argentina, 20 May 1961 (CM), just across the Río Uruguay from the town of the same name in Rio Grande do Sul, Brazil. Incidentally, the Argentine portion of the range of this species as given by Meyer de Schauensee (1966: 432) should read "Misiones and Corrientes *westward* [not eastward] to eastern Formosa, eastern Chaco and northern Santa Fe."

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BLENNIUS ANTHOLOPS, NEW DEEP-WATER FISH, FROM THE GULF OF GUINEA, WITH COMMENTS ON THE BATHYMETRIC DISTRIBUTION OF THE FAMILY BLENNIDAE

By Victor G. Springer and William F. Smith-Vaniz
Smithsonian Institution and University of Miami Rosensteil School of Marine and Atmospheric Sciences[1]

A single specimen of an undescribed blenniid fish was obtained during the R/V Pillsbury Deep-Sea Biological Expedition to the Gulf of Guinea, 1964–1965 (Voss, 1966). The specimen was obtained at a depth of 101–128 meters and is noteworthy as few species of blenniids are known to occur at depths greater than 25 meters.

There are only two other blenniids besides the new species that are known to occur at depths of 100 meters or more. These are the Mediterranean *Blennius ocellaris* Linnaeus and its close relative, *B. normani* Poll, from the west African coast. Field data for specimens in the collections of the Division of Fishes, U.S. National Museum of Natural History, indicate depths of capture as great as 400 meters and commonly over 100 meters for *B. ocellaris*, and depths of capture to 200 meters for *B. normani*. All three of the deep-dwelling species are members of the least specialized tribe of the Blenniidae, the Blenniini (subfamily Blenniinae). Of the other two tribes in the Blenniinae, no species of the Omobranchini are known from depths greater than a very few meters (probably all less than 5 meters), and the deepest occurring species of the Salariini known is an undescribed species of *Ecsenius* McCulloch observed by Springer at a depth of 36.6 meters in the Gulf of

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[1] Contribution No. 1180 University of Miami, Rosenstiel School of Marine and Atmospheric Sciences.

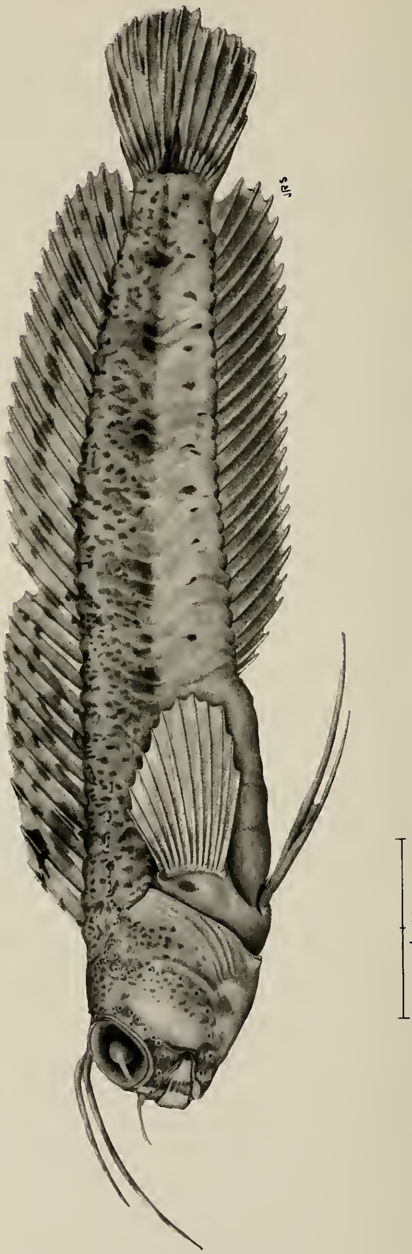

Fig. 1. *Blennius antholops.* USNM 204644, holotype, 53.6 mm SL, drawn by W. R. Schroeder.

Aqaba. Kuthalingam and Menon (1965) reported obtaining two specimens of *Xiphasia setifer* (Swainson) from a trawl haul made at a depth of 50–54 meters off the west coast of India. This depth is the deepest known for a species of the other blenniid subfamily, Nemophidinae. Most records of *Xiphasia* are based on specimens either washed up on shore or caught under a night light. No specimens are known to have been collected from shallow reefs, and it may be that *Xiphasia* commonly frequents fairly deep water. Springer observed an individual of the nemophidine *Meiacanthus nigrolineatus* Smith-Vaniz at a depth of 36.6 meters in the Gulf of Aqaba.

Blennius antholops new species

Figures 1 and 2

Holotype (*only known specimen*): USNM 204644, male, 53.6 mm SL, Gulf of Guinea from 40′ otter trawl haul extending from 5°19′N and from 4°45′ to 4°48′E, depth from 128 to 101 m, 12 May 1965, R/V *Pillsbury* station P-236, originally cataloged as UMML 21381.

Description (osteological terminology is that of Springer, 1968): Dorsal fin rays XII,20; fin notched between spines and segmented rays, attached by membrane to caudal peduncle. Anal fin rays II,22; spines not enveloped in fleshly swellings; fin attached to caudal peduncle by membrane. Pectoral fin rays 12–12. Pelvic fin rays I,3–I,3; middle segmented ray longest, free for about two thirds its length from outermost segmented ray, which is about 73 percent length longest ray; innermost segmented ray, which is about 27 percent length longest ray, much reduced in diameter, closely bound for its entire length to middle segmented ray, and difficult to see. Upper lobe of caudal fin with 4 unsegmented procurrent rays, followed by 2 weakly segmented, unbranched rays that do not articulate with fused dorsal hypural plate, 1 obviously segmented, unbranched ray and 6 segmented, branched rays that articulate with fused dorsal hypural plate; lower caudal lobe with 4 segmented, branched rays, 2 segmented, unbranched rays and 5 unsegmented procurrent rays. Caudal fin with two epurals, autogenous hypural 5 and autogenous ventral hypural plate. Vertebrae 11 + 27. Pleural ribs on vertebrae 3–11; epipleural ribs on vertebrae 1–15. Gill-rakers left side 9, right side 10. Pseudobranchial filaments left side 7, right side 6. Gill opening not restricted to side, extending from one side to other with deep, free fold across ventral side of head.

Premaxillary teeth (Roman numerals indicate canines) I-23-I (+I, replacement canine); dentary teeth I-20-I. Teeth not present on vomer. Dentaries joined at symphysis by even, non-interdigitating joint. Dorsal ends of premaxillary ascending processes abut ventral surface of protruding median ethnoid; kinethmoid not present.

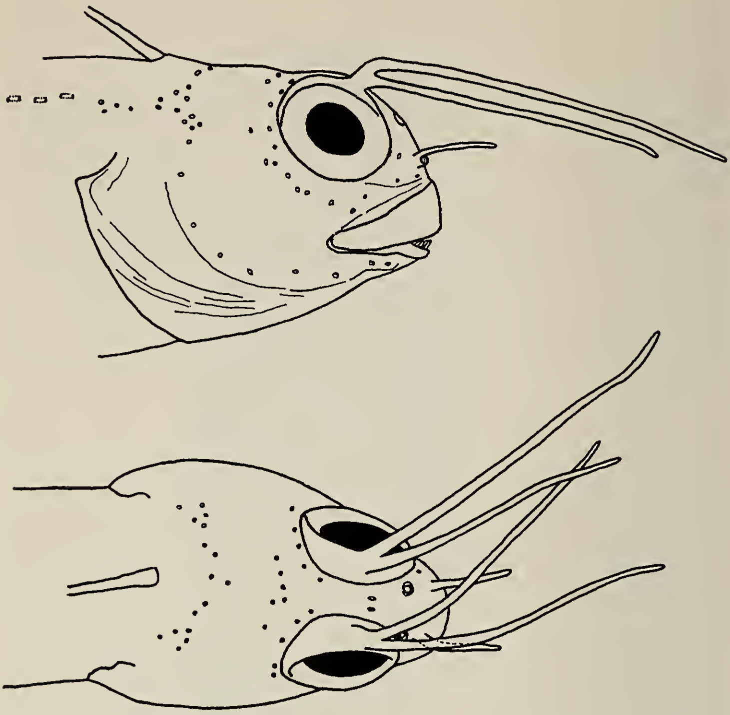

FIG. 2. *Blennius antholops.* USNM 204644, holotype, lateral and dorsal views of head illustrating sensory pore patterns.

Basisphenoid with belophram. Circumorbital bones 5, dorsalmost reduced, overlapped by adjacent ventral circumorbital and not visible in lateral view. Subocular shelf absent. Postcleithra 2, dorsal articulating with ventral and cleithrum. Post-temporal forked. Lateral extrascapular not fused with cranium.

Single, simple cirrus on anterior nostril, about 64 percent horizontal orbital diameter. Two long, rodlike cirri on each eye, longest lateral, about 3.2 times horizontal orbital diameter. No cirri on posterior nostril, nape or other portions of head. No fleshy occipital crest.

Sensory pores—Circumorbital series consisting of simple and horizontally paired pores; preoperculomandibular series of simple pores; supratemporal series with cluster of pores ventrally and longitudinal pair of pores mid-dorsally. Lateralis of 6 short, disconnected, longitudinally bipored tubes, posteriormost below level of 6th dorsal spine. Bone surrounding pores of posterior, supraorbital series raised, appearing externally as ornamentation.

Proportional measurements as percent SL: Head, 22.4; horizontal orbital diameter, 8.2; snout tip to posterior end of maxillary, 8.8; longest orbital cirrus, 26.5; nasal cirrus, 5.2; first dorsal spine (DS 1), 8.4; DS 2, 10.4; DS 3, 11.2; DS 5, 11.0; DS 11, 9.7; DS 12, 7.1; first segmented dorsal ray (DR 1), 10.1; DR 2, 11.4; DR 3, 11.2; DR 10, 12.7; DR 19, 8.6; DR 20, 6.0; first anal spine (AS 1), 3.7; AS 2, 4.8; first segmented anal ray (AR 1), 7.5; AR 5, 8.2; AR 10, 8.2; AR 21, 8.4; AR 22, 6.2; longest pectoral ray, 18.5; outermost segmented plevic ray, 23.2; middle pelvic ray, 31.7; innermost pelvic ray, 8.6; longest caudal ray, 16.8; insertion of DR 20 to caudal mid-base, 7.2.

Color pattern is complex and best discerned from figure 1.

Etymology: The Greek word *antholops* refers to a horned animal, probably the antelope, and is used here as a noun in apposition.

Relationships: We have examined a large number of blenniid species from throughout the world and find none that we consider to be particularly closely related to *B. antholops*. There is no other species in the tribe Blenniini that has orbital cirri proportionately as long, or disposed in quite the same way, as *B. antholops*. In addition we know of no species of Blenniini with pelvic fins proportionately as long as those of *B. antholops* or with ornamentation of the top of the head as is found in *B. antholops*. Our assignment of *antholops* to the genus *Blennius* is, therefore, provisional. It is our opinion that *Blennius*, as currently recognized, comprises a number of forms that will require generic recognition. The type-species of *Blennius*, *B. ocellaris*, and its only close relative, *B. normani*, have restricted gill openings, which is usually considered characteristic of genera other than *Blennius*. The same two species are the only ones in the tribe Blenniini that have the dentaries joined by an interdigitating joint. There are other generic names for species presently included in *Blennius*, but until the Blenniini have been treated comprehensively it is not possible to determine their applicability to *B. antholops*.

We are impressed with the similarity in color pattern between *B. antholops* and *B. tentacularis* Brünnich, which is a Mediterranean-Atlantic species. *B. tentacularis* also has a long supraorbital cirrus, but the cirrus is broad and bears fringes along its edges. While the cirrus may be as long as that of *B. antholops* relative to eye diameter, it is much shorter relative to head length: shorter than head in *B. tentacularis*; longer than head in *B. antholops*. In addition, *B. tentacularis* has 13–15 pectoral rays (rarely 13) as compared with *B. antholops* with 12 pectoral rays. There are numerous other differences between these two species, but as they are obviously not closely related there is little to be gained by a lengthy comparison.

Remarks: The large eye, long cirri and pelvic fins of *B. antholops* may be adaptations to a deep-water existence, where there is little light and much advantage in having well-developed sensory structures.

Blennius ocellaris and *B. normani* have very large eyes; however, their cirri and pelvic fins are not so well developed as those of *B. antholops*.

Acknowledgments: The junior author acknowledges support from a program of continuing studies of oceanic fishes supported by the National Science Foundation (NSF-GB-7015X), C. R. Robins, principal investigator, and from the Deep-Sea Biology Program supported by the National Geographic Society, G. L. Voss and F. M. Bayer, principal investigators.

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PROCEEDINGS
OF THE
BIOLOGICAL SOCIETY OF WASHINGTON

A NEW ELEUTHERODACTYLINE FROG FROM AMAZONIAN ECUADOR

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The discovery of petroleum deposits in Napo Province, Ecuador has proven to be of considerable importance in the herpetological exploration of the Amazonian rainforest in eastern Ecuador. Recently, Texaco Petroleum Company has undertaken the construction of a new airfield near its Lago Agrio oil field. The University of Kansas Museum of Natural History personnel have been fortunate to gain early entrance into this newly-opened area. During April and May, 1969, a group of three herpetologists collected and observed amphibians and reptiles at Lago Agrio while the Texaco crews were leveling primary rainforest for the new airstrip. A significant number of animals which had only rarely been collected in the past became relatively abundant, presumably because these species are dwellers of higher levels of the rainforest than are usually sampled by the terrestrial collector. Among the leptodactylid frogs collected amid the bulldozers were two specimens of a distinctive new species of *Eleutherodactylus.* Fortuitously, both an adult male and an adult female were collected. Both sexes of this species have dark brown and black gular regions; in allusion to the throat color, this new species is named

Eleutherodactylus orphnolaimus new species

Holotype: University of Kansas 125332, adult male collected at Lago Agrio, Napo, Ecuador, 330 m, on 7 May 1969 by Thomas H. Fritts.

Paratype: KU 125333, adult female, same locality, collected 9 May 1969 by William E. Duellman.

Diagnosis: (1) skin of dorsum relatively smooth with large tubercles on upper eyelid; skin of venter smooth with numerous pustules; discoidal fold present; (2) tympanum visible, its length less than one-half diameter of eye; (3) snout acuminate in dorsal view with small terminal papilla, pointed in lateral profile, overhanging lower jaw; (4) upper eyelid slightly narrower than interorbital distance; no cranial ridges; (5) prevomerine teeth present, 4–6 per fasciculus, arranged in a transverse row on triangular-shaped dentigerous processes; (6) males with vocal slits and sac; thumb of male bearing non-spinous nuptial pads; (7) first finger shorter than second; digital tips expanded, pads broader than long; subarticular tubercles simple; (8) fingers bearing poorly defined lateral fringes; (9) ulnar tubercles present, poorly defined; (10) tarsus with poorly defined inner tarsal fold for one-half its length; no heel tubercles; (11) inner metatarsal tubercles elongate, three to five times as large as rounded outer metatarsal tubercle; supernumerary plantar tubercles absent; (12) toes with lateral fringes and basal webbing; digital tips expanded, less so than fingers; (13) dorsum dull brown darkening on flanks; limbs dull brown with poorly defined bars; groin and posterior surface of thigh colorless in preservative; throat dark brown with black stripes in both sexes, venter cream mottled with dark brown; (14) male 24.0, female 33.4 mm SVL.

Description: Head wider than body, head as long as or slightly longer than its width; head width 40–41 per cent SVL; snout acuminate in dorsal view, sloping and overhanging lower lip in lateral profile; tip of snout bearing short, fleshy proboscis; canthus rostralis sharp, slightly concave; loreal region concave, sloping abruptly to lip; lips not flared; nostrils lateral, near tip of snout; snout long, distance from eye to nostril greater than length of eye; interorbital distance slightly greater than width of upper eyelid; tympanum visible externally, round, its upper edge concealed by supratympanic fold, tympanum length 39.3 per cent length of eye in male, 47.0 per cent in female; tongue large, fleshy, posterior one-third free, not or but slightly indented posteriorly; choanae relatively small, longer than wide, completely visible when roof of mouth is viewed from directly below; dentigerous processes of prevomers present, triangular in outline, larger than one choana, separated medially, lying mesiad and posterior to choanae, bearing 4–6 teeth arranged in transverse series; male with short vocal slits and a median, subgular vocal sac.

Skin of dorsum relatively smooth, lacking dorsolateral folds; upper eyelids bear two papillae (Fig. 1); flanks bear flat tubercles; skin of venter relatively smooth but bearing large scattered tubercles; skin of throat smooth except for a few papillae along edge of jaw; discoidal fold prominent posteriorly, not extending onto thighs; shank 48.0–48.2 per cent SVL; forearm bearing small ulnar tubercles; two palmar tubercles, median and outer fused; subarticular tubercles moderately small, simple, round; fingers bearing poorly defined lateral fringes; digital tips ex-

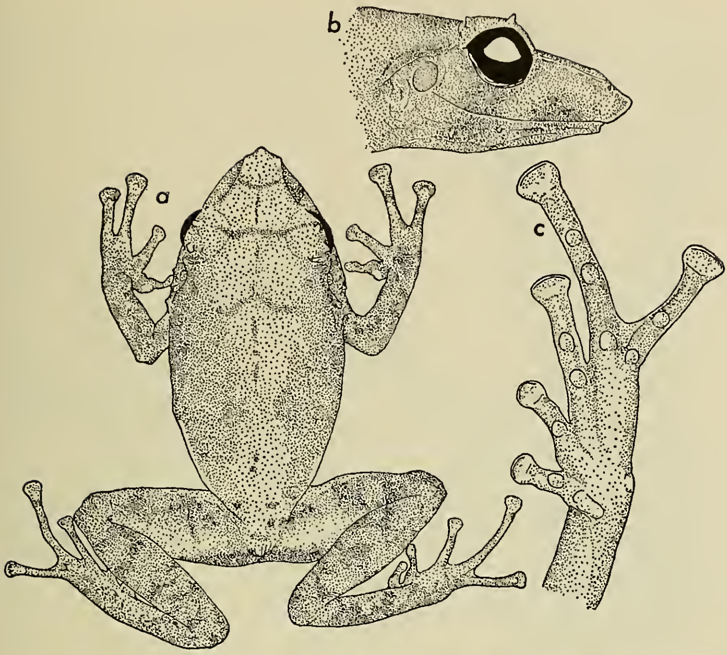

Fig. 1. *Eleutherodactylus orphnolaimus* new species. (a) dorsum, holotype, KU 125332; (b) side of head, paratype, KU 125333; and (c) foot, plantar view, holotype.

panded, pad on thumb smallest, those of other fingers broader than long, each bearing circumferential groove; first finger shorter than second; male with creamy-white, non-spinous nuptial swelling on thumb (Fig. 2).

Tarsus lacking tubercles or folds except for poorly defined inner tarsal fold for one-half length of tarsus; no tubercles on heel or shank; inner metatarsal tubercle elongate, not elevated or compressed, three to four times size of round outer metatarsal tubercle; plantar surface lacking supernumerary tubercles; subarticular tubercles of toes like those of fingers; toes bearing poorly defined lateral fringes and basal webbing (Fig. 1); digital tips expanded, broader than long, bearing circumferential grooves.

Dorsum and limbs gray-brown with poorly defined dark brown blotches; ground color darker on flanks; groin and concealed surfaces of thigh colorless in preservative; canthal and supratympanic stripes dark brown; labial bars dark brown; throat dark brown with black stripes; venter dirty-cream mottled with brown, bearing cream tubercles;

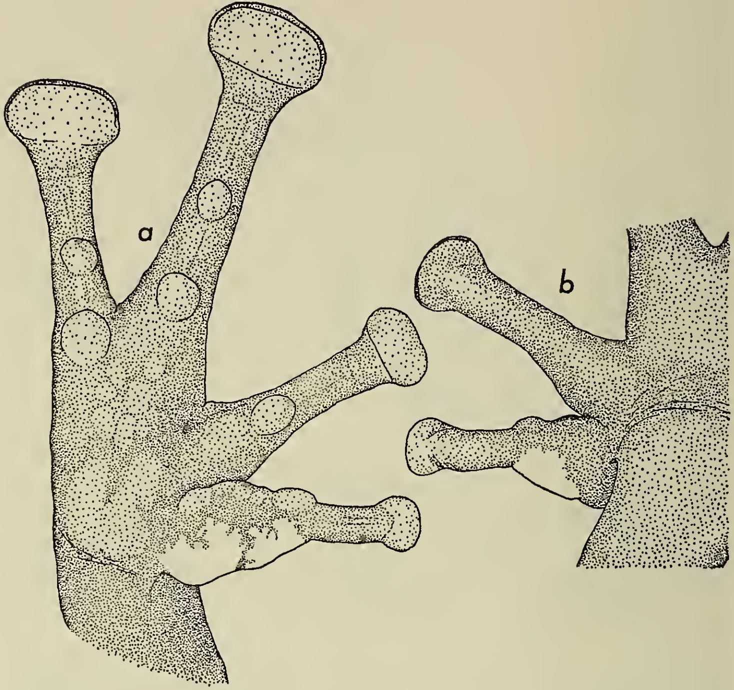

FIG. 2. Dorsal and thenar surfaces of hand of male holotype (KU 125332) of *Eleutherodactylus orphnolaimus* new species.

posterior part of venter colorless; undersurfaces of limbs mottled with brown.

In life, the dorsum is grayish-tan to tan with pale green to brown markings; concealed surfaces of thigh and groin rusty to reddish orange; venter yellowish-brown with creamy-white tubercles; throat dark tan or brown striated with black. Iris pinkish silver above, bronze below, with a reddish-brown horizontal streak.

Measurements in mm: the first value is for the male holotype, the second (in parentheses) for the female paratype: snout-vent length 24.0 (33.4); shank length 11.6 (16.1); head width 9.65 (13.7); head length 9.65 (14.0); interorbital distance 2.9 (IOD greater than eyelid width); eyelid width 2.7; tympanum length 1.1 (1.8); eye diameter 2.75 (3.85).

Etymology: Greek; *orphnos* and *laimos*, meaning dark or dusky throat.

Comparisons: In habitus, *E. orphnolaimus* is similar to *E. conspicillatus*; however, *conspicillatus* belongs to the section of the genus with an elongate first finger (*biporcatus, cornutus, fitzingeri, gollmeri, guentheri,* *nigrovittatus*, and *rugulosus* groups). The species of these groups are principally low elevation species with the notable exception of *E. lymani* which occurs at elevations above 2000 meters in the Huancabamba pass in southern Ecuador and northern Peru.

The elongate snout and fleshy proboscis of *orphnolaimus* are similar to the snouts of *E. appendiculatus* and *E. galdi*. However, both of these species have conical tubercles along the outer edge of the tarsus and lack digital webbing. In addition, the edges of the frontoparietals are enlarged in *galdi* to form cranial crests.

Eleutherodactylus orphnolaimus lacks frontoparietal ridges and squamosal serrations, and has large, elongated nasal bones. The sphenethmoid is large and protrudes anteriorly between the alary processes of the premaxillae recalling the condition exhibited by frogs of the *Leptodactylus sibilatrix* group (*L. fuscus* group of Heyer, 1969) and some hylids (see Trueb, 1970).

Frogs of the genus *Eleutherodactylus* lack nuptial asperities on the thumb. This characteristic apparently is correlated with clasping (amplexus) on land. Rivero (1968) described non-spiny, glandular nuptial pads on the thumbs of a new Venezuelan species, *E. pulvinatus*. *Eleutherodactylus orphnolaimus* has similar pads on the thumb of the male (Fig. 2). At present, it is premature to suggest a close relationship between *E. orphnolaimus* and *E. pulvinatus*. *Eleutherodactylus pulvinatus* lacks discrete tubercles on the eyelids and has a more truncate, shorter snout than does *E. orphnolaimus*. The two species differ in color pattern and *E. orphnolaimus* has basally webbed toes whereas those of *E. pulvinatus* are free.

Eleutherodactylus orphnolaimus has no apparent close relatives in Ecuador or Colombia. The combination of characters of tuberculate eyelids, visible tympanum, expanded digital pads, basally webbed toes, short first finger, non-ornamented tarsus, and dark throat distinguish the species from all other congeners.

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PROCEEDINGS
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A REDESCRIPTION OF *ENOPLUS GROENLANDICUS* DITLEVSEN, 1926 (NEMATODA: ENOPLIDAE)

By W. Duane Hope and D. G. Murphy*
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The original description of *Enoplus groenlandicus* Ditlevsen, 1926, was based on two male specimens collected by the Danish Ingolf Expedition in the North Atlantic, one in the Davis Strait and the other south of Iceland. Ditlevsen's description was brief, included limited detail of salient morphological features, and through the intervening years has remained the only published description. Nonetheless, the males of this species usually can be recognized because of the unique bilateral asymmetry of the copulatory apparatus. As pointed out in the original description, one spiculum is approximately 0.5 mm long and nearly straight, while the other is about half as long and more strongly curved. Ditlevsen was of the opinion that the shorter spiculum has been functionally modified so that, together with the gubernacula, it serves as a guiding piece for the longer spiculum.

Numerous specimens made available as a result of the sampling programs conducted by Dr. Howard Sanders of the Woods Hole Oceanographic Institute and Dr. Roland Wigley of the Bureau of Commercial Fisheries, Woods Hole, Massachusetts were tentatively identified as *Enoplus groenlandicus*. This identification has since been confirmed by comparing these specimens with Ditlevsen's type specimens. The new material has enabled us to provide additional information regarding the anatomical features of this nematode, especially the copulatory apparatus, and has provided a basis for a description of the females.

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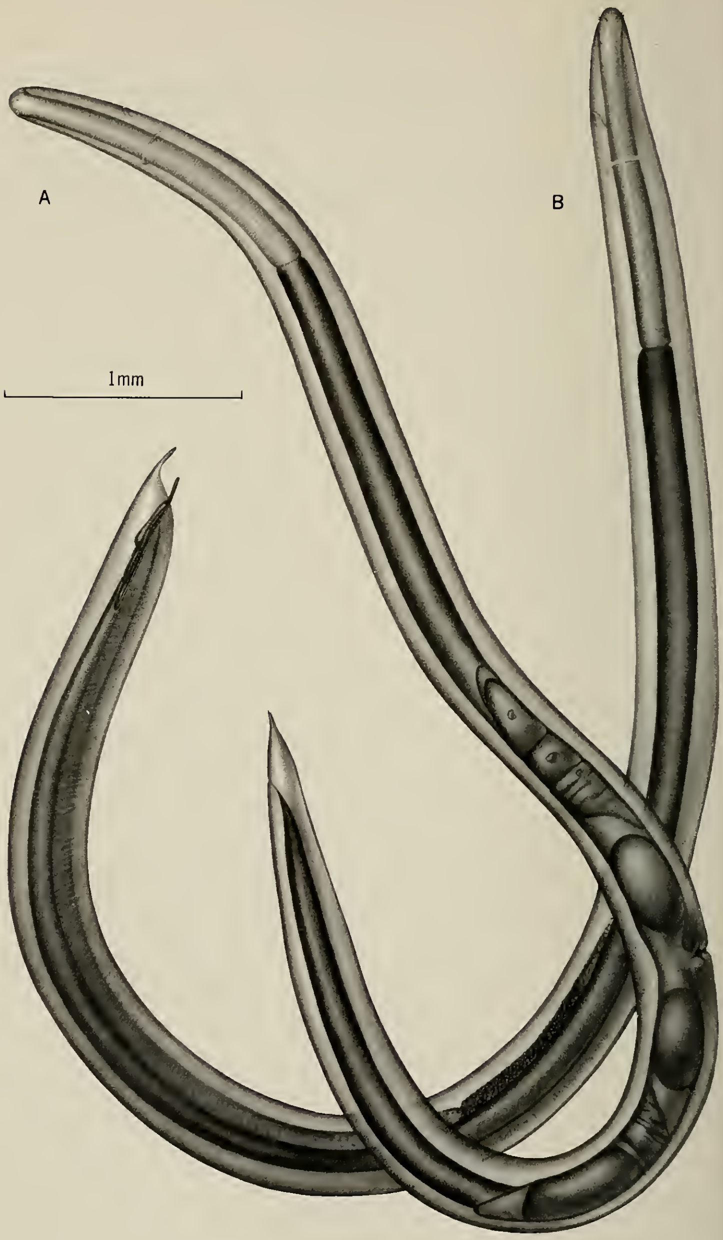
* Research Associate.


A
B
1mm

The majority of the new specimens used in this study were mounted in anhydrous glycerine. One male specimen (USNM Number 41352) was mounted and cleared in Hoyer's mounting medium for better observation of the copulatory apparatus in lateral view; the posterior end of a second male (USNM 41264) was mounted in glycerine jelly for ventral view of the copulatory apparatus; and the spicula and gubernacula were removed from three males (USNM Numbers 41251, 41252, and 41265) by micro-dissection and mounted in glycerine jelly for detailed study. The heads of two further specimens (USNM Numbers 41266, 41267) were embedded in polyethylene glycol, sectioned at 4 μ and stained by the method of Craig and Wilson (1937).

Dr. Ditlevsen's specimens, one complete male, herein designated the lectotype, and the posterior portion of a second male (paralectotype) had been mounted in glycerine jelly without supports to prevent compression. These specimens have been rehydrated, processed into anhydrous glycerine, and remounted.

Enoplus groenlandicus Ditlevsen, 1926

Figures 1–6

Males—Lectotype and Paralectotype: Zoologiske Museum, Copenhagen, Denmark.

Males—New material: U.S. National Museum of Natural History Numbers 41242–41256; 41258–41260; 41262–41267; 41314; and 41352.

Females—New material: U.S. National Museum of Natural History, Numbers 41295–41313; 41315; 41257; 41261; 41268–41294.

Juveniles—New material: U.S. National Museum of Natural History, Numbers 41316; 41320.

Description: A moderately large nematode. Head bluntly rounded, body tapered in cervical region. Tail basically conical, caudal glands present, slightly convoluted and not extending anterior to junction of mid-gut and rectum. Cells of mid-gut with dark brown pigment. Stoma partially closed by three thin, hyaline flaps. Head with inner circle of six labial papillae and outer circle of 10 cephalic setae. Cervical and somatic setae stout. Amphids lightly cuticularized and difficult to resolve in most specimens, but apparently oval in shape with transverse,

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FIG. 1. *Enoplus groenlandicus*. A, Female (USNM 41247). B, Male (USNM 41276).

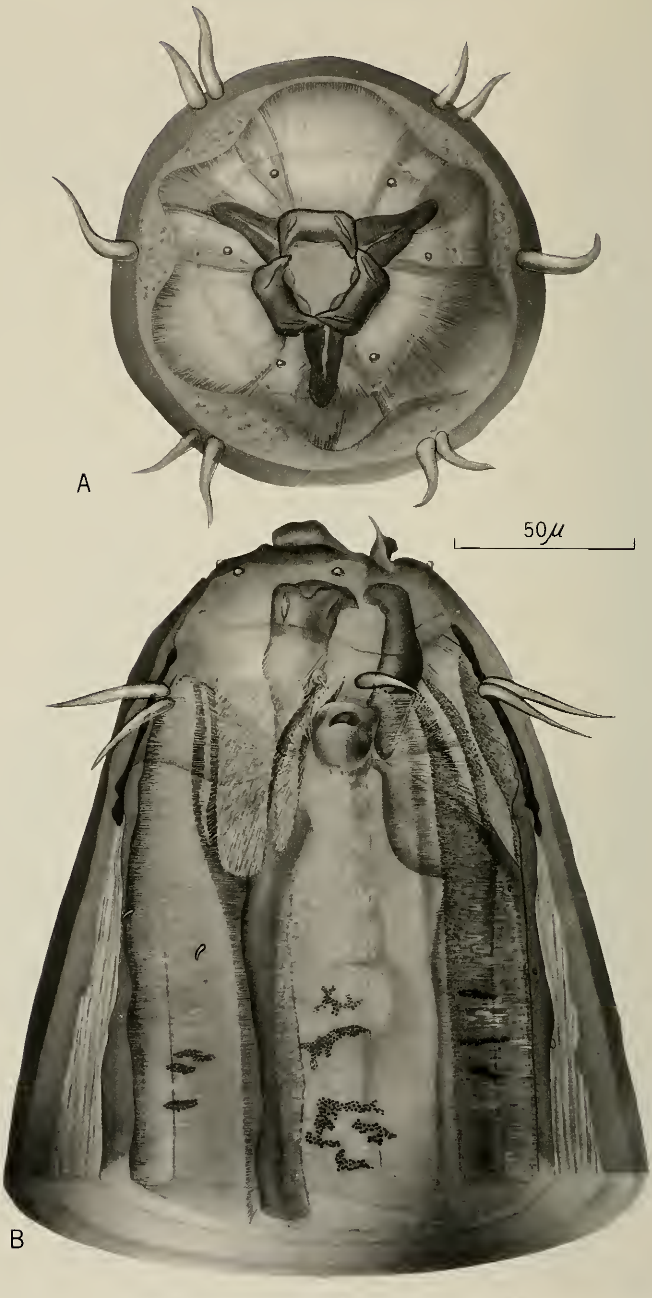

Fig. 2. *Enoplus groenlandicus.* A, Face view of male (USNM 41263). B, Lateral view of male head (USNM 41244).

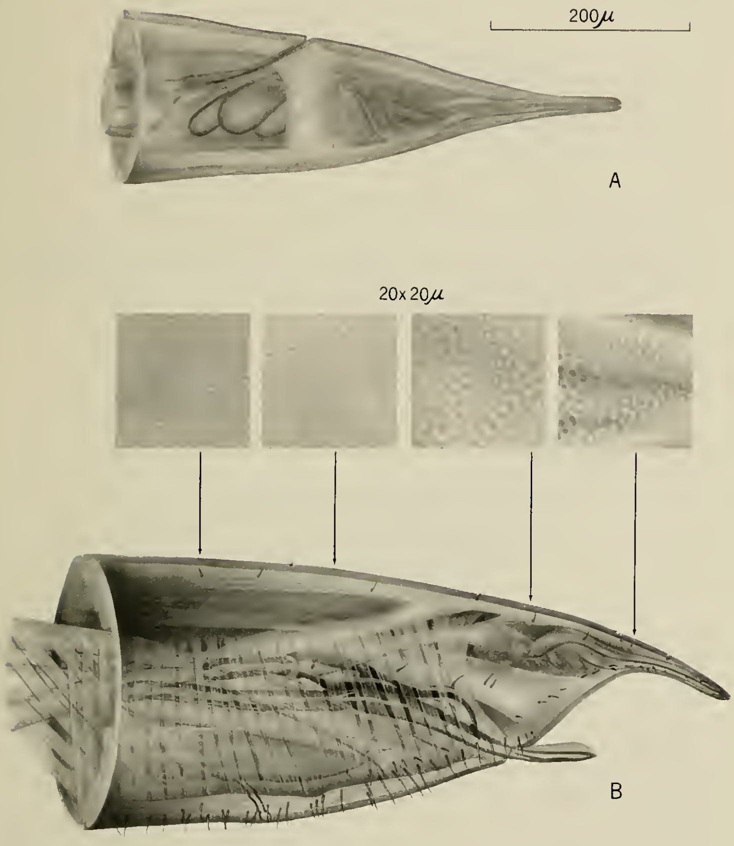

FIG. 3. *Enoplus groenlandicus.* A, Lateral view of female tail (USNM 41276). B, Lateral view of male tail (USNM 41247). Photographs of cuticular punctations taken in region of the lateral chord of the same male at levels indicated by the arrows.

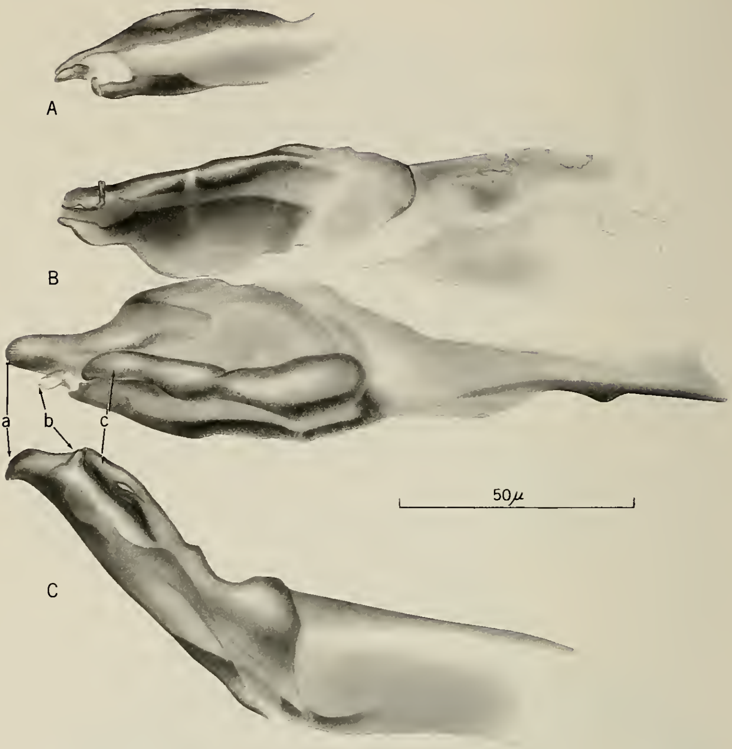

FIG. 4. *Enoplus groenlandicus.* A, Lateral view of right side of gubernacular complex (USNM 41352). B, Ventral view of gubernaculum with right component above and left component below. Note posterior (a), median (b), and anterior (c) lobes of left component (USNM 41265). C, Lateral view of left side of gubernacular complex (USNM 41352).

external slitlike orifice (Fig. 2B). Cephalic capsule present, but lightly cuticularized and difficult to resolve even in optical sections; cephalic suture present but faint (Fig. 2B). Cuticle posterior to cephalic suture with punctations up to nearly 2.0 μ in diameter on neck and anal regions,

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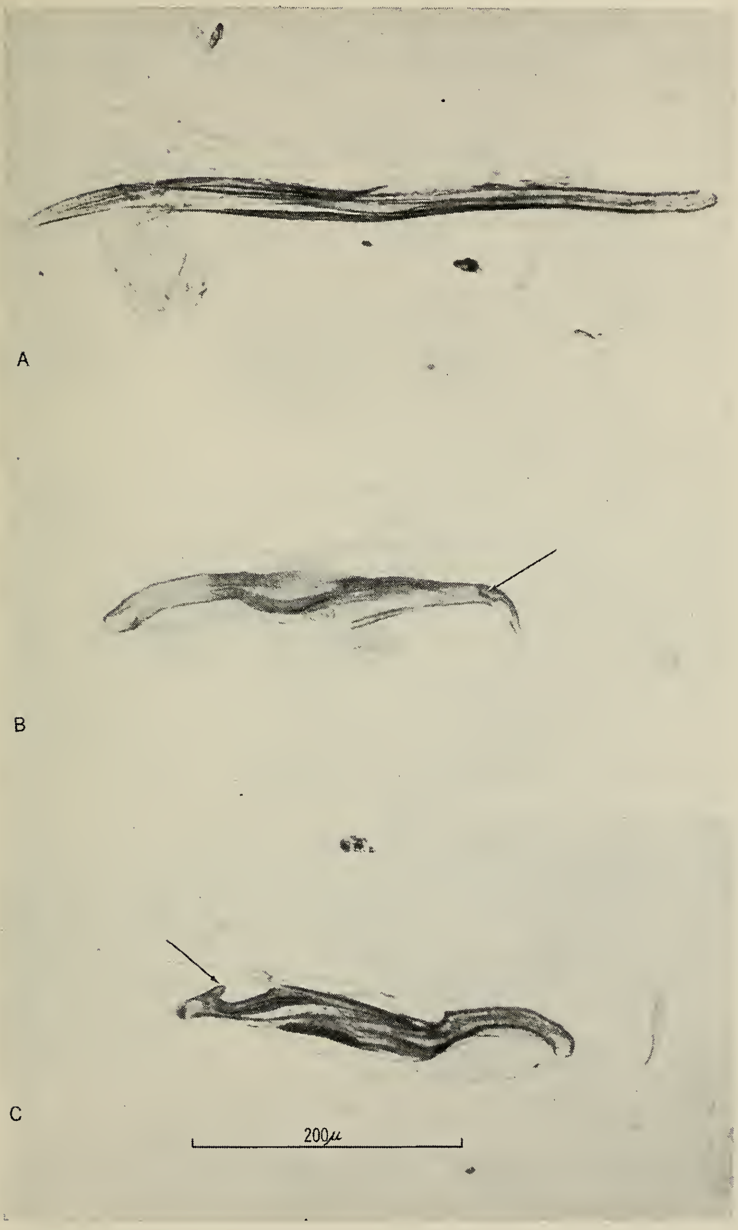
FIG. 5. *Enoplus groenlandicus.* A, Lateral view of right (retracted position) spiculum (USNM 41252). B, Lateral view of left (retracted position) spiculum (USNM 41265). C, Ventral view of left (protruded position) spiculum (USNM 41265). Arrows indicate each medial process.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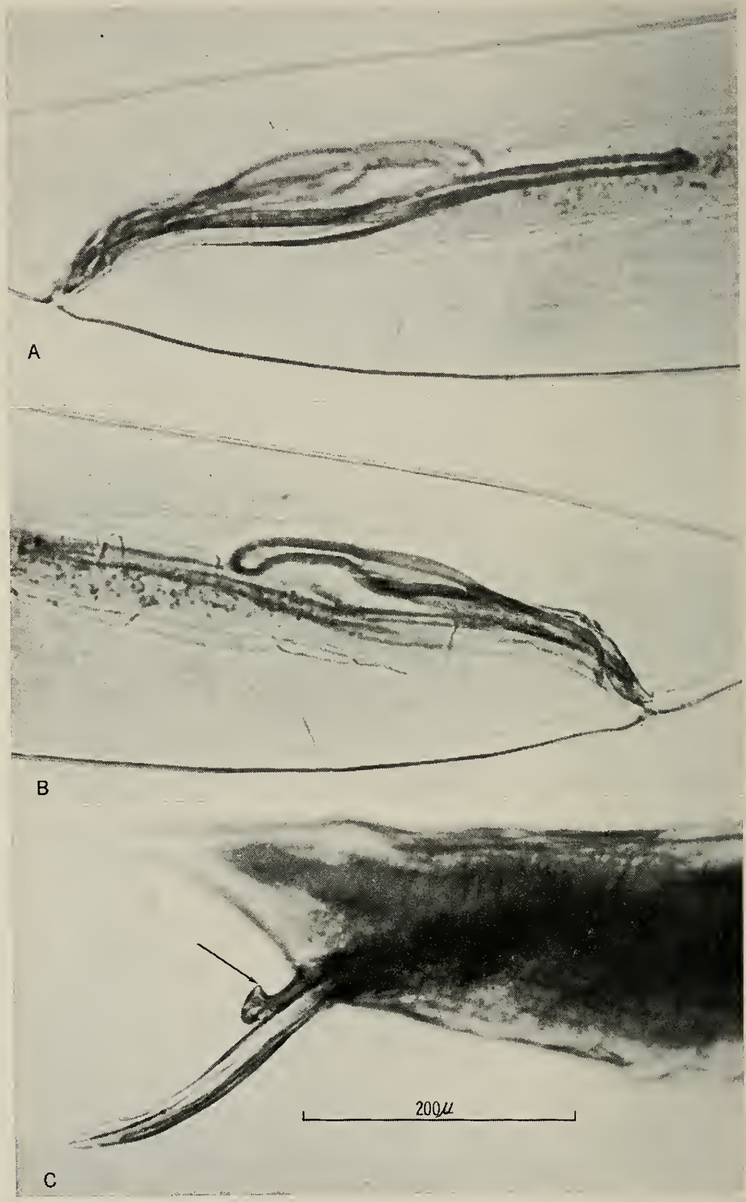
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less than 1.0 μ on mid-body regions and terminal portion of tail. Larger punctations with darker core (Fig. 3B).

Stoma with three prominent mandibles, each bifurcated to form two medially directed teeth. Radii of stoma in lip region with longitudinal striations. Esophagus cylindrical but slightly tapered and with diffuse pigmentation; ocelli absent. Excretory pore, terminal duct and ampulla usually, but not always distinct; ventral gland encircling base of esophagus.

Females—Females as above; ovaries paired and reflexed. Tail conical, tapered uniformly on dorsal and ventral sides (Fig. 3A).

Males—Subventral copulatory supplements setiform and numerous. Ventromedian supplement short, cylindrical and straight to slightly arched anteriad (Fig. 3B). Tail tapered, but more so on ventral side, and with slender, cylindrical, terminal process (Fig. 3B). Testes typically opposed and outstretched: sperm small, round. Vas deferens with narrow anterior portion and wider, muscular posterior portion. Right spiculum long and narrow; proximal one-half nearly straight; distal half with narrow velum bearing transverse striations (Fig. 3B). Distal end curved with tip directed caudoventrally when retracted (Fig. 6A), but curved with tip directed caudally when extended (Figs. 3B and 6C). Left spiculum in lateral view when retracted or resting (Figs. 3B, 5B and 6B) with proximal and distal ends directed ventrally; proximal third of spiculum relatively slender, becoming wider in mid-region and then tapering to acute distal end; process present on medial side of spiculum near distal end (Figs. 5B, 5C and 6C. Arrow). Left spiculum rotated 90° when extended with distal tip directed toward median longitudinal plane, and medial process directed dorsally (Fig. 5C and 6C). Both spicula devoid of semicircular plates. Gubernacular complex, comprised of two heavily cuticularized, right and left components, joined by a lightly cuticularized membrane. Left portion of gubernaculum (Figs. 4B and 4C) with three posteriorly directed lobes (a, b, c). Terminal or most posterior lobe (a) with longitudinal striations: middle, posteriorly directed lobe (b) shorter and possibly a sensory receptor; anterior lobe (c) arising from ventral surface of gubernaculum and arched laterally at distal extremity. Right half of gubernaculum shorter and apparently without comparable lobes (Figs. 4A and 4B).

Discussion: Enoplus groenlandicus can be distinguished from other species of this genus by the combined features of no eyespots; a short, rather straight, cylindrical ventromedian supplement; and no semicircular plates on the spicula. Furthermore, it is unique in having

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FIG. 6. *Enoplus groenlandicus*, male tail. A and B, Same specimen (USNM 41352) right (A) and left (B) lateral views. C, Specimen with spicula partially protruded (USNM 41258). Arrow indicates medial process.

TABLE 1.

	Number Measurements	Range	Mean	Standard Deviation	Standard Error
Total length ♂♂ (mm)*	8	8.29–9.93	8.99	0.58	0.21
Total length ♀♀ (mm)	10	9.09–11.12	10.00	0.60	0.19
Dist.—ex. pore ♂♂**	8	347–486	423	52.1	18.4
Dist.—ex. pore ♀♀	10	351–545	452	51.0	16.1
Length esoph. ♂♂ (mm)	8	1.31–1.50	1.40	0.08	0.03
Length esoph. ♀♀ (mm)	10	1.39–1.60	1.48	0.05	0.02
Distance to vulva (mm)	10	5.00–5.74	5.38	0.27	0.08
Tail length ♂♂	8	229.0–271.0	256.0	16.0	6.0
Tail length ♀♀	10	274.0–330.0	304.0	19.0	6.0
Head diameter ♂♂	8	97.0–108.0	100.3	4.1	1.5
Head diameter ♀♀	10	101.0–115.0	106.6	4.2	1.3
Length ceph setae ♂♂	8	31.0–36.0	33.5	1.8	0.6
Length ceph setae ♀♀	10	28.0–36.0	32.0	2.7	0.9
Dorsal mandible length ♂♂	8	46.4–50.5	48.7	1.51	0.54
Dorsal mandible length ♀♀	10	51.5–56.7	53.3	1.63	0.51
Maximum body diameter ♂♂	8	228.0–385.0	336.0	35.6	12.6
Maximum body diameter ♀♀	10	319.0–385.0	355.2	20.6	6.5
Anal body diameter ♂♂	8	153.0–163.0	157.0	3.4	1.2
Anal body diameter ♀♀	10	132.0–153.0	142.0	7.1	2.2
Length vms ♂♂***	8	41.7–57.2	51.1	4.8	1.7
Distance vms-anus ♂♂	8	198.0–247.0	228.0	20.0	7.1
Right spiculum ♂♂	8	483.0–548.0	522.0	24.1	8.5
Left spiculum ♂♂	10	275.0–315.0	299.0	16.1	5.1

* All measurements in micra except where milimeters are indicated.

** Dist.—ex. pore = distance from anterior end of head to level of excretory pore.

*** VMS = ventromedian copulatory supplement.

spicula that differ from one another in size and shape. It is of interest to note that the right spicula are dissimilar to the left in the males of *Mesacanthion diplechma* Southern 1914 (Enoplidae) and have at least a superficial resemblance to those of *Enoplus groenlandicus.* This similarity is here regarded as an example of convergent evolution since, in the case of the *Mesacanthion* species, the right spiculum is shorter than the left. Within the same superfamily, Enoploidea, other examples of dissimilar spicula may be found, such as in the case of *Pseudocella wieseri* Hope, 1967 and *P. panamaense* Allgen 1947.

The postulation by Ditlevsen that the left spiculum, together with the gubernacular complex, serves to guide the right spiculum is apparently not correct since in our material we have found specimens with both spicula protruding from the cloaca side by side and, therefore, it is likely that each has a similar function.

TABLE 2.

Ship	Cruise	Station	Date	Latiude N	Longitude W	Corrected Depth (Meters)	Sediment	♂♂	♀♀	Juve-niles
ALBATROSS III	101	11	22 Aug. 1957	41°49.0′	69°05.0′	181	Sandy silt-clay	1	0 –	0
ALBATROSS III	101	51	23 Aug. 1957	41°39.0′	68°50.0′	151	Very fine sand	0	3 (4)*	0
ATLANTIS I	277	D-1	23 May 1962	39°54.5′	70°35.0′	466–508	———	8	26(49)	0
ATLANTIS II	12	73	25 Aug. 1964	39°46.5′	70°43.3′	1330–1470	———	1	0 –	0
ATLANTIS II	24	126	24 Aug. 1966	39°37.0′ to 39°37.5′	66°47.0′ to 66°44.0′	3806	———	11	18(34)	4
DELAWARE	10	114A	29 June 1961	43°09.0′	69°00.0′	189	Fine sand	0	1 (7)	0
GOSNOLD	49	2089	8 Aug. 1964	37°11.0′	74°26.0′	1105	Clayey silt	0	0 –	1
GOSNOLD	49	2101	9 Sept. 1964	37°55.4′	73°54.0′	880	Clayey silt	1	0 –	0
GOSNOLD	49	2138	17 Aug. 1964	39°55.0′	70°51.9′	500	Sandy silt	0	1 (0)	0
DELAWARE	7	31A	16 June 1962	40°57.0′	70°30.0′	49	Fine sand	1	0 –	0

* Total number of ova for all females in parentheses.

A further peculiarity lies in the fact that the left spiculum appears to rotate 90° as it is extruded, thus presenting a very different appearance in lateral view. In this situation the medial process is directed dorsally and the distal extremity is directed medially (Figs. 5C and 6C). If but a single male specimen with the left spiculum extruded were available for identification, it might easily be misidentified as a member of another species. The right spiculum too, has a different appearance when extruded, as in this situation it arches dorsally (Fig. 3B). However, it is not clear whether it rotates or bends. The functional significance of this rotation, and possible bending of the right spiculum, is not understood, but it may serve to anchor the female to the male during copulation.

The new collections of *Enoplus groenlandicus* extend our knowledge of their distribution. Whereas the species had not been collected previously from further south than 61°28′N, it is now known to be distributed at least as far south as 37°11′N and at depths of 49 meters on the continental shelf to 3800 meters on the abyssal plain. The extreme depths suggest that pressure itself is not a limiting factor in the distribution of this species and supports a similar conclusion reached by Sanders, Hessler, and Hampson (1965) regarding invertebrates in general.

Temperature, on the other hand, may be important. A large number of temperature determinations have been provided by the National Oceanographic Data Center for all seasons of the year at localities and depths comparable to the two stations (D1 and 126) from which the largest numbers of specimens were obtained. The seasonal temperature variation at the deeper locations ranges from 2.2° to 3.5° C and at the shallower from 4.3° to 8.9° C. Thus, the known temperature range for *E. groenlandicus* is approximately 2.0° to 9.0° C. A few specimens have also been collected on the continental shelf, but in these instances they have been north of 41°N: samples examined to date from the continental shelf south of 41°N have not yielded representatives of this species. It may be that this species can exist in colder waters only, and that its southward distribution on the continental shelf might, therefore, be limited by the warmer waters of the Gulf Stream.

It is also possible that certain properties of sediments are important in regulating nematode distribution, as has been suggested by Wieser (1969). Unfortunately, in this study there were too few stations with adequate sediment data to draw correlations between numbers of specimens and sediment characteristics.

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NEW CRAYFISHES OF THE GENUS *CAMBARUS* FROM TENNESSEE AND GEORGIA (DECAPODA, ASTACIDAE)

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Of the two species described below, *Cambarus cymatilis* is by far the more esthetically attractive, but the comparative drabness of *Cambarus bouchardi* is compensated for by its possessing certain characteristics which are believed to be primitive and others which seem to link the most primitive member of the genus, *Cambarus pristinus* Hobbs, 1965: 268, with other species groups.

Hobbs (1965: 272) proposed the hypothesis that the genus *Cambarus* had its origin on the Cumberland Plateau because it is the home of not only *C. pristinus*, which is restricted to the Caney Fork of the Cumberland River, but also that of two not too distantly related relict troglobitic subspecies belonging to the genus *Orconectes*. Furthermore, the slightly more advanced *C. obeyensis* Hobbs and Shoup, 1947: 138, occurs on the Plateau in the Obey River drainage, also a tributary of the Cumberland River. The discovery of this third primitive species in headwater streams of the Big South Fork of the Cumberland lends additional evidence to support the conclusion that the Cumberland Plateau, and perhaps the present Cumberland River basin, represents the ancestral home of the genus.

Further importance attaches to this new crayfish in that whereas *C. pristinus* provided evidence of a link between the genera *Procambarus*, *Orconectes*, and *Cambarus*, *C. bouchardi* affords a tie between *C. pristinus* and some of the more advanced subgenera. In fact, as the subgenera are currently defined, this crayfish is not readily assignable to any of them.

Only two characteristics need to be discussed in any detail here. The first pleopod of the male resembles that of *C. pristinus* more closely than that of any other species, and with respect to the terminal elements resembles the troglobitic *Orconectes* even more than does *C. pristinus*, for the two terminals are even less reflected caudally than are those of the latter. The only feature of the pleopod which is distinctly more evolved from the hypothetical Adorconectoid stock (Hobbs, 1969: 119, 121) is the caudal knob which is more strongly developed in *C. pristinus*. The second character is the chela which in *C. bouchardi* is distinctly *Cambarus*-like in contrast to that of *C. pristinus* which is much more like that of the generalized members of the genus *Procambarus*. In the latter species, the chela is elongate, the dorsal surface of the palm is studded with ciliated tubercles, and the row of tubercles on the mesial surface of the palm is not conspicuously larger than those close by. The chela of *C. bouchardi* is subquadrate, resembling most closely those of members of the subgenus *Jugicambarus*, but the highly variable tuberculate condition of the mesial portion of the palm only occasionally consists of a "single cristiform row of tubercles" (Hobbs, loc. cit., p. 106). According to this character some individuals are *Depressicambarus*-like, and others are almost typical of *Puncticambarus* (see Variations following the description of *C. bouchardi* below). Thus, within the variants of the primitive *C. bouchardi* are found certain characteristics typical of three subgenera. Although such an occurrence makes for difficulty in diagnosing the subgenera, from a phylogenetic standpoint the presence of such variability within a species that, for the most part, is otherwise primitive does not weaken the subgeneric (or species group) concept but rather strengthens the probability of their supposed derivations from a common ancestral stock.

In my treatment of the genus *Cambarus* (1969), which was prepared prior to my knowledge of the existence of this crayfish, I gave careful consideration to the subgeneric designation of *C. obeyensis*. This species, except for the first pleopod of the male, seems clearly to have its affinities with those species assigned to the subgenus *Jugicambarus* and is strikingly different in a number of features from *C.* (*Veticambarus*) *pristinus.* The latter seemed so *Procambarus*-like in its large eyes, broad short areola, and its elongate, tuberculate chela that it was deemed best to emphasize the *Procambarus* traits by isolating it in a monotypic subgenus. With the discovery of *C. bouchardi*, however, there are now three species possessing primitive first pleopods, and two of them exhibiting characteristics diverging from the hypothetical cambaroid ancestor, to some degree, in different directions. Although, perhaps the *Procambarus* features of *C. pristinus* and the *Jugicambarus* traits of *C. obeyensis* will be somewhat obscured, it seems desirable to redefine the subgenus *Veticambarus* to receive the three species.

Subgenus *Veticambarus* Hobbs, 1969; emended

Cambarus (*Veticambarus*) Hobbs, 1969: 96

Diagnosis: Eyes moderately large to large and pigmented. Antennae not heavily fringed on mesial border. Rostrum wthout marginal spines or tubercles, margins not conspicuously thickened. Postorbital and cervical spines small. Suborbital angle acute. Branchiostegal spine small or reduced to tubercle. Areola broad (1.8 to 4.4 times longer than wide), constituting 30.0 to 38.6 percent of entire length of carapace and with few to many shallow punctations. Chela elongate or subquadrate and subovate to moderately depressed in cross section; mesial surface of palm with one or more rows of tubercles, dorsal surface with punctations or squamous tubercles; lateral margin of fixed finger somewhat costate with row of setiferous punctations and sometimes low tubercles basally but never bearing row of spines; fingers not gaping and with well-defined longitudinal ridges dorsally; proximal opposable margin of dactyl never deeply concave; conspicuous tuft of setae never present at mesial base of fixed finger, lateral base never strongly impressed. First form male with coxa of fourth pereiopod lacking large ventral setiferous pit on caudomesial boss; first pleopods almost contiguous basally; terminal elements consisting of (1) short, bladelike central projection with subterminal notch and recurved at 20 to 60 degrees to shaft; (2) thumblike or tapering mesial process directed caudodistally and somewhat laterally and extending caudad beyond tip of central projection; and sometimes (3) rounded caudal knob at caudolateral base of central projection.

Type-species: *Cambarus pristinus* Hobbs, 1965: 268; designated by Hobbs, 1969: 98.

List of Species: *Cambarus* (*Veticambarus*) *pristinus*, *Cambarus* (*Veticambarus*) *bouchardi* new species, and *Cambarus* (*Veticambarus*) *obeyensis* Hobbs and Shoup, 1947: 138.

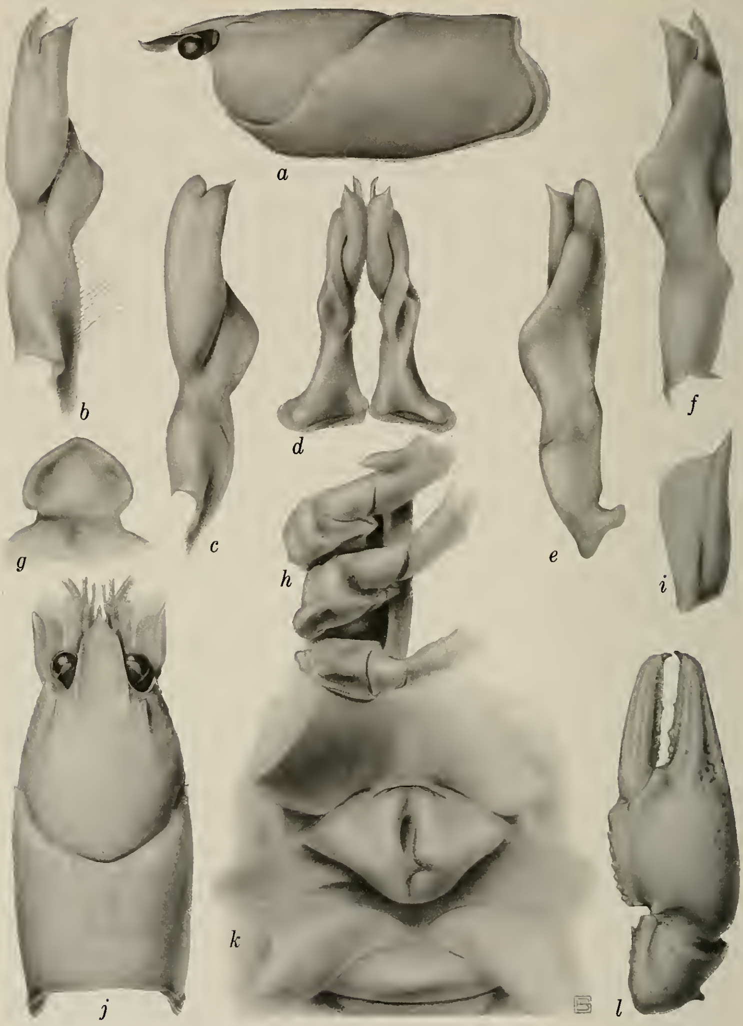

FIG. 1. *Cambarus* (*Veticambarus*) *bouchardi* new species (pubescence removed from all structures illustrated except for b, j, and l). a, Lateral view of carapace of holotype. b, Mesial view of first pleopod of holotype. c, Mesial view of first pleopod of morphotype. d, Caudal view of first pleopods of holotype. e, Lateral view of first pleopod of morphotype. f, Lateral view of first pleopod of holotype. g. Epistome of holotype. h, Proximal podomeres of third, fourth and fifth pereiopods of holotype. i, Antennal scale of holotype. j, Dorsal view of carapace

Cambarus (Veticambarus) bouchardi new species

Diagnosis: Body pigmented, eyes moderately large and well developed. Rostrum with gently convergent margins, lacking marginal spines or tubercles. Areola 2.9 to 4.4 times longer than wide and comprising 31.1 to 38.6 percent of entire length of carapace. Cervical spines moderately prominent and flanked by one or two tubercles caudodorsally. Suborbital angle acute. Postorbital ridges terminating cephalically in short, acute spines. Antennal scale 2.2 to 2.4 times longer than broad, broadest distal to midlength. Chela with one or two (occasionally three) rows of tubercles along mesial surface of palm, mesial row consisting of seven to 10 tubercles; lateral margin of palm rounded, and both fingers with well-defined longitudinal ridges on upper surface. First pleopod of first form male (Fig. 1b, d, f) with short, corneous, bladelike central projection recurved caudolaterally at angle of approximately 20 degrees, inclined slightly laterally, and bearing slight excavation (equivalent to subterminal notch in other species) distally; mesial process non-corneous, bulbous basally, tapering distally, reflected from axis of shaft at angle of approximately 45 degrees, and extending much farther caudolaterally than central projection; distinct prominence at caudolateral base of central projection corresponding to caudal knob in *C. pristinus*. Annulus ventralis (Fig. 1k) rather shallowly embedded in sternum, its marginal contour almost symmetrical, and bearing prominent median longitudinal trough flanked by pair of ridges; caudal portion depressed rather than elevated. Color mottled greenish tan, with banded abdomen.

Holotypic Male, Form I: Body subovate, depressed. Abdomen narrower than thorax (12.3 and 13.4 mm); greatest width of carapace greater than depth at caudodorsal margin of cervical groove (13.4 and 10.0 mm). Areola 3.2 times longer than wide, with scattered punctations, six across narrowest part. Cephalic section of carapace 1.9 times longer than areola (length of areola 34.0 percent of entire length of carapace). Rostrum with very gently convergent margins along basal two-thirds, becoming more sharply so in distal third, forming moderately long, slender acumen, its upturned tip reaching end of antennular peduncle; margins not thickened and devoid of spines or tubercles; upper surface irregular with cephalomedian elevation cephalically (not a carina), median concavity near level of caudal margin of orbit, and with setiferous punctations except in elevated cephalomedian area; subrostral ridges very weak but evident in dorsal view to base of acumen. Postorbital ridges rather short but well-defined, with dorsolateral groove, and terminating cephalically in small acute corneous tubercles. Suborbital angle strong and acute. Branchiostegal spine reduced to rounded tubercle. Carapace

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of holotype. k, Annulus ventralis of allotype. l, Dorsal view of distal podomeres of cheliped of holotype.

TABLE 1. Measurements (mm) of *Cambarus* (*Veticambarus*) *bouchardi.*

	Holotype	Allotype	Morphotype
Carapace:			
Height	10.0	12.8	10.7
Width	13.4	16.9	13.7
Length	27.4	33.0	27.5
Areola:			
Width	2.8	3.3	3.1
Length	9.3	11.2	9.6
Rostrum:			
Width	4.2	5.6	4.6
Length	8.0	8.3	6.5
Chela:			
Length of inner margin of palm	7.0	8.3	7.5
Width of palm	8.7	10.2	9.1
Length of outer margin of hand	20.3	24.0	21.3
Length of dactyl	11.4	14.6	11.8

mostly covered with shallow punctations dorsally and dorsolaterally and weakly granulate laterally; granules in hepatic area and linear series below cephalic portion of cervical groove larger than most of those on branchiostegites; gastric area polished. Cervical spines present and flanked dorsally by one or two moderately large tubercles. Abdomen longer than carapace (31.0 and 27.4 mm); pleura moderately short and rounded ventrally but those of second through fourth abdominal segments subangular caudoventrally. Cephalic section of telson with two spines in each caudolateral corner; mesial spines movable. Proximal podomere of uropod with strong medial and weak lateral spines overreaching lateral bases of corresponding rami; mesial ramus with keel on upper surface produced in moderate spine not reaching distal margin of ramus and another moderate spine on distolateral angle; lateral ramus of uropod with transverse row of spines across distal margin of proximal section.

Projecting portion of epistome (Fig. 1g) broadly ovate, approximately 1.3 times broader than long, its margins slightly elevated (ventrally) and little thickened; surface elevated caudomesially and with numerous setiferous punctations, fovea moderately prominent; caudal margin of epistome thickened and broadly arched. Antennules of usual form with small spine at base of distal third of ventral surface of basal podomere. Antenna reaching fifth abdominal tergum. Antennal scale (Fig. 1i) about 2.3 times longer than broad, broadest distal to midlength with widest lamellar area approximately 1.6 times width of thickened lateral portion, latter terminating in moderately strong spine. Third maxillipeds densely setose and reaching base of distal podomere of antennal peduncle.

Right chela (Fig. 1l) not depressed, with subrectangular palm rounded laterally. Mesial surface of palm with three irregular rows of tubercles: mesial row of seven, ventral row of four, and very irregular dorsolateral row of six; remainder of chela punctate except for tubercle on ventral surface at base of dactyl, two or three smaller ones proximal to it, and opposable margins of both fingers. Fingers not gaping, both with well-defined median longitudinal ridges dorsally and ventrally. Opposable margin of fixed finger without tuft of setae proximoventrally but with row of four corneous tubercles along proximal half, third from base largest, and no conspicuous gap between tubercles; fifth tubercle present below level of row at base of distal two-fifths of finger; several rows of minute denticles extending between tubercles and distally to corneous tip of finger. Corresponding margin of dactyl with row of four similar tubercles along proximal three-fifths and with distinct gap between third and fourth (left chela with fourth tubercle closer to third and no conspicuous gap between them); minute denticles arranged as on fixed finger; mesial surface of dactyl with large punctations, one of proximal punctations with single squamous tubercle projecting into proximal border of pit.

Carpus of right cheliped longer than broad with wide oblique furrow dorsally; dorsal surface with five (four on left) small tubercles dorsomesially, otherwise mostly punctate; mesial surface with one large spikelike tubercle and smaller one proximal to it; ventral surface with usual two tubercles on distal margin and two smaller ones between mesial marginal tubercle and major tubercle on mesial surface.

Merus of right cheliped with two (three on left) spiniform tubercles on upper distal surface; mesial and lateral surfaces sparsely punctate, and ventral surface with lateral row of three (left with four) spikelike tubercles and mesial row of eight. Mesial surface of ischium with row of three small tubercles and proximal knoblike tubercle.

Hooks on ischia of third pereiopods only (Fig. 1h); hooks simple, not opposed by tubercle on basis, but extending proximal of distal end of latter. Coxa of fourth pereiopod with single large obliquely vertical prominence (boss) caudomesially; coxa of fifth pereiopod without prominences.

Sternum moderately shallow between third, fourth, and fifth pereiopods and with tufts of plumose setae extending ventromesially from margins of sternum and coxae.

First pleopods (Fig. 1b, d, f) symmetrical and reaching coxa of third pereiopod when abdomen is flexed. (See diagnosis for description.)

Allotypic Female: Differs from holotype in following respects: cephalomedian portion of upper surface of rostrum plane; branchiostegal spines small but acute; projecting portion of epistome with margins more thickened and elevated ventrally; mesial surface of palm of left chela (right regenerated) with two tubercles below proximal end of mesial row of tubercles and irregular row of four above distal end; opposable margin of fixed finger with row of five tubercles and that of dactyl with row of six, tubercles below and distal to row on fixed finger absent; lower surface of carpus with group of three tubercles between mesiodistal tubercle and major tubercle on mesial surface; lower surface of merus with lateral row of five tubercles and mesial one of nine with two smaller tubercles near lateral margin of latter row; sternum between bases of third through fifth pereiopods and coxae of pereiopods without conspicuously long tufts of setae.

Annulus ventralis (Fig. 1k) not deeply embedded in sternum but firmly fused with sternal plate immediately cephalic to it; cephalic portion superficially, at least, as heavily sclerotized as caudal portion, but entire annulus movable. Cephalic portion with median longitudinal trough flanked by comparatively low ridges; caudal two-thirds of floor of trough weakly sclerotized; sinus originating on sinistral side of caudal end of trough, curving sinistrally for short distance before turning caudodextrally to median line, from there extending caudally on caudal shelflike portion of annulus to caudal margin. Median sternite between fifth pereiopods somewhat spindle-shaped in outline with transverse ventral elevation reaching peak at middle of sclerite. First pleopod uniramous and reaching midlength of annulus when abdomen is flexed.

Morphotypic Male, Form II: Differs from holotype in following respects: upper surface of rostrum more nearly concave throughout its length; subrostral ridges evident in dorsal aspect for only approximately half length of rostrum; branchiostegal spines small but acute; cervical spines very small and flanking tubercles weak; pleura of abdomen more rounded; mesial surface of palm of right chela (left regenerated) with mesial row of eight tubercles and irregular rows of five below and three above it; opposable margin of fixed finger with row of three tubercles and more distal tubercle below level of row; lower surface of merus with lateral row of four tubercles; ischium with row of four; hooks on ischia of third pereiopods reduced and not reaching distal margin of basis; protuberances on coxae of fourth pereiopods only little less conspicuous than those on holotype.

First pleopod (Fig. 1c, e) with neither terminal element corneous; central projection inflated and only slightly curved caudodistally; mesial process reduced but constructed and disposed essentially as in holotype; prominence at caudolateral base of central projection and oblique suture on shaft very prominent.

Type-locality: Perkins Creek, 6.9 miles north of Oneida, Scott County, Tennessee on U. S. Hwy. 27. This stream is a tributary of the Big South Fork of the Cumberland River, and on 6 April 1969, when I collected in this locality, the stream was flooded, and the current of cloudy water was so swift that it was difficult to maintain a firm footing on the rocky stream bed. On this occasion, the creek was 25 to 50 feet in width and had a maximum depth of two feet in the areas seined. There were no aquatic plants but *Tsuga*, *Alnus*, and *Rhododendron* thickets flanked the water line, and *Pinus* and *Quercus* were growing on the banks.

Disposition of Types: The holotypic male, form I, the allotypic female, and morphotypic male, form II, are deposited in the Smithsonian Institution (nos. 130295, 130296, and 130297, respectively) as are the following paratypes: 4♂, form I; 20♂, form II; 31♀; 8 juvenile ♂; and 9 juvenile ♀. The remaining paratypes (11♂, form I; 5♂, form II; 11♀; 8 juvenile ♂; and 1 juvenile ♀) are in the collection of Raymond W. Bouchard.

Size: The largest male, form I, has a carapace length of 37.5 mm, the largest female, 38.4, and the smallest first form male, 25.7 mm.

Color Notes: All of the adult specimens collected in April were encrusted with a black coating, and few observations could be made on the color pattern. A second form male was brought into the laboratory and molted to first form in August. The following observations were made on this specimen within a few days following its molt.

Ground color of carapace greenish tan mottled with cream tan and brown; branchiostegites with longitudinal subtriangular bars extending cephalically from caudal margin to cervical groove; hepatic region with similarly colored bar contiguous with caudolateral irregular splotches on surface of origins of mandibular muscles; gastric region mostly orange-tan although mottled with paler markings; ventrolateral portions of carapace fading to tannish cream. Abdomen pale olive, speckled with brown and with two distinct pairs of scalloped longitudinal brown bands: broader dorsolateral ones extending from base of abdomen to midlength of sixth abdominal tergum; lateral band extending along bases of pleura to spine on base of uropod; first abdominal segment with pair of conspicuous cream spots between just-mentioned rows. Cervical spines cream. Eyes with narrow cream band bordering faceted region. Chela brown with dark brown mottlings; tubercles pale, especially major ones on opposable margin of fixed finger; both fingers with scarlet tips; carpus and distal portion of merus also dark brown with all major tubercles cream; proximal portion of merus and remaining basal podomeres cream, similar to those of other pereiopods; second through fifth pereiopods with upper surface of distal portion of merus to extremity of appendages mottled greenish cream; lower surfaces of all pereiopods pale tan to cream. Antennae and outer ramus of antennule ringed with dark greenish brown; inner ramus of antennule lighter in color; basal podomeres of both appendages mottled cream and dark brown; antennal scale with dark greenish tan borders and cream lamellar area. Ventral surfaces of gnathal appendages mostly cream but articular areas of third maxilliped pinkish.

Range: *Cambarus bouchardi* is known from only three localities in the Big South Fork of the Cumberland River: the type locality; Roaring Paunch Creek, approximately 8.5 miles north of Oneida, Scott County, Tennessee on U. S. Hwy. 27; and the latter creek at County Rte. 2449.

Variations: The range of variation in specimens from these localities does not seem to differ appreciably. Most conspicuous among the variations are those of the chela. Whereas in general shape it is usually subquadrate, resembling that typical of most members of the subgenus *Jugicambarus*, the variations in the armature of the mesial surface of the palm is equal to, or exceeds, that of any species of the genus. In some individuals, it consists of a single subcristiform row of tubercles with scarcely a trace of tubercles above or below the row; in others, a few tubercles may flank such a row on both sides; in yet other specimens, there are three distinct rows, and finally, the tubercles are so irregularly situated that it is difficult to perceive a linear arrangement. The rostrum, too, is somewhat variable in the relative thickness of the margins and in their cephalic convergence; in some specimens, the margins are distinctly more thickened than they are in the holotype but hardly approach the thickened conditions observed in many other members of the genus, and the borders extending onto the acumen may narrow imperceptibly or rather suddenly. The cervical spines, nearly always small in larger specimens, are occasionally reduced to spiniform tubercles. Variations in the first pleopod of the first form male include a slight flaring of the terminal portion of the central projection in some specimens, and much more variation in the distal portion of the mesial process. In some individuals, the latter is more attenuate than that illustrated (Fig. 1b, d, f), and its distalmost portion is curved somewhat mesially. In the dextral pleopod of one of the males from Roaring Paunch Creek, the process is broadly rounded distally, lacking the tapering distal portion which is otherwise characteristic of the species. The annulus ventralis varies chiefly in the degree of sclerotization of the cephalic portion, but it is never membranous as in such species as *C. cymatilis* (see below). Ratios of variations of the length of the areola to that of the carapace are shown in Figure 2.

Relationships: *Cambarus bouchardi*, as was pointed out in the introductory remarks, has its closest affinities with *Cambarus pristinus* and *C. obeyensis* from which it may be distinguished by the more nearly distally directed terminal elements of the first pleopod of the male. *Cambarus pristinus* has a broader, and usually shorter areola, 1.8 to 2.3 times longer than broad and constituting only 30.0 to 33.3 percent of the total length of the carapace, whereas, the corresponding measurements in *C. bouchardi* are 2.8 to 4.4 and 31.1 to 38.6 percent (lower percentages generally in small or juvenile specimens), and in *C. obeyensis* 3.3 to 4.4 and 33.5 to 37.6. The chela of *C. pristinus* is also elongate and the upper surface of the palm covered with squamous tubercles while that of *C. bouchardi* and *C. obeyensis* are subquadrate, and tubercles on the palm are limited to the mesial portion. Thus, there are several characters which distinguish *C. bouchardi* from *C. pristinus*; while there are fewer which separate it from *C. obeyensis*, the first pleopods are distinct and generally there are fewer tubercle rows on the mesial surface of the palm of the chela in *C. obeyensis*. In neither the latter species nor in *C. bouchardi* is

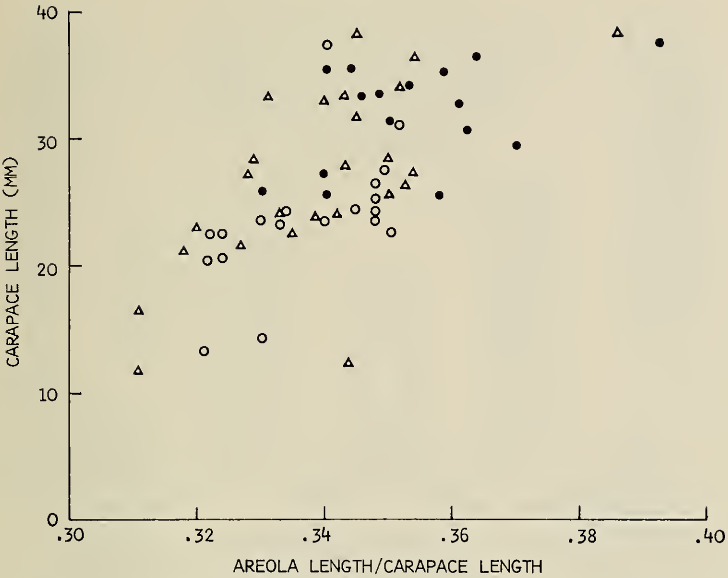

FIG. 2. Relationship of relative length of areola to carapace length in *Cambarus* (*Veticambarus*) *bouchardi.* Triangles signify females; solid circles, first form males; and open circles, second form males.

the caudal knob of the pleopod nearly so well developed as it is in *C. pristinus.*

Life History Notes: The available specimens were collected on 26 May 1968, 17 and 22 September 1968, and 6 April 1969. First form males were present in the collections made in September and April; none of the females was carrying eggs or young.

Etymology: This crayfish is named in honor of its discoverer, Mr. Raymond W. Bouchard, who has added much to our knowledge of the crayfishes of Tennessee.

Cambarus (Depressicambarus) cymatilis new species

Diagnosis: Body pigmented, eyes small but well-developed. Rostrum concave with convergent margins, and lacking marginal spines or tubercles. Areola very narrow or obliterated, at least almost linear at midlength, and comprising 41.7 to 44.8 percent of entire length of carapace. Cervical spines or tubercles lacking. Suborbital angle acute. Postorbital ridges terminating cephalically without tubercles or spines. Antennal scale 2.4 to 2.8 times longer than broad, broadest distal to midlength. Chela with two rows of tubercles on mesial surface of palm, mesial row consisting of six to eight; lateral margin of chela costate, and both fin-

FIG. 3. *Cambarus* (*Depressicambarus*) *cymatilis* new species (pubescence removed from all structures illustrated except for b and l). a, Lateral view of carapace of holotype. b, Mesial view of first pleopod of holotype. c, Mesial view of first pleopod of morphotype. d, Caudal view of first pleopods of holotype. e, Lateral view of first pleopod of morphotype. f, Antennal scale of holotype. g, Lateral view of first pleopod of holotype. h, Epistome of holotype. i, Proximal podomeres of third, fourth, and fifth pereiopods of holotype. j, Dorsal view of cara-

TABLE 2. Measurements (mm) of *Cambarus* (*Depressicambarus*) *cymatilis.*

	Holotype	Allotype	Morphotype
Carapace:			
Height	12.9	16.0	9.9
Width	15.6	19.5	12.9
Length	31.0	39.7	26.2
Areola:			
Width	0.1	0.2	0.0
Length	13.5	17.8	11.4
Rostrum:			
Width	4.6	5.4	4.0
Length	5.1	6.1	4.6
Chela:			
Length of inner margin of palm	7.5	8.4	6.3
Width of palm	11.5	13.4	9.4
Length of outer margin of hand	22.3	26.2	19.2
Length of dactyl	14.3	17.7	12.2

gers with well-defined longitudinal ridge on upper surface. First pleopod of first form male (Fig. 3b, d, g) with comparatively short, corneous central projection recurved at angle of approximately 110 degrees, slightly tapering and with distinct subterminal notch; mesial process non-corneous, sub-conical, and extending caudally beyond tip of central projection. Annulus ventralis (Fig. 3k) deeply embedded in sternum, markedly asymmetrical with strongly caudally deflexed ridge disappearing beneath opposite elevated and inflated wall. Color blue.

Holotypic Male, Form I: Body subcylindrical. Abdomen narrower than thorax (11.0 and 15.6 mm); greatest width of carapace greater than depth at caudodorsal margin of cervical groove (15.6 and 12.9 mm). Areola sublinear at midlength with room for no more than one punctation in narrowest part. Cephalic section of carapace 1.3 times longer than areola (length of areola 43.5 percent of entire length of carapace). Rostrum with gently convergent margins along basal four-fifths, becoming sharply convergent in distal fifth forming short triangular acumen reaching midlength of penultimate podomere of antennule; margins not thickened and devoid of spines or tubercles; upper surface concave

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←

pace of holotype. k, Annulus ventralis of allotype. l, Dorsal view of distal podomeres of cheliped of holotype.

with submarginal row of small punctations and with sublinear transverse rows of punctations basally, basal portion with shallow median longitudinal trough extending caudally, broadening and disappearing at level of caudal extremities of postorbital ridges; subrostral ridges comparatively weak but evident in dorsal view almost to base of acumen. Postorbital ridges weak, with dorsolateral groove, and merging with carapace cephalically, lacking spines or tubercles. Suborbital angle strong and acute. Branchiostegal spine obsolete. Carapace mostly evenly punctate dorsally and weakly granulate laterally; granules in hepatic area and linear series below cephalic portion of cervical groove slightly larger than those on branchiostegites; gastric area not polished. Cervical spines or tubercles lacking. Abdomen shorter than carapace (27.0 and 31.0 mm); pleura short and rounded ventrally. Cephalic section of telson with one fixed spine in each caudolateral corner. Proximal podomere of uropod with one strong spine over-reaching lateral portion of mesial ramus; latter with median keel on upper surface produced in strong spine extending much beyond distal margin and additional prominent spine on distolateral angle; lateral ramus of uropod with transverse row of spines across distal margin of proximal section (in some specimens lateral and median spine distinctly larger than others).

Projecting portion of epistome (Fig. 3h) narrow, its width and length subequal, its margins elevated (ventrally) and thickened; except for thickened margins, covered with very fine setiferous punctations; fovea present; caudal margin of epistome much thickened and broadly triangular. Antennules of usual form with small spine at base of distal fourth of basal podomere. Antenna broken but probably reaching sixth abdominal tergum. Antennal scale (Fig. 3f) about 2.6 times longer than broad, broadest distal to midlength with widest lamellar area approximately 1.5 times width of thickened lateral portion, latter terminating in moderately strong spine. Third maxillipeds densely setose and almost reaching distal podomere of antennal peduncle.

Right chela (Fig. 3l) depressed but with palm slightly inflated, lateral margin costate, costa almost reaching base of palm. Mesial surface of palm with two rows of tubercles, more mesial one of eight and adjacent one of six; smaller scattered tubercles present immediately dorsolateral to these rows and extending laterally slightly beyond line joining proximal and distal articular condyles; remainder of chela, except proximomesial surface of dactyl and opposable margins of both fingers, punctate. Lower surface of propodus with one prominent tubercle adjacent to base of dactyl and three smaller tubercles proximal to it. Fingers gaping, both with well-defined median longitudinal ridges dorsally and ventrally. Opposable margin of fixed finger with inconspicuous tufts of setae proximoventrally and with row of four tubercles along proximal three-fifths, third from base distinctly largest, broad gap between it and second tubercle; fifth tubercle present below level of row at base of distal fourth of finger; row of minute denticles extending from distal base of third tubercle (interrupted by fourth) to base of corneous tip of finger; corresponding margin of dactyl with row of six tubercles along basal two-thirds, second from base largest; row of minute denticles extending from base of distalmost tubercle to corneous tip of finger; mesial surface of dactyl with two rows of six tubercles each along basal half, distal half punctate.

Carpus of right cheliped longer than broad with deep longitudinal furrow dorsally; dorsal surface with few tubercles mesially but mostly with large deep punctations; mesial surface with two large subspiniform tubercles, distal one distinctly larger; ventral surface with two large tubercles on distal margin; another large tubercle, flanked by two or three much small ones dorsomesially, proximomesial to mesial marginal tubercle.

Merus of right cheliped without dorsal spine; mesial and dorsal surfaces scabrous, lateral punctate, and ventral surface with mesial row of 12 tubercles and lateral one of three (10 and two, respectively, on left merus). Row of three smaller tubercles on ischium corresponding to mesial row on merus.

Hooks on ischia of third pereiopods only (Fig. 1i); hooks simple, not opposed by tubercle on basis, but extending proximad of distal end of latter. Coxa of fourth pereiopod with two prominent, mesially situated protuberances; coxa of fifth pereiopod without prominences.

Sternum between third, fourth, and fifth pereiopods, deep, and with prominent tufts of plumose setae extending ventromesially from margins of sternum and coxae of third and fourth pereiopods, that of fifth with only few setae.

First pleopods (Fig. 3b, d, g) symmetrical and reaching coxa of third pereiopods when abdomen is flexed (See diagnosis for description).

Allotypic Female: Differs from holotype in following respects: margins of rostrum, while convergent, slightly concave, acumen longer and with corneous, distinctly up-turned tip; granules on hepatic areas of carapace similar in size to those on branchiostegites immediately caudal to cervical groove; third maxillipeds reaching distal podomere of antennal peduncle; mesial margin of palm of right chela with inner row of seven tubercles and adjacent row with three (six and five, respectively, on left chela); ventral surface of propodus of chela with four tubercles on right (one on left) in addition to spine adjacent to base of dactyl; opposable margin of fixed finger of right chela with third tubercle from base much reduced (left with only four tubercles, but third as in holotype); ventral base of finger with conspicuous tuft of plumose setae; upper distal surface of merus with single acute tubercle; lower surface with mesial row of 10 tubercles and lateral row of five on right chela and six on left; sternum between third and fourth pereiopods without tufts of setae.

Annulus ventralis (Fig. 3k) deeply embedded in sternum and firmly fused with sternal plate immediately cephalic to it; cephalic portion not heavily calcified and, therefore, flexible. Flexible portion with median

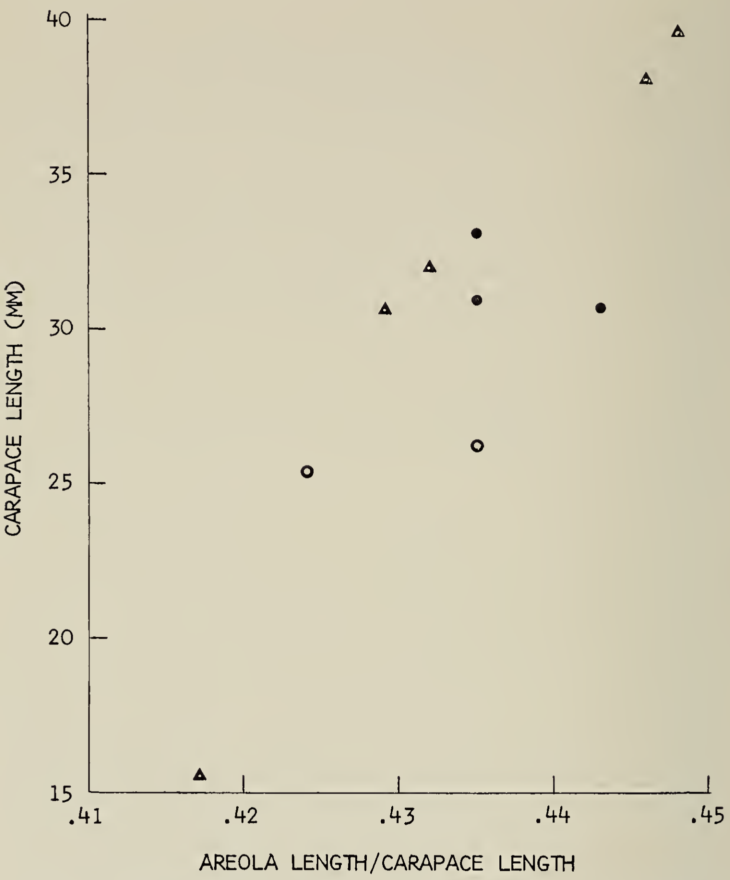

FIG. 4. Relationship of relative length of areola to carapace length in *Cambarus* (*Depressicambarus*) *cymatilis*. Triangles signify females; solid circles, first form males; and open circles, second form males.

longitudinal trough broadening caudally in deep depression flanked by V-shaped, heavily calcified portion; sinistral arm of V produced mesially as tongue dipping below thickened dextral wall; sinus originating in depression dextral to median line, extending caudosinistrally slightly sinistral to median line before turning caudodextrad, cleaving midcaudal margin of annulus. Median sternite between fifth pereiopods subovate with gentle transverse elevation at midlength. First pleopod uniramous and reduced in size but reaching caudal margin of annulus when abdomen is flexed.

Morphotypic Male, Form II: Differs from holotype in following minor respects: third maxillipeds extending forward to base of ultimate podomere of antennal peduncle; mesial margin of palm of chela with six tubercles in each row and no tubercles on dorsal surface lateral to two rows; ventral surface with only two tubercles proximal to tubercle at base of dactyl; opposable margin of fixed finger with dense tuft of setae proximoventrally; corresponding margin of dactyl with third tubercle from base largest; upper distal surface of merus of right cheliped with small tubercle, ventral surface of both right and left with lateral row of four tubercles and mesial one of nine; hooks on ischia of third pereiopods reduced, not reaching distal end of corresponding basis; caudal protuberance on coxa of fourth pereiopod reduced in size.

First pleopod (Fig. 3c, e) with neither terminal element corneous, both bent caudally at approximately 95 to 100 degrees; central projection lacking subterminal cleft, and mesial process projecting only slightly beyond and lateral to central projection.

Type-locality: In burrows near the western city limits of Chatsworth, Murray County, Georgia, in lawn and rose garden of Mr. Charles S. Dunn, off Chestnut Street. There the water table was only six inches below the surface, and the specimens were extracted from the burrows with considerable ease. The burrows of the males were simple with only a single opening; those of the females were more complex, all possessing at least two crudely formed chimneys.

Disposition of Types: The holotypic male, form I, the allotype, and the morphotypic male, form II are deposited in the Smithsonian Institution (nos. 129860, 129861, and 129862, respectively) as are the paratypes, which consist of 2♂, form I; 1♂, form II; 4♀ and 1 juvenile ♀.

Size: The largest male, form I, has a carapace length of 33.3 mm, the largest female, 39.7 mm, and the smallest first form male, 30.7 mm. All of the specimens were collected within two miles of the type-locality. The largest specimen available is the allotype.

Color Notes: Dorsal surface of carapace and abdomen dark cobalt blue, fading rapidly on lateral surfaces of hepatic area, branchiostegites, and pleura through pale blue to cream with a faint bluish suffusion. Cephalic section of telson mottled with blue laterally and dark blue triangular area medially, caudal section pale bluish gray. Uropod also pale bluish gray with median longitudinal dark blue line in each ramus, lateral ramus with additional dark blue line along proximal margin of transverse suture. Dorsal surface of peduncle of antenna and lateral margin of antennal scale dark blue. Cheliped dark blue dorsally from distal third of merus almost to ends of fingers; lateral margin of propodus, distal portions of tubercles and fingers, and ventral surface pale gray to bluish cream; tips of fingers corneous (yellow or orange). Dorsal portions of remaining pereiopods from merus to propodus mottled with dark blue, otherwise cream to pale grayish blue. Sternal area mostly cream to white with isolated blue patches.

Range: This new crayfish is known from only three localities in the immediate vicinity of Chatsworth: the type-locality; 214 Fourth Avenue, in Chatsworth; and in a field adjacent to Holly Creek, 1 mile northeast of Chatsworth.

Variations: Among the few available specimens, none of the variations noted differ appreciably from those pointed out in the allotype and morphotype. Mirrored images of the annulus ventralis described for the allotype occur among the paratypic females, and there is evidence that the length of the areola in both male and females increases proportionately with increase in carapace length. (See Fig. 4).

Relationships: *Cambarus cymatilis* has its closest affinities with *Cambarus striatus* Hay, 1902: 437, and *Cambarus sphenoides* Hobbs, 1968: 262, but may be distinguished from both by the blue coloration. It also differs from the former in possessing a subterminal notch on the central projection of the first pleopod of the male, and from the latter in possessing a sublinear areola and a conical mesial process on the first pleopod of the male.

Should one attempt to assign this species to one of the subgenera by use of Hobbs' key (1969: 95), he would have difficulty upon reaching "couplet 5," for there are eight tubercles in the mesial row on the palm of the chela in some of the available specimens. Thus far, I have been unable to discover a quantitative character to alleviate the difficulty; consequently, for lack of a better distinction, perhaps the following modification of the couplet may be helpful.

5. Chela elongate; mesial surface of palm with row of 8 or more tubercles 6
   Chela broadly triangular; mesial surface of palm with row of no more than 8 tubercles, usually fewer 8

The broad palm with two rows of tubercles along the mesial margin and additional tubercles dorsolaterally seems definitely to associate *C. cymatilis* with members of the subgenus *Depressicambarus.*

In distinguishing it from other members of the subgenus, the narrow areola and well-developed suborbital angle will ally this crayfish with *C. sphenoides* in the second couplet of the key (loc. cit., p. 104). It may, however, be distinguished from the latter by the characters cited above.

Life History Notes: All of the specimens were collected in April, among them three first form males, two second form males, six females, and a juvenile female.

Etymology: *Cymatilis*, L.—sea-colored, blue; so named because of the blue coloration typical of all the specimens examined.

Acknowledgments: Mr. Raymond W. Bouchard asked me to examine the first specimens of *C.* (*V.*) *bouchardi* that I had seen, and I erred in identifying them as *Cambarus obeyensis*. Later, I collected the species in two localities, one of which proved to be the same as that previously visited by Mr. Bouchard. Only then did I recognize it as distinct from *C. obeyensis*. I am most grateful to Mr. Bouchard for permitting me to

describe the species which is named in his honor. For assistance in collecting the specimens on which the above descriptions are based, I wish to thank Raymond W. Bouchard, Edward T. Hall, Jr., Daniel J. Peters, and Jean E. Pugh. For the excellent illustrations, I am indebted to Carolyn B. Gast. Appreciation is also expressed to Fenner A. Chace, Jr., Marian H. Pettibone, and Joseph F. Fitzpatrick, Jr. for their criticisms of the manuscript.

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PROCEEDINGS
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BIOLOGICAL SOCIETY OF WASHINGTON

THYSANOPROBOLUS, A NEW ACRITARCH GENUS FROM THE EARLY DEVONIAN (LATE GEDINNIAN) HARAGAN FORMATION OF OKLAHOMA, U.S.A.

By Alfred R. Loeblich, Jr. and Helen Tappan
Chevron Oil Field Research Company, La Habra, California
and University of California, Los Angeles

Acritarchs, organic-walled cysts of unknown organisms, probably planktonic algae, are thus far poorly known from North America. This important group nevertheless is abundantly represented in Paleozoic and Late Precambrian sediments. The distinctive *Thysanoprobolus polykion*, new genus, new species, is common in acid insoluble residues of the Early Devonian (Late Gedinnian) Haragan Formation of the Arbuckle Mountain area of Oklahoma. It should be an excellent stratigraphic marker for that horizon.

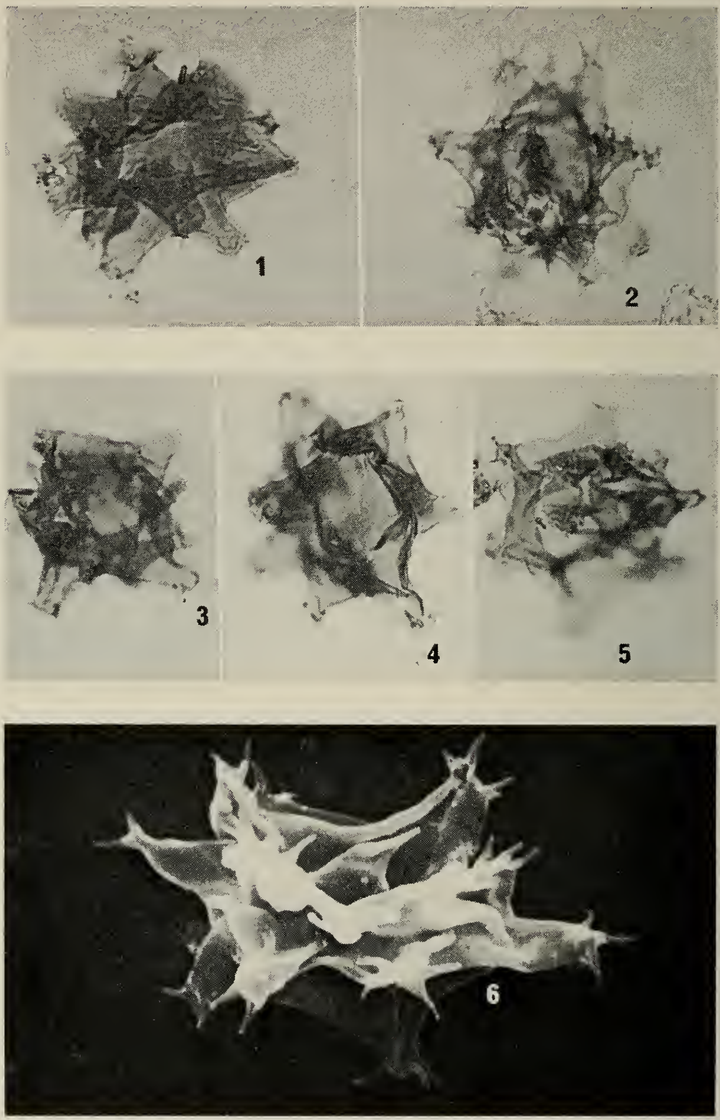
Thysanoprobolus new genus

Acritarch of small size with subangular to subcircular central body; variable number of short, thick, conical to cylindrical processes, distally blunt or truncated, that communicate with central body; processes with crown of hairlike, flexible spines near distal end; wall thin, psilate, no differentiation of wall character between central body and processes. No pylome observed.

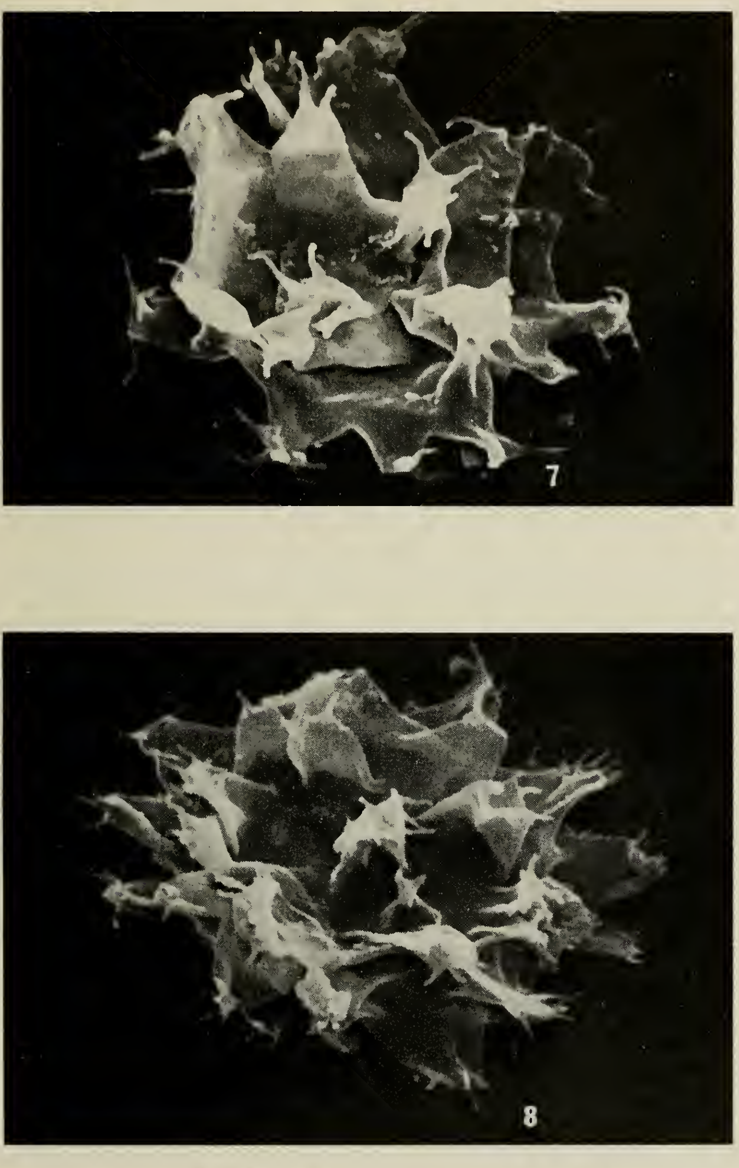
Remarks: *Thysanoprobolus* new genus, resembles *Micrhystridium* Deflandre, in showing no differentiation of the wall between the central body and the processes. The present genus differs in possessing the characteristic and numerous broad-based, conical to cylindrical terminally-tufted processes.

Derivation of name: *Thysanoprobolus*, from Greek, *thysanos*, fringe, tassel + *probolus*, projection, jutting object or prominence. Gender, masculine.

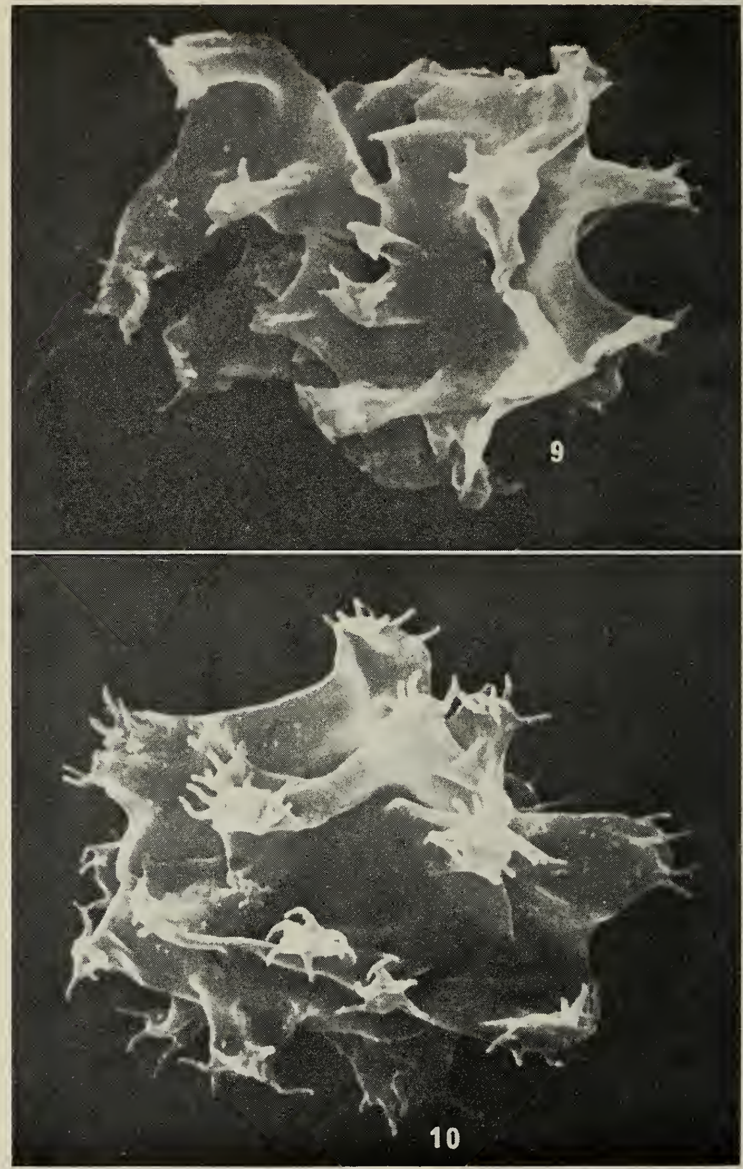
Type species: *Thysanoprobolus polykion* new species.



FIGS. 1–6. *Thysanoprobolus polykion* n. sp. 1–5, light microscope photographs of paratypes showing characteristic overall shape and conical processes that may be truncated distally and are crowned by a tuft of small flexible spines, × 960. 6, scanning electron micrograph of paratype showing psilate wall of central body and conical processes, × 2000.



FIGS. 7, 8. *Thysanoprobolus polykion* n. sp. Scanning electron micrographs of paratypes showing variable shape of processes which are commonly distally truncated and have a crown of spines just below the summit, × 2000.



Figs. 9, 10. *Thysanoprobolus polykion* n. sp. 9, paratype, showing psilate wall and variable width and length of processes. 10, holotype, showing broad based low processes, commonly truncated at the distal end due to collapse; the process at the right shows the uncollapsed character with a tuft of small spines just below the summit (See Figure 11). Both scanning electron micrographs, × 2000.

FIGS. 11, 12. *Thysanoprobolus polykion* n. sp. 11, holotype, enlargement of large process center right margin of figure 10, showing form of uncollapsed process and 5 prominent spines and a tip of the sixth one in the lower center of the process which arise a short distance below the summit. 12, enlargement of lower right process of figure 10, showing 8 spines just below summit. Both scanning electron micrographs, × 10,000.

Thysanoprobolus polykion new species

Figs. 1–12

Central body subangular to subcircular, extremely variable shape resulting from distortion during burial and compression of the sediments; 14–25 broad and low processes visible from one side, of extremely variable width near their proximal end, processes truncated distally, ranging from a broad-based conical to cylindrical shape; process interior freely communicates with the central body, distal ends of processes rounded, or more commonly wrinkled and truncated, probably due to collapse, 3–8 short secondary spines, commonly 5 or 6, with a maximum length of about 4 μ, arise a short distance below the distal end of the process, proximal part of these small secondary spines opens into the processes but distally they gradually become solid, flexible and hairlike; wall thin, transparent, less than 0.5 μ in thickness, psilate, wall of processes not differentiated from that of central body. No pylome observed.

Diameter of central body ranges from 19 μ–25 μ, and overall diameter from 32 μ–42 μ.

Remarks: This distinctive species is superficially similar to *Baltisphaeridium guapum* F. H. Cramer, but differs in the process character. Processes of *B. guapum* terminate in a sharp point, and have 4–6 sharp tipped secondary appendages at their mid-point, whereas in the present species the processes are truncated or broadly rounded and crowned with a tuft of hairlike spines just below the tip.

Derivation of specific name: From the Greek, *polys*, many + *kion*, column, pillar.

Types and occurrence: Holotype 69–193–SEM 730–732 (Figs. 10–12) and figured paratypes 67–169–SEM 776 (Fig. 6), 777 (Fig. 7), 779 (Fig. 8), 780 (Fig. 9), 67–169 (1) 30.1–93 (Fig. 1), 67–169 (1) 35.1–92.3 (Fig. 2), 67–193 (1) 38.5–108.9 (Fig. 3), 67–193 (1) 46.4–99.3 (Fig. 4), and 67–193 (1) 43.7–92.8 (Fig. 5), all from the Early Devonian (Late Gedinnian) Haragan Formation, calcareous shale intercalated between limestone beds in the lower part of the formation, exposed in an escarpment in the NW 1/4, Sec. 8, T. 1 S., R. 8 E., west of Clarita, Coal County, Oklahoma. All specimens are in the Helen Tappan Loeblich collection at the University of California, Los Angeles. Collected by H. T. and A. R. Loeblich, Jr., 3 September 1967.

Acknowledgment: The writers are indebted to our associate, R. B. MacAdam, for picking the specimens and for taking the photographs with the JEOLCO JSM-1 Scanning electron microscope.

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PROCEEDINGS
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A NEW WORMFISH (GOBIOIDEA: MICRODESMIDAE) FROM THE NORTHERN RED SEA

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The unique specimen discussed here is immature but the presence of scales and well developed coloration preclude its consideration as a larval or postlarval microdesmid. This represents the third species referable to the recently described genus *Paragunnellichthys* (Dawson, 1967) and constitutes the first record of the family Microdesmidae from the Red Sea. Since it appears unlikely that further collections can readily be obtained from the type locality or that additional study material will become available in the near future, description of this new wormfish seems warranted at this time.

Head length is measured from the tip of the lower jaw to base of the uppermost pectoral ray; body depth is measured at anal fin origin; caudal fin length is the distance from the rear of the hypural to the tip of the longest ray. All fin rays are counted separately and vertebral counts are from a radiograph. Proportions are shown as percentages of standard length (SL) or head length (HL). The specimen, deposited in the collections of the Smithsonian Institution (USNM), was collected with the financial support of a Smithsonian Institution foreign currency grant [SFC-7-0062(2)], Drs. W. Aron and H. Steinitz, principal investigators.

The drawing was prepared by Mr. Harry L. Moore, Jr. This study was supported in part by National Science Foundation Grants GB-6823 and GB-15295.

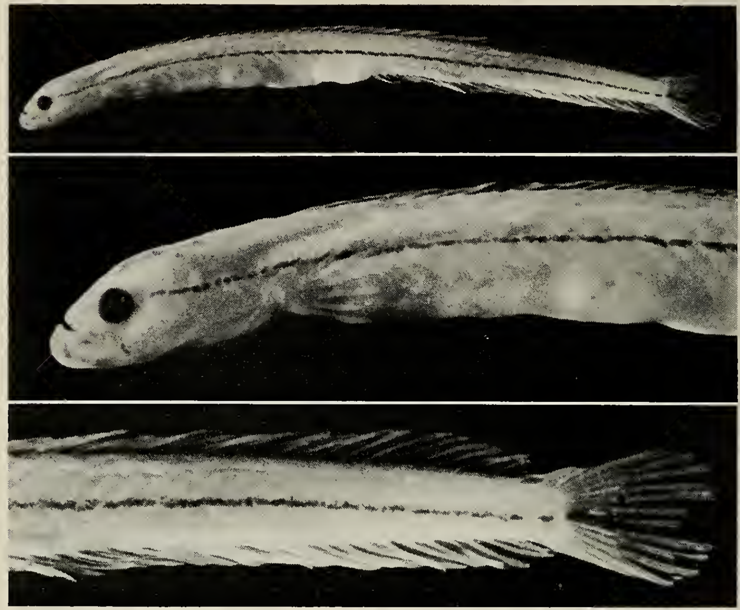

FIG. 1. *Paragunnellichthys springeri.* USNM 204613; holotype; 22.0 mm SL.

Paragunnellichthys springeri new species

(Fig. 1)

Holotype: USNM 204613; 22.0 mm SL; Red Sea, southern Sinai Peninsula, Aristocrat Beach, Sharm el Moiya, approx. 27°51'30"N, 34°17'30"E (Admiralty Chart No. 756); from a depth of 20–30 cm over sand bottom; 29 Sept. 1969; V. G. Springer and L. Hughes-Games; Sta. No. VGS 69–32. This is the only known specimen.

Diagnosis: A species of *Paragunnellichthys* with short pelvic fins, separate to their bases; interradial membranes of anterior dorsal fin with an interrupted series of submarginal dark blotches terminating just behind anal fin origin; with a narrow midlateral dark stripe originating just behind the eye and extending onto caudal fin; dorsum with a dark median stripe from nape to caudal peduncle; total dorsal elements 54; total vertebrae 54; anal fin origin beneath interspace between 24th and 25th dorsal fin elements.

Description: Dorsal spines 20, dorsal segmented rays 34, total dorsal elements 54; anal rays 32; pectoral rays 10; pelvic fin I, 2; vertebrae $25 + 29 = 54$.

Measurements (mm) are followed by percent SL or HL in parentheses.

Caudal fin length 2.2 (10.0); least depth of caudal peduncle 0.8 (3.6); body depth at anal fin origin 1.4 (6.4); predorsal length to tip of lower jaw 3.6 (16.4); preanal length 12.1 (55.0); pectoral fin length 1.6 (7.3); pelvic fin length 0.7 (3.2); distance from pelvic fin insertion to anal fin origin 9.2 (41.8); head length 3.1 (14.1). Diameter of fleshy orbit 0.5 (16.1); distance from anterior margin of eye to tip of lower jaw 0.8 (25.8); snout length 0.5 (16.1); postorbital length 1.8 (58.1); tip of lower jaw to angle of gape 0.7 (22.6).

Body moderately elongate; compressed, breadth at anal fin origin 3.6 percent of SL, greatest breadth (5.4 percent of SL) at opercle; caudal fin (now damaged) rounded. Head depth at opercle about 12 percent greater than body depth; interorbital convex, narrow, its width about 57 percent of eye diameter; eye lateral, high on head, its diameter subequal to snout length; lower jaw prominent, fleshy, extends about three-sevenths of eye diameter beyond snout tip, its lateral depth about 15 percent less than eye diameter, narrowing in front to a prominent subvertical symphysial ridge; gape moderate, reaches a vertical from anterior margin of eye, slightly inclined; upper lip narrow in front, continuous across the symphysis and concealed by the overhanging snout, laterally expanded to form a broad fleshy fold posteriad; lower lip represented by a slight outfolding of the oral margin of the lower jaw, not distinctly pouchlike, includes anterior portion of upper lip when mouth is closed; anterior naris opens dorsolaterally at anterior terminus of a rather prominent lateral snout ridge, opening slightly larger than that of posterior naris, not distinctly tubiform; posterior naris dorsolateral on a vertical through anterior margin of eye, without a distinct tubule, minute, its diameter about 10 in eye; dentition difficult to determine even under high magnification (90×), apparently without enlarged caniniform teeth.

Gill opening originates on pectoral peduncle a short distance anteriad of insertion of uppermost pectoral ray, continues almost perpendicularly ventrad across peduncle then angles forward to unite with lower margin of peduncle at or just posteriad of its ventral insertion; ventral terminus of gill opening concealed. Depressed tips of posteriormost dorsal rays fail to reach beyond hypural, depressed anal fin slightly longer; dorsal fin originates over anterior third of pectoral fin; interspace between 1st two dorsal spines about one-third shorter than those which follow; 1st dorsal spine about two-thirds the length of the 2nd; the 1st segmented ray about 20 percent longer than the last spine; the last two dorsal and anal rays separate, more closely spaced than their fellows but not approximated; all segmented dorsal and anal rays apparently simple; caudal fin with 9 branched rays and three simple segmented rays together with four or five simple spiniform elements above and below; pectoral fin elongate, narrowly rounded, fin-rays simple, the 6th ray the longest; pectoral peduncle not completely concealed by the opercle and branchiostegal membrane. Pelvic fins inserted two-thirds their length in advance of dorsal fin origin, separate to their bases, each with an outer spine

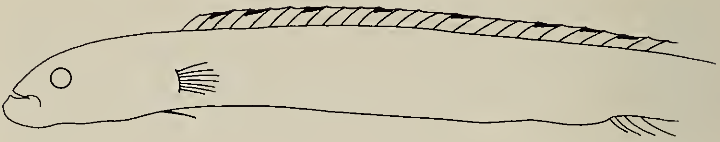

FIG. 2. *Paragunnellichthys springeri.* Semi-diagrammatic delineation of anterior body showing dorsal fin markings. The two posteriormost blotches are somewhat less distinct than shown here.

and two simple rays, the innermost the longer. Anal fin origin beneath interspace between dorsal elements 24 and 25.

Squamation incomplete, apparently not fully developed; scales embedded, difficult to see, present on lateral body, not seen on head. Dermal papillae inconspicuous, short rows cross upper portion of eye, preorbital and interorbital, a longitudinal row on upper cheek and another on suborbital, one or two lateral rows on lower jaw, apparently with two or three vertical series between pelvic fin and pectoral peduncle, four short vertical rows above pectoral and pectoral peduncle, lateral body with short vertical rows of three or four papillae crossing midline of most myomeric impressions.

First dorsal spine inserted over interspace between 3rd and 4th abdominal vertebrae; frontals poorly ossified and fail to reach mesethmoid in radiograph.

Ground color, in alcohol, pale tan; a narrow midlateral stripe formed by a more or less continuous series of large dark brown melanophores extends from just behind eye to the hypural where it continues for two-thirds of the caudal length as a darker brown streak along the 8th segmented ray and portions of its ventral membrane; a few smaller black melanophores are superimposed on this stripe between verticals from the 5th and 20th anal-fin rays; there are several irregular brown blotches on lower jaw, preorbital and lower cheek and there is a short but prominent vertical bar below middle of eye; ventral aspect of lower jaw with an irregular scattering of brown blotches. Dorsum with a median brown spot near snout tip and a brown bar crosses anterior interobital; there is a small median interorbital spot and a posteriorly directed chevronlike bar crosses the posterior interorbital; a short broad transverse bar crosses the nape and this is continued posteriad as a narrow stripe to the dorsal fin origin; a dense scattering of lighter brown melanophores continues posteriad as a stripe along either side of dorsal fin to the caudal peduncle. Anterior dorsal fin membranes with an interrupted series of 8 submarginal longitudinal brown streaks which terminate slightly behind the anal fin origin (Fig. 2), the anterior 6 are very dark and prominent whereas the remainder are pale and indistinct, each dark streak narrowly margined above by the hyaline membrane; remaining interradial membranes, anal, caudal and paired fins immaculate; some scales finely but incompletely margined with brown.

Etymology: I take pleasure in naming this species after the collector, Dr. V. G. Springer, in recognition of his many contributions to modern ichthyology.

Comparisons: Presence of dark blotches on the dorsal fin membranes and similar meristic counts suggest a close relationship between *P. springeri* and *Paragunnellichthys fehlmanni* (Dawson, 1969). The latter species differs from *springeri* in having united pelvic fins. Fin markings are more numerous, of different configuration, and occur on both dorsal and anal fins in *fehlmanni* and there are no distinctive color marks on either head or body. The present species differs from its only other known congener, *P. seychellensis* Dawson, in both meristics and coloration, but both species have separate pelvic fins. Compared with a 25 mm SL specimen of *fehlmanni*, the snout and gape are about two percent longer and the postorbital is about four percent shorter in *springeri*.

Remarks: Incomplete squamation and the presence of 9 branched caudal rays, rather than 11 as recorded for its congeners, indicate the juvenile status of the type of *springeri*. Nevertheless, I consider the color pattern to generally represent that which will be found in adults. I have shown that adult coloration may develop at early stages in *Microdesmus* (Dawson, 1968) and a similar situation, confirmed by my own unpublished observations, has been reported for *Gunnellichthys* (Smith, 1958). Specimens of *Paragunnellichthys seychellensis* may be sexually mature at 31–34 mm SL and it is likely that *springeri* is also a small species.

The striped color pattern is superficially similar to that occurring in *Gunnellichthys pleurotaenia* Bleeker and *Clarkichthys bilineatus* (Clark). The lateral stripe is, however, much narrower and not continued on the snout in *Paragunnellichthys springeri*.

Paragunnellichthys has previously been known only from the Seychelles and the Chagas Archipelago and the present specimen represents the northernmost and easternmost Indo-Pacific record of the family Microdesmidae.

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THE CARIBBEAN ATLANTIC BLENNY *LUPINOBLENNIUS DISPAR* (TRIBE: BLENNIINI), WITH OBSERVATIONS ON A PACIFIC POPULATION

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The tropical American monotypic blenniid genus *Lupinoblennius* has apparently been unrecognized in collections since its description (Herre, 1942), and subsequent literature citations are confined to listings by Böhlke (1953) and Springer (1968). Herre's description, based on a single unfigured female, is hardly diagnostic and it is not surprising that this fish has received scant attention. I was first apprised of *Lupinoblennius* by Dr. V. G. Springer while attempting to identify three very similar and troublesome blennies I had collected from Campeche, México and the Pacific coast of Panamá in 1968. These fish generally agreed with much of Herre's description but identification remained doubtful.

In a continuing attempt to identify these specimens and to investigate the status of *Lupinoblennius*, efforts were made to obtain additional material. Search of unidentified blennies in the Smithsonian Institution (USNM) produced several examples from the Caribbean, additional Pacific material was obtained from the University of Miami, Institute of Marine and Atmospheric Sciences (UMML) and I later collected a series of specimens from the Atlantic coast of Guatemala in 1969. Study of this material shows that my original specimens represent a widely distributed Caribbean Atlantic blenny that also occurs, in at least a restricted habitat, on the Pacific coast of Panamá. This sexually dimorphic species exhibits considerable variation in coloration and body proportions but I consider it

Fig. 1. *Lupinoblennius dispar* Herre (GCRL 4278), Atlantic coast of Guatemala. Upper: 27.4 mm SL, male. Lower: 21.8 mm SL, female.

to be conspecific with *Lupinoblennius dispar* Herre. The holotype of *L. dispar* is damaged and in poor condition but it appears to fall within the range of variation observed in present material. The purpose of this report is to redefine and illustrate *L. dispar* and to comment on the Pacific population.

Fin-ray and cirri lengths are measured from the anterior angle of insertion to their distal extremity. Vertebral counts are from radiographs; measurements are in millimeters (mm).

Lupinoblennius dispar Herre

(Figs. 1 and 2)

Blennius sp. Hildebrand, 1939: 30 (Gatun Locks, Atlantic Panamá).
Lupinoblennius dispar Herre, 1942: 302–303 (type locality: English Harbor, Antigua).

Description: Dorsal fin rays XII, 13–14; without prolonged anterior

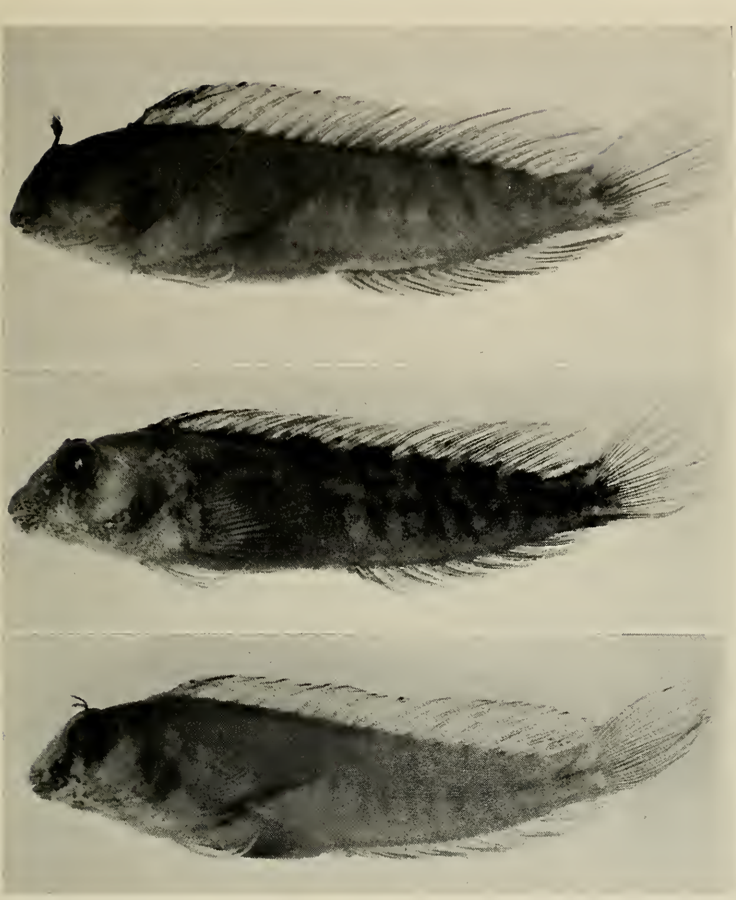


Fig. 2. *Lupinoblennius dispar*, Miraflores Third Lock, Pacific Panamá. Top: 27.2 mm SL, male (UMML 24678). Middle: 32.0 mm SL, female (UMML 24678). Bottom: 21.9 mm SL, female (GCRL 4277).

spines; 1st dorsal spine up to three percent longer than depth of caudal peduncle, 3rd spine slightly longer than the 1st, the 12th spine about equal in length to the 1st but averages 3–5 percent shorter than the 1st segmented ray, the 9th segmented ray is 3–5 percent longer than the 1st; anal fin rays II, 14–16; the 1st segmented ray slightly shorter than the 1st dorsal spine; the posteriormost ray the shortest in both dorsal and anal fins, not divided to base, bound to caudal peduncle by moderately broad membranes, which terminate at or near caudal fin base; pectoral fin rays 12–14 (usually 13); pelvic rays I, 4; segmented caudal rays predom-

TABLE 1. Frequency distribution of dorsal, anal and right pectoral fin rays of Atlantic and Pacific *Lupinoblennius dispar* (*marks holotype).

	Segmented Dorsal Rays		Segmented Anal Rays			Right Pectoral Rays		
Locality	13	14	14	15	16	12	13	14
Atlantic	7*	19	1	12*	12	1	23*	2
Pacific	5	4	1	6	2		9	

inately 13 (14 in two, 15 in one), usually with the middle seven branched, occasionally with one or two middle rays simple and with branched rays above and below, all rays may be simple in 10–14 mm SL juveniles; pseudobranchial filaments 5 (in two); gill rakers on 1st arch 8 (in two); vertebrae $10 + 21 - 22 = 31 - 32$. See Tables 1 and 2 for additional counts and proportional measurements.

Body deep anteriad (averages 24–25 percent of SL at pelvic fin insertion), tapering posteriad to about 9 percent of SL at caudal peduncle; moderately compressed, head breadth at opercle 12–18 percent of SL, breadth at posterior angle of gape about 5–8 percent of SL; mouth small, posterior angle of gape may reach vertical from middle of eye, frequently fails to reach anterior margin of orbit; lips distinct but hardly conspicuous, without free posterior margins across symphyses; anterior naris with a short fragile tube, usually with a small posterior marginal filament; posterior naris a large simple pore with a slightly elevated margin, its diameter about a third greater than that of anterior naris and about 10 in eye diameter; without nuchal cirri; with a single leaflike, simple, supraorbital cirrus over each eye, much the longer and broader in males. Gill opening originates beneath interspace between 2nd and 3rd dorsal spines, above and in advance of the upper pectoral angle; gill membranes united across the isthmus, forming a broad fold with a free posterior margin. Caudal fin subtruncate to broadly rounded; pectoral fin rounded, the 7th–9th rays from the dorsalmost the longest, reaches to or slightly beyond anal fin origin; pelvic spine minute and closely bound to the outer ray, 1st and 3rd rays about 20 percent shorter than the 2nd which is 30–50 percent longer than the 4th.

Lateral line (Fig. 3) somewhat variable both bilaterally and between individuals; usually with a high anterior portion from upper opercular angle to below the 9th or 10th dorsal spine and a separate midlateral portion beginning at or near anal fin origin; anteriorly with a moderately long, pored but unbranched, tubiform segment followed by a series of about four short two-pored tubes; midlateral line usually represented by 5–8 separated, short, two-pored segments, occasionally with one or two short segments between upper and lower portions of lateral line. Head pores single at all positions, distributed as shown in Fig. 3, the paired interorbital pores are slightly offset in some specimens.

TABLE 2. Ranges and means ($\bar{x}$) of selected proportional measurements of the holotype and male and female *Lupinoblennius dispar* from Atlantic and Pacific localities in percent of standard length or head length (*).

	Atlantic					Pacific			
	Holotype	Range	$\bar{x}$	Range	$\bar{x}$	Range	$\bar{x}$	Range	$\bar{x}$
Sex	Female	Male		Female		Male		Female	
Number of specimens		8		11		5		4	
Standard length (mm)	28.2	20.2–35.7	27.3	20.0–30.2	23.3	24.5–31.0	27.3	20.9–32.0	26.4
Caudal fin length	20.9	18.2–23.0	20.6	19.7–22.0	20.7	21.6–24.7	23.5	21.6–23.0	22.1
Caudal peduncle depth	8.5	8.4–9.7	8.9	7.8–9.6	8.7	8.3–9.2	8.9	8.1–9.1	8.6
Depth at anal fin origin	19.5	19.3–21.3	20.7	17.5–22.5	19.8	16.8–20.1	19.2	17.8–20.6	19.5
Depth at pelvic fin insertion	25.9	22.8–28.7	24.8	22.7–25.5	24.2	21.9–24.5	23.0	21.6–23.0	22.5
Predorsal length	28.7	24.0–27.9	25.3	24.0–29.8	27.1	24.2–27.2	25.5	27.2–28.3	27.9
Preanal length	56.0	51.6–59.5	54.5	55.3–60.2	57.1	50.3–54.0	52.0	51.6–55.3	53.0
Pectoral fin length	22.0	20.1–24.4	23.2	19.8–25.1	23.2	23.6–25.4	24.8	23.4–24.9	24.4
Pelvic fin length	–	15.1–19.4	16.8	16.3–19.8	18.1	17.1–19.1	18.1	18.1–18.8	18.6
Length of 1st dorsal spine	–	10.2–11.7	10.9	6.5–10.2	9.1	9.8–13.4	11.6	9.1–10.5	9.8
Length of 3rd dorsal spine	–	11.8–13.1	12.4	10.2–11.9	10.8	12.2–16.1	14.1	11.4–12.5	11.8
Length of 12th dorsal spine	–	8.9–12.3	10.6	7.7–9.3	8.5	10.2–15.2	12.9	9.6–10.9	10.0
Length of 1st dorsal ray	–	12.8–16.0	14.1	11.3–14.6	13.3	14.3–20.5	16.7	13.2–14.4	13.9
Length of 9th dorsal ray	–	14.6–19.9	17.5	15.7–19.2	17.0	18.4–21.9	20.0	17.4–21.4	18.8
Length of 1st anal ray	–	6.3–11.0	9.1	7.6–9.6	8.3	7.6–9.6	8.3	5.2–9.6	7.4
Head length	34.8	29.1–36.5	31.3	28.6–35.5	32.7	29.4–30.4	29.9	31.5–33.0	32.0
Eye diameter*	23.5	20.0–25.7	23.2	21.2–29.8	23.8	23.1–27.3	25.4	21.4–27.3	23.7
Snout length*	30.6	20.0–28.7	23.0	22.4–31.3	24.7	19.8–20.9	20.4	27.5–31.8	29.4
Length of gape*	–	26.2–30.5	27.8	22.0–31.0	27.0	28.6–29.7	29.2	27.3–30.1	28.3
Longest supraorbital cirrus*	13.3	28.6–44.8	35.7	9.0–25.3	12.4	20.9–31.9	26.1	8.7–17.4	14.2

Table 3. Comparison of standard length and total number of teeth on premaxillaries and dentaries of Atlantic and Pacific *Lupinoblennius dispar*.

	ATLANTIC			PACIFIC		
Standard length class (mm)	Total teeth on premaxillary	Total teeth on dentary	N	Total teeth on premaxillary	Total teeth on dentary	N
10–14	16–18	16–19	4			
15–19	18	16	1			
20–24	19–24	18–20	9	22–24	19–20	3
25–29	19–24	18–23	6	23–24	18–21	3
30–34	30	24	1	24–29	18–26	3

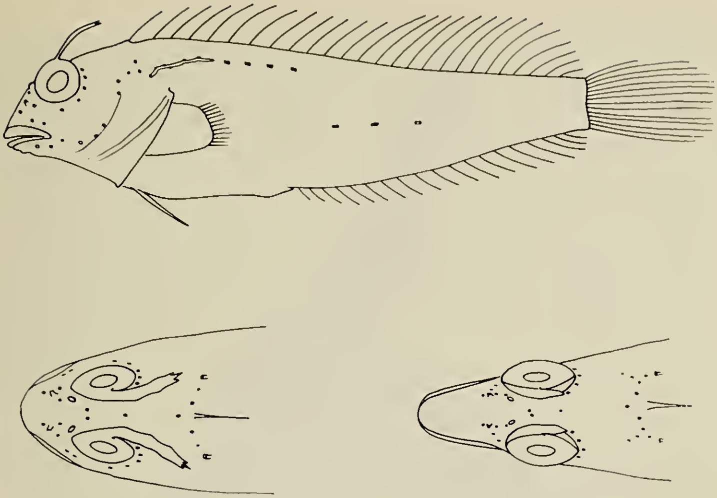


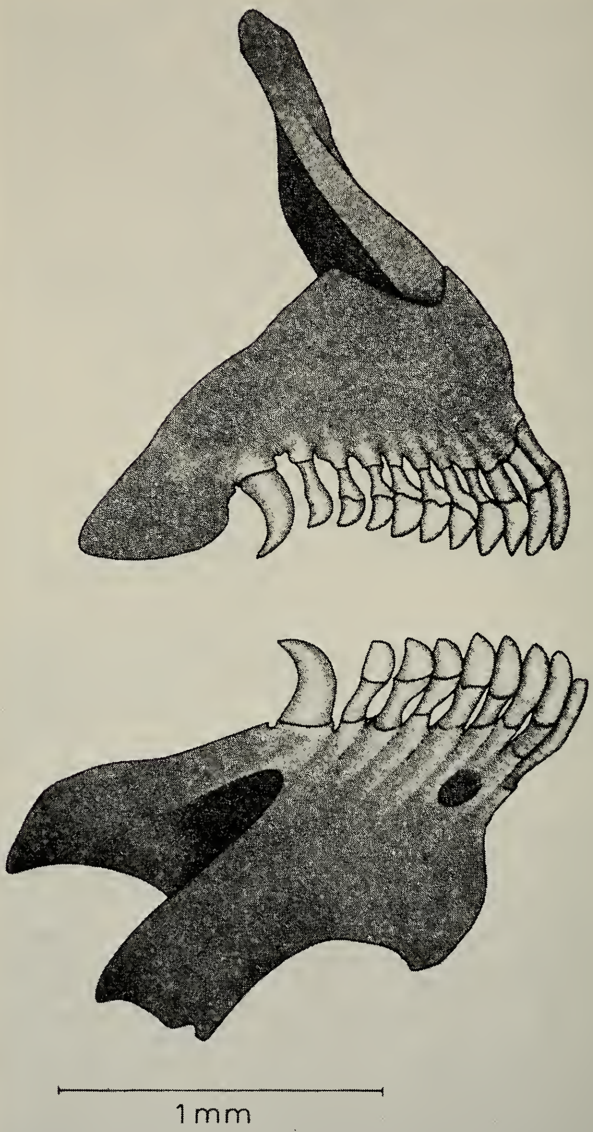
Fig. 3. Semidiagrammatic delineation of lateral line, head pore distribution and head configuration of adult *Lupinoblennius dispar*. Upper: lateral aspect. Lower left: dorsal view of head of 27 mm SL male. Lower right: dorsal view of head of 32 mm SL female.

Snout length averages slightly longer in 20 mm SL and larger females, and the anterior profile of the largest females is somewhat pointed (Figs. 2 and 3), whereas it is generally obtuse in adult males; this is an allometric character that varies considerably with size and between individuals of the same size and sex; no definite difference was noted in snout lengths of males and females less than 16 mm SL.

Teeth in a single series in each jaw, with 16–30 premaxillary teeth and 16–24 teeth on dentary, the number apparently increasing with size (Table 3); males, in some cases at 12 mm SL, with enlarged, recurved, posterior canines in both jaws (Fig. 4); females with smaller but distinct posterior canines on dentary, without enlarged premaxillary canines but frequently with the posteriormost tooth slightly isolated from its fellows; other teeth incisoriform, firmly fixed in jaws, not distinctly depressable.

Circumorbitals 5; vomer edentate; dentaries unsutured at symphysis; epipleurals on 1st through 12th vertebrae, pleural rips on 3rd through 10th; posteriormost dorsal and anal pterygiophores support single fin rays; hypural 5 absent; one epural; ventral hypural plate not fused to urostyle. These observations are from a cleared and stained 20 mm SL female.

Two males, 27 and 36 mm SL, have distinctly enlarged distal fleshy knobs on the anal spines, all but the last two or three anal rays with slightly swollen fleshy knobs which extend well beyond the distal tip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of the fin support, the interradial membranes of the anal fin are deeply incised and the dorsal fin membrane, anteriad of the 1st dorsal spine, is broadened and has a distinct basal notch (Figs. 1 and 5). When depressed, the longest supraorbital cirrus of the larger fish just reaches the dorsal fin insertion, its breadth about four in length (4.7 mm) and it is slightly V-shaped in cross section. A 25 mm male has distal modifications of the anal rays but there is no distinct anal spine enlargement and the dorsal membrane modification is just developing. A 36 mm male from Trinidad has a broadened dorsal membrane but lacks anal fin modifications. In juvenile and adult females the 1st anal spine is included within the genital papilla; anal fin rays and anterior dorsal fin membrane are not modified females. Supraorbital cirri lengths of 20 mm SL and larger females are usually about 30–50 percent of that observed in males of similar size; no distinct difference observed in cirri lengths of males and females less than 16 mm SL.

Ground color in alcohol light tan to brown, body shaded with varying concentrations of darker micromelanophores; usually with a dusky bar from anteroventral margin of orbit to upper lip and another, a short distance behind, extending across posterior suborbital; lips and anterior lower jaw with an irregular scattering of small dark brown blotches; frequently with irregular dusky shading on cheek, opercle and predorsal; supraorbital cirri dusky with pale tips in females, dusky with darker margins or black marginal points in males. Lateral body with about eight or nine irregular, frequently interrupted, dark bars; often with pale blotches superimposed on bars so as to form a series of O or U-shaped markings; lateral bars continue a short distance on proximal dorsal fin in some specimens; abdomen, chest and ventral gill membrane dusky to pale, membrane dark spotted in some; micromelanophores on chest continued well forward beneath gill membrane. A dark blotch on membrane between 1st and 2nd dorsal spines, this may extend to the 3rd spine in largest males; membrane on anterior margin of 1st dorsal spine with 1–4 dark brown or black spots; some specimens with interrupted dark streaks edging margin of fin; remainder of dorsal fin light to dusky, shaded with micromelanophores. Anal fin dusky to rather dark brown, tips of fin rays lighter; caudal fin occasionally pale, usually with dusky streaks on interradial membranes; pectoral and pelvic fins pale to dusky, occasionally tipped with dark brown. Large males usually exhibit the darkest overall coloration. Holotype and most other specimens preserved for a number of years are badly faded but spots on the anterior dorsal spine and the blotch on 1st interradial membrane usually persist.

Except where noted, the foregoing description is based on 20–36 mm

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FIG. 4. Right side dentition of 24.2 mm SL *Lupinoblennius dispar* (USNM 44198).

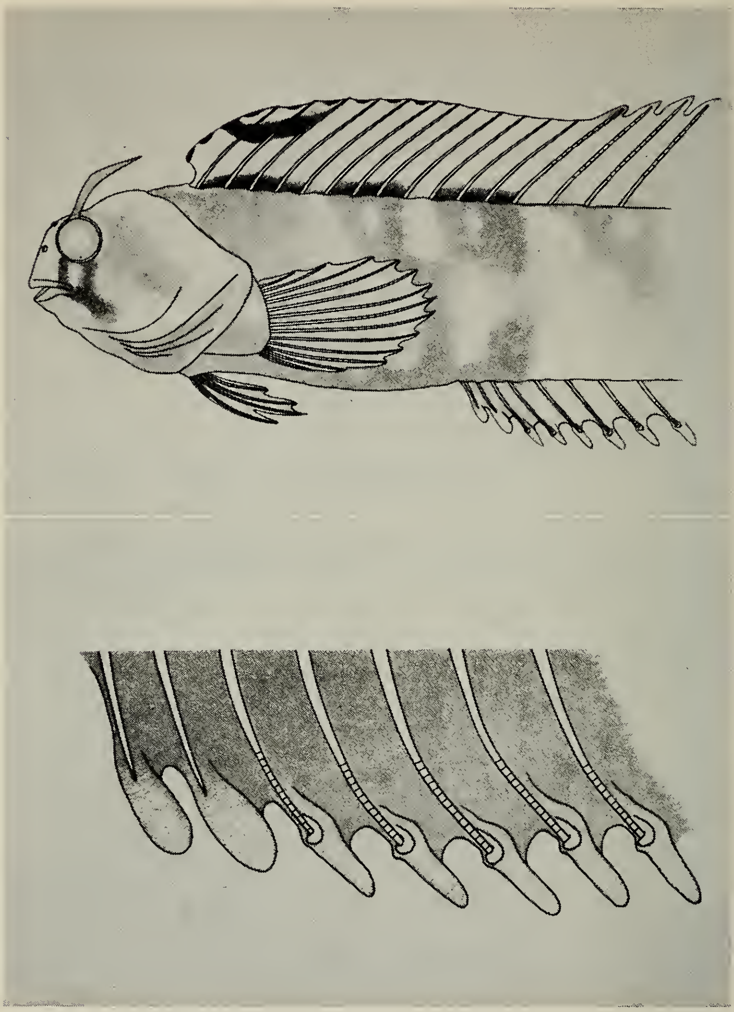

FIG. 5. Semidiagrammatic delineation of adult male *Lupinoblennius dispar.* Upper: Anterior body illustrating basal notch and broadening of anterior dorsal fin membrane, together with general pattern of most distinctive markings. Lower: Detail of anal fin modification.

SL specimens from the Atlantic (Caribbean) coast of Guatemala (GCRL 4278, 4279; USNM 204926).

Pacific Panamanian population.—Dorsal, anal and pectoral rays (Table 1), as well as numbers of vertebrae and principal caudal rays fall within the observed range of Atlantic material. There are not significant differences in the number of teeth at a given standard length (Table 3) and the shape of both incisoriform and canine teeth agrees with that of Atlantic fish. Proportional measurements (Table 2) suggest that the dorsal fin is slightly higher in Pacific fish and there may be some tendency toward a longer snout in females and shorter supraorbital cirri in males. Pacific specimens are slightly darker in ground coloration but pale individuals occur (Fig. 2) and variations in color pattern are within the range noted for Atlantic fish.

Remarks: The holotype of *Lupinoblennius* has four segmented rays in each pelvic fin rather than two as described, and two anal spines (the 1st included within the genital papilla) rather than one. Due to the poor condition of this specimen, I was unable to satisfactorily confirm the reported absence of canine teeth. The mouth is damaged and a number of teeth, particularly in the lower jaw, are obviously missing. There appear to be about 14 teeth on the left side of the upper jaw and there is no posterior canine. Unilateral absence of the posterior canine was noted on dentaries of four females from both Atlantic and Pacific localities during this study, and it is not unlikely that both canines may be lost or fail to develop in some individuals. The posterior canine in females is not exceptionally enlarged and it may have been present and overlooked in the undamaged holotype. Proportional measurements of the holotype (Table 2) generally fall within the range observed here for Atlantic females and compare favorably with those of similar Pacific specimens. There appears little doubt that present material is conspecific with *L. dispar*, and I find no morphological basis for subspecific separation of Atlantic and Pacific Panamanian populations.

Comparisons: This species is similar to *Blennius nicholsi* Tavolga, 1954 (= *Semablennius gallowayi* Fowler, 1954) in general body configuration, lateral line development, head pore distribution and in having large posterior nares. Snout length is a sexually dimorphic character in each and both inhabit protected estuarine environments. *Lupinoblennius dispar* usually has one less segmented dorsal and anal ray, the supraorbital cirri are larger in both sexes and the 1st dorsal spine of females is about half as long as in female *Blennius nicholsi*. There is no prominent barred color pattern in *B. nicholsi* and mature males develop a very distinctive prolongation of the anterior dorsal fin. These closely related forms are most likely congeneric but, pending revision of the tribe Blenniini, it seems inappropriate to comment further on the systematic status of *Lupinoblennius*.

Atlantic (Caribbean) distribution: This species is now known from Campeche and Yucatan, México, Guatemala, Nicaragua and Panamá as well as from the islands of Jamaica, Antigua and Trinidad.

Discussion of Pacific population: Despite numerous collections by myself and others in likely localities from México to Panamá, *Lupinoblennius dispar* has been found in only one Pacific habitat: the unused

Miraflores Third Lock near the western terminus of the Panama Canal. This unique artificial environment was described by Rubinoff and Rubinoff (1968) in discussing a breeding population of the typically Atlantic euryhaline goby *Lophogobius cyprinoides.* Breeding has not been observed in *Lupinoblennius dispar* but collection of young fish at this locality in both 1967 and 1968 suggests either local breeding or annual recruitment from Atlantic stocks.

Although many of the Blenniini are stenohaline, *L. dispar* is evidently well adapted to low salinity habitats. I have collected specimens from estuarine environments in México and Guatemala and I recorded a surface salinity of 9.7 ‰ in the Third Lock on 6 August 1968. There have apparently been no recent collections from Atlantic Panamá but Hildebrand's specimens (USNM 144798) show that this fish occurred as far inland as the Gatun Locks in 1935. Approximate salinities in the two lower chambers at Gatun ranged from 10–16 ‰ on 10 June 1935 (Hildebrand, 1939).

Rubinoff and Rubinoff (1969) have shown that eggs of the Pacific *Gobiosoma nudum* could survive transport through the freshwater lakes of the Canal and subsequently hatch in Atlantic waters. It is not known whether adult *Lupinoblennius dispar* have traversed the Canal but it is not unlikely that eggs of this species could pass through as ship's fouling and hatch on the Pacific side. As postulated for *Lophogobius cyprinoides* (Rubinoff and Rubinoff, 1968), widespread Pacific distribution of *Lupinoblennius dispar* is probably restricted by the absence of an acceptable unoccupied niche.

Present collections and general observations on the fishes of the Third Lock by Rubinoff and Rubinoff (1968) would indicate a small Pacific population of *L. dispar* but further collecting may eventually prove otherwise. If breeding does not occur in or near the Third Lock, the present collections may represent a significant component of small Atlantic to Pacific recruitments during 1967 and 1968.

Material examined: México: Campeche; GCRL 4276 (2, 21.6–24.7), mangrove slough, about 13 mi E of Champoton, approx. 19°33′30″N, 90°42′W; 13 June 1968; C. E. Dawson. Yucatan; USNM 192398 (1, 25.9), Ascension Bay; 16 April 1960. Guatemala: GCRL 4278 (6, 9.6–27.4), Izabal, Bahia de Matias de Galvez, approx. 15°43′46″N, 88° 38′05″W; 28 May 1969; C. E. Dawson. GCRL 4279 (1, 20.4, cleared and stained); USNM 204926 (5, 10.6–35.7), other data as for GCRL 4278. Nicaragua: USNM 44198 (3, 20.2–25.4), Greytown; 3 April 1892; C. W. Richmond. USNM 44198 (1, 24.2, cleared and stained). Jamaica: USNM 131302 (1, 21.7), 1–11 March 1884; ALBATROSS. Antigua: SU 37288 (holotype, 28.2), English Harbor; July 1918; Col. W. K. Fisher. Panamá: USNM 144798 (4, 20.6–30.2), Gatun, lowest chamber of locks; 24 Feb. 1935; S. F. Hildebrand. Trinidad: USNM 163129 (1, 35.6), no other data; 1949; Wm. Beebe.

Pacific.—Panamá: UMML 24678 (8, 20.9–32.0), E of Cocoli, Miraflores Third Lock; 17 May 1967; R. S. Birdsong and party. GCRL 4277 (1, 21.9), locality as above; 6 Aug. 1968; C. E. Dawson.

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PROCEEDINGS
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PYCNOGONIDA OF THE SMITHSONIAN-BREDIN PACIFIC EXPEDITION, 1957.

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Washington, D. C.

This paper reports on a small collection of 54 specimens representing eight species of littoral to shallow water pycnogonids from the Society Islands and Tuamotu Archipelago. The material was collected mostly along the shores and reefs and by washing coral and algae from these same areas.

There has been no previous work published on pycnogonids of the Society and Tuamotu Islands. It is therefore not surprising that five of the eight species listed here were undescribed, particularly in view of the recognized localization of many littoral species as contrasted with the widespread dispersal of many deeper water forms. The genus *Tanystylum* is represented in over half of the collection with three species. In addition, there are two species of *Ammothella*, and a single species each of *Achelia*, *Anoplodactylus*, and *Ammothea.*

Collection data is missing for two of the Bora Bora samples, recorded here as Vial 1 and Vial 2. The Bora Bora stations are numbered 47 through 72, from 22–27 April, and, although the deepest depth possible for these stations was 27 meters, the two samples in question were probably shallow to littoral, since the majority of stations were at these depths.

Pycnogonids of the islands of the Pacific Basin and even of the coasts and islands of the Pacific rim are so poorly known that comments on the origin or dispersal of the Society Islands fauna would be premature. In this collection there is only one faunistic affinity with Indo-West Pacific pycnogonids, *Ammothella indica* Stock. If the synonymy of *Ammothea hilgen-*

dorfi (Böhm), as combined by Utinomi (1959) and Stock (1966) is to be accepted, the collection represents part of an amphi-Pacific tropical-temperate complex. None of the East Indian endemic genera are present. The five genera reported in this paper are pan-tropical or pan-temperate, although the species within each have a tendency, with several exceptions such as *Tanystylum orbiculare* Wilson, to be localized.

Dr. Joel W. Hedgpeth kindly reviewed the manuscript, and his suggestions are greatfully acknowledged. The figures are the author's, drawn with a camera-lucida using whole unmounted material and stained mounted material for the appendages.

FAMILY *PHOXICHILIDIIDAE* SARS, 1891

Genus *Anoplodactylus* Wilson, 1878

Anoplodactylus erectus Cole

Anoplodactylus erectus Cole, 1904, pp. 289–291, pl. XIV, fig. 12, pl. XXVI, figs. 1–9; Hall, 1913, p. 133 (key); Hilton, 1916, pp. 25–34, figs. 1–6; Schmitt, 1934, p. 69; Hilton, 1939a, p. 28; Hilton, 1939b, p. 72, pl. II, fig. 9; Hedgpeth, 1941, p. 257 (key), pl. 11; Hilton, 1942a, pp. 283–286, pl. 37; Hilton, 1942b, p. 72; Stock, 1955, pp. 239–243, figs. 13–14.

Material examined: Tuamotu Archipelago, Makatea Island, Temao harbor, north of pier, 16 April 1957. One male (young adult?). Sta. 37–57.

Remarks: This single specimen agrees well with Cole's species and Stock's (1955) redescription, except for mensural characters. It is only about half as large, but the greatest difference seems to be in the shorter relative length of the lateral processes, proboscis, and chelifores in relation to the rest of the animal. This leads me to believe it is a young adult, possibly in the penultimate molt stage. Other reasons for this belief are that with normally tuberculate species, the tubercles are usually longer in juveniles and young adults. The lateral process tubercles on this specimen are slightly larger in relation to the processes than on adults of the species, and small palpi stubs are present which usually disappear in the adult of *A. erectus*. There is also a lack of trunk segmentation which often occurs in juveniles.

The specimen has the following characters which agree with *A. erectus*: the subcuticular femoral cement gland produced at the distal end as a duct, leaving most of the gland as a conspicuous tube beneath the surface; the lateral pair of setae on both distal sides of the neck; the same relative lengths of the leg and oviger joints as in the described adults; setae, heel, and sole spines that agree in number and size with the description, but the propodal lamina seems to be either missing or barely distinguishable as a small raised portion at the distal end of the sole.

This record extends the range of *A. erectus* into the southern hemisphere.

Its previously known range was Hawaii and the Pacific coast of North America from Panama to British Columbia. This specimen from considerably further west extends the distribution pattern into the South Pacific.

FAMILY *AMMOTHEIDAE* DOHRN, 1881

Genus *Achelia* Hodge, 1864

Achelia adelpha new species

Fig. 1.

Material examined: *Holotype.* Tahiti, Papeete Harbor, anchor chain of yacht *Mareva*, in water about 4 months, 0–11 meters, 8 April 1957. One ovigerous male. Sta. 3–57. USNM 128622. *Paratypes.* Huahine, Baie de Maroe, sandy shoal and wooden post, ½–1 meter, 30 April 1957. Two males, 1 juvenile. Sta. 84–57. USNM 128623.

Description: Trunk circular, lateral processes touching. Cephalic segment armed with 2 narrow tubercles with 1 spine each at anterolateral margins. Lateral processes armed with narrow tubercles each with single spine: 1 on anterior and 2 on dorso-distal margin of first lateral processes; 1 on anterior margin of second and third; 1 each on anterior and posterior margins of fourth. Ocular tubercle a low rounded cone capped with small blunt tubercle, situated at anterior margin of cephalic segment. Eyes large, lightly pigmented. Abdomen short, upcurved, extending to posterior margin of fourth lateral processes and armed with 2 lateral setae near tip. Proboscis long, fusiform, broadest in proximal half.

Chelifores 2-jointed, broadening distally from narrow base, armed with 2 lateral spines and 1 distal spine. Chelae rounded stubs carried inward almost at right angles to scape, glabrous and without finger.

Palpi 8-jointed, second joint slightly longer than fourth. Suture line between joints 3 and 4 indistinct, but with marked constriction. First 3 joints glabrous, fourth with 5–6 dorsal and distal setae. Four terminal joints quadrangular with terminal joint rounded at tip, armed with ventral setae and distal setae on terminal joint.

Oviger 10–jointed, second and third joints subequal, each armed with single seta, fourth and fifth joints subequal, fourth with 2 setae and fifth with 4–5. Sixth joint armed with 1 seta, seventh with 2, eighth with 1 seta and 1 (or possibly 2) denticulate spine. Ninth joint with 1 distal seta and 2 denticulate spines, terminal joint a rounded knob having 2 denticulate spines.

Legs moderately long, first coxae with 2 lateral and 1 dorsal thin setose

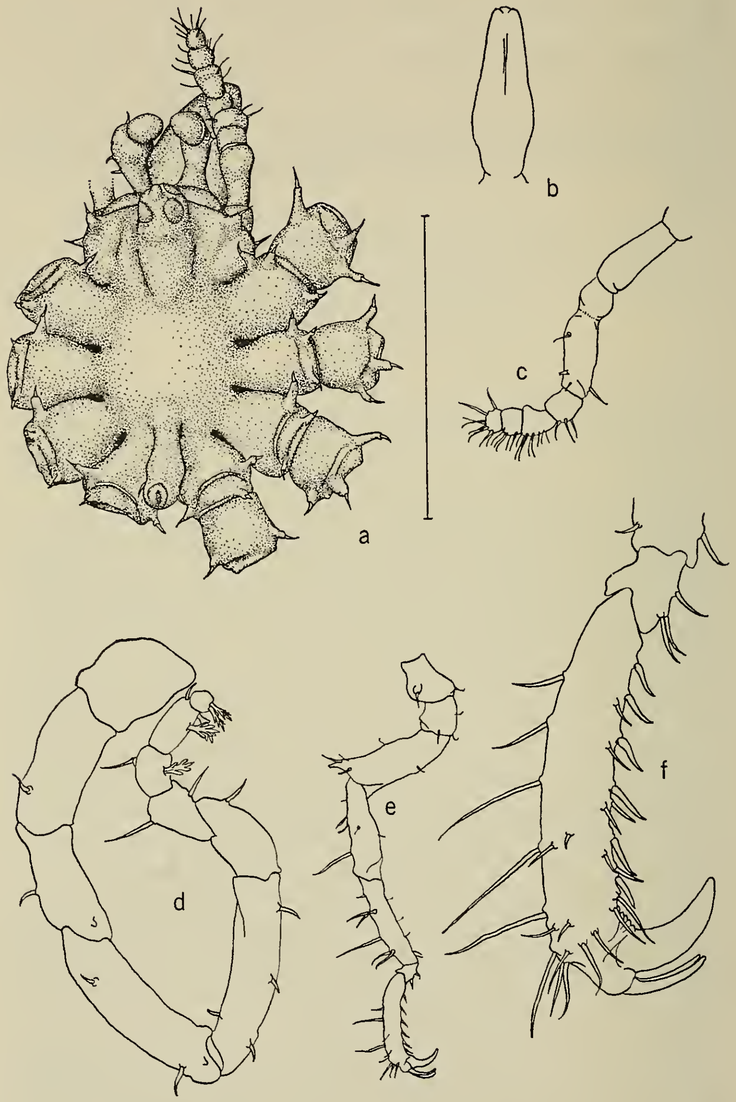


FIG. 1. *Achelia adelpha* new species. a. Dorsal view of trunk (line = .5 mm.); b. ventral proboscis; c. palp; d. male oviger; e. third leg; f. distal joints of third leg.

tubercle, second coxae with 2 lateral setose tubercles, third coxae with lateral setae only. Femur with several scattered setae and 3 spines circling femoral cement gland, a dorso-distal extension of the joint forming a distally directed funnel. Tibae 1 and 2 subequal to femur, armed with dorsal and dorso-lateral setae longer than diameter of joint, and several short ventral setae. Propodus subequal to femur, moderately curved, without heel, armed with 6 sole spines of equal size and several dorsal and distal long setae. Terminal claw slightly less than one-third length of propodus, auxiliaries five-sixths length of terminal claw.

Measurements (in mm):

Length (anterior margin cephalic segment to tip 4th lateral process)	0.54
Width (across second lateral processes)	.50
Ventral length of proboscis	.47
Length of abdomen	.17
Length of chelifore	.15
Third leg:	
Coxa 1	.11
Coxa 2	.16
Coxa 3	.12
Femur	.33
Tibia 1	.34
Tibia 2	.36
Tarsus	.06
Propodus	.31
Claw	.10

Distribution:

Type-locality: Tahiti and Huahine Islands, Society Islands.

Depth range: 0–11 meters.

Remarks: I hesitate to add another species to this confused and in some cases extremely variable genus, but the characters of the four specimens in hand are not all shared by any other of the genus. A few species such as *Achelia nana*, *variabilis* (small form), *dohrni*, *australiensis*, *transfuga*, and *sawayai* have a circular trunk and lateral process configuration, however, this shape is more typical of the genus *Tanystylum*. *Achelia adelpha* has the 4 small terminal palp joints typical of *Achelia*, but it has some characters that are similar to those of *Tanystylum intermedium* Cole. The proboscis and trunk shape similarities are the most notable, but it lacks the large dorsal lateral process tubercles, long abdomen and ocular tubercle, and has denticulate oviger spines and smaller coxal tubercles than *T. intermedium*.

Achelia adelpha is most closely related to *A. sawayai* Marcus, 1940 (forma *besnardi* Stock, 1955, pp. 245–6). *Achelia adelpha*, however, has a shorter abdomen, smooth chelae placed anaxially rather than synaxially on the scape, and 2 tubercles on the lateral margins of the cephalic segment, whereas, *sawayai* has single dorsal margin tubercles only.

The specific name *adelpha* is from the Greek *adelphus*, meaning sisterly or brotherly, signifying the close relationship of this species to *A. sawayai.*

Genus *Ammothea* Leach, 1814

Ammothea hilgendorfi (Böhm)

Corniger hilgendorfi Böhm, 1879, pp. 187–189, pl. II, figs. 3–3d.
Lecythorhynchus hilgendorfi Utinomi, 1959 (literature), pp. 209–212, figs. 5–6.
Lecythorhynchus marginatus Ziegler, 1960, p. 20.
Ammothea hilgendorfi Stock, 1966, p. 388 (in lit.).

Material examined: Bora Bora, west of Motu Tapu, lagoon side of ocean reef, 25 April 1957. One juvenile. Sta. 62–57.
Bora Bora, no location, 22–27 April 1957. Vial 1. One male.
Moorea, Nuarei Bay, reef opposite Pointe Teanatira, 11 May 1957.
One ovigerous male. Sta. 126–57.

Remarks: These 3 specimens agree with the fine figures and description by Lou (1936). This is the first record of this species from the South Pacific and of a purely tropical habitat. The North Pacific range previously recorded placed the species in a more temperate environment.

Genus *Ammothella* Verrill, 1900

Ammothella indica Stock

Ammothella indica Stock, 1954, pp. 113–119, figs. 54, 55, 56c, 57a-c; Stock, 1959, p. 551; Utinomi, 1959, pp. 203–205, figs. 2, 3a-f; Stock, 1968, p. 11.

Material examined: Tahiti, Papeete Harbor, anchor chain of yacht *Mareva,* in water about 4 months, 0–11 meters, 8 April 1957. One male, 4 juveniles. Sta. 3–57.

Remarks: These specimens differ from Stock's description of the types principally with regard to the placement and number of setae and spines. The count of heel spines varies from Stock's 3, to 4 and 5 in these specimens, and the sole spine count varies from 6 to 9. The long tubular spine on the first joint of the scape is not present, but is replaced by a long thin seta and the number of tubular spines is less on the femur where they are mostly lateral and ventral. The long dorsal leg setae are more than 3 times the diameter of their joint. The palpi, chelae, abdomen, and oviger correspond with the type figures.

This species has a wide distribution in the Indo-Pacific. If Utinomi's 2 juveniles are indeed *A. indica,* it ranges from South Africa to the Society Islands to Central Japan. With so few specimens recorded, it is impossible to discuss further variation or zoogeography for the species.

Ammothella schmitti new species

Fig. 2.

Material examined: *Holotype*: Bora Bora, west of Motu Tapu, lagoon side of ocean reef, 25 April 1957. One male. Sta. 62–57. USNM 128624. *Paratypes*: Bora Bora, same station. One juvenile. USNM 128625; Bora Bora, no location, 22–27 April 1957. Vial 1. One male, 3 juveniles. USNM 128626; Bora Bora, no location, 22–27 April 1957. Vial 2, rubble and algal washings. One male, 1 female, 2 juveniles. USNM 128627; Moorea, Nuarei Bay, reef opposite Pte. Teanatira, 11 May 1957. One ovigerous male, 1 juvenile. Sta. 126–57. USNM 128628.

Description: Trunk oval, lateral processes separated by one-third their width, first armed with 2 posterior spines, second with 2 anterior and 2 posterior spines, third with 1 anterior seta and 2 posterior spines, fourth with 1 anterior seta. Cephalic segment moderately broad, slightly more than twice lateral process width, armed with pointed setose tubercles on anterior margin over point between insertion of palpi and chelifores. Ocular tubercle in center of segment, short, without apical tubercle or seta. Eyes large, well pigmented. Proboscis a broad oval, typical shape for genus, with flat oral surface. Abdomen moderately short, horizontal, extending to distal end of coxa 1, armed with 3–4 lateral and dorsal tubular setae, 4 dorso-lateral long feathered setae, and 2–3 ventro-distal short setae.

Palpi 9-jointed, second and fourth joints subequal, fifth and sixth joints subequal. Terminal joint almost twice length of seventh or eighth. Second joint with distal fringe of short setae, third joint with same distal fringe and 1 lateral tubular seta, fourth joint with distal and ventral fringe of short setae, 4 long feathered dorsal setae, and 2 short ventral feathered setae. Terminal 5 joints with short to long ventral feathered setae and random short plain setae.

Chelifores shorter than proboscis, with 2-jointed scape, second joint ⅕ longer than first. First joint with 4-5 dorsal and lateral tubular setae and 1 feathered lateral seta. Second joint with 5–7 tubular setae and 3–5 feathered setae. Chelae with 1–2 tubular setae and 1 long feathered seta, without finger except a minute rounded stub.

Oviger 9-jointed, fourth and fifth joints longest, subequal, second next longest and third slightly shorter. Third, fourth, fifth, and sixth joints with 1–2 short setae, seventh with 1 long and 1 short seta, 2 terminal joints with 2 denticulate spines each.

Legs setose, rather robust. Coxae 1 and 2 armed with 2–3 dorsolateral tubular setae, some with spatulate tips, and 3–4 long feathered setae. Coxa 3 with 1–2 long feathered setae. All coxae with ventral tufts of short setae. Coxa 2 and 3 subequal and together subequal to femur. Femur shorter than either tibia which are subequal. Femur and tibiae with numerous dorsal and lateral long feathered setae and 3–4 lateral tubular setae on femur. Femoral cement gland a tube, shorter than

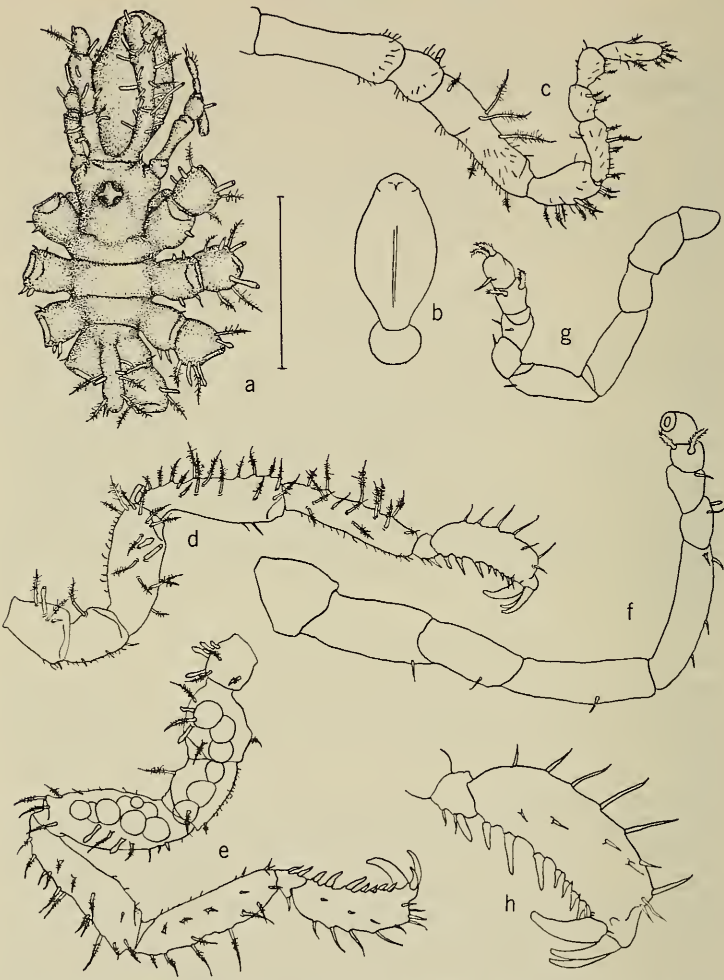


FIG. 2. *Ammothella schmitti* new species. a. Dorsal view of trunk (line = .5 mm.); b. ventral proboscis; c. palp; d. third leg (male); e. third leg (female); f. male oviger (tip broken off); g. female oviger; h. distal joints of third leg.

diameter of joint, at dorso-distal rim of joint. Tibia 2 with short ventral setae. Tarsus with 1 ventral spine and 2 setae. Propodus robust, slightly curved, subequal to femur, with 8 dorsal setae, shorter than propodal diameter, a line of 4 lateral setae, 3 heel spines, and 5 shorter sole spines.

Terminal claw little more than one-third length of propodus with auxiliaries about four-fifths length of terminal claw. Female femur slightly longer than either tibia, propodus only three-fourths length of femur.

Measurements (in mm):

Length (anterior margin cephalic segment to tip 4th lateral process)	0.66
Width (across second lateral process)	.54
Ventral length of proboscis	.62
Length of chelifore	.55
Length of abdomen	.28
Third leg:	
Coxa 1	.11
Coxa 2	.22
Coxa 3	.21
Femur	.38
Tibia 1	.45
Tibia 2	.44
Tarsus	.08
Propodus	.35
Claw	.13

Distribution:

Type-locality: Bora Bora and Moorea Islands, Society Islands.

Depth range: indefinite, but probably shallow to littoral.

Remarks: This proposed species is closely related to the Pacific species *A. heterosetosa* Hilton, and a new species to be described by the author and J. W. Hedgpeth, from the Galapagos Islands. I regret comparing this species with one whose description has not been released, but their several similarities make it necessary.

The above mentioned species have the following similarities: an inflated oval proboscis; an oval trunk with closely set lateral processes; strong chelifores with many tubular, feathered, or plain setae; moderately to heavily setose legs; and size and spine similarities in the ovigers. *Ammothella schmitti* differs from *A. heterosetosa* in the following characters: it has many less setae on the chelifores than *heterosetosa*, the setae of the latter being arranged in more or less lateral planes along the sides of the chelifores while the fewer setae of *schmitti* are arranged randomly; the tubular "spatulate" spines of *heterosetosa* seem to be inflated in the middle and taper to a narrow blunt point rather than appearing spatulate or flattened, as described by Hilton (1942a, pp. 299–300), whereas a few of the spines on the legs of *schmitti* are spatulate and appear flattened when viewed from their tip; tibia 2 is longer than either tibia 1 or the femur in *heterosetosa*, while the 2 tibiae are subequal in *schmitti*; the femoral cement gland, while of the same shape as *schmitti*, is set back from the distal rim of the joint in *heterosetosa*; there are fewer feathered setae on the legs of *heterosetosa*, but there are more plain tubular setae in *schmitti* out of the total number of setae on each species; finally, *schmitti* has small spinose tubercles on the cephalic segment margin while *heterosetosa* has expanded lateral tubercles without setae on this segment.

The undescribed species from the Galapagos Islands differs from *A. schmitti* in having longer legs with many ventral feathered tubular setae (long hollow tubes with many tiny lateral setae), a much longer abdomen with long setae having granules along their length, very long granular lateral tubercles on the cephalic segment, very long terminal palp joints, and an ocular tubercle set at the anterior margin of the cephalic segment instead of the middle as in *schmitti*.

The new species is named for Dr. Waldo L. Schmitt, scientific leader of the expedition and indefatigable collector of marine invertebrates over the past 60 and more years.

Genus *Tanystylum* Miers, 1879

Tanystylum bredini new species

Fig. 3

Material examined: *Holotype*: Bora Bora, no location, 22–27 April 1957. Vial 1. One ovigerous male. USNM 128629. *Paratypes*: Bora Bora, same sample. Vial 1. One ovigerous male, 2 males. USNM 128630 Bora Bora, west of Motu Tapu, lagoon side of ocean reef, 25 April 1957. One male. Sta. 62–57. USNM 128631; Moorea, Maharepa Bay, west of Irihonu Pass, 10 May 1957. One male, 1 ovigerous female, 1 juvenile. Sta. 116–57. USNM 128632; Moorea, same as 116–57, collected from pieces of coral pavement, 10 May 1957. One ovigerous male, 1 male. Sta. 116a–57. USNM 128633.

Description: Trunk circular, without suture lines. Partial fold or "suture" in integument between ocular tubercle base and anterior base of abdomen. Lateral processes with small blunt dorso-lateral tubercles on distal margins. Anterior margin of cephalic segment armed with single spine at lateral ends. Ocular tubercle a truncated cone at anterior margin of cephalic segment, capped by small blunt tubercle. Eyes lightly pigmented. Abdomen with a glabrous hump at base and extending only slightly beyond fourth lateral processes, armed with 3–4 dorso-lateral setae. Abdomen angled almost horizontally. Proboscis slightly curved along margins with truncated cone shape.

Chelifores of moderate length, one-fourth length of proboscis, armed with 3 distal setae.

Palpi 4-jointed, sum of 2 terminal joints less than length of second joint. Second joint with 4–5 setae and a tuft of 2–3 ventro-distally. Terminal 2 joints with distal and ventral tufts of setae.

Ovigers 10-jointed, typically reduced by half their size in the female. First joint of male as long as wide. Fourth joint longest, second and fifth slightly shorter, third just over half the fourth. Seventh and eighth joints synaxial, seventh without lateral tubercle, but with strong spine on proximal margin, appearing opposable to 2 nondenticulate spines on terminal joint. Single seta on second, third, and fifth joints, 2–4 on sixth through ninth joints.

Legs short, robust, spinose. Coxae 1 with bilobed anterior tubercle and low dorsal tubercle with spines on tubercles and posterior margin. Coxae 2 with low ventral spinose tubercle, reduced in female. Coxae 3 nontuberculate, with 3–4 ventral setae. Femur slightly shorter than sum of coxae, moderately spinose, without marked swellings on dorsal surface. Femoral cement gland a cone on dorso-distal margin, curved dorsally. Tibiae with proximal, median, and distal swellings, each bearing tuft of setae. Tibia 1 slightly longer than tibia 2, each with several small ventral setae. Tarsus without strong ventral spine, but with 2 setae. Propodus strongly curved, without heel, with 3 large basal spines and 6–8 small sole spines. Terminal claw less than half propodal length. Auxiliaries about ¾ length of terminal claw.

Measurements (in mm):

Length (anterior cephalic segment to tip 4th lateral process)	0.58
Width across 2nd lateral processes	.64
Length of proboscis (ventral)	.5
Length of abdomen	.31
Length of chelifores	.08

Third leg (male):

Coxa 1	.17
Coxa 2	.16
Coxa 3	.19
Femur	.48
Tibia 1	.38
Tibia 2	.35
Tarsus	.1
Propodus	.34
Claw	.16

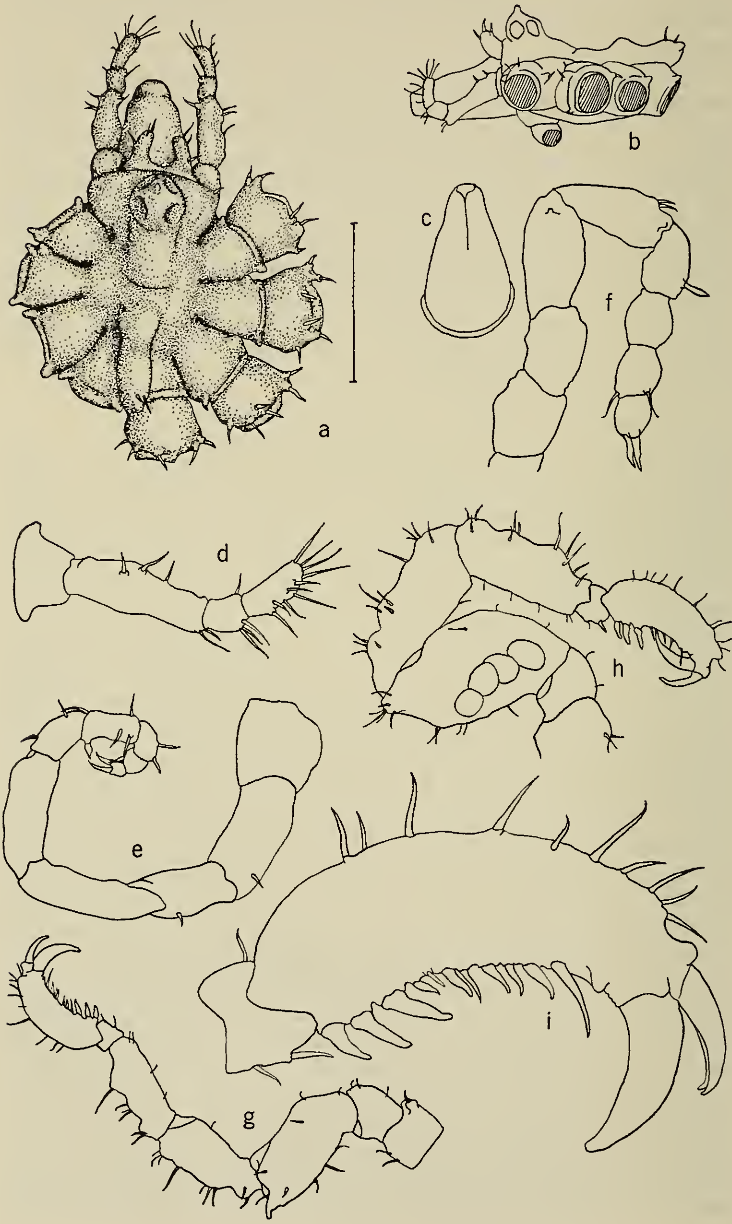
Distribution:

Type-locality: Bora Bora and Moorea Islands, Society Islands.

Depth range: indefinite, but probably littoral to shallow.

Remarks: The length of the proboscis among the 9 adult specimens varies from that figured to approximately one-sixth longer. It varies among specimens from the same station. The longer proboscis appears to be narrower, but is the same width at the base as in the shorter specimens. The specimens agree in all other respects.

Tanystylum bredini is most closely related to *T. geminum* and *isthmiacum.* All three share the following characteristics: a 4-jointed palp, fairly long chelifores, similarly shaped proboscis, and legs with dorsal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setose swellings, longer femorae than the tibiae which are almost equal, and similar propodal spination. Unfortunately, only the female is known of *T. isthmiacum*, but both *T. geminum* and *bredini* have the eighth oviger joint placed synaxial to the seventh, which lacks tubercles or lateral projections. The new species differs from *T. geminum* in having tubercles on the lateral processes and first coxae. It differs from *T. isthmiacum* by the presence of shorter chelifores and cephalic segment, a shorter abdomen having a hump at its base, a less tubular distal end of the proboscis, and tubercles on all lateral processes.

The proposed species is named for Mr. J. Bruce Bredin, generous sponsor ~~and leader~~ of this expedition.

Tanystylum nesiotes new species

Fig. 4.

Material examined: Holotype: Moorea, Maharepa Bay, west of Irihonu Pass, 10 May 1957. One ovigerous male. Sta. 116–57. USNM 128634. *Paratype*: Moorea, NW end, west of Pointe Hauru, collection from reef, 8 May 1957. One female. Sta. 105–57. USNM 128635; Moorea, Nuarei Bay, reef opposite Pointe Teanatira, 11 May 1957. One male, 1 female, 6 juveniles. Sta. 126–57. USNM 128636; Tahiti, Papeete Harbor, anchor chain of yacht *Mareva*, in water about 4 months, 0–11 meters, 8 April 1957. One female, 2 juveniles. Sta. 3–57. USNM 128637; Bora Bora, west of Motu Tapu, lagoon side of ocean reef, 25 April 1957. One female. Sta. 62–57. USNM 128638; Bora Bora, no location, 22–27 April 1957. Vial 1. One female. USNM 128639; Bora Bora, no location, 22–27 April 1957. Vial 2, algal and rubble washings. Two males, 1 female. USNM 128640.

Description: Trunk circular, unsegmented. Lateral processes fully in contact except where first pair curve anteriorly away from second pair, all with low anterior and posterior tubercles except first pair which has posterior tubercles only. Anterior of cephalic segment a distinct broad truncated triangle with glabrous lateral points. Ocular tubercle a truncated cone projecting slightly forward of vertical, capped with low tubercle, situated in center of cephalic triangle. Eyes lightly pigmented. Abdomen very short, erect to 60–70 degrees, extending only halfway to posterior of fourth lateral processes, armed distally with 4–5 short setae. Proboscis bluntly conical, tapering slightly from base to distinct dorsal constriction on four-fifths distance toward mouth, a flat oral surface.

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FIG. 3. *Tanystylum bredini* new species. a. Dorsal view of trunk (line = .5 mm.); b. lateral view of trunk; c. ventral proboscis; d. palp; e. male oviger; f. female oviger; g. male third leg; h. female third leg; i. distal joints of male third leg.


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Chelifores one-sixth dorsal length of proboscis, only as long as wide, armed with 2 distal setae.

Palpi 3-jointed, first joint longest, slightly inflated, second joint half length of third. First joint with 4 dorsal and several ventral setae. Second joint with ventral tuft of long setae. Terminal joint with a few long dorsal, distal, and ventral setae. Palp only slightly longer than proboscis.

Oviger 10-jointed, much reduced in female. Second, third, and fourth joints subequal, fifth longest. Second, fourth, sixth, and seventh joints armed with several short setae. Seventh joint without lateral tubercle or projection, eighth joint attached synaxial to seventh. Seventh, eighth, and ninth joints armed with distal tuft of 3–4 long setae. Tenth joint a button bearing 2 long nondenticulate spines. Spination of female oviger reduced with tenth joint bearing 2 short hooked spines.

Legs short, moderately stout, spinose. Coxa 1 with anterior and posterior lateral tubercles, each with apical spine, coxa 1 of legs 3 and 4 also armed with single median dorsal spine distally. Coxa 2 with low dorsal tubercle. Coxa 3 with small sharp dorsal tubercle. Femur and tibia 1 subequal. Femur with 3–4 dorsal setae on and around distal bulge. Femoral cement gland inconspicuous, without tubule, situated at curve of distal margin of femur. Tibia 1 and 2 with proximal, median, and distal swellings armed with tufts of setae shorter than tibial diameter. Tibia 2 longer than tibia 1. Tarsus armed ventrally with single broad blunt spine and 3 setae. Propodus robust, moderately curved, with slight heel bearing 3 broad blunt spines. Sole with 10–11 short thick spines. Claw half propodal length with auxiliaries ⅔ length of terminal claw.

Measurements (in mm):

Length (anterior margin cephalic segment to tip 4th lateral process)	0.48
Width (across second lateral processes)	.5
Length of proboscis (ventral)	.34
Length of chelifore	.05
Length of abdomen	.17
Third leg:	
Coxa 1	.11
Coxa 2	.16
Coxa 3	.15
Femur	.33

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FIG. 4. *Tanystylum nesiotes* new species. a. Dorsal view of trunk (line = .5 mm.); b. lateral view of trunk; c. ventral proboscis; d. palp; e. male oviger; f. female oviger; g. male third leg; h. female third leg; i. distal joints of third leg (male); j. oblique view of distal joints showing spine arrangement.

Tibia 1	.34
Tibia 2	.35
Tarsus	.07
Propodus	.32
Claw	.14

Distribution:

Type-locality: Tahiti, Moorea, and Bora Bora, Society Islands.

Depth range: 0–11 meters.

Remarks: There are three other species of this genus in which the abdomen is placed as far forward on the trunk as *T. nesiotes*, disregarding the wide variation in placement and carriage of the abdomen displayed in various figures of *T. orbiculare*. These are *T. brevicaudatum, occidentalis*, and an undescribed species from the Galapagos Islands. In *T. brevicaudatum*, the proboscis differs from *T. nesiotes* in being much longer and tubiform, and *nesiotes* has 3 palp segments, whereas *brevicaudatum* has four. *Tanystylum nesiotes* seems most closely related to *T. occidentalis*, except for the rounded oral surface of the proboscis, the lack of posterior tubercles on the first coxae, the rounded distal structure of the abdomen, and the greater length of the chelifores of *T. occidentalis*.

Tanystylum nesiotes is also similar to a series of specimens from the Galapagos Islands, to be described in a forthcoming paper on Galapagos pycnogonids by the author and J. W. Hedgpeth. *Tanystylum nesiotes* differs from the Galapagos specimens in the following respects: the Galapagos specimens are one-third larger and appear more robust and slightly more spinose; the ocular tubercle of *T. nesiotes* is larger in proportion to the trunk and the abdomen is carried much more erect and therefore appears to be larger than that of the Galapagos specimens; the palp terminal joint is longer in proportion to the other joints of *nesiotes* than in the Galapagos specimens; and the legs are notably less spinose, especially on the ventral surface of *nesiotes*. The relative lengths of the oviger joints offer one of the most striking differences between the species. The second, fourth, and fifth joints of *nesiotes* are shorter in relation to the third joint than with the Galapagos specimens. The fifth joint of both species is the longest, but it is only 1.5 times as long as the third joint of *nesiotes* and is over twice as long as the third for the Galapagos specimens. These several differences seem sufficient to erect the new species.

The proposed name *nesiotes* is Greek and refers to an islander.

Tanystylum rehderi new species

Fig. 5.

Material examined: *Holotype*: Bora Bora, no location, 22–27 April 1957. One ovigerous male. Vial 1. USNM 128641. *Paratype*: Moorea, Nuarei Bay, reef opposite Pointe Teanatira, 11 May 1957. One male. Sta. 126–57. USNM 128642.

Description: Trunk circular, lateral processes fully in contact. Small glabrous anterior and posterior tubercles on each lateral process. Cephalic segment slightly raised above trunk. Anterior margin of cephalic segment armed with small tubercle and seta on both lateral lobes. Ocular tubercle a truncated cone capped with small blunt tubercle. Eyes slightly pigmented. Abdomen extending only slightly beyond distal margin of fourth lateral processes, with large swelling at base, armed with 5–6 short setae. Proboscis almost length of trunk, with very large base, tapering gradually to narrow styliform tube over distal one-fourth of length.

Chelifores shorter than wide, extending about one-seventh length of proboscis, armed with single distal seta.

Palpi 6-jointed with fourth joint longest. Second and sixth joints subequal, about one-half length of fourth. Third joint little more than a short ring. Second, third, and fourth joints with a few random setae, fifth and sixth with tufts of ventral and distal setae.

Oviger 10-jointed. Second and third joints subequal. Fifth joint longest, having an apparent constriction just past mid-length. Seventh joint with lateral projection with 2 large apical setae. Tenth joint armed with 2 broad nondenticulate spines.

Legs short, robust, with sparsely developed spination. First coxae with large lateral and dorsal tubercles armed with 1–3 setae and small ventral tubercles armed with 1 seta. Coxa 2 longer by one-third than coxae 1 and 3 which are subequal. Coxa 2 with dorsal swelling bearing 1 seta. Coxae 2 and 3 with several short ventral setae. Femur with large midventral swelling armed with 1 seta and flat dorsal surface with 2 setae. Femoral cement gland a large dorsal cone projecting beyond distal margin of joint. Femur shorter than sum of coxae, but subequal to tibia 1. Tibia 2 slightly longer. Tibia 1 with 2 proximal, 1 median, and 1 distal swelling, tibia 2 with 1 proximal, median, and distal swelling, each armed with 1–5 setae. Tarsus with 1 thin spine and 2 small setae ventrally, 1 small seta dorsally. Propodus moderately curved, large, without heel, bearing 3 large heel spines and 8–9 sole spines. Dorsal surface with 9 setae and 3–5 lateral setae. Terminal claw less than half propodal length. Auxiliaries slightly longer than one-half terminal claw.

Measurements (in mm):

Length (anterior cephalic segment to tip 4th lateral process)	0.72
Width across second lateral processes	.73
Length of proboscis (ventrally)	.5
Length of abdomen	.31
Length of chelifore	.04
Third leg:	
Coxa 1	.16
Coxa 2	.21


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Coxa 3	.17
Femur	.44
Tibia 1	.46
Tibia 2	.43
Tarsus	.08
Propodus	.35
Claw	.18

Distribution:

Type-locality: Bora Bora and Moorea Islands, Society Islands.

Depth range: indefinite, but probably shallow to littoral.

Remarks: Among the 12 *Tanystylum* species having a more or less tubiform or styliform proboscis, there are four that share other characters with *T. rehderi.* These are *T. acuminatum, isabellae, oculospinosum,* and *tubirostre.* There are the following differences between *rehderi* and *acuminatum*: only the distal fifth of the proboscis of *acuminatum* is tubiform, whereas the distal fourth of *rehderi* is this shape; the palpi of both species are much alike, but the abdomen is longer in *acuminatum*; the sum of the coxae is slightly less than the length of the femur of *acuminatum,* but the coxal sum is one-fifth larger than the femoral length of *rehderi*; and the first coxal tubercles are of greater size in *rehderi* than in *acuminatum.* Unfortunately, only the female is known for *acuminatum* and only the male for *rehderi,* so differences within the same sex of the two species are not comparable. *Tanystylum rehderi* shares several characters with *T. isabellae*; coincidence of the number and length of palp joints, the lateral process and first coxal tubercles, the lateral tubercle or process on the male seventh oviger joint, the placement and shape of the femoral cement gland, and the general shape of the abdomen. It differs from *isabellae* in the following ways: *rehderi* has a larger ocular tubercle without a large apical spike and the ocular tubercle is placed in the middle of the cephalic segment instead of at the anterior margin; it has a somewhat larger and longer proboscis, longer chelifore stumps, different shape to the lateral projection on the seventh oviger joint, and *rehderi* has a reduced number of spines on the chelifores and anterior margin of the cephalic segment. *Tanystylum isabellae* apparently also lacks the small pointed tubercles on the corners of the cephalic segment.

The new species is less like the other two species, *T. oculospinosum* and *tubirostre,* that comprise its nearest relatives. The tubular proboscis of *rehderi* is larger and directed more forward than in *oculospinosum,* and the distal curvature of the proboscis of *tubirostre* is very unlike the

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FIG. 5. *Tanystylum rehderi* new species. a. Dorsal view of trunk (line = .5 mm.); b. lateral view of trunk; c. ventral proboscis; d. third leg; e. oviger; f. palp; g. distal joints of third leg.

new species. The arrangement and size of the lateral process and coxal tubercles are different for each of these 3 species.

The proposed species is named for Dr. Harald A. Rehder, scientific member of the expedition and continuing contributor to the malacology of the Society Islands.

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PROCEEDINGS
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MARSIPASTER ACICULA, NEW SPECIES (ASTEROIDEA: ECHINODERMATA), FROM THE CARIBBEAN AND GULF OF MEXICO

By Maureen E. Downey
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Among the starfishes collected by the Texas A&M University's R/V "*Alaminos*" in the western Gulf of Mexico was a small specimen of the genus *Marsipaster*, in very poor, fragmentary condition. Comparison with material in the U.S. National Museum showed it to be the same species as specimens catalogued and labeled, in A. E. Verrill's own hand, as *Pteraster acicula*. As far as I have been able to determine, this species was never described. Verrill's specimens were collected by the "Albatross" in 1885, one off Havana, Cuba, and two off the west coast of Florida, in 217 and 142 fathoms. He apparently overlooked them when preparing his 1915 report on the starfishes of this area. The "*Alaminos*" specimen was from 25°31′N, 95°91′W, 580–750 fathoms.

Marsipaster acicula new species

Arm short, disc plump, inflated. Supradorsal membrane very fragile, delicate, web like. Abactinal plates 4-lobed, paxillar columns tall, moderately stout; 8–25 long, slender, glassy spines crown each paxilla, longer than paxillar column and protruding through supradorsal membrane for as much as half their length; paxillar spines webbed together on each paxilla near their bases below supradorsal membrane. Central osculum not conspicuous, closed not by separate and distinct valves but by the irregular number of spines of adjacent paxillae webbed together in a continuous ring around the osculum. Spiraculae small, numerous.

Each half of jaw plate bears 5 oral spines; a single large epioral spine on each jaw plate, stout, smoothly tapering, glassy. Six erect adambulacral spines, plus a recumbent actinolateral spine which is very long,

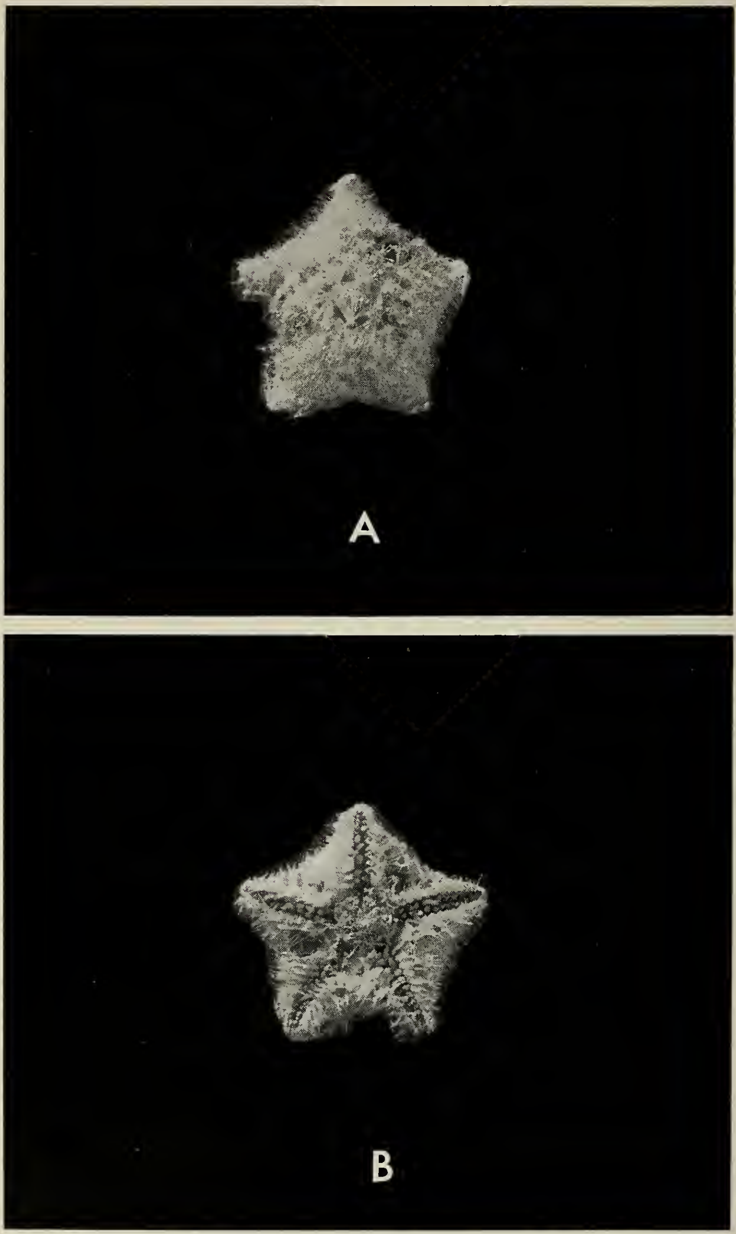

FIG. 1. *Marsipaster acicula* new species. A. Dorsal, B. Ventral.

slender, immersed in actinal membrane; adambulacral spines in curved series, innermost one small, very slender; others rather long, slender, acute, subequal. No actinolateral fringe.

R = 8 mm, r = 5 mm (in largest paratype). Rr = 1:1.6.

Holotype: USNM 18416, from "*Albatross*" station 2642.

Paratypes (2): USNM 10447, from "*Albatross*" station 2401.

Discussion: This species is very similar to another Caribbean form, *Pteraster caribbaeus* Perrier, 1881, in size and general facies, but it differs in lacking a marginal fringe, in having many more paxillar spines (8–25 vs. 8–10 for *P. caribbaeus*), and in having a smoothly tapered epioral spine, in contrast to the flattened, sublanceolate epioral spine of *P. caribbaeus*. The jaws are also broader and flatter, with 5 oral spines, not particularly slender; *P. caribbaeus* has 6 very slender oral spines on each jaw half. The supradorsal membrane is much more delicate and resembles spongin, rather than being a continuous sheet; there are, of course, no muscle bands. This is the first species of *Marsipaster* from the Atlantic. It differs from the Pacific species mainly in the armature of the mouth plates. Sladen (1889) lists 3 species of *Marsipaster*, one from the Atlantic. However, this species, *M. alveolatus* Perrier, is an undoubted *Pteraster*. *Marsipaster spinosissimus* Sladen, 1882, is from the mid-South Pacific; it differs from *M. acicula* in having 3 webbed oral spines and the epioral spine is replaced by a very small spine webbed to the oral spines. *M. hirsutus* Sladen, 1882, from the west coast of South America, has mouth armature similar to that of *M. spinosissimus*, but the oral spines are much longer and set back from the edge of the mouth plate, rather than being terminal on it.

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PROCEEDINGS
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FRESHWATER TRICLADS (TURBELLARIA) OF NORTH AMERICA.
III. *SPHALLOPLANA WEINGARTNERI* NEW SPECIES, FROM A CAVE IN INDIANA.[1]

By Roman Kenk
The George Washington University, and Smithsonian Institution[2]

Freshwater triclads or planarians represent important components of the subterranean aquatic fauna. The various species are generally found in very limited geographic areas, confined to individual cave systems. This geographic isolation has led to a high degree of speciation as is the case also with other true troglobites (see de Beauchamp, 1932; Hyman, 1960; Nicholas, 1960).

So far no obligate troglobitic planarian is known to occur in Indiana caves. *Phagocata subterranea* Hyman, a white and sometimes eyeless planarian reported from Donaldson's Cave in Spring Mill State Park near Mitchell, Lawrence County (Hyman, 1937: 474), proved to be a hypogean form of *P. gracilis* (Haldeman), a species widely distributed in surface waters. Professor Eliot C. Williams of Wabash College found in specimens from Donaldson's Cave "all gradations in pigmentation between light and almost black and similar variation in eyes" (personal communication).

On 15 August 1969, Mr. Lawrence Weingartner collected a sample of planarians in Bronson's Cave, also in Spring Mill State Park, and sent them to me alive. Bronson's Cave belongs to the same cave complex as Donaldson's Cave and is traversed

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Fig. 1. *Sphalloplana weingartneri*, sketch of gliding animal, from life.

by the same stream. The sample contained several specimens of the light-colored subterranean form of *Phagocata gracilis* and one blind planarian which, upon anatomical investigation, turned out to be a new species of *Sphalloplana.*

Sphalloplana weingartneri new species

External features (Fig. 1): Only one specimen, sexually mature, was at my disposal. This is a rather small unpigmented, white species, in life 6 mm long and 1.2 mm wide. The body is almost transparent, with some of the internal organs clearly discernible. The anterior end is truncate, with convex frontal margin and rounded side (auricular) edges which do not protrude laterally. Therefore, there is no constriction or "neck" seen behind the head region. The lateral margins gradually widen in the anterior half of the body, then soon converge again to form a rather rounded posterior end. The specimen is eyeless, blind. Behind the middle of the frontal margin an opaque spot indicates the location of the adhesive organ. A certain distance behind the front end the intestinal system begins, extending over the entire area of the body except the head, a broad border along the lateral margins, and the area of the copulatory complex. There are 9 or 10 ramified lateral branches on the anterior ramus of the intestine and more numerous shorter branches on each of the two posterior rami. The pharynx is inserted somewhat behind the middle of the body and is rather short, its length being about one-seventh the length of the body. In the postpharyngeal region the copulatory apparatus is seen as a round, transparent field in the center of which there is an opaque spot.

Surface epithelium: The epithelial covering of the body shows some modifications on the body margins. Along the lateral border is a strip of very tall cells containing rhabdites much longer than those of either the dorsal or the ventral surface. This strip is underlain by masses of rhabdite-forming glands in the neighboring mesenchyme. Adjoining this strip on the ventral side is the submarginal zone of adhesive gland openings. Both the thickened epithelial border and the adhesive gland zone reach anteriorly to about the lateral edges of the frontal margin of the head. Along the frontal margin the epithelium is of normal thickness, free of rhabdites, and heavily ciliated, which probably represents the auricular sense organs usually occurring in this location.

Adhesive organ: This organ, very characteristic of the genus *Sphalloplana* (including *Speophila*), is developed in the new species in the typical way. The anatomy of the adhesive apparatus has been discussed by Hyman (1937 and 1954) and in greater detail by Mitchell (1968: 611–613). From these descriptions it becomes clear that the shape of the organ as it appears in preserved and sectioned material is subject to great variation, depending on the state of contraction or protrusion at the moment of killing. In our specimen the organ is retracted, forming an invagination of irregular outline. The cells of the epithelium lining its cavity are engorged with a granular, eosinophilic secretion. They are approached by many gland outlets the cell bodies of which are scattered in the mesenchyme of the anterior half of the prepharyngeal region, both above and below the intestinal branches. Tinctorially the secretion of these glands differs from that of the submarginal adhesive zone, as they assume a deeper, somewhat bluish hue after staining with Eosin Y-Phloxine B. Attached to the glandular epithelium are many muscle fibers originating from the subepidermal muscle layers principally of the dorsal side, which function as retractors of the organ. Extension of the adhesive organ (which I have not observed in life) is probably accomplished by a contraction of the integumental muscles of the head region which increases the internal turgor of the head and pushes the inverted epithelium forward. Actually the subepidermal muscle layers at the level of the organ are markedly thickened, measuring in thickness 16 μ to 31 μ dorsally and 15 μ ventrally (at the level of the pharynx, the corresponding thicknesses are 9 μ and 9 μ, respectively). The fibers most prominently developed seem to run in a transversal ("circular") direction, although it is not possible to make a precise analysis of the integumental muscle layers on sagittal sections. It is known that the structure of these layers may be quite complex (see Graff, 1912–17: 2745–2746); in our case, the predominant fibers may belong to the circular or diagonal layers. This will have to be checked on tangential sections of the head region.

Reproductive system: The ovaries are located, as typical, on the medial sides of the ventral nerve cords, at a level behind the first or second lateral branch of the anterior intestinal ramus. No parovaria are developed. The vitellaria or yolk glands are not fully differentiated and are represented by strands of large cells with cyanophilic cytoplasm branching off from the oviducts dorsally and laterally. The testes are numerous and occupy two broad bands, one on each side of the midline, extending from the level of the ovaries to about the root of the pharynx. They are situated in both the dorsal and ventral parts of the mesenchyme, the dorsal position slightly prevailing. Individual large testes may bridge the entire depth of the body from the dorsal to the ventral subepidermal muscle layers.

The copulatory apparatus (Fig. 2 and 3) conforms with the design of the genus *Sphalloplana.* The genital aperture or gonopore (*gp*) leads

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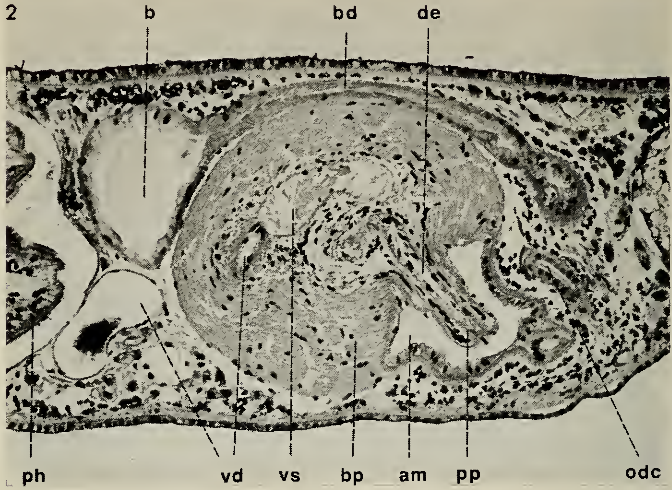

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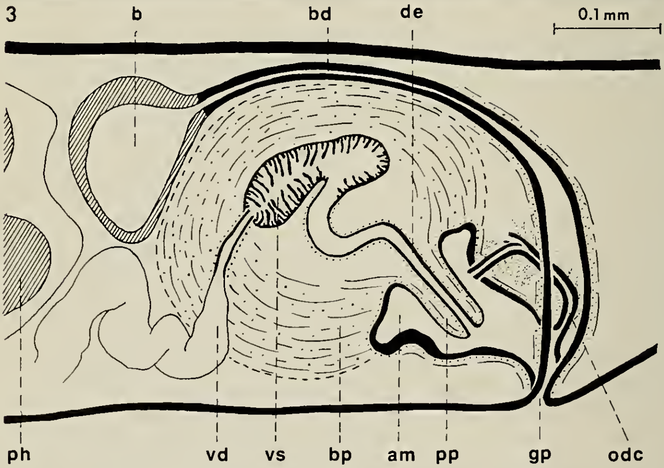

FIGS. 2–3. *Sphalloplana weingartneri,* copulatory apparatus. 1. Photomicrograph of sagittal section. 2. Semidiagrammatic view of sagittal section. *am,* male atrium; *b,* copulatory bursa; *bd,* bursa duct; *bp,* penis bulb; *de,* ejaculatory duct; *gp,* genital aperture; *odc,* common oviduct; *ph,* pharynx; *pp,* penis papilla; *vd,* vas deferens; *vs,* seminal vesicle.

anteriorly into a relatively small male atrium (*am*) and dorsally and somewhat to the left into the end portion of the bursa duct (*bd*). The atrium is lined with a cuboidal epithelium underlain by two layers of muscle fibers, a circular and a longitudinal one. No common genital atrium is developed. The penis consists of a large, spherical bulb (*bp*) and a rather small cylindrical or finger-shaped papilla (*pp*) protruding into the atrium. The bulb is very muscular, containing fibers which are arranged in more or less concentric layers. It encloses an elongated cavity, the seminal vesicle (*vs*), the wall of which is formed by cells projecting villuslike into the lumen and apparently having a glandular (apocrine) function. From this vesicle extends a narrow canal which, after some initial convolution, enters the penial papilla and opens at its tip, the ejaculatory duct (*de*). This canal is surrounded by a layer of circular muscle fibers. The two sperm ducts or vasa deferentia (*vd*), which at the level of the pharynx have enlarged to form the usual false seminal vesicles (spermiducal vesicles according to Hyman's, 1951, terminology), enter the penis bulb ventrolaterally. They proceed toward the seminal vesicle, each narrowing to a short canal with a coat of circular muscles, and open into the anterior part of the vesicle in close proximity to each other. The penis papilla (*pp*) is covered by a flattened epithelium with the usual two underlying muscle layers, a circular and a longitudinal one.

The two oviducts, which in the anterior part of the body have run along the upper side of the ventral nerve cords, ascend in the region of the copulatory complex, approach the midline, the left one passing through the space between the atrial wall and the bursa duct (*bd*), and unite above the male atrium. The common oviduct (*odc*) thus formed curves ventrally and opens into the posterior part of the atrium. The paired oviducts after they have left the nerve cords and the common oviduct receive numerous gland ducts with eosinophilic secretion, the so-called shell glands.

The copulatory bursa (*b*) is a smooth rounded sac lying dorsally between the pharyngeal pouch and the bulb of the penis. Its outlet, the bursal stalk or duct (*bd*), runs posteriorly above the penis bulb and behind this curves ventrally and somewhat to the left of the midline to open to the outside at the gonopore (*gp*). The anterior part of the duct is rather narrow and seems to be devoid of the muscle layers usually present in other planarian species. Behind the penis, the bursa duct widens and acquires two muscular coats of circular and longitudinal fibers. This terminal part, clearly differentiated from the anterior portion, may be termed a vagina.

The paucity of mesenchymal glands connected with the copulatory apparatus is remarkable. Only the shell glands emptying into the oviducts could be identified. On the other hand, some of the epithelia lining the various cavities are definitely of a glandular nature, such as the walls of the seminal vesicle, of the bursa duct, and of the copulatory bursa.

Distribution: The only specimen was collected in Bronson's Cave, Spring Mill State Park, Lawrence County, Indiana. It was taken 50–70 m inside the cave in the company of more common light-colored specimens of *Phagocata gracilis*. The collector informs me that the planarians occurred in a section of the cave which has a rich fauna of both epigean and true troglobitic species, probably as a result of both animals and food being washed in through the stream which enters the cave from above ground.

Taxonomic position: There is always a certain risk involved in describing a new planarian species on the basis of the study of one single specimen. The copulatory complex, which furnishes the most important features characterizing the individual species, is subject to great variation in the shape of muscular organs capable of contraction, extension, and distortion. Thus, the configuration of the penis, the size relation between its bulb and papilla, and other dimensional relations vary considerably depending on the method used in killing the animal, on the phase of its maturity, and possibly even on the physiological condition of the specimen. Considering these handicaps I may stress that my specimen was well-preserved as to its shape and histology. It had been killed in a saturated aqueous solution of corrosive sublimate ($HgCl_2$) applied hot and later acidulated with acetic acid. The sections were stained with Ehrlich's hematoxylin and Eosin Y-Phloxine B. At most there may be a certain longitudinal contraction in the area of the copulatory complex, judging from the unusual curvature of the ejaculatory duct and the shortness of the penis papilla.

The genus *Sphalloplana* was established by de Beauchamp (1931: 321) for *Dendrocoelum percoecum* Packard (1879). In a later paper, Hyman (1937: 462) described and defined a related genus, *Speophila*, differing from *Sphalloplana* in the anatomy of the adhesive organ. Subsequently (Hyman, 1945: 481), as she studied additional species of the two genera, she expressed the opinion that probably all gradations in the development of the adhesive organ will be found and that *Speophila* may be, in the future, considered a synonym of *Sphalloplana*. This step was finally taken by Mitchell (1968: 613–615) and seconded by Kawakatsu (1969: 45). I fully agree with their conclusions in this matter.

The genus *Sphalloplana* consists at present of about 19 species some of which may be placed in synonymy by future investigators. They are found generally in subterranean waters and in springs, chiefly in North America (16 species), eastern Asia, and Siberia. *Sphalloplana weingartneri* differs from the other species of the genus mainly in the anatomy of its copulatory apparatus. The most outstanding characteristic is the excessive development of the penis bulb and the reduction in size of the penis papilla. Although the shape of the penis and size proportions of bulb and papilla may present variable aspects in preserved specimens as a result of muscular contraction, the spherical shape of the bulb appears to be its natural condition in life, corresponding to the circular field seen in the postpharyngeal region of the living animal (Fig. 1). Other peculiarities concern the clear histological differentiation of the penis lumen into a seminal vesicle and an ejaculatory duct, and the modification of the terminal part of the duct of the copulatory bursa as a vagina, without the presence of a pronounced sphincter in this area. There is a superficial resemblance between the anatomical features of the copulatory complex of

S. *weingartneri* and those of S. *pricei* Hyman (1937). Apart from the difference in the size of the two species (S. *weingartneri*, 6 mm long in life, 4 mm after preservation; S. *pricei*, up to 15 mm long in the preserved state), which by itself is not a significant distinction, details in gross morphology and histology of the copulatory organs clearly separate the species. I have compared the slides of Hyman's type specimen of S. *pricei* (U.S. National Museum 20228) and sections of three topotypic specimens (Refton Cave, Lancaster County, Pennsylvania, USNM 36121) with S. *weingartneri* and have noticed the following distinctive characters: In S. *pricei* the penis papilla is larger, conical, rather plump, and apparently very pliable judging from the various distorted shapes and constrictions it shows in different specimens. The two vasa deferentia, which enter the bulb from the ventrolateral sides, unite within the bulb; the common vas deferens thus formed opens into a wider cavity, the seminal vesicle, from which a canal, the ejaculatory duct proceeds to the blunt tip of the papilla. There is no histological distinction between the epithelia of the seminal vesicle and the ejaculatory duct.

Type material: Sphalloplana weingartneri, holotype, set of two slides of sagittal sections, U.S. National Museum No. 41181.

Acknowledgment: The new species is named in honor of Mr. Lawrence Weingartner (now at Michigan State University) who kindly furnished the specimen on which the present description is based.

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PROCEEDINGS
OF THE
BIOLOGICAL SOCIETY OF WASHINGTON

THE TYPES AND TAXA OF HAROLD H. BAILEY

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Rockbridge Alum Springs Biological Laboratory,
Goshen, Virginia, and Bureau of Sport
Fisheries and Wildlife, National Museum of
Natural History, Washington, D. C.

The late Harold Harris Bailey (1878–1962) was the author of 14 scientific names of birds and four of mammals. Most of these were published in his private journal "The Bailey Museum and Library of Natural History Bulletin" (abbreviated herein as B.M.L.N.H. Bull.), of which 16 issues appeared at irregular intervals between 1920 and 1945. Because of the limited circulation of this bulletin, and because most of the type material has until recently been generally unavailable in Bailey's private collection, it seems desirable to present a critical review of his types and taxa. Our objective is to assess these entites in the light of modern taxonomic treatment. This assessment is based on pertinent studies by other workers and on our own investigations. When possible, our studies have included direct comparison of specimen material, but we have not attempted revisionary work beyond our immediate concern with Bailey's types and taxa.

All holotypes in the H. H. Bailey collection, which is now the property of Virginia Polytechnic Institute, Blacksburg, Virginia (Hubbard, 1969), have been deposited in the National Museum of National History (abbreviated herein, U.S.N.M.). For several taxa for which Bailey did not designate a holotype, we have selected lectotypes from his collection.

We are grateful to Kenneth C. Parkes, who gave us a preliminary assessment of certain of these taxa prior to our study and who read an early version of the manuscript. Harrison B.

Tordoff and Ned K. Johnson provided us with information on types in the University of Michigan Museum of Zoology and the Museum of Vertebrate Zoology, respectively. John L. Paradiso, Bureau of Sport Fisheries and Wildlife, assisted in our work with the mammals. The H. H. Bailey Trust is acknowledged for many contributions which facilitated our work.

BIRDS

Guara alba longirostris. B.M.L.N.H. Bull. 4 [p. 1]. 1 April 1930.

Lectotype, here designated: USNM 525728 (ex Bailey collection 2161), immature female (actually male?), Cape Sable, Monroe Co., Florida, 14 April 1924, collected by H. H. Bailey.

Bailey described this subspecies of the white ibis as being longer-billed than the nominate form, bill measurements being 6.375 to 7.125 inches (162 to 181 mm) versus 5.125 inches (130 mm). Bill length was said to be independent of age or sex, and the implication was that both long- and short-billed birds occur together in Florida. The source of Bailey's measurement of the bill length in the nominate race is Catesby (1754), an earlier edition of which work provided the basis for the Linnaean name of the species. Bailey apparently measured the bill directly from the illustration, for his "5.125" inches is far short of the "six inches and a half" given in Catesby's text. Thus if a name had been needed, it should have been applied to the shorter-billed form. No name is necessary, however, as bill length is sexually dimorphic in the white ibis, with males having longer bills (Palmer, 1962). Apparently Bailey was misled in this regard by missexed specimens. We follow Peters (1931) and Hellmayr and Conover (1948) in treating *longirostris* as a synonym of monotypic *Guara alba* (Linnaeus) (now *Eudocimus albus*; see Parkes, 1951).

The specimen here designated as the lectotype is the only one in Bailey's collection which has a bill length within the range attributed to *longirostris*. The length of the bill (173 mm) suggests that it is a male, not a female as labeled. This bird is immature, attaining the white plumage of the adult.

Haliaeetus floridana. B.M.L.N.H. Bull. 4 [p. 2]. 1 April 1930.

This form of bald eagle was described as being "much smaller in every way" and with "much smaller" eggs than breeding birds of the Carolinas, Virginia, and Maryland. Its range was regarded as including peninsular Florida, probably "overlapping" with the northeastern subspecies in Georgia or Carolina. From Bailey's wording, it is obvious that he meant the name *floridana* to apply to a subspecies of *H. leucocephalus* (Linnaeus), not to a species as the name is given.

Peters (1931: 258) points out that "there is a steady decrease in the size of *H. leucocephalus* from north to south throughout its range."

Neither Peters (op. cit.) nor Friedmann (1950) regarded the Florida birds, representing an extreme of this cline, as recognizably distinct from the nominate subspecies. We agree with their placement of *floridana* in the synonymy of *H. l. leucocephalus.*

Because of the absence of a suitable specimen in the Bailey collection, we feel that no lectotype can or should be designated at this time.

Bonasa umbellus helmei. B.M.L.N.H. Bull. 14 [p. 1]. 5 January 1941.

Holotype: USNM 525729 (ex Bailey collection 6552), female, Miller Place, Long Island, New York, 29 December 1887, collected by A. H. Helme.

This subspecies was diagnosed by Bailey as follows: "A small ruffed grouse, probably restricted to Long Island, having a very light buffy throat and a light-colored upper mandibile [sic]. As a race, generally uniform with more whitish belly than any of the other races, heavily barred below with blackish; dark breasted bird, but with more buffy breast than **togata**; neck ruffs and subterminal tail band black, in most cases of both male and female. The males (24) and females (16) are all of a gray-tailed type with few exceptions."

Aldrich and Friedmann (1943) treated *helmei* as a synonym of *B. u. umbellus* (Linnaeus), although noting that specimens from Long Island were intermediate between that form and *B. u. togata* (Linnaeus). They did not have the opportunity to examine Bailey's large series from Long Island.

Our comparison of female specimens of *helmei* with specimens of *umbellus* from New Jersey and southern New York shows that the former have blacker ventral barring, especially on the flanks but also on the lower throat and breast, and are darker and more reddish on the breast. From females of *togata* from New England, those of *helmei* differ in having plainer, less barred, abdomens and in having the barring on the flanks darker. Males of *helmei* are less definitely distinct from *umbellus*, but the nature of the variation generally parallels that in females. Both sexes of *helmei* tend to be fairly uniform in color and pattern, with reddish dominating. Contrary to Bailey's statement, birds with gray tails make up only about one-half the sample. The purported smaller size appears to be an illusion resulting from the compact make-up of the skins, and the supposedly light maxilla has no taxonomic significance.

In view of marked and constant differences, especially in females, we conclude that the native population of ruffed grouse on Long Island was sufficiently distinct to warrant recognition, and we recommend that *helmei* be accepted as a valid subspecies. Whether the present population of grouse on Long Island bears a close resemblance to the original is open to doubt because introduced stock from other parts of the country has been liberated in the New York area (Bull, 1964: 165). Therefore, pending study of modern specimens, we would apply the name *helmei* only to native grouse from Long Island, which probably persisted in "pure" form only until the turn of the century.

Megalornis c[anadensis] woodi. B.M.L.N.H. Bull. 4 [p. 2]. 1 April 1930.

Lectotype, here designated: Univ. Michigan Museum of Zoology 838d, male, Unadilla, Livingston Co., Michigan, 28 May 1898, collected by Bond.

Sandhill cranes "from the peninsula of Michigan and possibly nearby territory" were separated as being as large as or larger than Florida birds (*Grus canadensis pratensis* Meyer), thus larger than the nominate form, and differing from all other subspecies in having brown or rusty plumage.

Bailey disclaimed that adventitious factors were responsible for the brown or rust coloration frequently found in Michigan birds, but Walkinshaw (1949) has shown that such plumage coloration is the result of staining. Bailey also stated that this coloration did not occur on birds from other areas, but this is demonstrably erroneous and such coloring cannot be used as a criterion for recognition of the Michigan population. We follow others (Peters, 1934; Hellmayr and Conover, 1942; Ridgway and Friedmann, 1941) in considering *woodi* a synonym of *Grus canadensis tabida* (Peters).

The mounted specimen here designated as the lectotype was selected and placed in the U.M.M.Z. type collection some time ago by Josselyn Van Tyne (H. B. Tordoff, pers. comm.).

Coturnicops noveboracensis richii. B.M.L.N.H. Bull. 10 [p. 1]. 1 September 1935.

Holotype: USNM 525732 (ex Bailey collection 4547), adult male, Canton [Stark Co.], Ohio, 12 October 1887, collected by R. H. Bulley [not Bully as given by Bailey].

This subspecies of the yellow rail was distinguished as having the wing .125 to .1875 inches (3 to 4.5 mm) shorter than the nominate form, with less white on the belly, and a darker back with the white ticking much more pronounced. The range was given as "From the West Indies (Porto Rico) and the Gulf states, to Manitoba."

See under next form for discussion.

Coturnicops neveboracensis [sic, = *noveboracensis*] *emersoni.* B.M.L.N.H. Bull. 10 [p. 2]. 1 September 1935.

Holotype: Museum of Vertebrate Zoology 30727, adult male, Shandon, San Luis Obispo Co., California, 9 October 1917. Bailey gave the location of the type as "Museum Comp[arative] Zoology." According to Ned K. Johnson (in litt.), who confirms that the specimen is in the Museum of Vertebrate Zoology, additional data on the original label are: "Collection of Leo Wiley" and "Caught by Edgar Hansen."

This subspecies was characterized as being smaller than the nominate form or *richii* (see above), with a much redder breast and less white on the belly. Legs, feet and bill are supposedly smaller, and wing length "will average .1875" [4.5 mm] less than *richii*." The breeding range was given as "up the Pacific Coast from Calif. (to Oregon.?)."

Measurements given by Ridgway and Friedmann (1941: 174, 175) show no consistent trends in geographic variation in size of yellow rails across the continent. Our examination of specimens (not including the holotype of *emersoni*) in the U.S.N.M. confirms that the color differences mentioned by Bailey are due to age, seasonal, and individual variation, as suggested by Hellmayr and Conover (1942: 388). Thus we follow these authors and consider both *C. n. richii* and *C. n. emersoni* to be synonyms of *C. n. noveboracensis* (Gmelin).

Zenaidura macroura peninsulari. Wilson Bulletin 35: 100. June, 1923.

Holotype: USNM 525735 (ex Bailey collection 911), immature male, Miami Beach [Dade Co.], Florida, 3 February 1923, collected by H. H. Bailey.

This form was separated from *Z. m. carolinensis* (Linnaeus) on the basis of its smaller size, rusty upperparts (upper tail coverts, secondaries, and back), light buff belly and under tail coverts, cinnamon chest, and by the lack of metallic coloration on the neck. Bailey considered it to be resident in the peninsula of Florida, probably intergrading with the larger *carolinensis* in northern Florida and Georgia.

As Aldrich and Duvall (1958: 118) pointed out, the type series of *peninsulari* was taken in February and does not necessarily represent the southern Florida breeding population of mourning doves. Because of the possible heterogeneity of the type series, we concentrated on the holotype in assessing *peninsulari*. Although post-mortem color change and peculiarities of preparation make comparison somewhat difficult, in both the small size (wing 133.0, culmen 12.0 mm) and extent of buffy coloration this individual is inseparable from *Z. m. macroura* (Linnaeus), the subspecies of the West Indies and the Florida Keys. On this basis we adopt the suggestion of Aldrich and Duvall (op. cit.) that *peninsulari* be considered a synonym of *Z. m. macroura* which occasionally occurs northward to the Miami area.

We gratefully acknowledge the assistance of John W. Aldrich in our study of this species.

Streptopelia risoria alba. B.M.L.N.H. Bull. 9 [p. 2]. February, 1935.

Lectotype, here designated: USNM 525733 (ex Bailey collection 5046), adult male, Coral Gables, Dade Co., Florida, 8 February 1934. Photographs of three specimens of this dove were published with the description, but only the lectotype and one other specimen can be identified with certainty. The second specimen, here designated a paralectotype, is:

USNM 525734 (ex Bailey collection 5077), male, Coral Gables, Dade Co., Florida, 3 April 1934.

This subspecies was distinguished from the "brown race" in Florida by the entirely white plumage and by averaging .25 inches [6 mm] shorter in wing length. No geographic range was given, but all examples in Bailey's collection were from Coral Gables, Florida, where they were apparently confined to his aviary.

This aviary variety, produced and maintained by selective breeding, has no standing as a subspecies in the general sense of the concept. For the nomenclatural record, *alba* may be considered a synonym of *Streptopelia "risoria"* (Linnaeus) (see Goodwin, 1967: 129).

Thryothorus ludovicianus alleghani. B.M.L.N.H. Bull. 2 [p. 1]. 1 June 1924.

Holotype: USNM 525737 (ex Bailey collection 1926), [immature female], Roswell [Cobb Co.], Georgia, 3 August 1923, collected by D. V. Hembree.

This form of Carolina wren was characterized as being smaller than *T. l. ludovicianus* (Latham) of Maryland, Virginia, and South Carolina, which has a "much redder breast" and "lighter reddish colored backs," and as having a longer, more curved bill than that subspecies. It was distinguished from *T. l. miamensis* Ridgway of Florida in being smaller, with a shorter and more slender bill, less reddish on the back and lighter on the head, and was said to differ from *lomitensis* Sennett of Texas in being darker with a heavier bill. The range was given as "probably the lower Alleghanies and the upper Piedmont sections of Georgia, South and North Carolina, and Southwestern Virginia."

The holotype is clearly a grown juvenile (not an adult male as stated by Bailey) as is one other specimen in the type series. These two birds are pale, bright reddish above and differ from most other specimens examined, including near-topotypical *ludovicianus* which are darker and duller. Several juveniles from the southeastern Atlantic coast resemble those of *alleghani*, as do three birds from central Texas. The significance of the pattern of variation in juveniles is not clear. The seven adults in the type series of *alleghani* are similar in plumage characters to topotypical specimens of nominate *ludovicianus*, and measurements given for *alleghani* fall well within the range of variation given by Lowery (1940) for the nominate form. Thus, we follow Lowery (op. cit.) who considered *alleghani* a synonym of *T. l. ludovicianus.*

Vireosylva o[livaceus] scotti. B.M.L.N.H. Bull. 4 [p. 3]. 1 April 1930.

In naming this subspecies, Bailey commented on the "great difference" between red-eyed vireos of coastal and montane Virginia, stating that "This applied also to their song, nesting habits and the size of the eggs." The only definite comparison given in the description of the montane birds, however, was that "Their song differed greatly from those of the Tidewater section, and the eggs were larger and easily distinguished from the Tidewater sets." The range was given as "higher altitudes throughout the Alleghanies" of southwestern Virginia, North and South Carolina, and Georgia. This paucity of comparative information led Blake (*in* Peters, 1968: 122) to state: "The name is probably a *nomen nudum* although it could be argued that the reference to the eggs being larger satisfies the requirement of an 'indication' according to the Inter. Code Zool. Nomencl., 1961, Art. 17(4); a bird egg is doubtless a 'stage in life history'." We do not feel qualified to decide the standing of the name *scotti*, but believe that a designation of a lectotype would be inappropriate at this time.

We compared specimens from the purported range of this form, including one female taken with its nest and eggs, with those from coastal areas and from other portions of the range of the species. We found no significant differences in egg size or in characters of the study skins, and thus follow Blake (*in* Peters, op. cit.) in placing *scotti* in the synonymy of *Vireo olivaceus* (Linnaeus).

Dendroica discolor collinsi. B.M.L.N.H. Bull. 3 [p. 1]. 16 November 1926 (=? 10 February 1930; see Van Tyne, 1956).

Holotype: USNM 525740 (ex Bailey collection 1875), [probably immature male], Miami Beach [Dade Co.], Florida, 22 July 1923, collected by A. T. W. [=? Arthur T. Wayne].

This subspecies was distinguished from the nominate form by color characters, the "female" (holotype) having a lighter yellow breast and whitish throat, with less reddish and more grayish on the back. Males supposedly lack the black markings on the sides, the orange on the throat, and the reddish of the back typical of the nominate form. The range of this subspecies was implied to be southern Florida.

Our examination of the holotype reveals that it is in fresh autumn plumage (thus not a breeding bird as indicated on the label) and that it is probably an immature male rather than a female as stated by Bailey. It differs from northern specimens by virtue of the grayish dorsum (especially the crown), the lack of reddish on the back, and the reduced ventral streaking, and can be considered as representing the subspecies of southern Florida.

The southern Florida population of prairie warbler is generally regarded as a valid subspecies (A.O.U., 1957), but we follow Van Tyne (1956) in considering the name *collinsi* predated by, and therefore a synonym of, *Dendrocia d. paludicola* Howell.

Thryospiza maritimus shannoni. B.M.L.N.H. Bull. 7 [p. 1]. 1 August 1931 [=? 2 December 1931].

Holotype: USNM 525741 (ex Bailey collection 4884), adult male, 12 mi. east of Jacksonville, Duval Co., Florida, 20 June 1931, collected by W. E. Shannon.

This population of seaside sparrow was characterized as being uniformly dark olive brown, darker than *T. m. maritimus* (Wilson) and *T. m. macgillivraii* (Audubon), and having a very large, blackish bill; the throat and chin patch whitish, but not as large or pronounced as in *macgillivraii* or *peninsulae* (Allen); and lacking the chestnut on the middle wing coverts of *peninsulae*. The range was given as the northeast coast of Florida, especially north of the St. John's River.

Apparently because of uncertainty regarding the date of publication of *shannoni* (see Auk 49: 253, 1932), Hellmayr (1938: 509) placed that name in the synonymy of *T. m. pelonota* Oberholser, described at about the same time from northeastern Florida (type locality New Smyrna, Volusia Co.). Our comparison of the type series of *shannoni* and *pelonota*, both taken in the breeding season, reveals slight differences in color, with *shannoni* averaging darker on the upperparts and in the ventral streaking than *pelonota*. Both populations are darker than "*waynei*" Oberholser from coastal Georgia, a light form intervening between them and the dark topotypical *macgillivraii* from South Carolina, and *shannoni* also averages darker than the latter. Useful comparison of measurements is precluded by the fact that size differences in the Atlantic coastal populations are slight.

Although our limited investigation does not preclude the possibility that *pelonota* and *shannoni* are different, the age and wear of the material at hand mitigate against any decision on their status. The entire Atlantic coastal complex of this sparrow should be studied further, and recently taken freshly molted specimens are needed. Meanwhile, we suggest that *shannoni* continue to be considered a synonym of *pelonota*, in the modern combination *Ammospiza maritima pelonota*.

Melospiza melodia rossignolii. B.M.L.N.H. Bull. 10 (= 11) [p. 2]. 1 December 1936.

Holotype: USNM 525744 (ex Bailey collection 5562), adult female, Hogg [= Hog] Island, Northampton Co., Virginia, 22 May 1936, collected by H. H. Bailey.

This subspecies was compared only to *M. m. juddi* Bishop, from which it differs in much grayer coloration throughout. The range was given as Hog Island, Virginia. (Bailey consistently used two g's in the spelling of the name of this island.)

Bailey was under the impression that the song sparrows of Hog Island had changed in character over a period of about two decades, and that *rossignolii* had replaced (or displaced) the form previously present, which he considered to have been the nominate subspecies. The only specimen taken earlier in Bailey's collection from Hog Island (May 1911) is indeed more reddish and more heavily streaked than typical breeding birds of the area and thus suggests *M. m. melodia* (Wilson). However, its characters can be matched by extreme specimens of *M. m. atlantica* Todd, a subspecies described from Smith Island, somewhat south of Hog Island. Thus, although the one early specimen from Hog Island is somewhat atypical it is hardly basis for considering that a replacement of subspecies has occurred. Further, the holotype of *rossignolii* and series taken in 1924 and 1936 are inseparable from the type series of *atlantica* taken in 1898, and we consider *rossignolii* a synonym of the latter.

[*Melospiza melodia*] *alleghanii.* B.M.L.N.H. Bull. 10(=11) [p. 3]. 1 December 1936.

The name *alleghanii* is clearly a *nomen nudum.* It is used 13 times in this Bulletin (spelled with a single i once), without a description, in reference to birds of the mountains of southwestern Virginia (Mountain Lake, Giles Co.) and North Carolina (Mt. Mitchell). These populations are currently included in *Melospiza melodia euphonia* Wetmore (A.O.U., 1957).

MAMMALS

Sciurus carolinensis minutus. B.M.L.N.H. Bull. 12 [p. 4]. 15 January 1937. Not *Sciurus minutus* duChaillu.

Sciurus carolinensis matecumbei. Jour. Mammalogy 18: 516. 14 November 1937. New name for *S. c. minutus* Bailey, preoccupied.

Holotype: USNM 347444 (ex Bailey collection 178), adult female, Key Largo, Monroe Co., Florida, 13 June 1923, collected by H. H. Bailey.

This insular gray squirrel was described as being smaller than *S. c. extimus* Bangs, lacking the yellowish gray cast on the back and the reddish sides of that subspecies. The range was considered to be "only on some of the lower Keys, off the mainland of Dade and Monroe Counties, Florida."

This subspecies is accepted by Miller and Kellogg (1955: 238) and by Hall and Kelson (1959: 371). However, we have compared Bailey's series and five other specimens from Key Largo in the Smithsonian Institution with specimens from several localities in southern Florida including Miami, the type locality of *S. c. extimus*, and find that *matecumbei* is not sufficiently distinct to warrant recognition. The very slightly smaller size is merely a reflection of this population's location, at the end of a cline of decreasing size southward through Florida, and the color characters given by Bailey simply do not hold in comparison with *extimus* from southern Florida. We recommend that the name *S. c. macumbei* be placed in the synonymy of *S. c. extimus.*

Sciurus niger bryanti. B.M.L.N.H. Bull. 1 [p. 1]. 1 August 1920.

Holotype: USNM 347443 (ex Bailey collection 123, old number 602), adult female, Dorchester Co., Maryland, 21 December 1917, collected by [a hunter for] R. W. Jackson.

This subspecies was separated from S. *n. niger* Linnaeus on the basis of its larger size, the only comparative statement relating to the skull which was called "distinctly larger." Color characters given are not comparative but are diagnostic. A statement of range appears only in the title of the paper, as ". . . the Eastern Shore of Maryland."

The native fox squirrels of the Delmarva Peninsula, and formerly northward to Lancaster Co., Pennsylvania (Poole, 1944), are of a distinctly gray subspecies, to which the name *bryanti* was applied for many years. Poole (1944) resurrected the name *neglectus* (Gray) for this form, placing *bryanti* in synonymy. Later, Barkalow (1954) showed that both names were predated by, and thus synonyms of, *Sciurus niger cinereus* Linnaeus.

Erithizon epixanthum doani. B.M.L.N.H. Bull. 12 [p. 1]. 15 January 1937.

Holotype: USNM 347446 (ex Bailey collection 718), female, Piniware River, 15 miles NW of Red Bay, Labrador, 11 April 1935, collected by E. Doane, original number 24.

Although named as a subspecies of the then recognized western (yellowish) porcupine *E. epixanthum* Brandt, this form was compared only to the sympatric population of the dark eastern species, *E. dorsatum* Linnaeus. It was distinguished by its smaller size, light coloration, and the shape of some bones of the skull. No range other than the type locality was given.

The holotype of *doani* is obviously an immature animal, as can be seen from the photographs in Bailey's paper, which accounts for the small size and the characteristics of the skull. The color characters denote individual rather than taxonomic variation. Our examination of specimens from eastern Canada shows that light colored individuals occur only infrequently among the dark brown ones in Labrador populations of porcupines (Bailey, quoting information on the original label, gave the ratio as about 1 in 20), but that intermediates are more common.

Anderson and Rand (1943) reviewed the taxonomy of the porcupines and combined *epixanthum* with *dorsatum* as a single species bearing the latter name. Although their revision was at the subspecific level, they did not mention *doani*. Miller and Kellogg (1955) and Hall and Kelson (1959) place *doani* in the synonymy of *E. d. picinum* Bangs, an action with which we concur.

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PROCEEDINGS
OF THE
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THE EPIMERA OF NORTH AMERICAN FRESH-WATER SPECIES OF *GAMMARUS* (CRUSTACEA: AMPHIPODA)[1]

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Taxonomic difficulties inherent in making specific identifications of gammarid amphipods are notorious. The perplexing variations among instars and size classes, sexual dimorphism, the difference between summer and winter populations, the lack of systematic importance associated with the genitalia, overlapping ecological and geographic ranges, and the morphological differences between isolated conspecific populations are well known (Sexton, 1924; Bousfield 1958, 1969; Holsinger 1967; Nijssen and Stock 1966; Minckley and Cole 1963).

Workers studying the Nearctic, fresh-water amphipods owe a great debt to Bousfield (1958), who first applied the subtle refinements of European taxonomists to the North American fauna. Despite this, difficulty persists in correctly identifying the species of *Gammarus* found in fresh waters of this continent. For example, *Gammarus minus* Say is confused with at least *G. pseudolimnaeus* Bousfield, *G. troglophilus* Hubricht and Mackin, *G. pecos* Cole and Bousfield, and *G. lacustris* G. O. Sars. The long standing uncertainty concerning the status of *G. fasciatus* Say and *G. tigrinus* Sexton is documented by Hynes (1954), Hynes *et al.* (1960) and Bousfield (1958, 1969).

Structures that rarely have been detailed in depth, even

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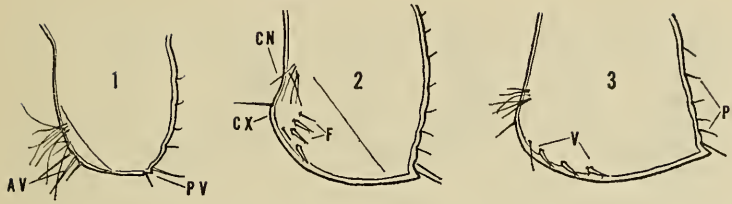
though they serve in specific identification, are the epimera of the first three abdominal segments of North American *Gammarus* species. These have been termed variously as abdominal side plates, epimeral plates, metasomal plates, or epimera. For the species occurring in North American fresh and brackish waters, good figures of all three plates exist only for *G. tigrinus* (Sexton 1939, Figs. 18, 19, 22), *G. lacustris limnaeus* (Bousfield 1958, Fig. 9), *G. minus* (Shoemaker 1940, Fig. 2, j), *G. bousfieldi* (Cole and Minckley 1961, Figs. 13, 14, 15), *G. pecos* (Cole and Bousfield 1970, Figs. 22, 23, 24), and the recently described *G. daiberi* (Bousfield 1969, Fig. 1) which ecologically approximates *G. tigrinus*. This is unfortunate because, despite expected individual variation and slight sexual dimorphism, there are many instances where shape and armature of the abdominal side plates serve to distinguish and separate morphologically similar species that are puzzling to the non-specialist.

It is the purpose of this report to describe in detail the abdominal side plates of the named Nearctic fresh-water species of *Gammarus*, and the oligohaline-brackish water *G. tigrinus*.

The euryhaline *G. duebeni* Lilljeborg (Figs. 1–3) is used to illustrate general features of the three epimera. This species occurs, on this continent, in tide pools and tidal fresh waters from southern Labrador to Massachusetts (Bousfield 1958). Within this geographical and ecological range there is no fresh-water species with which it could be confused, although its abdominal side plates closely resemble those of *G. minus*. *G. duebeni* will be discussed later and briefly with the latter.

General Description of the Epimera

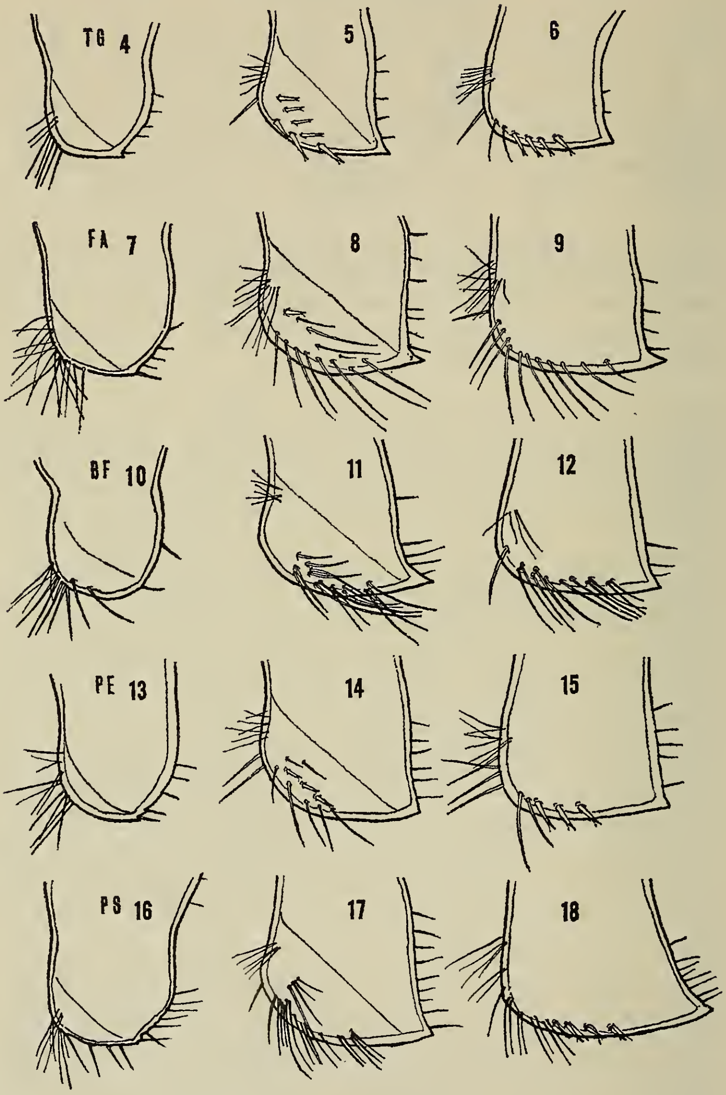
Epimeron I (Fig. 1) is more or less rounded with a faint diagonal chitinous line running from the antero-proximal region to the postero-ventral region. The ventral margin may vary individually; in most species it is nearly straight, appearing truncate. Anterior setae are inserted near the antero-ventral angle (Fig. 1, AV); they become stouter near the angle where they are mostly marginal in origin. These stout setae usually originate in notches. In some instances there may be a short,



FIGS. 1–3. Epimera of male *Gammarus duebeni*, Jewer Cove, Nova Scotia. 1. First epimeron; AV, antero-ventral setae; PV, postero-ventral angle and setae. 2. Second epimeron; CN, proximal concavity; CX, anterior convexity; F, facial armature. 3. Third epimeron; V, submarginal ventral armature; P, posterior setae.

spinelike seta at the antero-ventral angle. In most species there are marginal, ventral setae close to the antero-ventral corner, and no more than one third of the ventral margin is clothed; there are specific exceptions to this. There are no facial setae inserted above the ventral items on epimeron I. The postero-ventral angle (Fig. 1, PV) is usually marked by a sharp notch from which a seta arises. In those specimens with a truncate first epimeron, an angular appearance is imparted by the notch. The posterior margin is convex and armed with relatively short setae.

Epimeron II (Fig. 2) is marked anteriorly by a proximal concavity (Fig. 2, CN) followed by a broad convexity (Fig. 2, CX) that is part of the rounded antero-distal angle. The ventral surface is relatively straight or faintly convex and the postero-ventral corner is either quadrate, slightly produced and acute, or conspicuously produced. The posterior margin is either straight, oblique, or somewhat sinuate. A thickened line of chitin runs from the antero-proximal region to the postero-ventral angle. In most species there are hairlike setae in the anterior concavity, inserted marginally or slightly submarginally. These submarginal setae usually arise from the inner surface of the plate. Slender, straight setae may be borne marginally on the anterior convexity. The ventral setae and spines are submarginal in origin, inserted in most species within the anterior half of the plate; in others they extend nearly to the posterior angle. The ventral spines and setae are some-



Figs. 4–18. TG 4, 5, 6. Epimera of male *Gammarus tigrinus*; pond near Moonstone Beach, South Kingstown, Washington Co., Rhode Island. FA 7, 8, 9. Epimera of male *Gammarus fasciatus*; Delaware River, N. of Riverton, Burlington Co., New Jersey. BF 10, 11, 12. Epimera of male *Gammarus bousfieldi*; Doe Run, near Ekron, Meade Co., Kentucky. PE

times inserted singly; in other species they may occur in groups, items of each group originating closely in vertical rows. Facial spines and/or setae (Fig. 2, F) are characteristic of epimeron II. Facial items may be inserted singly or in groups, depending on species. A few slender, posterior setae originate marginally, the distal one being very near the postero-ventral angle.

Epimeron III is somewhat broader than the preceding and this is pronounced in certain species. The proximal anterior concavity is shallower than that of epimeron II, and there is no diagonal structure such as those evidenced in epimera I and II. The ventral border is straight or weakly convex. The postero-ventral corner is acute or produced in most species. Hairlike setae originate at the shallow anterior concavity; in some species these are very rare. The antero-distal convexity sometimes bears marginally inserted, slender, straight setae; in some species it is naked, or the setae at this region are distinctly submarginal. The ventral armature (Fig. 3, V) is submarginal and extends posterior to the midway mark in a few species. Ventral insertions may be single or multiple. Facial armament occurs on this plate very rarely. The setae lining the posterior margin (Fig. 3, P) of epimeron III are usually numerically inferior to those of epimeron II.

SPECIFIC DESCRIPTIONS OF THE EPIMERA

Gammarus tigrinus Sexton
(Figs. TG 4, 5, 6)

This species occurs in brackish and tidal fresh waters along the Atlantic coast from the north shore of the Gulf of St. Lawrence to North Carolina with a Florida population in the St. John's River and estuary; it co-occurs with a sibling species *G. daiberi* Bousfield in the Chesapeake-Delaware Bay region (Bousfield 1969). Apparently it has been introduced to England, Ireland (Bousfield 1958, Hynes *et al.* 1960), Germany (Schmitz 1960) and the Netherlands (Nijssen and Stock 1966). Although probably native to the east coast of North America, it was first recognized as a distinct species in material collected in Worcestershire, England (Sexton 1939).

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13, 14, 15. Epimera of male *Gammarus pecos*; Willbank Spring, Fort Stockton, Pecos Co., Texas. PS 16, 17, 18. Epimera of male *Gammarus pseudolimnaeus*; Elm Spring, Pine Hills area, Union Co., Illinois.

Several good taxonomic references are available for *G. tigrinus.* They are: Sexton (1939); Bousfield (1958, 1969); Hynes *et al.* (1960); and Nijssen and Stock (1966).

Epimeron I (Fig. TG 4). Anterior surface with eight to 15 slender setae; two to five are submarginal, singly inserted or in groups of two or three continuous with the stouter, spaced, marginal setae near and at the antero-ventral angle. Ventral margin fairly straight and unarmed. Postero-ventral angle conspicuously notched; posterior margin with three to five rather short setae.

Epimeron II (Fig. 5). Anterior concavity with three to 13 hairlike slightly submarginal setae. Slender straight marginal setae inserted distally on the antero-ventral convexity, lead to the angle near where the submarginal ventral insertions commence. Ventral armature consisting of mixed setae and spines, or all spines clothing the anterior half of the plate and set singly; spines protruding beyond the distal margin of the plate. Facial items include four to nine single insertions, forming a sharply oblique row of setae and spines, or of spines alone, leading postero-ventrad to become continuous with the ultimate or penultimate ventral item. Postero-ventral corner quadrate or with slight production; posterior margin bears three to seven short setae.

Epimeron III (Fig. 6). Up to 12 fine, hairlike submarginal setae in the anterior proximal region, and more distally one to four slender, straight setae on the margin of the anterior convexity. The latter set singly and confluent with the submarginal ventral series. Ventral armature with up to eight setae and spines, set singly and clothing more than half the distal border. Postero-ventral angle quadrate or with slight production; posterior margin bears two to five setae.

Discussion: Sexton's figures (1939, Figs. 18, 19, 22) of the abdominal side plates are at odds with the present account. As Bousfield (1958) noted, the North American material he examined revealed nearly quadrate corners, although Sexton described and portrayed the second and third plates with prominent postero-ventral production. Sexton also showed longer posterior setae on the plates, especially the third, than I have figured here. Nijssen and Stock (1966) have shown that younger mature males of this species do not exhibit many of the features "characteristic" of *G. tigrinus.* Sexton's figure of an entire male (1939, Plate IV) was based on a November specimen; I examined June material only, and this may explain some discrepancies. In most instances, the oblique row of facial spines beginning rather high, leading to and confluent with the penultimate or ultimate ventral spine seems to be diagnostic.

Gammarus fasciatus Say
(Figs. FA 7, 8, 9)

According to Bousfield (1958, 1969), *G. fasciatus* occurs in the lower tidal and non-tidal reaches of Atlantic rivers and streams from the St. Lawrence south to the Chesapeake drainage. It is present in the Great

Lakes (see Clemens 1950) and occurs, perhaps, in the Mississippi system. The best taxonomic references to this species are those of Bousfield (1958, 1969).

Epimeron I (Fig. FA 7). As many as 32 anterior setae, usually marginal. At the antero-distal corner setae stouter and arise from notches. Usually no ventral setae, although at times one or two setae close to the antero-ventral corner originate within and clothe approximately the anterior one-fourth of the plate. The postero-ventral notch bearing a seta stouter than the other posterior setae; they total four to six.

Epimeron II (Fig. 8). Up to 12 hairlike setae slightly submarginal in the anterior concavity. Antero-ventral convexity with three to six straight, slender setae marginally inserted. Submarginal ventral setation starting far anteriorly in the antero-ventral angle region, extends almost to posterior margin. Six to eight main ventral insertions, composed of up to 12 long setae; in some individuals these are in close-set vertical groups of two or three. Facial items composed of all setae, a mixture of spines and setae, or all spines; a total of five to seven diagonal or subparallel insertions begin above or anterior to the first ventral setae and lead toward the more posterior ventral setae. The postero-ventral corner usually sharply produced; there are five to nine posterior setae.

Epimeron III (Fig. 9). Anterior concavity with up to 15 hairlike setae, slightly submarginal, single or in groups of three or four; one to five distal setae, spaced and marginal lead to the antero-ventral corner. Ventral armature with up to 11 submarginal, long setae clothing at least three-fourths of the distal margin beginning high and far forward in the antero-ventral region and extending almost to the produced postero-ventral corner. The posterior border lined with two to five setae. Spines usually absent from this plate.

Discussion: Difficulties in distinguishing between *G. tigrinus* and *G. fasciatus* in coastal areas, where their habitats overlap or are contiguous, can be overcome by comparing the epimera. Although *G. tigrinus* may have some facial and ventral setae on epimeron II (not shown in Fig. 5), the extreme setation typical of *G. fasciatus* is not achieved. Furthermore spines are common ventral elements of epimeron III of *G. tigrinus*, but are extremely rare on the setose third plate of *G. fasciatus*.

Gammarus bousfieldi Cole and Minckley

(Figs. BF 10, 11, 12)

Gammarus bousfieldi is known only from the upper reaches of a cave stream in Meade Co., Kentucky, where it coexists with a population of aberrant *G. minus*. Cole and Minckley's original description (1961) contains the only figures of this species. Further notes on its ecology are found in Minckley and Cole (1963), and its affinities are discussed by Cole and Bousfield (1970).

Epimeron I (Fig. BF 10). A short, rounded plate with seven to 12 anterior setae, close-set or in groups of two near the antero-ventral corner; they are stouter near the angle and originate from fine notches. Ventral surface rounded, bearing one to three submarginal setae usually clothing the anterior half only; occasionally the most posterior seta near the postero-ventral angle. Posterior margin with two or three setae.

Epimeron II (Fig. 11). Anterior concavity with three to six submarginal, hairlike setae. The antero-ventral convexity bare. Ventral submarginal setation including single setae and groups of two or three, totaling up to 18 setae; more than half the ventral margin clothed. Facial items consist of long setae, singly or in groups of two to five in vertical rows; there are two or three groups. The postero-ventral corner produced and three to six long setae on posterior margin. No spines occur on this plate.

Epimeron III (Fig. 12). Anterior margin with three to eight small submarginal setae at or slightly distal to the anterior concavity. The antero-ventral convexity unarmed except for a straight submarginal seta, which may belong to the ventral series. Ventral armature with up to 20 long setae, arising singly or in vertical groups of two and extending caudad at least midway and usually almost to the postero-ventral corner. The postero-ventral angle somewhat produced; two to four long setae on the posterior border.

Discussion: *G. bousfieldi* is unique because there are no spines on its plates. In some specimens of *G. fasciatus* this may also apply, but the two species differ in their first epimera, and because *G. fasciatus* has much more anterior and antero-ventral setation. The few ventral setae on the first plate of *G. bousfieldi*, and the seta at the anterior convexity of epimeron III are unique in originating submarginally.

Gammarus pecos Cole and Bousfield
(Figs. PE 13, 14, 15)

This species is known from a limnocrene and spring brook near Fort Stockton, Pecos Co., Texas. Other gammarids occur within the Pecos River drainage system north to at least Roswell, Chaves Co., New Mexico; these are of uncertain status but are closely related to *G. pecos* and obviously were derived from the same stock The original description of *G. pecos* (Cole and Bousfield 1970) is the only published taxonomic reference available.

Epimeron I (Fig. PE 13). Anterior surface with eight to 13 fine setae, mostly marginal and singly inserted; proximal setae sometimes in groups of two or three. The more distal setae stouter, lead to the antero-ventral corner. Usually no ventral setae, but sometimes one to three setae occupying marginal notches within anterior half of the ventral margin. The postero-ventral corner usually notched and the posterior edge supports three to seven relatively long setae.

Epimeron II (Fig. 14). Anterior concavity with eight to 10 hairlike setae; first two or three marginal, subsequent insertions submarginal single and paired. Anterior convexity with two or three slender straight setae spaced and inserted marginally. Ventral submarginal armature of three to seven items inserted singly; spines and setae arise from the anterior half of the plate. Facial armament of three to five single spines and setae (rarely as many as seven), diagonally arranged or sub-parallel to antero-ventral curve and leading toward penultimate or ultimate ventral item. Postero-ventral angle quadrate or produced; the posterior margin bears four to eight relatively long setae.

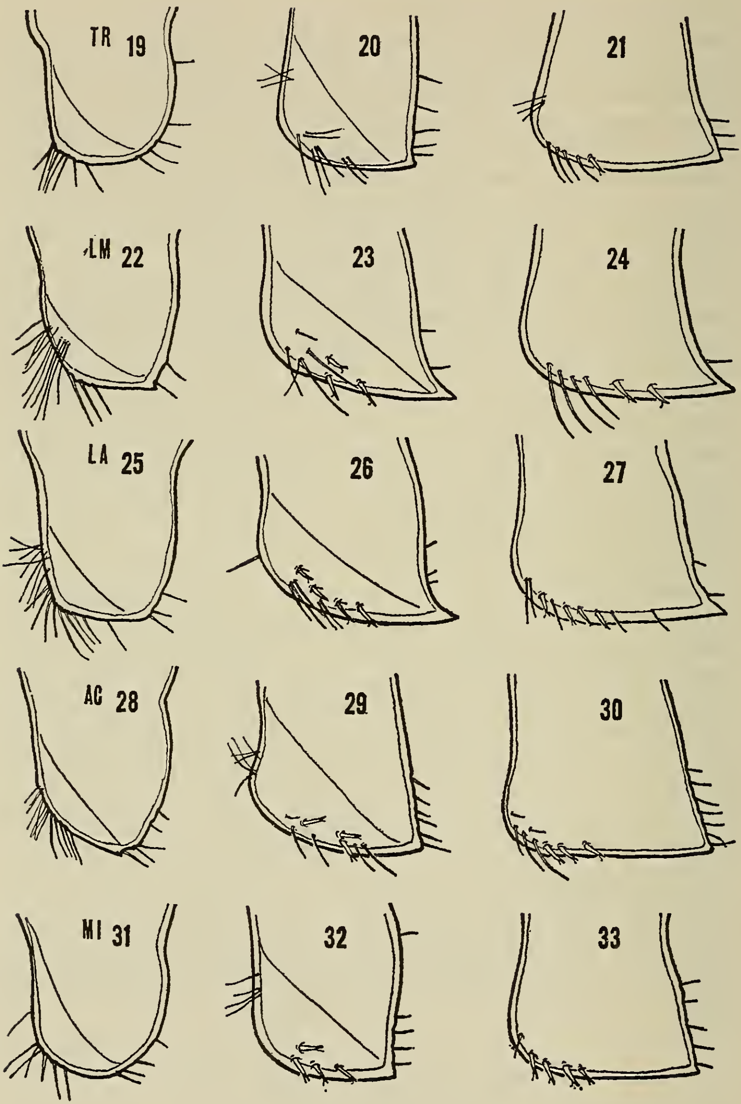
Epimeron III (Fig. 15). Up to 11 long hairlike setae in the anterior concavity; proximal setae arise marginally, distal items originate submarginally, single and paired. One to four marginal, spaced, slim setae lead to the antero-ventral corner. Ventral submarginal armature includes four to six spines and long setae inserted singly and only in anterior half of the plate; armature may consist of mixed spines and setae, all spines, or all setae. Rarely one or two slim facial setae inserted singly in the region of the penultimate ventral item. The postero-ventral angle quadrate or moderately produced; the posterior border bears four to seven relatively long setae.

Discussion: The four species discussed to this point have served to blur distinctions between the subgenera *Gammarus* and *Rivulogammarus* (Cole and Minckley 1961; Cole and Bousfield 1970). In life they are conspicuously banded, and on the basis of other morphological features they seem to be closely related. They show certain similarities in their epimera; in this sense, *G. tigrinus* is much like *G. pecos*, and the origin of the latter from a *G. tigrinus*-like ancestor is not unreasonable. *G. bousfieldi* and *G. fasciatus* possess much more setose epimera than do the other two species, and have more produced postero-ventral corners of epimeron II and III than do the others. In all four species the facials of epimeron II are diagonally arranged and lead toward the penultimate or ultimate ventral items; this is especially marked in *G. tigrinus* and least in *G. bousfieldi.*

It is noteworthy that in addition to the linking of the two subgenera, *Gammarus* and *Rivulogammarus*, by intermediate species, there are nomenclatural technicalities calling for the rejection of the latter (Stock 1969).

Gammarus pseudolimnaeus Bousfield
(Figs. PS 16, 17, 18)

This gammarid is common in the Mississippi drainage and the southwestern St. Lawrence system (Bousfield 1958). It occurs in large rivers, lakes and their tributary streams, springs, rheocrenes, and cave streams. It coexists in appropriate areas with *G. fasciatus*, *G. troglophilus*, and *G. minus*; in small springs of the Pine Hills region, Union Co., Ill., it co-



Figs. TR 19, 20, 21. Epimera of male *Gammarus troglophilus*; Elm Spring, Pine Hills area, Union Co., Illinois. Figs. LM 22, 23, 24. Epimera of male *Gammarus lacustris limnaeus*; Grand Lake, St. Louis Co., Minnesota. Figs. LA 25, 26, 27. Epimera of male *Gammarus lacustris lacustris*; spring in Adobe Valley, Mono Co., California. Figs. AC 28, 29, 30.

occurs with the last two species simultaneously. It has been confused with several species, both before and after Bousfield recognized its specific status. His paper (Bousfield 1958) is the only publication with figures and other taxonomic aids concerning this widespread form.

Epimeron I (Fig. PS 16). Up to 20 close-set anterior setae, at times arising rather high on the plate. The proximal setae submarginal, the distal setae stouter and marginal; the antero-ventral angle may bear a short spinelike seta arising from a notch. The ventral edge rounded, bears three to eight well spaced setae originating from notches; the entire border usually clothed. The posterior margin bears three to eight relatively long setae.

Epimeron II (Fig. 17). Anterior concavity with four to 10 submarginal hairlike setae. The antero-ventral convexity sometimes bears a slender, marginal seta, but usually no marginal antero-ventral setae. Submarginal ventral armature with 11–20 long setae, set singly and in vertical groups; these begin in the antero-ventral region; spines very rare on this plate. Facial armature includes five to nine setae singly or in groups of two to four, arranged diagonally; the anterior facial items starting roughly above the third ventral item. The postero-ventral angle usually unproduced; five to 10 long posterior setae.

Epimeron III (Fig. 18). Anterior concavity with four to 10 hairlike setae, mostly submarginal. On the antero-ventral convexity one to five singly inserted or paired straight setae. Submarginal ventral armature consisting of two to six groups starting far forward; the anterior items may be paired or single setae, the posterior items are spines, each accompanied by a short seta. Ventral armature investing approximately the anterior half, or less. The postero-ventral corner produced more than epimeron II, and there are two to eight long posterior setae.

Discussion: *G. pseudolimnaeus* is characterized by the first epimeron being clothed by ventral setae, a setose second epimeron that rarely bears spines and, uniquely, a third plate with ventral spines, each of which is accompanied by a short seta. Its second plate is much like that of *G. bousfieldi*; its first plate is intermediate between those of *G. fasciatus* and *G. bousfieldi*; its third plate is uniquely armed.

Gammarus troglophilus Hubricht and Mackin
(Figs. TR 19, 20, 21)

The exact range of this species is not known; it is relatively common south of Wisconsin glaciation limits in Illinois and Missouri. It is present in cave streams, springs and rheocrenes, where it may co-occur with *G.*

←

Epimera of male *Gammarus acherondytes*; Morrison's Cave, Burksville, Monroe Co., Illinois. Figs. MI 31, 32, 33. Epimera of male *Gammarus minus*; Morgan's Creek, Otter Creek Park, Meade Co., Kentucky.

pseudolimnaeus, *G. minus*, or *G. acherondytes*. The papers of Hubricht and Mackin (1940) and Bousfield (1958) are the best taxonomic references to *G. troglophilus*.

Epimeron I (Fig. TR 19). Five to eight anterior strong setae near the antero-ventral corner, usually inserted singly although some proximal setae may be paired; stoutest setae at the corner and in faint notches; sometimes a spinelike seta present at the angle. Setae continue on to no more than the anterior third of the straight or broadly rounded ventral margin. The posterior border with two to six long setae.

Epimeron II (Fig. 20). Anterior concavity with two to five fine submarginal setae, often arising in a vertical series. Antero-ventral convexity and angle naked. Ventral submarginal armature consisting of two or three groups of setae arranged in vertical series, or spines each with a long seta directly above it. Ventral insertions not extending beyond the anterior half of the plate. The facial setae include one or two insertions, sometimes double and close to the ventrals, especially posteriorly. The postero-ventral angle quadrate or slightly produced. Relatively long setae (two to six) line the posterior margin.

Epimeron III (Fig. 21). Anterior concavity with two to four hairlike setae inserted submarginally and vertically arranged, singly or in groups of two. Ventral items include three to six submarginal insertions extending caudad less than half the breadth of the broad plate; armature consisting of long setae and spines, usually mixed, rarely only setae are present; setae occasionally in pairs vertically arranged. Rarely a slender seta or a spine inserted facially midway between the penultimate and ultimate ventral items. Slight production of the postero-distal corner; the posterior border bears two to four setae. This plate markedly broader than epimeron II.

Discussion: Probably *G. troglophilus* is most often confused with *G. pseudolimnaeus*. The latter species has more setose abdominal side plates and is always distinguishable by the ventral armature of the third plate.

Gammarus lacustris limnaeus S. I. Smith
(Figs. LM 22, 23, 24)

Gammarus lacustris lacustris G. O. Sars
(Figs. LA 25, 26, 27)

The nomenclature here follows Bousfield (1958) who designated the populations in the St. Lawrence drainage basin as *G. l. limnaeus*, and those in the Hudson Bay drainage, western North America, and northwestern Europe as *G. l. lacustris*. Whether this is a polytypic species or two distinct species is not explored here. The variations shown among the figures portraying epimera of *G. l. limnaeus* and *G. l. lacustris* are not much greater than can be found among different populations of a single species, although *G. l. limnaeus* may be more setose than the latter. Discussions and figures of this species or species complex have appeared in the literature since the late 19th Century, but the best modern taxonomic aids are the papers of Bousfield (1958) and Hynes *et al.* (1960).

Epimeron I (Figs. LM 22, LA 25). Anterior surface with up to 20 relatively strong setae inserted singly and in groups of two to four, marginal and submarginal. The distal setae sometimes set in notches and leading to the antero-ventral corner where they are confluent with the ventral setae. Ventral margin truncate; ventral setae marginal, set in fine notches and usually close to the antero-distal corner. Postero-ventral angle either blunt or with an obvious notch; one to three setae on the posterior margin.

Epimeron II (Figs. 23, 26). No anterior setae or one slender straight submarginal seta arising from the anterior convexity. The ventral armament includes two to eight submarginal insertions, often in groups of two; they clothe about half the distal margin. The ventral armature with spines and setae, the anterior setae being the longest; short setae sometimes accompany the spines. The facial insertions fewer than the ventrals, but include spines and setae, and sometimes paired; facial armature set low above the anterior ventral items. The postero-ventral corner remarkably produced; the posterior margin bears one to five (usually two or three) small setae.

Epimeron III (Figs. 24, 27). Usually no anterior setae, but sometimes one or two slender setae arise from margin of anterior convexity. The ventral armature with spines and setae occupying half or more of the ventral margin; these include three to 10 submarginal insertions, usually single but rarely two setae in a group: no short setae with the spines. The postero-ventral angle remarkably produced; posterior margin bears one to four short setae.

Discussion: The variation seen among epimera in any single species may not be exaggerated in the figures for *G. lacustris limnaeus* (Figs. 22–24) and *G. lacustris lacustris* (Figs. 25–27) although the third plate of the former (Fig. 24) often has longer setae than usually found in *G. l. lacustris.* Whether these represent two species or a single polytypic species is questionable. Hynes *et al.* (1960) show the second and third epimera of *G. lacustris* from England with less production of the postero-ventral corners. Bousfield (1958) portrayed the three epimera of *G. l. limnaeus* with produced corners on the last two plates. He stated (*loc. cit.*, p. 81) that the North American material of *G. lacustris lacustris* has subquadrate or acute, but unproduced abdominal side plates, but that (*loc. cit.*, p. 84) *G. lacustris limnaeus* has acutely produced corners. He also implied variation by stating that lotic-water specimens tend to have more acutely produced abdominal side plates than lentic-water forms.

Gammarus acherondytes Hubricht and Mackin
(Figs. AC 28, 29, 30)

As far as is known, *G. acherondytes* is restricted to cave streams of Monroe Co., Illinois, north of the Illinois Ozarks. It co-occurs with *G.*

troglophilus. The original description by Hubricht and Mackin (1940) and Bousfield's redescription (1958) are the only taxonomic publications on this species.

Epimeron I (Fig. AC 28). Distal anterior surface and antero-ventral angle with seven to 15 setae; the proximal setae in groups of two or three and slightly submarginal; setae near the antero-ventral corner marginal, stouter and set in fine notches. Ventral margin oblique and mostly unarmed. A conspicuous postero-ventral notch and a rather straight posterior margin lined with two to six setae.

Epimeron II (Fig. 29). In the distal part of the anterior concavity zero to six close-set, hairlike setae. The antero-ventral convexity bare. Submarginal ventral armature including three to five singly inserted spines and setae occupying a little more than half of the margin. Facial items include three to seven spines and setae inserted singly and subparallel to ventral margin. The postero-ventral angle acute but unproduced; posterior margin bears two to six setae.

Epimeron III (Fig. 30). No fine setae found in the anterior concavity. Ventral, submarginal insertions include four to six items set singly, commencing near the antero-ventral margin and clothing no more than the anterior half of the broad plate. Anterior ventral items may be setae; the posterior two to four items are spines. One or two small facial setae may occur in the anterior part of the plate. Postero-ventral corner often acute, but not produced; posterior margin with up to eight setae.

Discussion: The first epimeron of this rare species has an unique oblique ventral margin. Its second plate is reminiscent of that of *G. minus*, and its third plate has armature similar to that of *G. troglophilus*, *G. lacustris* and *G. minus*, although shaped like the last.

Gammarus minus Say
(Figs. MI 31, 32, 33)

Apparently *G. minus* is found in an east-west band south of the Wisconsin Glaciation limits and north of the greatest advances of the Eocene Sea during the Mississippi Embayment. It ranges from the Philadelphia and Washington regions west into the Ozark Plateau. Although the species shows pronounced geographical variation, the abdominal side plates seem to be remarkably uniform throughout its range. There are two good descriptions of the species, although based only on eastern specimens (Shoemaker 1940; Bousfield 1958).

Epimeron I (Fig. MI 31). Up to 10 anterior setae, mostly near the antero-ventral corner, set singly and in groups of two, three, or four; proximal setae often slightly submarginal; distal setae marginal spaced and stouter, inserted in notches; sometimes a short, spinelike seta present at the distal corner. Ventral margin rounded or straight; some setae continuous with the antero-ventral setae extend onto the anterior third of the plate; rarely a single seta set in a notch at the midway mark.

Postero-ventral corner sharply notched, or blunt, with one or two setae; posterior margin with one to four setae.

Epimeron II (Fig. 32). Anterior concavity with zero to four submarginal hairlike setae. Antero-distal convexity bare. Ventral submarginal armature usually includes three items set singly, three spines, two setae and a spine or two spines and a seta. Tips of the ventral spines do not, or scarcely protrude past distal margin. Ventral armature may occupy less or slightly more than half the plate's breadth. Facial armature of one or two items, usually a spine, two spines, or a spine and a seta. When one item is present, it is relatively low; the second item anterior and dorsal to it. The postero-ventral corner quadrate or little produced; the posterior setae range from two to eight, rarely more than five.

Epimeron III (Fig. 33). Anterior concavity with zero to five small, slightly submarginal setae. Antero-ventral convexity and angle bare although the first submarginal ventral item may be at that angle. Ventral items, two to five, set singly; anterior ones may be relatively long setae, posterior ones spines, or all of them spines, occupying less than one-half the breadth of the plate. Postero-ventral corner quadrate or very slightly produced; posterior margin with one to five setae.

Discussion: In general, the North American *Gammarus* species can be arranged from the most setose, *G. bousfieldi*, to the least, *G. minus*. The epimera of *G. minus* have the sparsest armature of all species discussed here. In this respect its plates are most like those of *G. acherondytes* and *G. duebeni*. The facial items on epimeron II are especially wanting; in larger specimens a second item is present, although not shown in Fig. 33; Shoemaker (1940, Fig. 2, j) shows this. He stated (*loc. cit.*, p. 390) that the last two plates have ". . . the lower hind corners sharply produced." His figures show, in my opinion, acute corners with very slight production.

G. duebeni (Figs. 1–3) is probably not to be found within 400 or more km of the nearest *G. minus* population; its epimera, however, are much like those of the latter species. They differ specifically from *G. minus* in having: more posterior setae on all plates; a slender, straight, marginal seta near the anterior convexity in plates II and III; more convex ventral margins of plates II and III; more setae in the anterior concavity of epimeron III; more facial armature on epimeron II; and, that facial armature arranged vertically rather than diagonally.

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PROCEEDINGS
OF THE
BIOLOGICAL SOCIETY OF WASHINGTON

FURTHER COMMENTS ON THE RANGE OF *MUREX FLORIFER* REEVE[1]

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In my recent comments on muricids (Work, 1969: p. 665), I misinterpreted Vokes' (1965) introductory remarks concerning *Chicoreus* to mean that she was at that point (p. 181) considering *Chicoreus* as a subgenus of *Murex* (sensu lato) but subsequently (pp. 182, 184) giving it full generic standing. The latter was obviously her only intention, as she did not in any sense state that *Chicoreus* is a subgenus of *Murex*. In my paper, I also expressed doubt that *Murex* (*Chicoreus*) *florifer* Reeve actually occurs in the Caribbean Sea and therefore questioned the locality of Honduras as one of Reeve's sources of this species. However, Radwin (1969) listed this species from Payardi Island, Panama. Through the kindness of Axel A. Olsson of Coral Gables, Florida, I have since examined numerous specimens from the same locality. As those specimens unquestionably are *Murex florifer*, the restriction of the type-locality of this species as Honduras by Clench and Pérez Farfante (1945) is completely credible. *Murex florifer* is known also from the southeastern United States, the Bahamas, and the northern coasts of Cuba and Hispaniola. Since the species is not known from the Lesser Antilles or the islands of the southern Caribbean, its occurrence in the Caribbean proper apparently is limited to the coast of Central America and possibly the southern coasts of Cuba and Hispaniola.

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[1] Contribution No. 1240 from the Institute of Marine and Atmospheric Sciences, University of Miami.

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PROCEEDINGS
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MATERIALS FOR A REVISION OF THE TRICHIUROID FISHES OF THE GENUS *BENTHODESMUS*, WITH THE DESCRIPTION OF FOUR NEW SPECIES AND ONE NEW SUBSPECIES.

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When studying trichiuroid fishes of the families Scombrolabracidae, Gempylidae and Trichiuridae, the authors concluded that it was necessary to change the existing views on the number of species in the genus *Benthodesmus* reviewed recently by D. W. Tucker (1953, 1955, 1956).

The bulk of the material studied was collected by USSR research vessels in the Pacific and Indian oceans and is in the collections of the Institute of Oceanology in Moscow and the Zoological Institute in Leningrad (ZIL). Some additional material and data were received from the U.S. National Museum. The authors are greatly indebted to Drs. V. G. Osipov and V. P. Shuntov (Vladivostok) for presentation of their material, to Dr. B. B. Collette (Washington) for his kind help in loaning a specimen and sending radiographs from the U.S. National Museum and for critical review of the manuscript, to G. N. Pokhilskaya for drawings, and to A. A. Korovkina for X-raying the specimens.

Genus *Benthodesmus* Goode and Bean

Benthodesmus Goode and Bean, 1882: 379 (type-species *Lepidopus elongatus* Clarke = *B. elongatus*).

For description and full bibliography see Tucker (1953, 1955, 1956).

Comparative notes: Benthodesmus is closely allied to *Aphanopus*. The two genera form a natural group recognized by Tucker (1956) as the subfamily Aphanopodinae.[1]

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[1] *Diplospinus* (and related *Paradiplospinus*) must be separated from here as having two nostrils on each side of the snout, much lower number of vertebrate and differing in some other features.

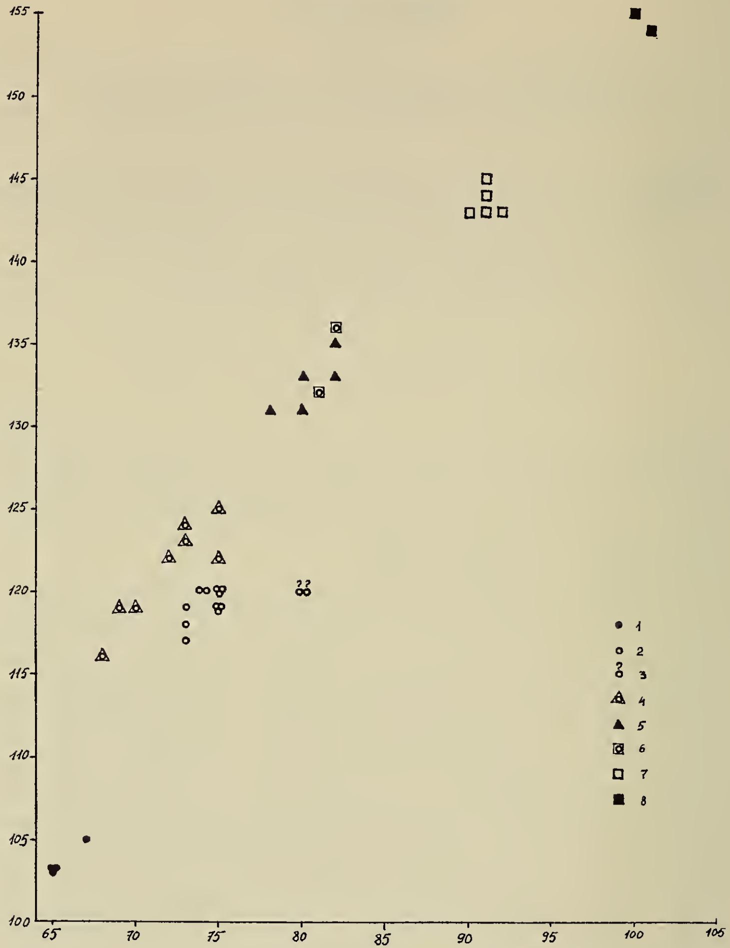

FIG. 1. Total number of dorsal fin-rays plotted against the number of anal fin-rays in *B. oligoradiatus* (1), *B. macrophthalmus* (2), *B. macrophthalmus* ? (3), *B. tenuis* (4), *B. tuckeri* (5), *B. vityazi* (6), *B. elongatus pacificus* (7), and *B. elongatus simonyi* (8). Only original data included.

Species: Tucker (1956) included only three species in *Bethodesmus* (*B. tenuis, B. elongatus* and *B. simonyi*) and suggested the possible specific identity of the two latter forms but postponed a final decision until the re-examination of the material from New Zealand, the type-locality of *B. elongatus.* All other nominal species of *Benthodesmus* were considered by Tucker as synonyms of *B. tenuis* (with which he identified *Lepidopus aomori* Jordan and Snyder, *B. benjamini* Fowler and, questionably, *L. argenteus* Brauer) or *B. simonyi* (the only synonym is *B. atlanticus* Goode and Bean).

We conclude that there are more species of *Benthodesmus* than were previously recognized. This is based upon the fact that it is possible to distinguish in our material well-separated groups differing in the total number of dorsal and anal fin elements (fig. 1), dorsal spines and vertebrae as well as in the position of vent, some body proportions and other features. Scarcity of specimens (especially adults) does not allow certain establishment of the systematic status of all the groups distinguished. Nevertheless, it seems possible to describe here four new species—*B. oligoradiatus*, *B. macrophthalmus*, *B. tuckeri* and *B. vityazi*—and one new subspecies—*B. elongatus pacificus*—which are undoubtedly distinct from all known species.

KEY TO THE SPECIES OF *BENTHODESMUS*

1(8) Pelvic fins inserted under the pectoral base or before the anterior end of the pectoral base. Total number of dorsal elements 103–135. Number of vertebrae 103–139.

2(3) Total number of dorsal elements 103–105, including 32–33 spines; number of anal rays 65–67; number of vertebrae 103–105. Vent located before the vertical with the first soft dorsal ray, base of anal spines—under soft dorsal ray 1–3 .... *B. oligoradiatus* new species.

3(2) Total number of dorsal elements 116–135, including 34–42 spines; number of anal rays 70–82; number of vertebrae 119–139. Vent located behind the vertical with third soft dorsal ray, base of anal spines—under soft dorsal ray 5–11.

4(7) Total number of dorsal elements 119–135, including 39–42 spines. External anal fin complete.

5(6) D XXXIX–XLII 79–88 (total 119–129). A II 69–75. Vert. 121–131. .... *B. tenuis* (Günther)[2]

6(5) D XXXIX–XLII 90–93 (total 131–135). A II 78–82. Vert. 136–139. .... *B. tuckeri* new species.

7(4) Total number of dorsal elements 116–121, including 34–36 spines. External anal fin rays present in posterior part of the fin only .... *B. macrophthalmus* new species.

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[2] Some differences do exist between local populations of *B. tenuis* in the number of fin-elements and vertebrae (data after Tucker, 1955 and original material combined):

Japan—D XXXIX–XLII 83–84 (total 122–126), A II 71–75, vert. 124–131.
Gulf of Mexico—D XL–XLII 83–87 (total 125–129), A II 72–75, vert. 129–131.
West Africa—D XXXIX–XLII 80–86 (total 120–125), A II 70–75, vert. 123–128.
Philippines— D XXXIX–XLI 79–81 (total 119–122), A II 69–72, vert. 121–123.

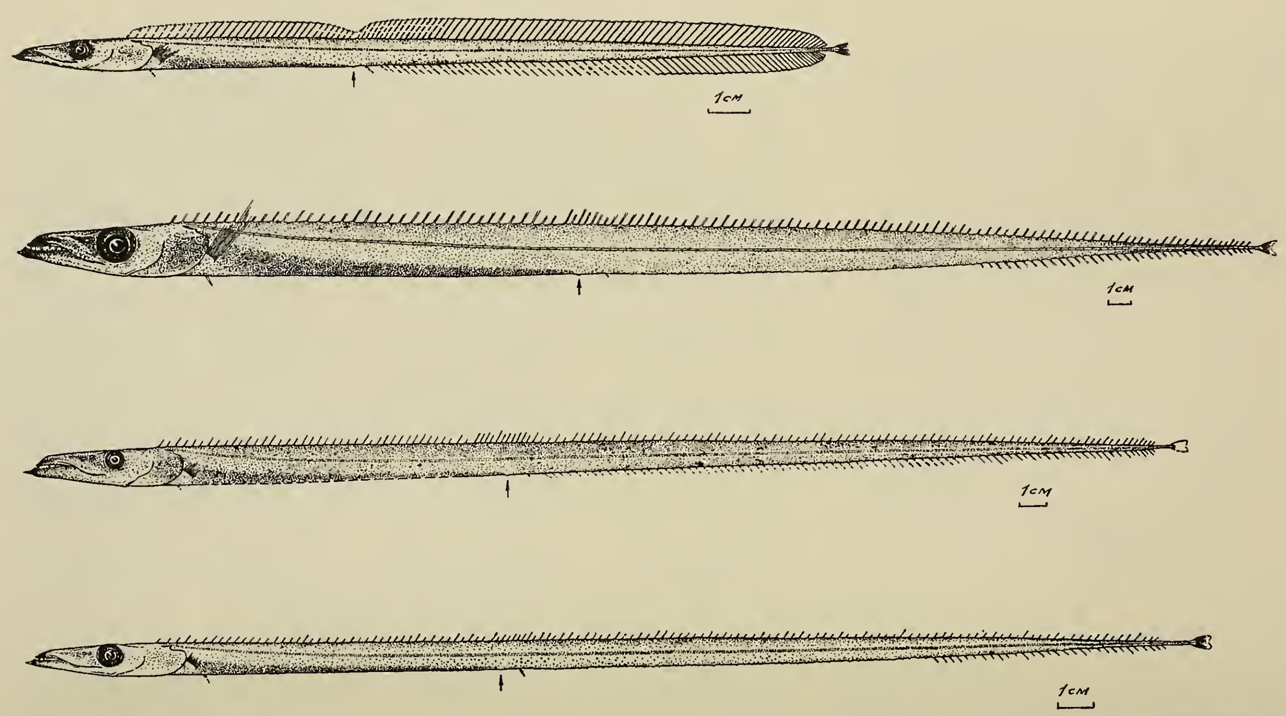

FIG. 2. New species of *Benthodesmus*. From above to below: *B. oligoradiatus* (holotype 183.2 mm SL, ZILN 39124), *B. macrophthalmus* (holotype 570 mm SL, ZILN 39125), *B. tuckeri* (paratype 454 mm SL, ZILN 39126), *B. vityazi* (holotype 264.5 mm SL, ZILN 39123).

8(1) Pelvic fins inserted distinctly behind the posterior end of the pectoral base. Total number of dorsal elements 132–155. Number of vertebrae 138–158.
9(10) D XLII–XLIII 89–93 (total 132–136). A II 81–82. Vert. 138–140. .... *B. vityazi* new species.
10(9) D XLIV–XLVI 98–100 (total 143–155). A II 90–101. Vert. 149–158.
11(12) D XLIV–XLVI 104–110 (total 148–155). A II 93–101 ....
.... *B. elongatus simonyi* (Steindachner)
.... *B. elongatus elongatus* (Clarke)
12(11) D XLIV–XLV 98–102 (total 143–147). A II 90–92 ....
.... *B. elongatus pacificus* new subspecies.

The main diagnostic features used in the key are summarized in Table 1. The data for the variant specimens included in *B. macrophthalmus* with a question mark are shown in a separate column of the table.

Benthodesmus oligoradiatus Parin and Becker new species

(Fig. 2a)

?*Lepidopus argenteus* (*nec* Bonnaterre) Brauer, 1906: 292 Taf. XII, fig. 2.

Material: 4 specimens from 4 stations in the Arabian Sea and the Bay of Bengal.

R/V "*Vityaz*", st. 4725 (13°35′ N, 54°31′ E; 15 April 1960), conical net (1000 m—surface)—1 (183.2 mm SL), st. 4957 (13°33′ N, 90°54′ E; 15–16 Feb. 1961), Isaacs-Kidd Midwater Trawl—IKMT (100 m—surface)—1 (102.2 mm SL), st. 4959 (18°39′ N, 89°12′ E; 17 Feb. 1961), IKMT (314 m—surface)—1 (98.1 mm SL). R/V "Baikal", st. 4 (12° 54′ N, 64°27′ E; 9 Oct. 1966), IKMT (325 m—surface)—1 (175.7 mm SL).

Type series: Holotype—specimen 183.2 mm SL; R/V "*Vityaz*", st. 4725; ZIL 39124. Paratypes—all other specimens of the type-series (see *Material*). In the following description the numbers and notes in parentheses concern the paratypes.

Diagnosis: A species of *Benthodesmus* with pelvic fins inserted under the anterior end of the pectoral fin base; with a low number of vertebrae, dorsal and anal fin-elements; with the anal fin complete; with a rather large head; with the vent located from under the next to the last dorsal spine to the first dorsal soft ray.

Description: D XXXII 71, total 103 (XXXII–XXXIII 70–72, total 103–105). A II 65 (II 65–67). P 12 (12–13). Vert. $40 + 63 = 103$ ($41 + 64 = 105$ in one paratype).

Measurements of the holotype 183.2 mm SL (the three paratypes 98.1 mm, 102.2 mm and 175.7 mm SL) in per cent of SL (from the tip of the *lower* jaw): preanal distance 42.9 (45.0, 43.0, 43.0), predorsal distance 13.5 (15.6, 15.2, 13.4), snout-vent distance 41.4 (44.3, 42.4, 42.0), head 16.6 (19.8, 19.5, 17.1), body depth 4.0 (4.3, —, 3.8), caudal peduncle depth 0.2 (0.3, 0.3, 0.3), length of spinous dorsal base 28.0 (29.2, 28.2, 29.6), length of soft dorsal base 52.7 (52.3, 55.2, 53.7). In per cent of head: interorbital 4.0 (4.1, 3.5, 4.0), eye 16.8 (15.5, 14.6, 15.8), snout 38.2 (36.6, 36.7, 37.4), maxillary 30.4 (28.5, 28.7, 29.0), body depth 24.0 (21.6, —, 22.3), caudal peduncle depth 1.3 (1.5, 1.5, 1.6).

Vent located just behind last dorsal spine (under next to last spine to first soft ray), base of jointed anal spines under third soft dorsal ray (under first—third soft ray). Scalelike pelvic fins inserted under anterior end of pectoral fin base (just before or under anterior end of pectoral fin base). Second anal spine flat and acute. External rays developed along whole anal fin base.

Two widely spaced fixed fangs near tip of snout on both sides of upper jaw and three somewhat smaller depressible fangs located near the first right and both hinder fangs. A lateral row of 10 (14 in one paratype) small teeth outside of anterior fangs and about ten slightly larger teeth behind them. On lower jaw a fixed fang anteriorly and about 20 small lateral teeth behind it. A single series of 10 small teeth on palatines.

Comparative notes: B. oligoradiatus, though described from adolescent specimens, evidently differs from the other species in much lower numbers of vertebrae and fin elements. Presence of well-developed external rays along the anal fin base also seems to be of diagnostic value, if not applied to juveniles only.

Only two specimens of *Benthodesmus* (both collected by the "*Valdivia*") were recorded from the Western Indian Ocean (Tucker, 1953). The largest specimen (711 mm SL) was caught at 4°42′ N, 48°39′ E and identified by Brauer (1906) as *Lepidopus tenuis*. The number of fin elements (D 133, A 75) fully excludes the similarity with *B. oligoradiatus*. Another specimen—a juvenile 119 mm SL—from the same area (9°06′ N, 53°41′ E) has many fewer fin-rays (D ca. 115, A 67–70) and was described as the type of *Lepidopus argenteus* Brauer. Indication of approximate counting permits us to assume that the number of rays was probably higher. In this case the specimen may be conspecific with our material because other features in Brauer's description do not contradict the diagnosis of *B. oligoradiatus*. Nevertheless, the name *L. argenteus* Brauer, 1906 is invalid as being a primary junior homonym of *L. argenteus* Bonnaterre, 1788 [= *L. caudatus* (Euphrasen)] (see Tucker, 1953).

Distribution: Specimens of *B. oligoradiatus* were collected only in the Arabian Sea and the Bay of Bengal.

Benthodesmus macrophthalmus Parin and Becker new species
(Fig. 2b)

Material: 11 specimens from 2 stations in the Arafura Sea (and 2 variant specimens from 2 stations in the Western Equatorial Pacific).

R/S "*Akademik Berg*", st. A (9°01′ S, 130°39′ E; 26 May 1967; depth 540 m), bottom otter trawl—4 (454–570 mm SL), st. B (9°05′ S, 131°22′ E; 19 July 1967; depth 316 m), bottom otter trawl—7 (268–445 mm SL).

?R/V "*Vityaz*", st. 3699 (0°00′, 135°09′ E; 25 Aug. 1957), conical net (500 m—surface)—1 (227.3 mm SL), st. 3981 (4°58′ S, 146°59′ E; 27 April 1958), conical net (1000 m—surface)—1 (48.8 mm SL).

Type series: Holotype—specimen 570 mm SL; R/V "*Akademik Berg*", st. A, collected by V. P. Shuntov; ZIL 39125. Paratypes—10 specimens 268–504 mm SL from collection of the same vessel; the variant specimens collected by the R/V "*Vityaz*" are excluded from the type-series. In the following description, the numbers and notes in parentheses concern the paratypes.

Diagnosis: A species of *Benthodesmus* with pelvic fins inserted under the pectoral fin base; with relatively few dorsal spines; with a moderate number of dorsal and anal fin-elements; with external rays developed only in the posterior part of the anal fin; with a large eye.

Description: (for the type-series). D XXXVI 83, total 119 (XXXV–XXXVI 81–85, total 117–120). A II 73 (II 73–75). P 12 (12). Vert. $63 + 59 = 122$ $(58 - 63 + 59 - 62 = 119\text{–}123)$. (Gill rakers $4 + 1 + 18 = 23$).

Measurements of the holotype 570 mm SL (and 5 paratypes 268–504 mm SL) in percent of SL: preanal distance 46.0 (45.0–46.5), predorsal distance 12.0 (11.0–12.2), snout-vent distance 44.1 (43.0–44.0), head 14.3 (13.5–14.2), body depth 4.8 (3.5–4.8), caudal peduncle depth 0.2 (0.2), length of spinous dorsal base 30.9 (29.5–30.3), length of soft dorsal base 55.2 (55.2–57.1). In percent of head: interorbital 7.6 (6.2–7.6), eye 20.0 (18.5–22.2), snout 44.9 (39.9–44.4), maxillary 38.4 (34.1–38.9), body depth 33.4 (24.3–35.0), caudal peduncle depth 1.7 (1.3–1.7).

Vent located under third soft dorsal ray (under soft ray 3–5), base of jointed anal spines—under seventh soft dorsal ray (under soft ray 5–7). Small scalelike pelvic fins inserted under pectoral fin base. Anal spines damaged in all specimens. External rays developed only in posterior half of anal fin base. Body canal of lateral line wide, its posterior part occupying whole side of caudal peduncle.

Two widely spaced, strong, fixed, and laterally flattened fangs near tip of snout on both sides of upper jaw and, on left side, two smaller depressible fangs (depressible fangs absent or represented by one or two canines near any of fixed ones). A lateral row of 5 (4–8) very small teeth outside of anterior fangs and 6 (8–10) larger teeth behind them. On lower jaw, a small fixed fang anteriorly and 12 (8–10) lateral teeth behind it. A single series of 8 (5–10) small teeth on palatines.

Body silver, but peduncle almost black; belly slightly darker than sides.

Description of variant specimens: D XXXIV 84–86, total 118–120. A II 80. P 12. Vert. 124 (in larger specimen).

Measurements of two specimens 48.8 and 227.3 mm SL in percent of SL; preanal distance 50.0, 40.0, predorsal distance 17.6, 10.5, snout-vent distance 48.2, 38.3, head 19.8, 12.5, body depth 5.1, 2.7, caudal peduncle depth 0.6, 0.2, length of spinous dorsal base 30.5, 23.4, length of soft dorsal base 49.9, 61.7, length of pectoral fin 5.7, —. In percent of head: interorbital 4.3, 4.2, eye 17.0, 17.9, snout 41.5, 44.5, maxillary 33.0, 32.3, body depth 26.6, 20.7, caudal peduncle depth 3.2, 1.1, length of pectoral fin 29.9, —, length of ventral 13.7, —.

Vent located under fourth (in smaller specimen) or under interspace between sixth and seventh (in larger one) soft dorsal rays, base of jointed anal spines under sixth and ninth soft dorsal rays, respectively. Second anal spine (in smaller specimen) strongly flattened, cardiform. External rays developed only in posterior part of anal fin in larger specimen but along whole fin base in smaller one.

In the larger specimen two fixed fangs present near the tip of snout on both sides of upper jaw and one depressible canine on left side near posterior fixed fang. A lateral row of 12–14 very small teeth outside of anterior fangs and 6 larger teeth behind them. On lower jaw a fixed fang near symphysis and 12 lateral teeth behind it. A single series of small teeth on palatines.

Comparative notes. Some hesitation arises as regards the uniting of the specimens of the type-series and the variant juveniles from the Western Equatorial Pacific under the same specific name. These groups differ slightly in the number of dorsal spines and anal elements (D_1 XXXV–XXXVI, A II 73–75 versus D_1 XXXIV, A II 80). This distinction seems insignificant but as shown in fig. 1 the correlation between the number of elements in the dorsal and anal fins is very stable in *Benthodesmus* species. We suggest, therefore, that the variant specimens may belong to another and still undescribed species but provisionally leave them in *B. macrophthalmus* because of the absence of representative series.

B. macrophathalmus is quite distinguishable from other species of *B. tenuis*—group in lower number of dorsal spines, larger eye and absence of external rays in the anterior half of anal fin. The last feature is typical also for the species of *B. elongatus*—group in which pelvic fins are always inserted more posteriorly.

In total number of dorsal and anal elements, *B. macrocephalus* agrees with the original description of *B. benjamini* for which Fowler (1938) indicates D 115–120, A 74. Having examined, however, radiographs and measurements of all Fowler's specimens we can conclude that some of them (including holotype) belong to *B. tenuis* and the rest to *B. tuckeri*.

As regards the other specimens of *Benthodesmus* mentioned in the literature, only one specimen 535 mm SL described by Weber (1913) from the Indo-Australian Archipelago (Kei Islands) under the name *Lepidopus tenuis* may belong here. This specimen was characterized as follows: D 125–126, A 73, eye 6.5 in head. However the possibility of its correct identification is not less probable.

Benthodesmus tuckeri Parin and Becker new species (Fig. 2c)

Benthodesmus benjamini Fowler, 1938: 45 (in part: only two of the paratypes; Philippines).

Material: 4 specimens from 2 stations near the Philippines and Java. R/V "*Albatross*", st. 5444 (13°45′ N, 120°46′ E; 16 Jan. 1908; depth 554 m; paratype of *B. benjamini*; USNM 98822)—1 (598 mm SL).

R/V "Orlik", st. 3 (10° S, 112° E; 2 Feb. 1963), otter trawl—3 (415–467 mm SL, all badly damaged).

Additional material: Radiograph of the 614 mm SL paratype of *B. benjamini* (USNM 98824).

Type series: Holotype—ripe female 598 mm SL; R/V "*Albatross*", st. 5444, USNM 98822. Paratypes—all other specimens of the type-series (see *Material* and *Additional material*). In the following description the numbers and notes in parentheses concern the paratypes.

Diagnosis: A species of *Benthodesmus* with pelvic fins inserted before the anterior end of pectoral fin base; with rather high number of vertebrae, dorsal and anal fin-elements; with the anal fin complete; with the vent located under fifth-seventh dorsal soft ray; with a moderate-sized eye.

Description: D L 91, total 131 (XLI–XLII 90–93, total 131–135). A II 81 (II 80–82). P 12 (12). Vert. $62 + 74 = 136$ ($60 - 64 + 72 - 77 = 136–138$). Gill rakers $4 + 1 + 7 = 12$ ($4 + 1 + 8 = 13$).

Measurements of the holotype 598 mm SL (and 3 paratypes 415–467 mm SL) in percent of SL: preanal distance 42.1 (42.3–44.0), predorsal distance 10.4 (10.8–11.5), snout-vent distance 40.5 (40.6–42.4), head 13.0 (12.8–13.5), body depth 5.2 (3.3), caudal peduncle depth 0.2 (0.2–0.3), length of spinous dorsal base 28.1 (26.2–27.4), length of soft dorsal base 60.2 (58.6–59.8). In percent of head: interorbital 11.0 (8.4–9.7), eye 12.1 (11.0–11.1), snout 46.4 (48.6-49.4), maxillary 38.8 (36.0–37.6), body depth 41.0 (24.7), caudal peduncle depth 1.8 (1.7–2.0).

Vent located under fifth soft dorsal ray (under soft ray 5–7), base of jointed anal spines—under ninth soft dorsal ray (under soft ray 8–11). Pelvic fins broken off (in one paratype in the form of flattened daggerlike spines), inserted before anterior end of pectoral fin base. Anal spines damaged in all specimens. External rays developed along whole anal base.

Two widely spaced fixed fangs near tip of snout on both sides of upper jaw, depressible fangs absent (one or two depressible fangs located near posterior fixed fangs). A laterial row of 3+ very small teeth outside of anterior fangs and 10 (about 6) larger compressed teeth behind them. On lower jaw a short fixed fang anteriorly and 11 (6–8) teeth behind it. A single series of 8 (on the right side)—11 small teeth on palatines.

Comparative notes: This species is allied to *B. tenuis* but differs in a higher number of vertebrae, dorsal and anal fin-elements (see Table 1) and smaller eye. The difference in vertebral and fin-element counts seems especially significant when one compares the sympatric populations of both species from Philippines—Indonesian area. *B. tenuis* of this region has much lower counts than *B. tuckeri* (vert. 121–123; D XXXIX–XLI 79–81, total 119–122; A II 69–72 versus vert. 136–138; D XL–XLII 90–93, total 131–135; A II 80–82).

As can be seen from the radiographs, *B. benjamini*, described by Fowler (1938) from the Philippines, was established on mixed material in which 3 specimens of *B. tenuis* (one of them originally indicated as holotype) and 2 specimens of *B. tuckeri* were united. Both latter specimens are included here in the type-series of *B. tuckeri* one of them being selected as the holotype of the new species.

It is possible that *L. tenuis* from North-Eastern Africa described by Brauer (1906) may also belong to *B. tuckeri*. This specimen has 133 elements in dorsal fin but differs in somewhat lower count of anal rays.

Distribution: Specimens of *B. tuckeri* were collected in the waters adjacent to Philippine Islands (Fowler, 1938) and to the south of Java.

Benthodesmus vityazi Parin and Becker new species
(Fig. 2d)

Material: 2 specimens from 2 stations in the Equatorial Central Pacific.

R/V *"Vityaz"*, st. 5117 (0°04′ N, 154°05′ W; 20–22 Oct. 1961), IKMT (440 m—0)—1 (264.5 mm SL), st. 5139 (0°01′ S, 175°56′ W; 8–9 Nov. 1961), IKMT (170 m—0)—1 (197.5 mm SL).

Type series: Holotype—specimen 264.5 mm SL; R/V *"Vityaz"*, st. 5117; ZIL 39123. Paratype—specimen 197.5 mm SL; R/V *"Vityaz"*, st. 5139. In the following description the numbers and notes in parentheses concern the paratype.

Diagnosis: A species of *Benthodesmus* with pelvic fins inserted behind the posterior end of pectoral fin base; with a relatively low (for species with posterior position of pelvic fins) number of vertebrae, dorsal and anal fin-elements; with the vent located under second or third dorsal soft ray; with external rays developed only in posterior part of anal fin.

Description: D XLIII 89, total 132 (XLII 93, total 136). A II 81 (II 82). P 12–13 (12). Vert. 138 (140). Gill rakers $3 + 1 + 6 = 10$.

Measurements of the holotype 264.5 mm SL (and the paratype 197.5 mm SL) in percent of SL: preanal distance 41.5 (41.4), predorsal distance 11.0 (11.7), snout-vent distance 40.0 (39.9), head 13.2 (13.5), body depth 3.1 (3.4), caudal peduncle depth 0.2 (0.2), length of spinous dorsal base 28.1 (26.7), length of soft dorsal base 55.8 (57.0). In percent of head: interorbital 4.6 (4.5), eye 18.0 (15.4), snout 41.5 (41.4), maxillary 30.5 (29.4), body depth 23.1 (25.2), caudal peduncle depth 1.7 (1.5).

Vent located under interspace between second and third soft dorsal ray (under third soft ray), base of jointed anal spines under sixth soft dorsal ray (under interspace between sixth and seventh soft ray). Pelvic fins inserted conspicuously behind posterior end of pectoral fin base. Anal spines damaged (second anal spine flattened and sharpened). External rays developed only in posterior half of anal fin base (fine rays in anterior portion of fin before somewhat stronger rays in posterior half).

Two widely spaced fixed fangs flattened laterally near tip of snout on both sides of upper jaw. A lateral row of 6(8) very small teeth between symphysis of jaw and anterior fang, series of 8 (9) small teeth outside of fangs and about 10 larger teeth behind them. On lower jaw, a small fixed fang anteriorly and about 14 lateral teeth behind it. A single series of 13 teeth on palatines.

Comparative notes: There are no adult specimens of the species described in our collection and the type-series of *B. vityazi* consists of juveniles only. It seems evident, however, that presence of weakly developed external rays in the anterior portion of anal fin in the smaller of our specimens may be considered as a juvenile feature. The same growth changes are undergone by *B. elongatus* in which young specimens obtain external rays along the whole base of anal fin also.

B. vityazi is slightly distinguished from *B. tuckeri* in the number of dorsal and anal fin-elements and vertebrae but the position of pelvic fins is quite different in both species. This feature, as well as the external structure of the anal fin, indicates the closer relationship to *B. elongatus* than to any other member of the genus.

It is possible that the juvenile *Benthodesmus* collected between Hawaii and Tahiti (0°33′ S, 151°34′ W) by the "Challenger"—expedition (Günther, 1889) is conspecific with *B. vityazi.* This specimen was reexamined later by Tucker (1953) and identified as *B. tenuis* but according to the description the fish is in poor condition—abdominal portion of body together with pelvic and pectoral fins pulled out, caudal peduncle badly damaged, most of skin lost, and almost all of dorsal and anal fin-rays broken. The features retained—fin-ray counts (D XLI 76+, A I 68+) and especially location of the vent under second dorsal soft ray and the base of anal spines under fourth soft ray as figured by Tucker (1953)—may be considered as indicating possible identity with *B. vityazi.* Besides that, the localities where both our specimens and Günther's were collected are in the same region of the Pacific Ocean.

Distribution: All known specimens of *B. vityazi* came from equatorial part of the Central Pacific.

Benthodesmus elongatus pacificus Parin and Becker new subspecies

Lepidopus tenuis (*nec* Günther) Franz, 1910: 56 (Japan—Uruga Strait).

Benthodesmus atlanticus (*nec* Goode and Bean) Gilbert, 1917: 1 (Pacific coast of Canada).

Material: 5 specimens from 3 stations in the North-Western Pacific. R/V *"Vityaz"*, st. 3578 (38°35′ N, 142°53′ E; 11 May 1957), dip-netted on surface—1 (1014 mm SL), st. 4017 (32°34′ N, 158°46′ E; 17 Aug. 1958), IKMT (90 m—0)—3 (32.5–48.3 mm SL).

Trawler *"Vityaz"*, st. 22 (30° N, 141° E; 5 Sept. 1966), IKMT (500 m—0)—1 (230.9 mm SL).

Type series: Holotype—specimen 1014 mm SL R/V *"Vityaz"*, st. 3578; ZIL 39127. Paratypes—all other specimens of the type-series (see *Material*). In the following description the numbers and notes in paretheses concern the paratypes.

Diagnosis: A North Pacific subspecies of *B. elongatus* with fewer dorsal and anal fin-elements and vertebrae than in *B. elongatus simonyi* (Steind.) from the North Atlantic and probably in *B. elongatus elongatus* (Clarke) from New Zealand.

Description: D XLIV 99, total 143 (XLIV–XLV 98–102, total 143–145). A II 92 (II 91–92). P 12 (12). (Vert. 149). Gill rakers $5 + 1 + 8 = 14$.

Measurements of the holotype 1014 mm SL (and 3 paratypes 33.2, 48.2 and 230.9 mm SL) in percent of SL: preanal distance 41.9 (51.9, 48.0, 38.1), predorsal distance 11.3 (19.4, 17.1, 10.9), head 13.9 (23.0, 18.7, 12.6), body depth 3.8 (5.4, 3.7, 2.6), length of spinous dorsal base 28.3 (31.6, 29.4, 25.1), length of soft dorsal base 57.8 (45.0, 49.2, 60.8). In percent of head: interorbital 5.4 (3.9, 4.4, 4.1), eye 17.0 (17.1, 17.8, 14.9), snout 50.1 (40.9, 40.0, 44.6), maxillary 34.9 (28.9, 27.8, 30.4), body depth 27.0 (23.7, 20.0, 20.4), caudal peduncle depth 1.4 (2.6, 2.2, 1.4), length of second anal spine (26.4, 27.8, —).

Vent located under first soft dorsal ray (under the last spinous—second soft ray), base of jointed anal spines—under fifth soft dorsal ray (under third-sixth soft ray). Scalelike pelvic fins inserted conspicuously behind posterior end of pectoral fin base (second anal spine in juvenile paratypes very large, daggerlike, quite similar to that in young specimens of *Aphanopus carbo*). External rays ca. 30-developed only in posterior third of anal fin base (in juvenile paratypes along the whole anal fin base). Body canal of lateral line comparatively narrow.

Two widely spaced fixed fangs near tip of snout on both sides of upper jaw. A lateral row of 7 small teeth outside of anterior fangs and 9 moderately large teeth posteriorly. On lower jaw, a small fixed fang anteriorly and 14 lateral teeth behind it. Teeth on palatines indistinct.

Body silvery, caudal peduncle darkened.

Comparative notes: Specimens of *Benthodesmus* reported by Franz (1910) from Japan and by Gilbert (1917) from British Columbia evidently belong here. Both individuals were originally described as having 142 rays in the dorsal fin but after reexamination Tucker (1953) found 147 fin-elements in Gilbert's specimen.

The difference in total dorsal ray counts between the North Atlantic *B. elongatus simonyi* and *B. elongatus pacificus* is comparatively slight (148–155 and 142–147 rays respectively). However these counts seem not to intergrade and warrant recognition at the subspecific level.

Distribution: The range of *B. elongatus pacificus* is limited to the temperate North Pacific (Japan, British Columbia). Other subspecies (considered previously as separate species) are reported from the Southern Hemisphere (*B. elongatus elongatus*) and from temperate North Atlantic (*B. elongatus simonyi*) (see Tucker, 1953, 1955).

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TWO NEW GENERA OF SIGALIONIDAE (POLYCHAETA)

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As pointed out in a recent publication dealing with a revision of some species referred to *Leanira* Kinberg (Pettibone, 1970), the numerous sigalionid species that have been described as members of this genus, or subsequently referred to it, represent a heterogeneous group of species. In the above revision, seven species and one synonym were referred to *Leanira* Kinberg (limited) and one species and three junior synonyms were placed in *Ehlersileanira* Pettibone. In this report, two additional groups are distinguished. This includes two new genera, two new species, three new combinations, and one junior synonym, listed below:

Neoleanira new genus
- *N. tetragona* (Oersted) new combination
  - (= *Sigalion tetragonum* Oersted, 1845. Norway)
- *N. areolata* (McIntosh) new combination
  - (= *Leanira areolata* McIntosh, 1885. Japan)
  - (= *Leanira calcis* Hartman, 1960. Southern California)
- *N. magellanica* (McIntosh) new combination
  - (= *Leanira magellanica* McIntosh, 1885. Southern Chile)

Horstileanira new genus	*H. vanderspoeli* new species (= *Leanira sibogae* Horst, 1917—part. Dutch East Indies) *H. crosslandi* new species (= *Leanira japonica*.—Monro, 1939. Not McIntosh, 1885. Red Sea)

In addition to the sigalionid collections in the Smithsonian Institution (USNM), material was obtained from the British Museum (Natural History), London (BMNH), through J. D. George, the South African Museum Cape Town (SAM), through J. H. Day, and the Zoological Museum Amsterdam (ZMA), through S. van der Spoel. Additional type material was examined at the Allan Hancock Foundation, Los Angeles (AHF), through the courtesy of O. Hartman. I wish to thank the above-mentioned individuals for their cooperation and help. The manuscript benefited from the suggestions of M. L. Jones and H. H. Hobbs, Jr., both of the Smithsonian Institution.

The three closely related species from the North Atlantic, North Pacific and South Pacific off southern Chile, referred herein to *Neoleanira* new genus, are unusual among the sigalionids in having a pair of long dorsal cirri on segment III. The lateral antennae are fused to the inner sides of the tentacular parapodia but are rather long, not inconspicuous as in many sigalionids.

The two new species from the Malay Archipelago and the Red Sea, described under *Horstileanira* new genus, are unusual among the sigalionids in having very prominent ctenidia on the tentacular parapodia as well as on the ceratophore of the median antenna. They also have prominent dorsal tubercles on segment III.

Abbreviations on Figures

I–IV, segments
ac, aciculum
au, auricle
br, branchia
buC, buccal cirrus
ct, ctenidia

ItL, inner tentacular lobe
lAn, lateral antenna
mAn, median antenna
nuO, nuchal organ
OpaS, outer palpal sheath
pa, palp

dC, dorsal cirrus	st, stylode
dTc, dorsal tentacular cirrus	vC, ventral cirrus
dTu, dorsal tubercle	vTc, ventral tentacular cirrus
IpaS, inner palpal sheath	

Neoleanira new genus

Type-species: Sigalion tetragonum Oersted, 1845. Gender: feminine.

Diagnosis: Body elongate, depressed, with numerous segments (up to 300). Paired elytra numerous: on segments 2, 4, 5, 7, on alternate segments to 27, and on all succeeding segments. Elytra smooth, lacking tubercles; with or without delicate lateral borders of papillae. Digitiform branchiae and cuplike ctenidia, 3 per parapodium, from about segment VI posteriorly. Segment III with pair of long dorsal cirri on short cirrophores. Prostomium oval, partially fused to tentacular parapodia (I); ceratophore of median antenna stout, cylindrical, with small lateral auricles or ctenidia and long tapered style; lateral antennae rather long, tapered, fused to inner sides tentacular parapodia; palps very long, slender, tapered, emerging ventral to tentacular parapodia between large inner and small outer palpal sheaths. Tentacular parapodia (I) directed anteriorly, each with single aciculum, pair of tentacular cirri, and 2 bundles of capillary setae; inner or medial L-shaped tentacular lobe with thickened glandular ciliated ridge; with or without small dorsal ctenidium and without stylodes. Parapodia of segments II and III directed anteriorly; ventral buccal cirri (II) longer than following ventral cirri. Parapodia biramous. Notopodia with circlet of stylodes; notosetae numerous, capillary, finely to coarsely spinous. Neuropodia with bracts: 2 postsetal with stylodes and low presetal. Neurosetae forming upper vertical groups anterior to upper postsetal bracts, transverse subacicular groups dorsal to lower postsetal bracts, and lower diagonal groups within short presetal bracts. Neurosetae all compound, spinigerous, with blades relatively short and canaliculate; compound spinigers of segments II and III similar to those of following segments except more slender and with longer blades. Ventral cirri short, subulate. Pharynx with 11 pairs papillae and 2 pairs jaws.

KEY TO THE SPECIES OF *NEOLEANIRA*

1\. Elytra with borders entire, without lateral fringes of papillae. [Ventral ctenidia of middle and posterior segments small, clavate (fig. 7c). Branchiae without prominent basal spurlike processes (fig. 7a, c)] .... *N. magellanica* (McIntosh) new combination

1′. Elytra with delicate lateral fringes of papillae (absent on more anterior elytra) 2

2\. Ventral ctenidia of middle and posterior segments small, clavate (fig. 4b). Branchiae without prominent basal spurlike processes (fig. 4a, b). .... *N. tetragona* (Oersted) new combination

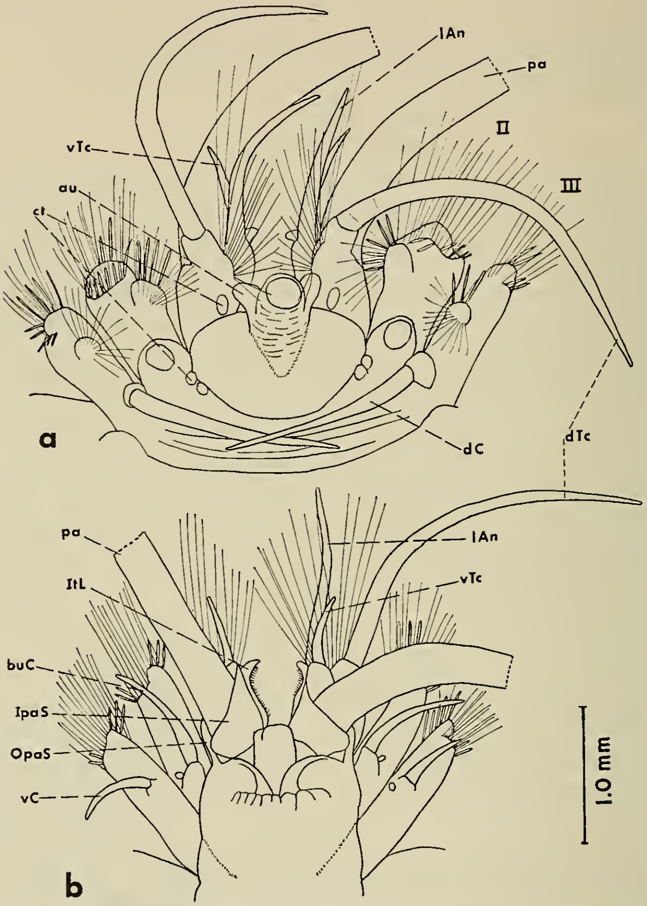

Fig. 1. *Neoleanira tetragona* (Gulf of Maine, USNM 42188): a, Anterior end, dorsal view; style of median antenna and elytra missing; b, anterior end, ventral view.

2′. Ventral ctenidia of middle and posterior segments large, boot-shaped (fig. 6a, b). Branchiae with prominent basal spurlike processes (fig. 6a, b). ____ *N. areolata* (McIntosh) new combination

Neoleanira tetragona (Oersted) new combination
Figures 1–4

Sigalion tetragonum Oersted, 1845, p. 404, pl. 5: figs. 5, 11.
Leanira tetragona.—Malmgren, 1865, p. 88, pl. 11: fig. 14 (synonymy).

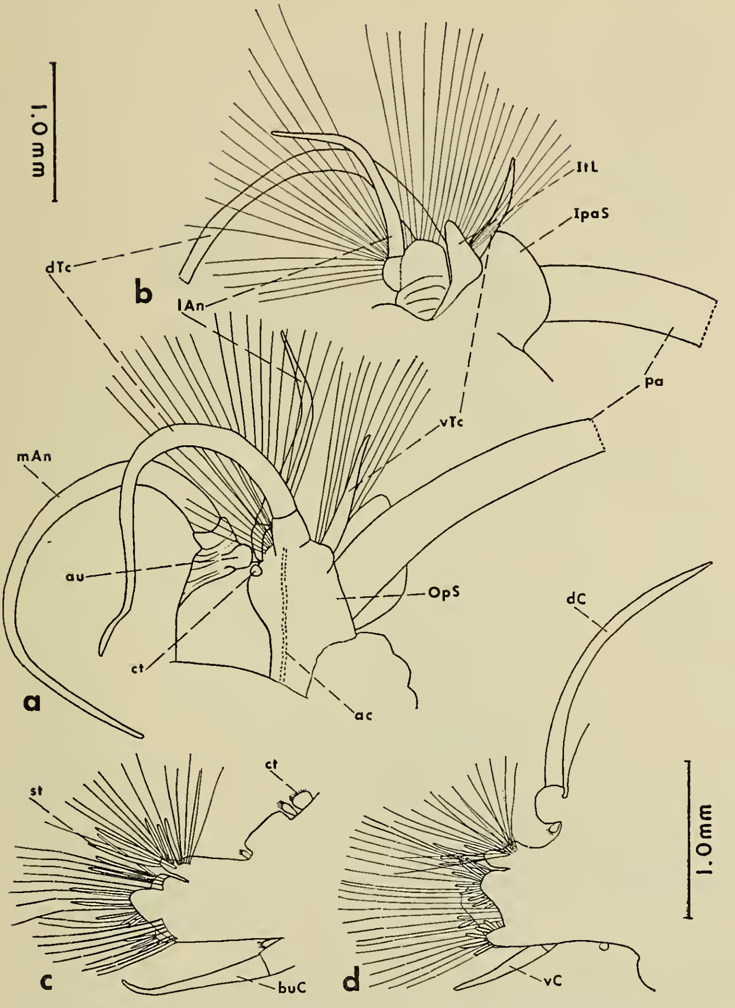

Fig. 2. *Neoleanira tetragona* (Gulf of Maine, USNM 42188): a, Prostomium and right tentacular parapodium, lateral or outer view; b, left tentacular parapodium, inner view; c, parapodium from segment II, anterior view; d, parapodium from segment III, posterior view.

—Kirkegaard, 1961, p. 216.—Pettibone, 1963, p. 53, fig. 10c (synonymy).

Leanira yhleni.—McIntosh, 1874, p. 268, pl. 10: fig. 14. [Not Malmgren, 1867].

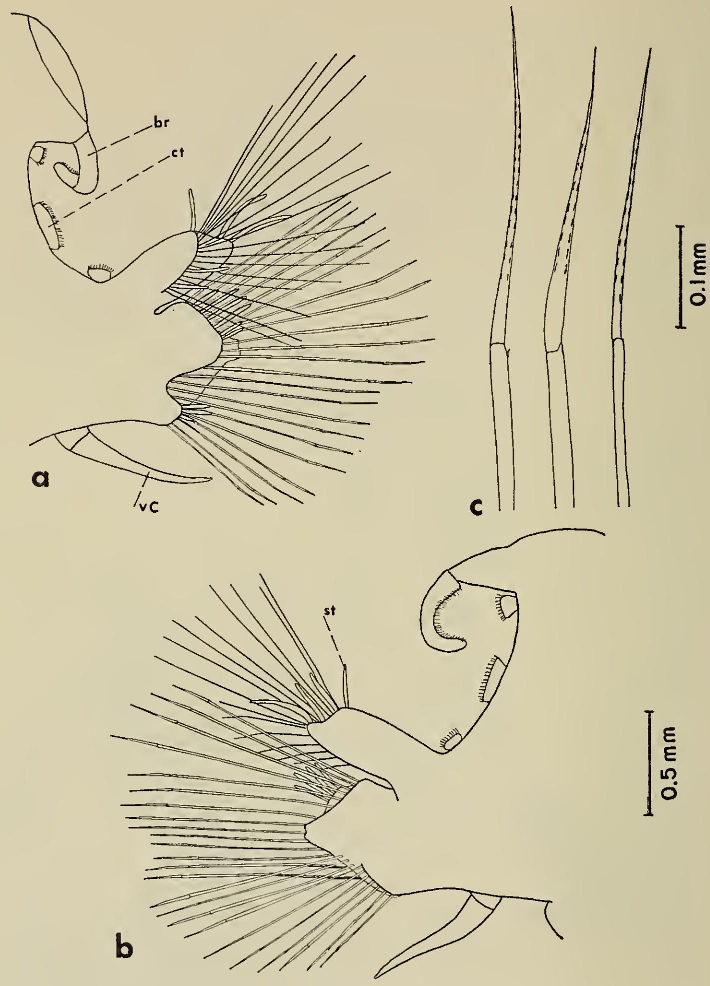

FIG. 3. *Neoleanira tetragona* (Gulf of Maine, USNM 42188): a, Parapodium from anterior region, posterior view; b, same, anterior view; c, upper, middle and lower neurosetae from same.

Sthenolepis tetragona.—Hartman, 1965, p. 55.—Not Day, 1967, p. 113.

Material examined: Anticosti, Gulf of St. Lawrence, Canada, 384 meters [by McIntosh (1874) as *Leanira yhleni*; BMNH 1921: 5: 1: 657]. Numerous specimens from Gulf of St. Lawrence, Gulf of Maine,

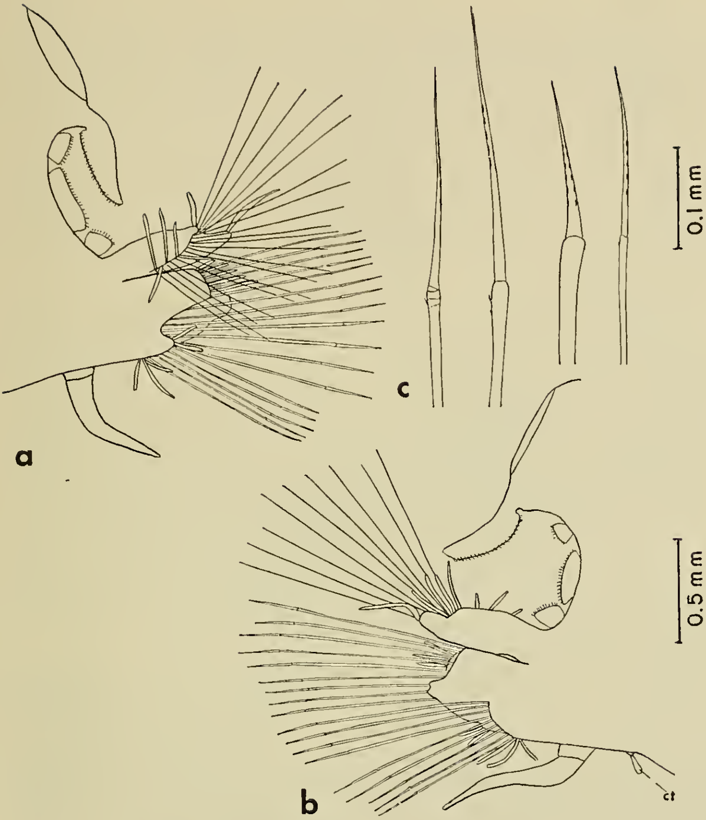

Fig. 4. *Neoleanira tetragona* (Gulf of Maine, USNM 42188): a, Parapodium from posterior region, posterior view; b, same, anterior view; c, upper, middle and lower neurosetae from same.

Georges Bank, and Massachusetts to off Chesapeake Bay, in 40 to 1660 meters; also in plankton (USNM).

Description: Length to 200 mm, width to 8 mm, including setae, segments up to 300. Elytra large, overlapping, covering middorsum except in anterior region, oval to subreniform in shape, transparent, smooth, without tubercles; except in more anterior segments, elytra fringed with delicate papillae on lateral borders. Prostomium wider than long, with stout cylindrical ceratophore of median antenna bearing small lateral auricles or ctenidia; style of median antenna long and slender (figs. 1a, 2a). Lateral antennae rather long—longer than prostomium and ventral tentacular cirri (figs. 1a, b; 2a, b). Eyes lacking. Palps very long, slender, tapered, and extending to about segment 20; inner palpal sheaths large and rounded; outer palpal sheaths very low (figs. 1b, 2a, b). Tentacular parapodium (I) with single aciculum, 2 bundles of capillary setae, and small rounded ctenidium dorsally. Dorsal tentacular cirri with distinct cirrophores; styles long, tapering, and subequal in length to median antenna; ventral tentacular cirri less than half as long as dorsal ones. Inner tentacular lobe, medial to tentacular cirri, L-shaped, with thicker glandular ciliated ridge (fig. 2b). Segment II with 2 pairs of small ctenidia medial to elytrophores (figs. 1a, 2c). Segment III with pair of long dorsal cirri on short rounded cirrophores; styles extending beyond middorsum (figs. 1a, 2d).

Branchiae and parapodial ctenidia beginning about segment 6 (figs. 3a, b; 4a, b). Notopodia cylindrical, with circlets of stylodes dorsoposteriorly and single terminal one. Notosetae numerous, capillary and finely spinous. Postsetal bracts of neuropodia with stylodes—upper bract truncate, lower one subtriangular (fig. 3a); lower presetal bract low, inconspicuous (fig. 3b); middle and posterior parapodia with few additional stylodes appearing ventrally near bases of neurosetae (fig. 4a, b). Compound spinigerous neurosetae with stems smooth; some of upper and lower neurosetae occasionally with subdistal spine or few faint spinous rows on stems; blades variable in length but none conspicuously long (figs. 3c, 4c); neuropodial blades in more posterior parapodia somewhat shorter (fig. 4c). Ventral cirri subulate, tapered. Ventral ctenidia of middle and posterior segments small and clavate (fig. 4b).

Remarks: The single specimen, upon which the record of *Sthenolepis tetragona* from off South Africa by Day (1967) was based, was examined [33° 50′ S, 17° 21′ E, 1097 meters, South African Museum Cape Town (SAM A19768)]. The specimen is in three pieces and in such poor condition that its specific determination is questionable. All the elytra are missing. It shows the general characters of *Neoleanira*, having a pair of long dorsal cirri on segment III (not shown on Day's figure).

Distribution: Siberian Arctic, Davis Strait, Gulf of St. Lawrence to off Chesapeake Bay, Iceland, Norway to the Azores, Mediterranean, and Adriatic. In 40 to 2200 meters.

Neoleanira areolata (McIntosh) new combination
Figures 5, 6

Leanira areolata McIntosh, 1885, p. 151, pl. 21: fig. 3, pl. 25: figs. 8, 9, pl. 13A: fig. 1.—Moore, 1903, p. 426.—Uschakov, 1950, p. 164, fig. 7; 1955, p. 163, figs. 35, C, 44A-D; 1965, p. 143, figs. 35, C, 44, A-D.—Levenstein, 1961, p. 152.

Sthenolepis areolata.—Moore, 1910, p. 391.—Chamberlin, 1919, p. 90.

Leanira calcis Hartman, 1960, p. 82, pl. 4: figs. 1–5.

Material examined: JAPAN: South of Yedo, 35° 11′ N, 139° 28′ E, 631 meters, green mud, *Challenger* station 232, 12 May 1875—Holotype

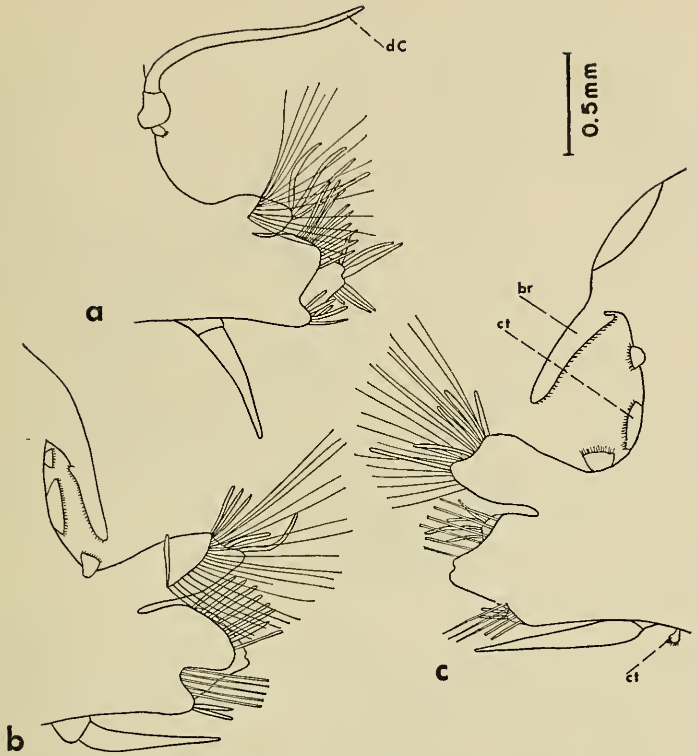

Fig. 5. *Neoleanira areolata* (Japan, USNM 5358): a, Parapodium from segment III, posterior view; b, parapodium from anterior region, posterior view; most of blades of neurosetae missing; c, same, anterior view.

of *Leanira areolata* (BMNH 1885: 12: 1: 116). Sagami Bay, 280 meters, green mud, *Albatross* station 3698, 5 May 1900—1 specimen (USNM 5358); 916-1370 meters, green mud, *Albatross* station 3696, 5 May 1900—2 specimens (USNM 5357). WASHINGTON: 47° 27′ N, 125° 42′ W, 1390 meters, green mud, *Albatross* station 3069, 28 June 1889—1 specimen (USNM 42192). CALIFORNIA: Off Monterey Bay, 1593 meters, *Albatross* station 4538, 31 May 1904—1 specimen (USNM 16858). Vicinity San Diego, 1174–1208 meters, *Albatross* station 4382, 18 March 1904—1 specimen (USNM 16984). Off southern California, 32° 40′ N, 117° 31′ W, 1503 meters, green mud, *Albatross* station 2923, 19 January 1889—1 specimen (USNM 42191). San Nicolas Basin, 1584 meters, *Velero* station 6340–59—Holotype of *Leanira calcis* (AHF).

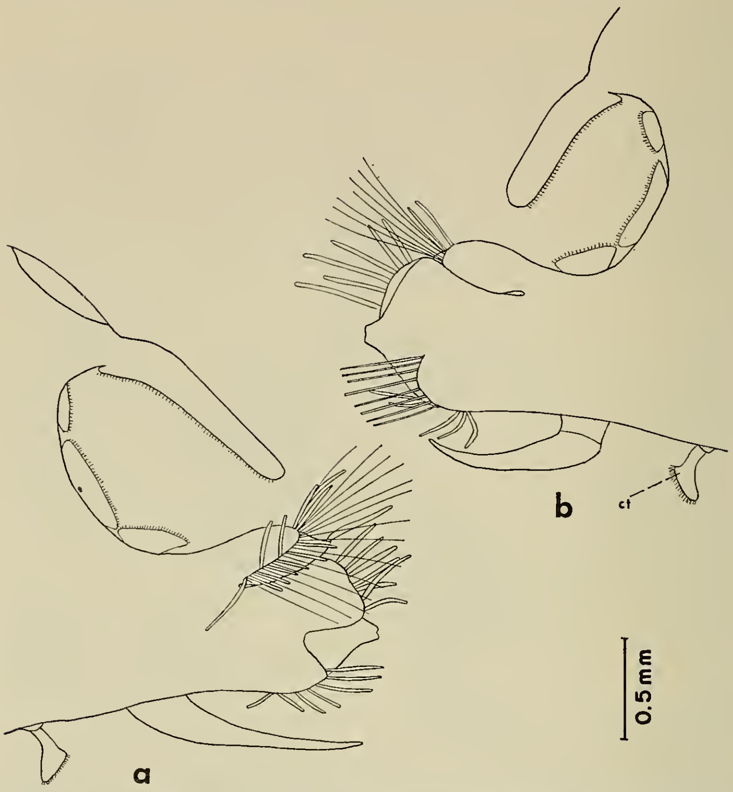

FIG. 6. *Neoleanira areolata* (Japan, USNM 5358): a, Parapodium from middle region, posterior view; most of blades of neurosetae missing; b, same, anterior view.

Type-material: The holotype of *Leanira areolata* (BMNH) is a complete specimen, 160 mm long, 9 mm wide, including setae, and has about 185 segments. Most of the elytra are missing as are most of the blades of the neurosetae. The holotype of *Leanira calcis* (AHF) consists of a middle fragment, 65 mm long, 10 mm wide, including setae, and about 44 segments; anterior and posterior ends and all the elytra are missing.

Description: Length to 200 mm, width to 9 mm, including setae, segments 200 or more. Elytra large, overlapping, nearly covering middorsum, transparent, smooth, without tubercles; except in more anterior segments, elytra fringed with delicate papillae on lateral borders. Prostomium and tentacular parapodia similar to those of *N. tetragona*. Segment II with 2 pairs of small ctenidia medial to elytrophores. Segment III with pair of long dorsal cirri on short globular cirrophores (fig. 5a).

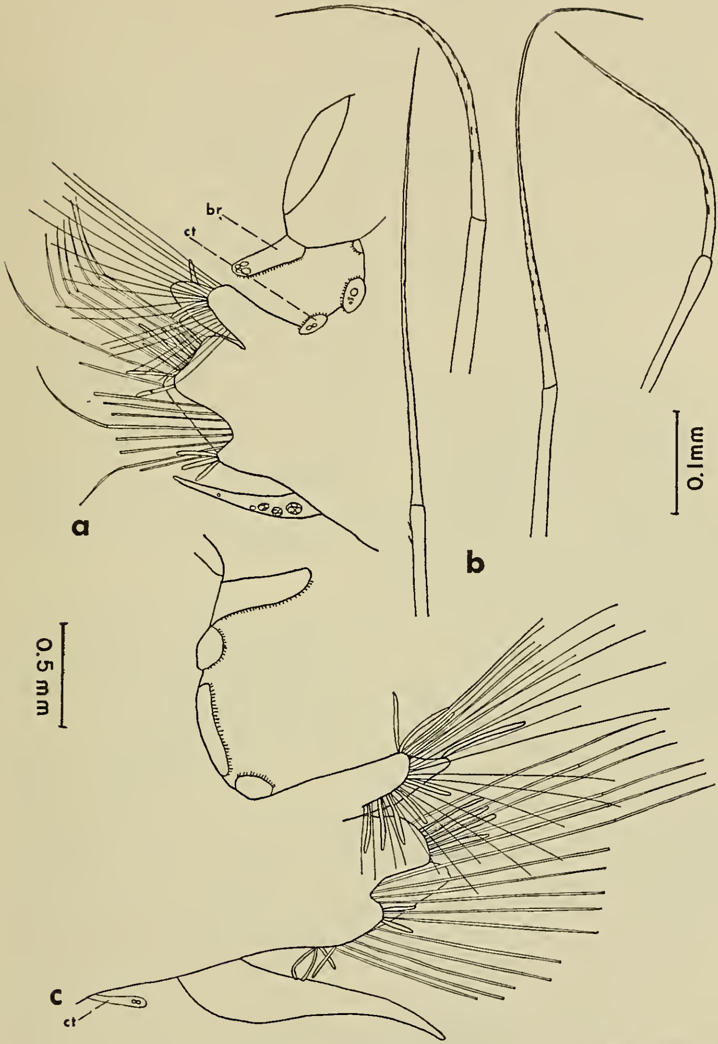

FIG. 7. *Neoleanira magellanica* (Syntype, BMNH 1885: 12: 1: 115): a, *Parapodium* from anterior region, posterior view; some of blades of neurosetae missing; b, upper, middle and lower neurosetae from same; c, parapodium from middle region, posterior view.

Branchiae and parapodial ctenidia beginning about segment 6; branchiae with prominent basal spurlike processes (figs. 5b, c; 6a, b). Parapodia and ventral cirri similar to those of *N. tetragona* (figs. 5b, c;

6a, b). Ventral ctenidia of middle and posterior segments, medial to ventral cirri, large, boot-shaped (fig. 6a, b).

Remarks: *Leanira calcis* Hartman from southern California, based on a middle fragment, is referred herein to *N. areolata.* The characteristic basal spurlike processes of the branchiae and the large ventral ctenidia (accessory processes or fimbriated organs), medial to the ventral cirri, are also found on specimens of *N. areolata* from Japan and southern California.

Distribution: Japan, Okhotsk Sea, Bering Sea, off Washington to southern California. In 110 to 4820 meters.

Neoleanira magellanica (McIntosh) new combination
Figure 7

Leanira magellanica McIntosh, 1885, p. 150, pl. 21: fig. 7, pl. 23: fig. 13, pl. 25: figs. 6, 7, pl. 13A: figs. 19, 20.
Sthenolepis magellanica.—Hartman, 1967, p. 41.

Material examined: Strait of Magellan, 48° 27′ S, 74° 30′ W, 631 meters, blue mud, *Challenger* station 306A, 2 January 1876—Syntype (BMNH 1885: 12: 1: 115). Off Chile, South America, 53° 01′ S, 73° 42′ W, 675 meters, green mud, *Albatross* station 2780, 2 February 1888—32 specimens (USNM 42193).

Type material: The syntype examined by me has a length of 75 mm, a width of 8 mm, including setae, and 100 segments; the posterior end is missing; the elongated pharynx, 13 mm in length, is fully extended; only one elytron remains; most of the blades of the neurosetae have been lost. The specimen is infested with protozoan parasites.

Description: Length more than 140 mm, width 7–8 mm, including setae; segments more than 150. Elytra delicate, transparent, without tubercles or lateral fringes of papillae. Prostomium and tentacular parapodia similar to those of *N. tetragona.* Palps very long, extending to about segment 30. Tentacular parapodia without dorsal ctenidia or sometimes small one present. Segment II usually with dorsal ctenidia lacking, occasionally with 1 or 2 small ones medial to elytrophores. Segment III with pair of long dorsal cirri on short bulbous cirrophores.

Branchiae and parapodial ctenidia beginning about segment 7 (fig. 7a, c). Parapodia and ventral cirri similar to those of *N. tetragona* (fig. 7a, c). Compound spinigerous neurosetae with somewhat longer, more slender blades than in *N. tetragona* (fig. 7b). Ventral ctenidia of middle and posterior segments small, clavate (fig. 7c).

Remarks: Protozoan parasites were present in the syntype of *N. magellanica* and noted by McIntosh (fig. 7a). They were also found in several specimens from off southern Chile (*Albatross* station 2780), penetrating all parts of the body, including the elytra. Those parasites in the elytra were mistakenly described as papillae by McIntosh (1885: 150, pl. 25: figs. 6, 7).

Distribution: South Pacific, off southern Chile. In 485 to 675 meters.

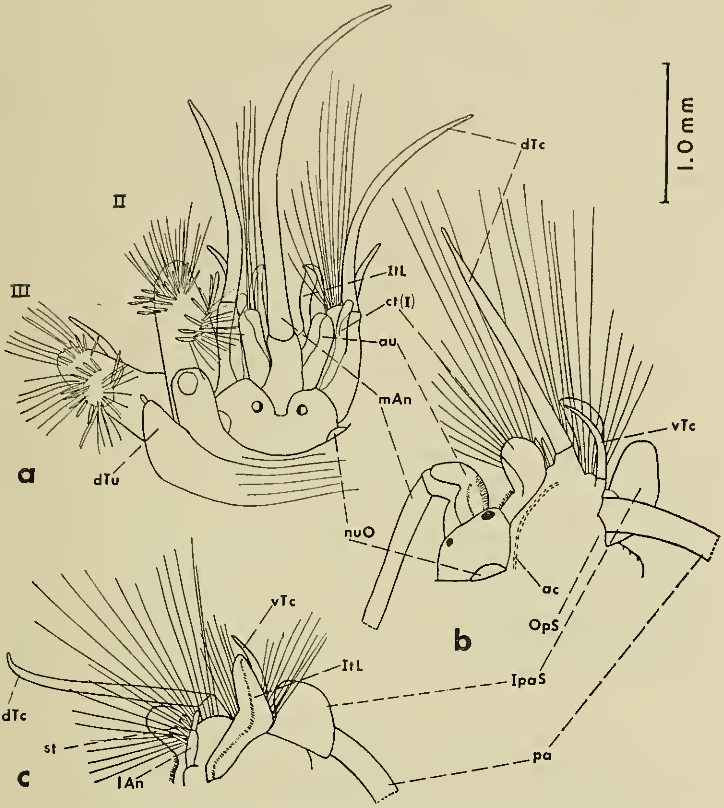

FIG. 8. *Horstileanira vanderspoeli* new genus, new species (Holotype, ZMA 526.6): a, Dorsal view anterior end, right parapodia of segments II and III cut off; palps hidden from view; b, outer or lateral view of prostomium and right tentacular parapodium; c, inner view of left tentacular parapodium.

Horstileanira new genus

Type-species: Horstileanira vanderspoeli new species. Gender: feminine.

Diagnosis: Body slender, depressed, sides nearly parallel, with numerous segments (more than 80). Paired elytra numerous: on segments 2, 4, 5, 7, on alternate segments to 27, and on all succeeding segments. Elytra smooth, lacking tubercles and papillae. Digitiform branchiae and cuplike ctenidia, 3 per parapodium, from about segment IV posteriorly. Segment III without dorsal cirri but with prominent conical dorsal tubercles. Prostomium oval, partially fused to tentacular parapodia (I); ceratophore of median antenna long, cylindrical, with prominent lateral auricles or ctenidia and long, tapered style; lateral antennae small, bilobed, fused to inner sides tentacular parapodia; palps moderately long, tapered, emerging ventral to tentacular parapodia between large inner and low outer palpal sheaths. Tentacular parapodia (I) directed anteriorly, each with single aciculum, pair of tentacular cirri, 2 bundles of capillary setae; prominent inner or medial L-shaped tentacular lobe with thickened glandular ciliated ridge; with prominent dorsal ctenidium (similar to antennal auricles) and with variable number stylodes. Pair of semicircular nuchal organs lateral to prostomium. Parapodia of segment II directed anteriorly, with ventral buccal cirri longer than following ventral cirri. Parapodia biramous. Notopodia with circlet of stylodes; notosetae numerous, capillary, smooth and finely spinous. Neuropodia with bracts provided with stylodes—2 presetal and 2 postsetal. Neurosetae forming upper vertical S-shaped groups and lower diagonal groups within the anteroventral bracts. Neurosetae mostly compound spinigers with blades short and canaliculate; additional small group of spinous simple neurosetae in upper parts of neuropodia; compound spinigers of segments II and III with blades long, tapered, canaliculate (blades of few lower neurosetae sometimes with tips minutely bifid, falcigerous). Ventral cirri short, subulate, with prominent knobs on outer basal parts. Pharynx (not dissected).

Etymology: The genus is named for the late Dr. R. Horst, eminent student of the Polychaeta.

KEY TO THE SPECIES OF *HORSTILEANIRA* NEW GENUS

1. Articulations of blades of neurosetae from middle parapodia distinct (fig. 10e). All compound neurosetae from segments II and III spinigerous (fig. 9b). No dorsal ctenidia on segment II (fig. 8a) .... *H. vanderspoeli* new species

1′. Articulations of blades of some of neurosetae from middle parapodia obscure (fig. 12d). Some of lower compound neurosetae of segments II and III bifid, falcigerous (fig. 11e). Pair of small mediodorsal ctenidia on segment II (fig. 11a) .... *H. crosslandi* new species

Horstileanira vanderspoeli new species

Figures 8–10

Leanira sibogae Horst, 1917, p. 115 [in part; *Siboga* station 313].

Material examined: Anchorage east of Dangar Besar, Saleh Bay, sand, coral, and mud, up to 36 meters, *Siboga* station 313, 14/16 February 1900—Holotype (ZMA 526.6, as Syntype of *Leanira sibogae* Horst).

Type material: The holotype consists of two fragments: anterior one 18 mm in length, 4 mm in width, including the setae, and 36 segments;

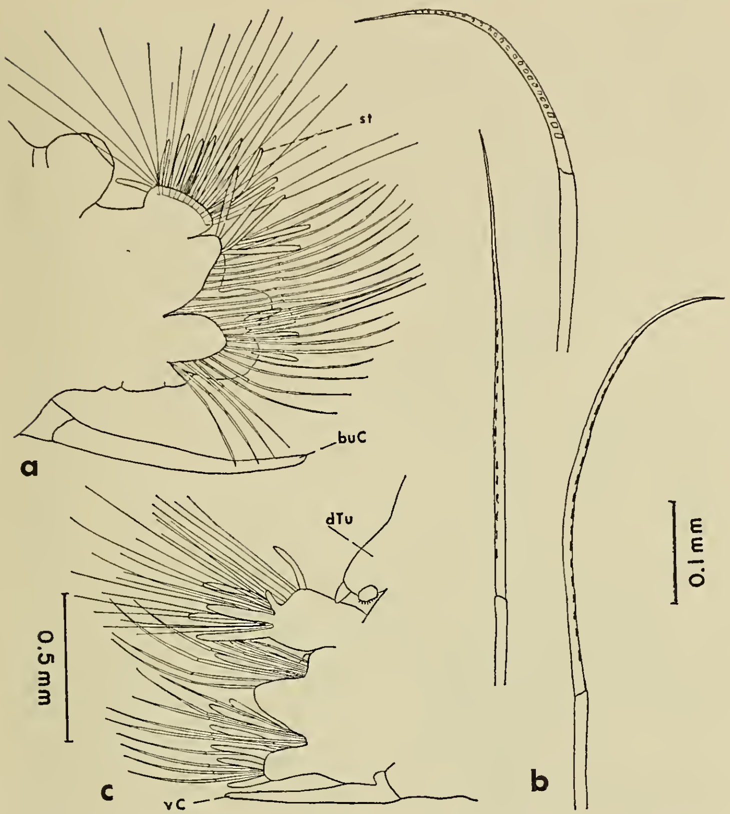

FIG. 9. *Horstileanira vanderspoeli* new genus, new species (Holotype, ZMA 526.6): a, Parapodium from segment II, posterior view; elytron missing; b, upper, middle and lower neurosetae from same; c, parapodium from segment III, anterior view.

middle fragment 12 mm in length, 3.5 mm in width, and 24 segments. It differs from the other syntypes described by Horst (1917) under *Leanira sibogae.*

Description: Length more than 30 mm, width 4 mm, including setae; segments more than 60. Elytra large, overlapping, covering middorsum except in anterior region, oval to subreniform in shape, opaque, milky white with smooth shiny surface, lacking tubercles and papillae. Prostomium wider than long, with long cylindrical ceratophore of median antenna bearing very prominent, somewhat curled auricles, basal half with longitudinal thickened ciliated ridges ventrally; style of median antenna

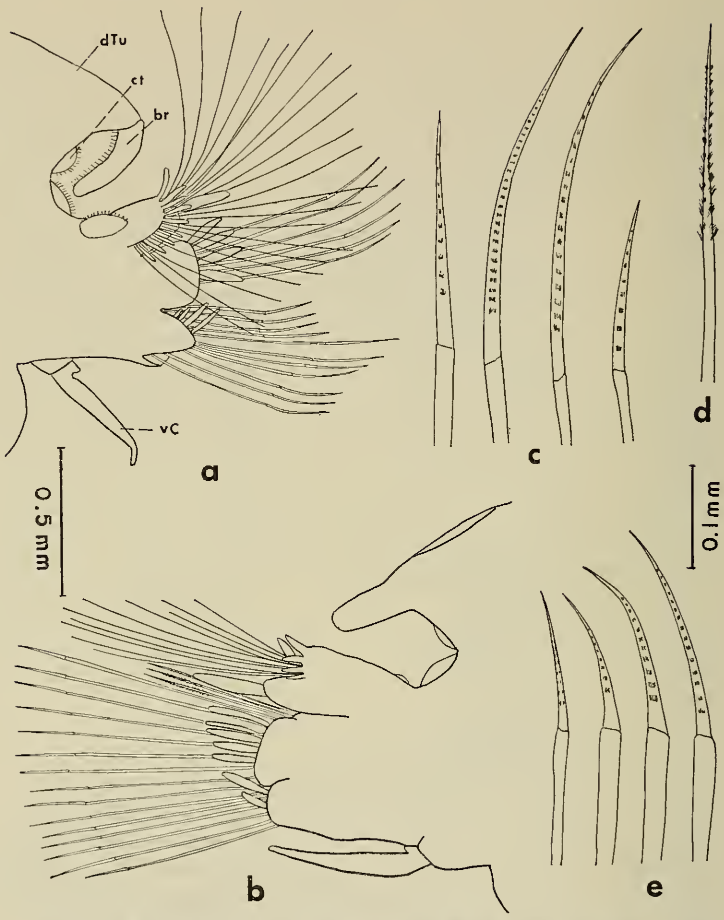

FIG. 10. *Horstileanira vanderspoeli* new genus, new species (Holotype, ZMA 526.6): a, Parapodium from anterior region, posterior view; b, parapodium from middle region, anterior view; c, upper, middle and lower neurosetae from same; d, upper simple neuroseta from same; e, upper, middle and lower neurosetae from separate middle fragment.

long and tapered (fig. 8a, b). Lateral antennae small, bilobed and attached to inner sides of tentacular parapodia (fig. 8c). Eyes 2 pairs: anterior pair twice size of posterior pair, hidden by antennal auricles; posterior pair lateral to base of median ceratophore (fig. 8a, b). Palps moderately long, tapered, extending to about segment 10; inner palpal sheaths large, rounded; outer palpal sheaths very small (fig. 8b, c).

Tentacular parapodium (I) with single aciculum, 2 bundles of capillary setae, and about 4 short filiform stylodes; with very prominent ctenidium on dorsal side, similar to antennal auricles, emerging from prostomium as long stem, with dorsal ciliated ridge, and flaring distally (fig. 8a-c). Dorsal tentacular cirri with distinct cirrophores; styles long, tapering, not so long as median antenna; ventral tentacular cirri short, about one-third as long as dorsal ones. Prominent L-shaped inner tentacular lobes situated medial to tentacular cirri, and with thickened glandular ciliated ridges (fig. 8a, c). Pair of semicircular nuchal organs lateral to prostomium. Parapodia of segments II and III with very numerous stylodes (fig. 9a, c); neurosetae compound spinigerous, with blades long, canaliculate, tapering to delicate tips (fig. 9b). Segment III with conical dorsal tubercles bearing small terminal papilla or rudimentary branchia and small ctenidium (figs. 8a; 9c).

Branchiae and parapodial ctenidia beginning on segment 4. Notopodia cylindrical, with circlets of stylodes dorsoposteriorly and larger terminal one. Notosetae numerous, capillary, finely spinous and smooth. Neuropodia with four neuropodial bracts and numerous stylodes within the bracts: 2 presetal bracts—upper one larger, and truncate; lower one shorter, rounded and extending ventrally (fig. 10b); 2 postsetal bracts—upper one truncate, lower one conical (fig. 10a). Compound spinigerous neurosetae with smooth stems; blades variable in length but none conspicuously long (fig. 10c); neuropodial blades of more posterior fragment somewhat shorter (fig. 10e). Shorter group of spinous or bipectinate simple neurosetae present in upper part of neuropodia (fig. 10d), sometimes absent, however, in more anterior parapodia. Ventral cirri subulate, with prominent knobs on outer basal parts.

Etymology: The species is named in honor of Dr. S. van der Spoel of the Zoological Museum Amsterdam, who has been most helpful in lending me specimens of polychaetes.

Distribution: Dutch East Indies. Up to 36 meters.

Horstileanira crosslandi new species

Figures 11, 12

Leanira japonica.—Monro, 1939, p. 171 [not McIntosh, 1885].

Material examined: Shubuk, Red Sea, 9 meters, C. Crossland, collector, 1904–5—Holotype (BMNH 1941: 4: 4: 225); Paratype (BMNH 1941: 4: 4: 226); Paratype (USNM 42194).

Type material: The three type-specimens are incomplete posteriorly. The holotype has a length of 40 mm, width of 3.5 mm, including setae, and 86 segments. The smaller paratype (BMNH 1941: 4: 4: 226) has a length of 15 mm, width of 4 mm, and 48 segments. The larger paratype (USNM 42194) has a length of 34 mm, width of 5 mm, and 77 segments.

Description: Length more than 40 mm, width 3.5 to 5 mm, including setae, segments more than 90. Elytra large, overlapping, covering mid-

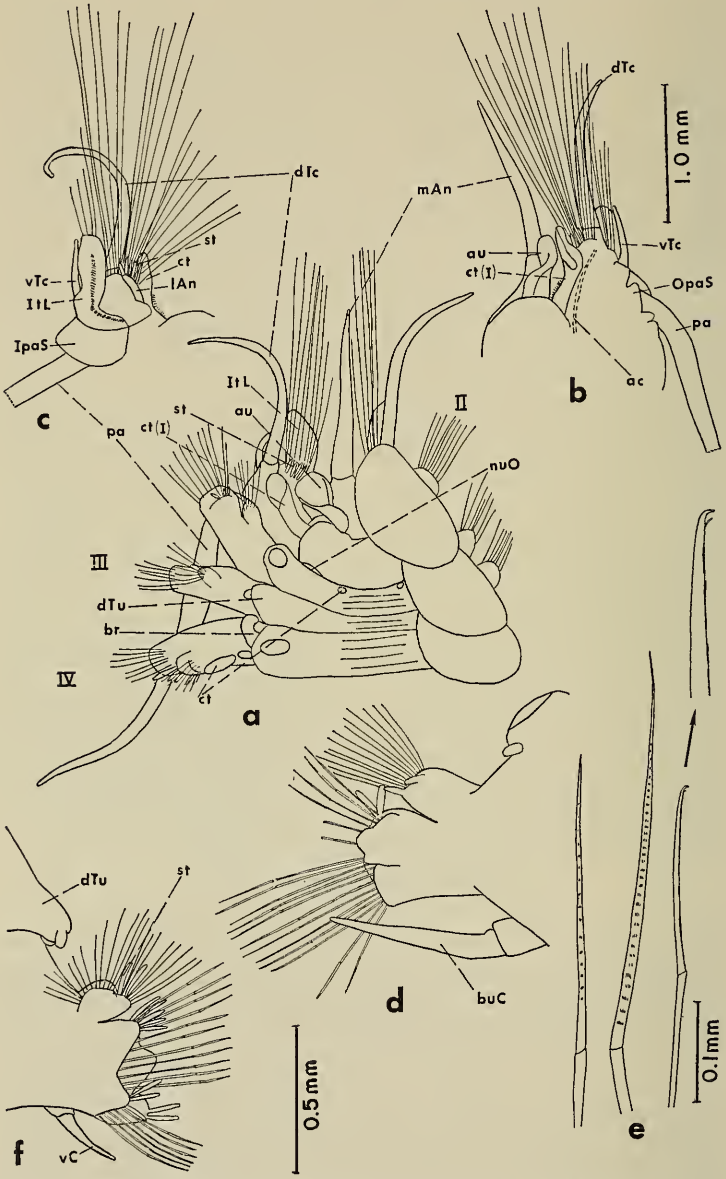

FIG. 11. *Horstileanira crosslandi* new species (Holotype, BMNH 1941: 4: 4: 225): a, Anterior end, dorsal view, elytra on left side removed; b, prostomium and left tentacular parapodium, outer or lateral

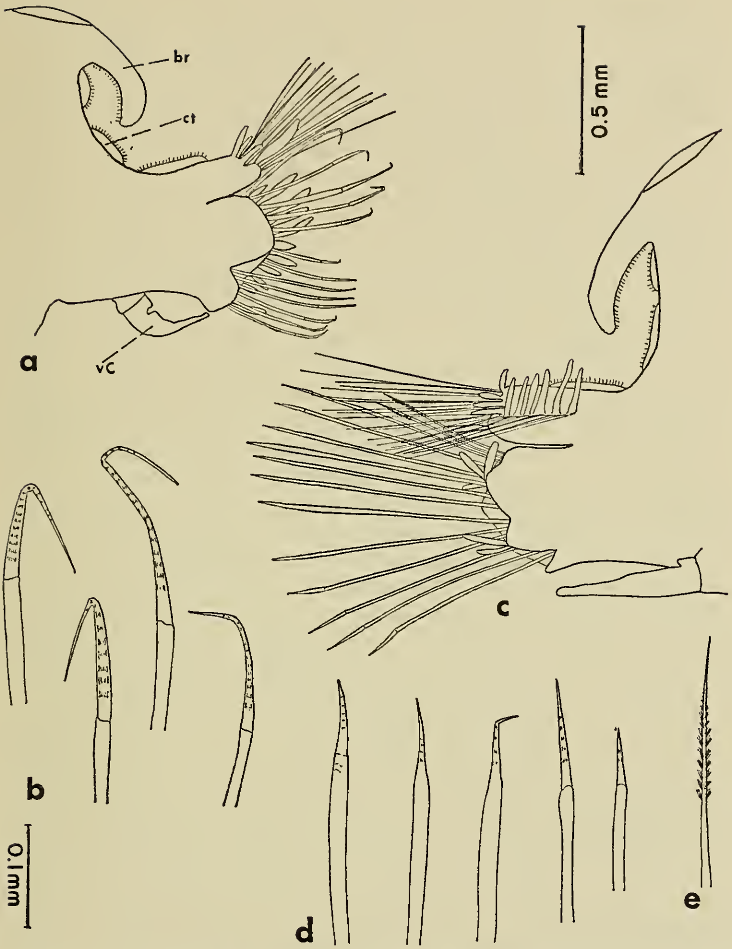

FIG. 12. *Horstileanira crosslandi* new species (Holotype, BMNH 1941: 4: 4: 225): a, Parapodium from anterior region, anterior view; b, upper, middle and lower neurosetae from same; c, parapodium from middle region, posterior view; d, upper, middle and lower neurosetae from same; e, upper simple neuroseta from same.

←

view; c, left tentacular parapodium, inner view; d, parapodium from segment II, anterior view, e, upper, middle and lower neurosetae from same; f, parapodium from segment III, posterior view.

dorsum except in anterior region, oval to subreniform in shape, delicate, transparent, smooth, lacking tubercles and papillae. Prostomium wider than long, with long cylindrical ceratophore of median antenna bearing prominent auricles, with basal half narrower and flaring distally; style of median antenna moderately long and tapering (fig. 11a, b). Lateral antenna small, bilobed, attached to inner sides of tentacular parapodia (fig. 11c). Eyes absent (holotype and smaller paratype) or faint (larger paratype), similar in position to those of *H. vanderspoeli.* Palps moderately long, tapered, extending to about segment 8–10; inner palpal sheaths large, collarlike; outer palpal sheaths short (fig. 11b, c). Tentacular parapodium (I) with single aciculum, 2 bundles of long capillary setae, and 5–7 short filiform stylodes; with very prominent ctenidia on dorsal side, similar to antennal auricles, emerging from prostomium as long stem, with dorsal ciliated ridge, and flaring distally (fig. 11a-c). Dorsal tentacular cirri with distinct cirrophores; styles moderately long, tapering, similar to median antenna; ventral tentacular cirri short, less than half as long as dorsal ones. Prominent L-shaped inner tentacular lobes situated medial to tentacular cirri, with thickened glandular ciliated ridges; lobes fused basally with the large inner palpal sheaths (fig. 11c). Pair of semicircular nuchal organs lateral to prostomium. Segment II with pair of small ctenidia mediodorsally (fig. 11a). Parapodia of segments II and III with few to numerous stylodes (fig. 11d, f); neurosetae compound spinigerous, with blades long, canaliculate, tapering to delicate tips; some of lower ones with tips falcigerous, with delicate secondary tooth (Fig. 11e). Segment III with conical dorsal tubercles bearing small terminal papilla or rudimentary branchia and small ctenidium (fig. 11a, f).

Branchiae and parapodial ctenidia beginning on segment 4. Notopodia cylindrical, with circlets of stylodes dorsoposteriorly. Notosetae numerous, capillary, finely spinous and smooth. Neuropodia with four neuropodial bracts and stylodes within bracts: 2 presetal bracts—upper one larger and truncate; lower one shorter, rounded and extending ventrally (fig. 12a); 2 postsetal bracts—upper one larger, truncate; lower one smaller, conical (fig. 12c). Compound spinigerous neurosetae with stems smooth; blades variable in length but none conspicuously long (fig. 12b); neuropodial blades of middle parapodia shorter, some of them having obscure articulations (fig. 12d). Shorter groups of spinous or bipectinate simple neurosetae present in upper parts of neuropodia (fig. 12e); sometimes absent in more anterior parapodia. Ventral cirri subulate, with prominent knobs on outer basal parts.

Etymology: The species is named for the collector, the late Cyril Crossland.

Distribution: Red Sea. In 9 meters.

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PROCEEDINGS
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THE SMALL SPECIES OF *EUCHONE* MALMGREN (SABELLIDAE, POLYCHAETA)[1]

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This paper reviews all of the previously known members of *Euchone* Malmgren with 12 or fewer abdominal segments preceding the anal depression and describes *Euchone hancocki* and *E. southerni*, with a subspecies *E. southerni incisa.* Following the special part, a key for the treated species is given, and a direction for further work on the origin of Sabellidae is suggested.

The starting point for the reconsideration of the small species of *Euchone* is the observation that in two species represented by many specimens, *E. incolor* Hartman and *E. hancocki* new species, the number of abdominal setigers before the beginning of the anal depression is constant. These species are each uniquely characterized by their glandular girdles on abdominal segments and can be identified without considering the characters used previously for identification. Therefore, more emphasis is given here to the number of anterior abdominal setigers for distinguishing the small species of the genus than

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[1] Contribution No. 548 from the Department of Oceanography, University of Washington, Seattle, Washington 98105. The Allan Hancock Foundation, University of Southern California, Los Angeles (AHF), the National Museum of Ireland, Dublin (NMI), the Swedish State Museum of Natural History, Stockholm (SMNH), the Systematics-Ecology Program, Marine Biological Laboratory, Woods Hole, Massachusetts (SEP), the University of Cape Town (UCT), the U.S. National Museum, Washington, D.C. (USNM), and the Zoological Museum of the University of Copenhagen (ZMC) kindly lent material for study. Drs. O. Hartman and M. H. Pettibone provided study space during visits to the Allan Hancock Foundation and the U.S. National Museum. Also, Dr. O. Hartman allowed the inclusion in this paper of her unpublished records of *Euchone incolor.* This help is greatly appreciated. The preparation of the paper was partially supported by Contract AT (45–1)–1725 of the U.S. Atomic Energy Commission (ref. RLO-1725-165), Principal Investigator Dr. C. A. Barnes. I gratefully acknowledge this support also.

has been given by earlier authors.[2] However, the feature does not seem to be useful for the species with more than about 20 abdominal segments, and apparently varies in the small *E. arenae* Hartman, discussed below.

Whereas previous authors stressed the number of segments forming the anal depression (or funnel) as a diagnostic character, it is recognized here that the full complement of segments is not present in juveniles. Therefore, this character cannot be relied upon unless mature animals are studied, whereas all anterior abdominal setigers are present when the first depression segment is formed.

Some authors have already drawn attention to the fact that the uncini of the depression segments may differ markedly from those of the anterior abdominal setigers by having relatively higher crowns of teeth above the rostra (cf. Fig. 1e); the present study shows that this condition is common. It is thus necessary to state from which region uncini are described. Not only are the relative proportions of the uncini changed, but the teeth above the rostra are considerably more numerous than those of the "typical" anterior hooks. However, *small* differences in the number of teeth seen in the side view of thoracic or abdominal hooks are not considered of diagnostic value. Slight variations in numbers of teeth have been found by different authors working on the same sample or even the same specimen, presumably because of slightly varying orientation of the setae or varying resolution of the microscopes (even the general outline of thoracic limbate setae or abdominal uncini has not been described correctly in many cases).

Throughout this work, staining of epidermal mucus cells, following the suggestion by Hofsommer (1913), has been employed. Specimens are left for a few minutes in a very dark solution of methyl green in ethyl alcohol and are then differentiated for a few minutes. The remaining dye is removed by alcohol in a few hours or days, depending on the

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[2] In the text as well as in the key, the term "anterior abdominal setigers" refers to the segments preceding the anal depression. In many species the segment immediately before the first depression segment is modified such that the ventral shield is deformed or that the intra- and posterior intersegmental furrows do not reach the fecal groove (see the eighth abdominal setiger of *E. southerni incisa*, Fig. 5a). Such segments are called here "transition segments."

dye concentration and the size of the specimen. The distribution of stain-accepting cells not only facilitates counting of segments but yields additional characters for identification. Because the degree of variability has been studied only in *E. incolor*, the diagnoses given below are still based on conventional characters, but the distribution of stain-accepting cells has been included in the descriptions. Unlike the other figures, the figures of the staining patterns present body outlines and setae schematically.

All species studied so far, including larger ones to be treated elsewhere, have a postsetal girdle of glands in the second thoracic setiger (cf. Fig. 1a). It had been previously reported for some species only.

In view of the new observations, the genus *Euchone* can still be considered as very homogeneous, although some species emerge as being more primitive than others. The following characters should be added to the generic diagnoses as given by Fauvel (1927), Ushakov (1955) and Day (1967).

> A postsetal girdle of glands on the second thoracic setiger. Three kinds of notosetae, 1) upper ordinary limbate, 2) median spatulate or subspatulate, and 3) lower short limbate setae with very thin wings.[3] Ventral shields sometimes present.

Euchone rosea Langerhans

Fig. 1

Euchone rosea Langerhans, 1884, p. 271.

E. rosea.—McIntosh, 1923, p. 286 *partim* (see also *E. southerni southerni*).

E. rosea.—Kirkegaard, 1959, p. 101 *partim* (see also *E. southerni incisa*).

not *E. rosea.*—Southern, 1914, p. 144 (see *E. southerni southerni*).

not (?) *E. rosea.*—Berkeley and Berkeley, 1954, p. 468 (see *E. incolor*).

not *E. rosea.*—Berkeley, 1968, p. 556 (same record as Berkeley and Berkeley, 1954).

not *E. rosea.*—Day, 1967, p. 774 (see *E. southerni incisa*).

Types: The type material collected in Madeira is apparently lost: The Museum at the Zoological Institute of the University of Freiburg, Germany where Langerhans worked has been destroyed (Prof. K. Sanders,

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[3] Variously called by earlier authors basal, bayonet, or geniculate setae. In large species they insert anterior to the spatulate setae as also in *Chone*.

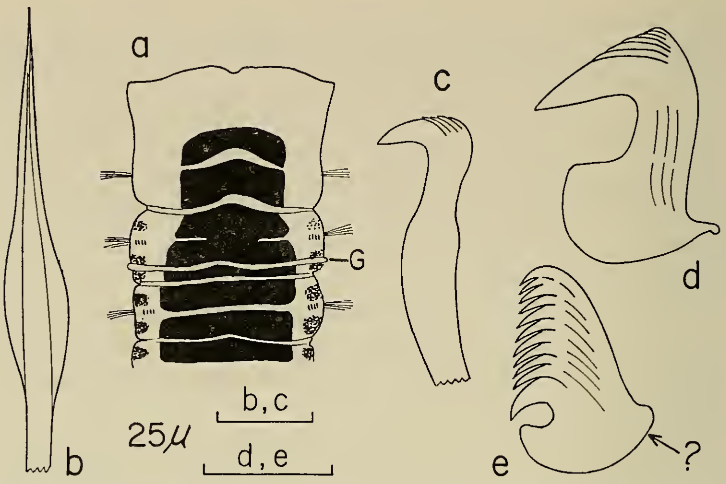

FIG. 1. *E. rosea*, from Ivory Coast: a, staining pattern of anterior end in ventral view (G: glandular girdle); b, median seta from thoracic (7th) notopodium; c, thoracic hook; d, uncinus from anterior (2nd) abdominal segment; e, uncinus from depression (13th) segment (question mark indicates my uncertainty about the exact outline).

26 Jan. 1968). Furthermore, none of the material is at the Zoological Museum of the Humboldt University at Berlin (Dr. G. Hartwich, 24 February 1969), where the collections of the Academy of Sciences, Berlin, which supported Langerhans' travel, are deposited.

Diagnosis: A *Euchone* species with 10–12 anterior abdominal setigers and six to seven depression setigers. Palmate membrane uniting the radioles for at least half their length. Distinct ventral shields. Spatulate setae in thoracic notopodia. Abdominal uncini markedly different between anterior and posterior setigers.

The diagnosis is based on the description by Langerhans (1884), except with regard to the numbers of anterior and depression setigers. The total number of abdominal setigers is 18.

Material studied: Atlantide station 65, 11 January 1946, Ivory Coast, 4°24′ N, 7°05′ W, 78 m (collected and identified as *E. rosea* by J. B. Kirkegaard). ZMC, journal entry of 1 December 1946. (One specimen.)

Description: The animal from the Ivory Coast is described here in some detail because it comes closest to the original description of the species, which otherwise is not adequately known. The specimen is complete. Its length is about 12 mm, of which the branchial crown contributes about 5.5 mm; its width is 0.8 mm. It has eight thoracic and 18 abdominal setigers. Ten of the latter are anterior, and the 11th is transitional; the anterior border of the anal depression is situated in the 12th abdominal setiger.

The branchial crown consists of eight pairs of radioles with pinnules, united about two-thirds of their length by a palmate membrane, and three or four pairs of short naked filaments. Each radiole carries three to four dozen pairs of pinnules of about equal length. Beyond the palmate membrane, a flange borders the radioles and reaches to the ends of the terminal pinnules. The filiform tips of the radioles are about one-tenth of the total radiole length.

The high collar protrudes slightly foward on the ventral side where a small notch is found (Fig. 1a); in addition there is the usual dorsal incision. A postsetal girdle of glands encircles the second thoracic setiger. Conspicuous ventral shields cover the underside of the thoracic and abdominal setigers. The shields are very obviously divided into presetal and postsetal pairs in the abdomen.

Thoracic notopodia (after the first one) contain a few geniculate setae with narrow wings besides the upper, long limbate and the median, subspatulate (Fig. 1b) setae. Neuropodia have about a dozen hooks with slender beaks (Fig. 1c). The abdominal uncini differ markedly between the anterior and posterior tori (Fig. 1d, e).

After treatment with methyl green, the ventral pattern in the thorax delineates the shields (Fig. 1a) and shows that most are divided also in the thorax. A division of the shield on the second setiger into a presetal and a postsetal ring is rudimentary and can barely be discerned. An outstanding feature of the specimen is the clear separation of the lateral staining areas from the ventral shields through the fourth setiger. In the entire thorax the lateral fields do not continue onto the dorsal side. Dense rings of staining cells encircle the whole abdomen (except the fecal groove) separated by broad rings at the segmental borders and more narrow ones in the plane of the parapodia. The latter rings are absent on the segments contributing to the anal depression. The stained areas continue onto the wings of the depression. Also the pygidium accepts the dye.

Discussion: The material from the Ivory Coast agrees with that from Madeira (type locality) in the number of abdominal segments and possibly also in the number of setigers of the depression. Further, there is the marked divergence of the anterior and posterior abdominal hooks (present also in other species, however). It may be pointed out that Langerhans did not note a posterior extension (Fig. 1d) of the anterior hooks. The Ivory Coast form is more than twice as long as the type material, although the latter contained mature females. Possibly, total length and number of radioles are correlated within species so that the difference in length may explain the differences in the number of radioles between the type material (five pairs with pinnules) and the present specimen. Another feature in which the form from the Ivory Coast disagrees with that from the type locality is the palmate membrane, which in Langerhans' material extended only to one-half the length of the radioles. More important is that Langerhans depicted a spatulate thoracic notoseta with a short tip which I believe is clearly different from that shown in Fig. 1b. New material from the type locality may show whether these differences are significant.

Euchone olegi Zachs from the Sea of Japan (for additional description, see Buzhinskaja, 1967) is not yet clearly distinguishable from *E. rosea*, as defined here.

Euchone trilobata (Banse) new combination

Desdemona trilobata Banse, 1957, p. 92.

Type: Holotype, from the Falkland Islands, SMNH, type collection no. 1900.

Diagnosis: A *Euchone* species with two anterior abdominal setigers and four depression setigers. Radioles without flange or palmate membrane. Ventral shields absent. Middle series of thoracic notosetae with narrow wings. Abdominal uncini without rostra (pectinate).

Material studied: Holotype.

Additions to the Description: The second thoracic setiger has an indistinct postsetal girdle of glands. The thoracic notopodia have long limbate setae, shorter limbate ones in place of the usual spatulate setae, and a series of short fine limbate setae. The wings of the middle series seem to be hardly broader than those of the large limbate bristles; without dissection, the short setae cannot be described properly. Ellipsoidal eggs have a longest diameter of about 100 μ.

In the original description, (Banse, 1957) fig. 8b was incorrectely drawn: the wings of the anal depression terminate in the third abdominal setiger (cf. Banse, 1957, fig. 8c).

After treatment with methyl green, a small ventral area on either side of the border between the first segment and the first setiger stains fairly strongly and uniformly. Pairs of bands of scattered stained cells, interrupted by the fecal groove in the abdomen, are present ventrally in the last two or three thoracic and first two abdominal setigers in place of the ventral shields found in other species. Also the pygidium accepts the dye.

Discussion: The species had been assigned in 1957 to *Desdemona* Banse because of the form of the abdominal uncini lacking rostra. However, in view of the pectinate uncini of *E. arenae* and *E. hancocki*, which occur together with the "typical" uncini of *Euchone*, the combination with *Desdemona* must be considered as erroneous.

Euchone limnicola Reish

Euchone limnicola Reish, 1960, p. 717.
Euchone limicola.—Hartman, 1966, p. 203.

Types: Holotypes: AHF. Paratypes, AHF, USNM and British Museum (Natural History), London.

Diagnosis: A *Euchone* species with eight anterior abdominal setigers and ten depression setigers. Palmate membrane uniting the radioles for two-thirds of their length. Ventral shields present in thorax. Subspatulate setae in thoracic notopodia.

The diagnosis follows the description by Reish (1960).

Material studied: None.

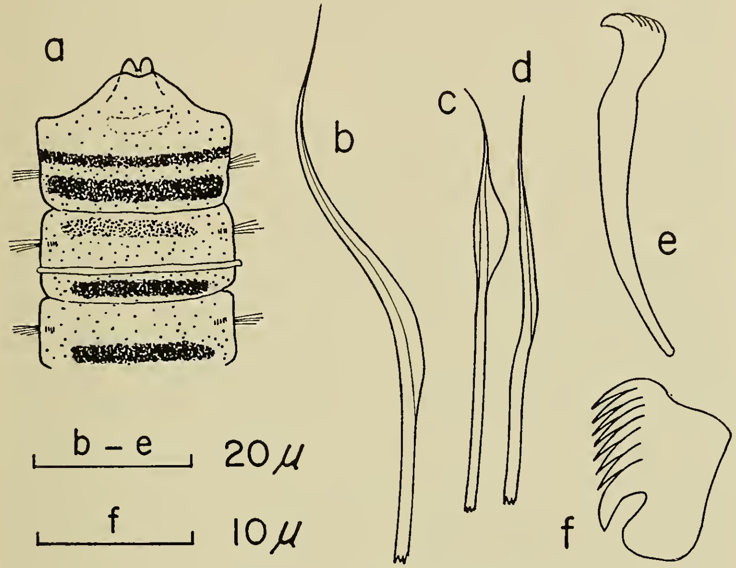

FIG. 2. *E. incolor*; a from type sample, the others from Puget Sound: a, staining pattern of anterior end in ventral view; b-d, upper, median, and lower setae from thoracic notopodia; e, thoracic hook; f, uncinus from anterior abdominal segment.

Euchone incolor Hartman

Fig. 2

Euchone incolor Hartman, 1965, p. 231 *partim.*—1966, p. 203 *partim* (see *E. hancocki*).

(?) *Euchone rosea.*—Berkeley and Berkeley, 1954, p. 468.

Euchone rosea.—Berkeley, 1968, p. 556 (same record as Berkeley and Berkeley, 1954).

Euchone trisegmentata Reish, 1965, p. 150.—Nichols, 1968, p. 16, 61.

Euchone barnardi Reish, 1968, p. 93.

Types: AHF.

Diagnosis: A *Euchone* species with six anterior abdominal setigers and three depression setigers. A presetal girdle of glands on third abdominal setiger. Palmate membrane reaching one-quarter to one-half of the length of radioles. Ventral shields absent. Subspatulate setae in thoracic notopodia.

Material studied: Three specimens from the sample from which the holotype was taken. Continental shelf off New England (station C 1, Hartman, 1965). AHF.

Three specimens from *Velero IV* station 3585 (see Hartman, 1966). AHF.

The four specimens of Berkeley and Berkeley (1954), from Hecate Strait, British Columbia. USNM 38984.

Holotype of *E. trisegmentata*, southeastern Bering Sea. USNM 30456.

Many specimens from stations, B, C, F, J, and K of Nichols (1968), Puget Sound, Washington (identified as *E. trisegmentata* by K. Banse). Some in USNM, No. 39812.

The three paratypes of *E. barnardi*, Gulf of California. USNM 38403.

New records: Many specimens from *Velero IV* station 2152, 27 Sept. 1952, near Santa Catalina Island, California, 33°23′33″ N, 118°21′47″ W, 25 m, sandy mud (identified as *E. incolor* by O. Hartman); AHF. One specimen from *Velero IV* station 2153, 27 Sept. 1952, near Santa Catalina Island, California, 33°24′28″ N, 118°21′36″ W, 81 m, broken shells and mud (identified as *E. incolor* by O. Hartman); AHF. Many specimens from station 1514 E5 of SEP, in Cape Cod Bay, 41°54′ N, 70°11′ W, 19 January 1967, 17.5 m, muddy sand (sample total, 47 specimens). Many specimens from station 1624 Ep of SEP, in Cape Cod Bay, 41°52′ N, 70°44′W, 13 May 1968, 31–32 m, sandy mud (sample total, 110 egg-bearing as well as juvenile animals). Three dredge stations near Orcas Island, Washington (48°38′ N, 122° 59′ W, 15 m, mud, 6 specimens; 48°35.5′ N, 122°55′ W, 27 m, mud, 13 specimens; 48°36′ N, 122° 47′ W, 40 m, mud, 64 specimens); all in July 1967; H. L. Sanders coll.—Some animals from the last three stations deposited in USNM (No. 40717), some in Friday Harbor Laboratories, University of Washington.

Additions to the Description: Specimens from the type locality, the Bering Sea, Hecate Strait, and Puget Sound (material of Nichols, 1968) provided the basis for the following observations.

The branchial crown makes up about one-third of the total length of the animals from the type locality, as is the case also for the material from the Pacific Ocean. In the longest animals from Woods Hole (7 to 8 mm) the contribution by the crown to the total length is one-fifth to one-fourth. Three pairs of radioles with pinnules are present in animals from all sites, each pair with a conspicuous axis consisting of a double row of cartilaginous cells, and two to four ventral pairs of single filaments almost half as long as the radioles with pinnules, likewise with conspicuous cellular axes. In the well-preserved material from the type locality, two pairs of large lips at the sides of the mouth opening are distinct; in a few animals, a thin palmate membrane, approximately one-quarter of the length of the radioles, could be made out. The pinnules arising in the mid-section of the radioles are longer than the distal ones so that many pinnules end at about the same level (but below the tips of the radioles). This gives the species an appearance superficially similar to species of *Fabricia* Blainville or *Oriopsis* Caullery and Mesnil. The free ends of the radioles extend about one-fourth to one-third of the length of the branchial crown beyond the most distal pinnules. The collar, as observed in animals from Puget Sound, is higher ventrally than laterally, with a slight ventral notch in the median line (Fig. 2a), plus a slight notch on each side, and the usual deep dorsal incision. Otocysts are present on the first segment.

The species has a postsetal girdle of glands on the second thoracic setiger, and a similar but less conspicuous presetal girdle on the third abdominal setiger. Ventral shields are absent. Forty-seven specimens from the sites mentioned, ranging from 2.5 to 8.5 mm in length (mostly above 4 mm), had nine abdominal setigers. The anal depression, which was observed in 25 to 30 specimens extended through three setigers in all except four, where the anterior ending reached the middle of the fourth to last setiger. The two smallest specimens in sample SEP 1624, about 1.4 and 1.8 mm long, had only six and seven abdominal setigers; the anal depression was not yet visible in either. In grown animals, the anal depression can have narrow wings as in fig. 3a of Reish (1965); when the wings are expanded a slight notch separates them at the anterior end of the depression.

In all animals studied, the thoracic notopodia, excepting those on the first setiger, contain three kinds of setae (Fig. 2b, c, d). A capillary seta with narrow wings accompanies each of the approximately three subspatulate notosetae. The approximately half a dozen abdominal neurosetae have slightly wider wings than do the lower thoracic notosetae. A thoracic hook is shown in Fig. 2e (from Puget Sound). Also in specimens from the type locality, the number of teeth of the thoracic uncini when viewed from the side is greater than three to four as stated in the original description. The shapes of the abdominal uncini (Fig. 2f) do not vary between the anterior and depression segments.

In two animals of 8.3 and 8.5 mm length from Woods Hole, the setigers from the third thoracic through the sixth abdominal contained eggs of almost cubic shape ($80\,\mu$–$100\,\mu$ side length). The total egg number was 300 to 350.

In all specimens treated with methyl green, a small area ventrally behind the collar remained unstained (Fig. 1a), as did the branchial crown. Most of the body took on a greenish hue. Against this background, the first setiger of the specimen from the type locality stained strongly ventrally and laterally, the region of the parapodia remaining pale. The anterior ring of pigment indicated on the first setiger extended dorsally to the fecal groove, which again remained pale. Other features are shown in Fig. 1a. In specimens from Bristol Bay as well as from Puget Sound,

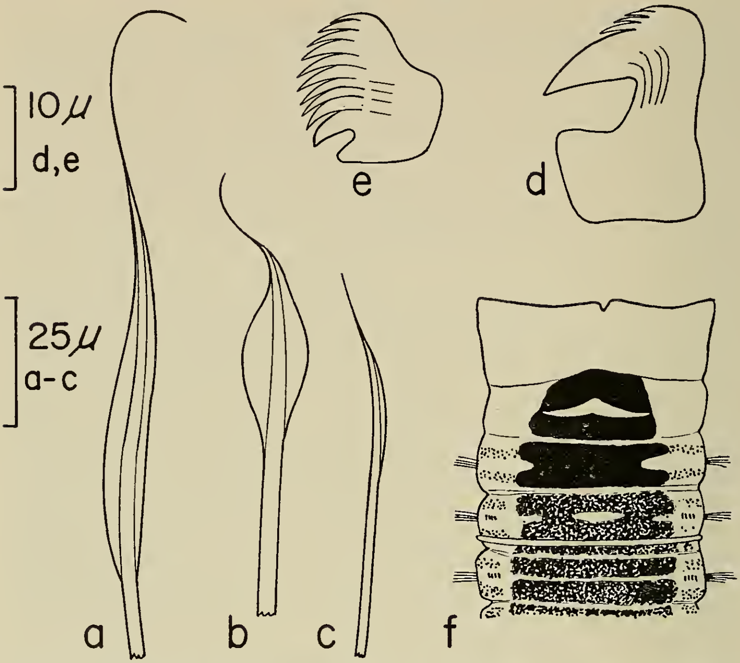

FIG. 3. *E. arenae*, from type locality: a-c, upper, median, and lower setae from thoracic notopodium; d, e, median and dorsalmost uncini from anterior abdominal (4th) notopodium; f, staining pattern of anterior end in ventral view.

almost no stained cells occurred in the first setiger. However, these animals exhibited a moderately strongly stained area ventrally on the second setiger anterior to the plane of the parapodia and a strongly stained area behind the girdle of glands on this setiger. Another strongly stained area occurred ventrally in the rear portion of the third setiger. The fourth thoracic setiger was strongly stained in the corresponding area in the material from the type locality and weakly so in that from the cool-temperate Pacific Ocean.

The animals from Woods Hole (including the very small ones), as well as those from the Gulf of California, stained rather uniformly ventrally on the first four thoracic setigers, excepting dye-free rings in the planes of the setae. Usually, presetal bands of pigment dorsally reached the fecal groove in these setigers in the animals from Woods Hole, whereas in those from the Gulf of California the postsetal bands were more pronounced.

A ring along the abdominal girdle of glands and the corresponding area of the fourth abdominal setiger stained in all animals from all sites; both pigment rings were interrupted by the fecal groove. Noticeably in material from the Atlantic and the Gulf of California, single scattered stained cells occurred ventrally in all thoracic and first abdominal setigers. Also, concentrations of these cells were observed in some specimens ventrally near the posterior borders of the first and second abdominal segments.

Discussion: The list of synonyms is based on the presence of the presetal girdle of glands on the third abdominal setiger as the principal distinguishing character of the species. No attention has been paid to the details of the outlines or shapes of setae reported by the various authors. Particularly the study of the original material of this species led to the statements made on p. 388. *Euchone incolor*, published on 5 April 1965 has priority over *E. trisegmentata* published on 25 August 1965.

It remains to be seen how widely the species is distributed in the Atlantic Ocean. It was not present on the two stations checked by me (G 1 and Ch 35 Dr 12, besides the type locality), among the stations listed by Hartman (1965) for *E. incolor*: The sample from station G 1 at about 2000 m depth off New England contains a *Euchone* sp. with apparently 12 abdominal setigers (four or five in the depression) and without the abdominal glandular girdle of *E. incolor*. The species found on station Ch 35 Dr 12, on the continental slope off Brazil, likewise is without this girdle and is probably different from the species found on station G 1. One previous record of the species off southern California is considered to be that of a new species, *E. hancocki*.

Euchone arenae Hartman

Fig. 3

Euchone arenae Hartman, 1966, p. 202.
Euchone cortezi Reish, 1968, p. 94.

Types: AHF.

Diagnosis: A *Euchone* species with six to nine anterior abdominal setigers and six depression setigers. Palmate membrane extending to less than one-fourth of the length of radioles. Ventral shields present. Subspatulate setae in thoracic notopodia. Marked divergence of shape among abdominal uncini within tori.

Material studied: Two specimens from the sample from which the holotype was taken. Near Santa Catalina Island, California (*Velero IV* station 2788, cf. Hartman, 1955). AHF.

Paratypes of *E. cortezi* from the Gulf of California. USNM 38405.

Additions to the Description: The two specimens from the type locality have 13 and 14 abdominal setigers, respectively, but Hartman (1966) has found animals with 15 setigers. In one of the present specimens, it could be seen that the radioles bearing pinnules each have a narrow flange for about two-thirds of their length. This is well beyond the palmate membrane that was observed by Hartman (1966) to unite less than one-fourth of the length of the radioles. The free ends of the radioles beyond the origin of the most distal pinnules comprise about one-sixth of the length of the radioles and extend beyond the ends of the pinnules. Pinnules arising in the middle of the radioles are almost half as long as the radioles and reach about as far as the distal pinnules. Ventral shields are present in the thorax and the abdomen.

Thoracic notosetae are of three kinds (Fig. 3a, b, c) except on the first setiger. Most abdominal uncini (checked on the first and the fourth setiger) have broad bases and large rostra surmounted by about four rows of short teeth (Fig. 3d). The two dorsalmost uncini in both tori, however, lack these broad bases, the rostra are small, and the surmounting teeth (almost ten rows of many teeth) are about as long as the rostra (Fig. 3e), *i.e.*, they can be called pectinate. The uncini of the depression segments are as in the later figure, with about ten teeth per horizontal row.

About five polygonal and ellipsoidal eggs per segment, up to about $100\,\mu \times 100\,\mu \times 70\,\mu$, were found from the fifth thoracic to the fourth abdominal setigers. They possibly occur farther forward and rearward as well.

In specimens treated with methyl green, only the anterior part of the collar, a transverse line at the origin of the collar on the ventral side, and the postsetal girdle of glands on the second thoracic setiger are essentially unstained (Fig. 3f). Otherwise the entire epidermis accepts the dye readily, but most of the collar and the entire fecal groove remain relatively pale. Ventrally, the most intensively stained area is immediately behind the mentioned transverse line on the collar. The staining extends to the posterior border of the first setiger. Patterns on the following three, ventrally strongly stained setigers, were difficult to work out; clearly from the third setiger a pale ring in the plane of the parapodia divides the shields. Two broad rings of staining cells per segment continue laterally and dorsally, particularly in the abdomen. In the thorax, beginning at the second setiger, the rings tend to be separated from the shields by unstained epidermis (Fig. 3f; cf. also *E. rosea*), but are rudimentary on most of the dorsal surface. The rings of stained cells (more or less fused within the segments) continue onto the wings of the anal depression. Also the pygidium is stained.

Discussion: The paratype of *E. cortezi*, a small specimen of 2 mm total length, has 11 or 12 abdominal setigers, of which six are in the anterior part of the abdomen; the seventh is transitional to the depression segments. Thoracic notopodia after the first one have three kinds of setae. As seen in the second to fourth abdominal segments, each notopod has two kinds of uncini as depicted for the type series of *E. arenae*. The staining pattern is slightly different from the material collected at the type locality: presetal and postsetal rings of staining cells encircle the body, except at the fecal groove, without being interrupted at the lateral ends of the ventral shields.

I consider *E. cortezi* to be a synonym of *E. arenae*, a species that Reish (1968) had not included in the discussion of his record. The variability in the number of abdominal segments and the disagreement on the height of the palmate membrane (Hartman, 1966; Reish, 1968) must be noted.

Euchone hancocki new species
Fig. 4

Euchone incolor.—Hartman 1966, p. 203 *partim.*

Types: Holotype from *Velero IV* station 2298, 24 April 1953, on the southwestern end of the top of Lasuen seamount, off southern California, 33°24′01″ N, 118°00′00″ W, 122 m, shelly sand and rocks. AHF.

Paratypes from the same station. AHF (12 specimens).

Diagnosis: A *Euchone* species with five anterior abdominal setigers and three depression setigers. Palmate membrane and ventral shields absent. Radioles flanged. Collar without distinct ventral incision. A postsetal girdle of glands on first abdominal setiger. Middle series of thoracic notosetae with fairly narrow wings. Abdominal uncini without distinct rostra.

The species is named in honor of the late Captain A. Hancock.

Material studied: Type series.

Description: The largest animals are almost 4 mm long (to which the branchial crowns contribute almost 1 mm) and 0.2 mm wide. The branchial crowns of several animals are regenerating; others have been lost. Apparently, there are four pairs of radioles that bear pinnules for about two-thirds of their length. Up to about this level, they are lined by a broad flange; a connecting palmate membrane could not be found. The free slender tips of the radioles reach well beyond the ends of the pinnules. At least one pair of bare radioles is found ventrally. On each side of the mouth opening is a narrow lip.

The collar (Fig. 4a) is of about equal height laterally and ventrally; a slight ventral notch is present in addition to the dorsal gap. Otocysts are visible. The second thoracic and the first abdominal setigers each bear a postsetal girdle of glands. However, the latter is visible only after staining. Three of the eight abdominal setigers are incorporated in the anal depression. Ventral shields are absent.

The first thoracic setiger carries fascicles of about four long and four short limbate setae; the remaining thoracic setigers each bear about four long limbate setae (Fig. 4b), usually three shorter setae have so narrow wings that they hardly can be called subspatulate (Fig. 4c) and three shorter (ventralmost) capillary bristles with narrow wings (Fig. 4d). About half a dozen long-handled hooks occur in each neuropodium (Fig. 4e). Abdominal notopodia each contain six to ten pectinate uncini with

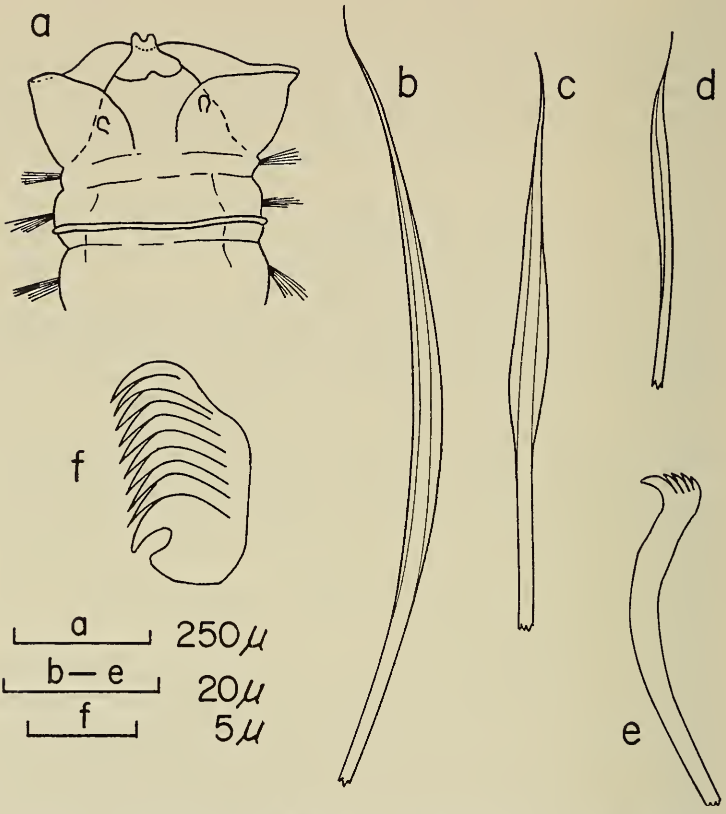

FIG. 4. *E. hancocki* new species: a, anterior end in dorsal view, with branchial crown removed; b-d, upper, median, and lower setae from thoracic notopodium; e, thoracic hook; f, uncinus from anterior abdominal segment.

notably small base plates and small rostra, above which are about nine rows of six to eight small teeth (Fig. 4f). The backs of the hooks are in side view strongly striated. The form of the hooks is uniform in the entire abdomen. The three to four abdominal neurosetae are limbate.

Two specimens appeared to have one or two eggs each in the sixth and seventh thoracic setigers. Eye spots could not be seen.

After treatment with methyl green, the branchial crown and the collar become only pale green. Otherwise, most of the body is fairly densely covered with stained cells except the girdles of glands, the segmental borders, rings in the plane of the parapodia (which appear to make the setigers biannulate), and the fecal groove. This pattern is most regular in the abdomen. In the thorax, the entire presetal area on the first setiger stains particularly strongly, as do the second and third setigers ventrally. The dorsal surface of the thorax has the fewest staining cells of the body.

Euchone southerni new species

Euchone rosea.—Southern, 1914, p. 144.
E. rosea.—McIntosh, 1923, p. 286 *partim.*

Types: Holotype from station L. 245 of a survey by the Irish Fisheries Branch, 3 September 1903, Ballynakill Harbor, NW Ireland (see Southern, 1915), 2–5 m (1–3 fathoms). NMI, No. 77.1908.

Paratype from the same sample. NMI, No. 77.1908. One specimen.

Diagnosis: A *Euchone* species with eight anterior abdominal setigers and four depression setigers. Palmate membrane to half the length of the radioles. Collar with very small ventral incision. Distinct ventral shields. Subspatulate thoracic notosetae. Abdominal uncini without posterior elongation, markedly divergent among anterior and posterior setigers.

The species is named for R. Southern. Because of the poor state of the holotype, the diagnosis is based primarily on Southern's description of this specimen. The small paratype largely agrees.

Material studied: Type series.

Additions to the Description: These specimens have been well described by Southern (1914). McIntosh (1923) examined one of Southern's specimens and drew the hooks. His characterization of the species, however, combined Langerhans' description of *E. rosea* and Southern's text.

A palmate membrane unites the radioles for about half their length. A flange extends to the tips. The ends of the more proximal pinnules do not reach nearly as far as the more distal ones. The holotype has 12 abdominal setigers. The smaller paratype has 11, owing to one setiger missing in the anal depression. In the holotype (cf. Southern, 1914, fig. 33A), the anterior edge of the depression is the posterior end of the eighth abdominal setiger, followed by four more setigers (not three, as in the drawing; likewise, if fig. 33B was made from this specimen, one depression segment was omitted). The elevation of the ventral surface of the animal (cf. Southern, 1914, fig. 33B) anterior to the depression proper starts at the end of the seventh setiger so that the eighth one is a transitional segment. The diameter of polygonal eggs in the holotype is 80 μ to 90 μ.

After application of methyl green, practically only the ventral shields stain, which stand out anyway even in unstained material (cf. Southern, 1914, fig. 33A). A square area on segment one, the shields on setiger one, and the presetal shield on setiger two accept the dye most readily. Staining indicates one pair (rather than two) of rudimentary ventral shields in the eighth setiger. Some scattered stained cells occur around

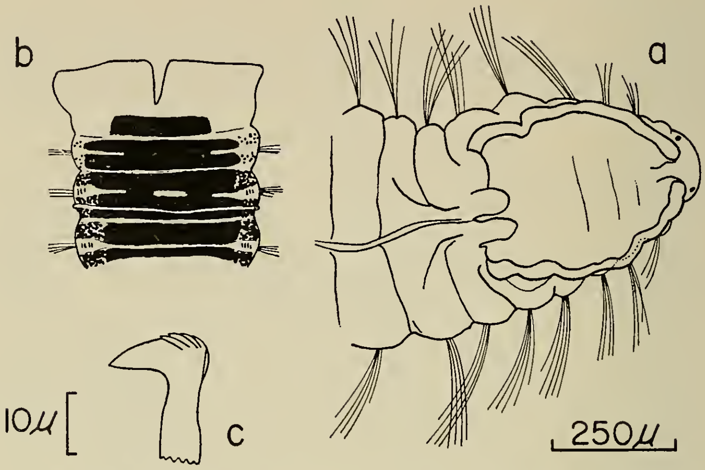

FIG. 5 *E. southerni incisa* new subspecies, from type series: a, posterior end in ventral view. The first segment shown is the sixth abdominal setiger; b, staining pattern of anterior end in ventral view; c, thoracic hook.

the parapodia, and in the holotype, transverse bands are present dorsally in the last anterior abdominal segments.

Euchone southerni incisa new subspecies
Fig. 5

Euchone rosea.—Kirkegaard, 1959, p. 101 *partim.*
Euchone rosea.—Day, 1967, p. 774 *partim.*

Types: Holotype: UCT, No. FAL 370K, from False Bay, 34°12′ S, 18°29.1′ E, 15 Nov. 1960, 40 m (collected by Ecological Survey, University of Cape Town). Fig. 37.6a in Day (1967) seems to be a drawing of this specimen.

Paratype from the same sample. UCT, No. FAL 370KK. (One specimen.)

Diagnosis: A subspecies of *Euchone southerni* with a marked ventral incision in the collar. Eight anterior abdominal setigers and five depression setigers. Abdominal uncini with posterior elongations.

Material studied: Type series.

Three specimens of the five from *Galathea* station 169, 3 January 1951, False Bay, Cape Province, 20 m (see Kirkegaard, 1959). ZMC (journal entry of 31 December 1952, as *E. rosea*).

Description: The types are complete and about 4.5 mm long, of which the branchial crown contributes 1.6 mm in both. The width is about 0.6 mm. The length of the largest specimen collected by the *Galathea* without a branchial crown is 4 mm, so that large specimens are at least 6 mm long.

The thorax has eight setigers, the abdomen 13, in all specimens except the paratype, which has 12 abdominal setigers. The anterior border of the anal depression is at the posterior margin of the eighth abdominal setiger in all specimens (Fig. 5a). Thus the depression comprises five setigers. However, the beginning of the depression is particularly difficult to locate in this species, and possibly its beginning is situated in the ninth abdominal setiger.

The radioles can be recognized only in the holotype; this specimen has two or three naked radioles and five pairs of radioles with a dozen (or slightly more) pairs of pinnules each. A conspicuous palmate membrane extends a little beyond half the length of the radioles and continues in a thick flange. The latter reaches beyond the origin of the distal pinnules and terminates in a very short filiform tip. The pinnules of the middle portions of the radioles terminate at about the same level as the distal pinnules.

The collar is of equal height dorsally and ventrally; in addition to the deep dorsal interruption, it has a distinct ventral incision (Fig. 5b; cf. fig. 37.6b of Day, 1967). The second thoracic setiger has the common postsetal girdle of glands. Ventral shields are distinct (see also below). Thoracic and abdominal setigers are two-ringed. A pair of eyes is found on the pygidium.

From the second setiger, thoracic notopodia each contain about a dozen setae in three series, limbate, subspatulate and short geniculate ones, the latter with a narrow wing. Neuropodial hooks have narrow heads (Fig. 5c). The abdominal limbate setae, about half a dozen per ramus in the anterior setigers, are conspicuous by being about half as long as the width of the abdomen. The notopodial uncini have small posterior elongations (cf. fig. 37.6f of Day, 1967).

After treatment with methyl green, the anterior ventral shields stain as shown in Fig. 5b; the following thoracic setigers are divided by an unstained ring in the plane of the parapodia. Each abdominal segment has two pairs of deeply stained shields, owing to the fecal groove. Each wing of the anal depression bears one area per segment of stained epidermal cells in the same position as the ventral shields of the anterior segments. Laterally and dorsally, a pair of rings of epidermal stained cells encircle the body except for the fecal groove in the thoracic and anterior abdominal segments; the rings, especially the presetal ring, are more conspicuous in the anterior abdominal segments. The depression segments have only one ring of stained cells per segment. Also the pygidium is stained.

Discussion: A subspecies (rather than a species) is erected because only two specimens have been found of the stem form and the variability of characters is unknown. Moreover, at the anterior end the pattern of staining upon treatment with methyl green can no longer be reliably studied in detail because of damage. Clear, nonmeristic differences between the stem form and the subspecies are the ventral incision of the collar and the form of the abdominal uncini. Possibily the form of the seventh, transitional abdominal setiger and the number of depression segments may be useful differential characters after more material has been studied. A mature specimen (holotype) of the stem species has clearly one abdominal segment fewer than the subspecies. The known geographic distribution of the subspecies suggests separation into species.

KEY

The key is arranged such that difficulties in deciding whether a segment is an anterior or transition segment should not lead to misidentification. The key does not distinguish between *E. rosea* and *E. olegi* because of insufficient knowledge of either species. It may also be noted that *E. rubrocincta* (Sars) from Ireland has only 12 anterior abdominal segments (rather than 13–15, as usual) and 10 setigers in the depression. However, it has somewhat more than 10 pairs of radioles with pinnules and is therefore not likely to be mistaken for *E. rosea* (with five to eight pairs) when the present key is used. After studying the type series of *E. eniwetokensis* Reish (13 to 14 abdominal setigers), I believe the species has to be included in *Chone*, and will report on it elsewhere.

1. 10 to 12 anterior abdominal setigers; 6 to 7 in the depression. Up to 8 pairs of radioles with pinnules .... *E. rosea*
– Fewer than 10 anterior abdominal setigers 2
2. 2 anterior abdominal setigers .... *E. trilobata*
– More than 2 anterior abdominal setigers 3
3. 5 or 6 anterior abdominal setigers; 3 setigers in the depression 4
– 6 to 9 anterior abdominal setigers; 4 or more setigers in the depression 5
4. A postsetal girdle of glands on the 1st abdominal setigers .... *E. hancocki*
– A presetal girdle of glands on the 3rd abdominal setiger .... *E. incolor*
5. 10 setigers in the depression, 8 anterior abdominal setigers .... *E. limynicola*
– 7 or fewer setigers in the depression; 6 to 9 anterior abdominal setigers 6
6. Two types of uncini within tori of anterior abdominal setigers (Fig. 3d, e) .... *E. arenae*
– One type of uncinus in anterior abdominal setigers; 8 anterior abdominal setigers 7
7. Ventral notch in collar (as in Fig. 3c). 4 setigers in the depression. Abdominal uncini without posterior elongation (as in Fig. 3d) .... *E. southerni southerni*

– Ventral incision in collar (Fig. 5b). 5 setigers in the depression. Abdominal uncini with posterior elongation (as in Fig. 1d) .... *E. southerni incisa*

GENERAL OBSERVATIONS

Of general interest to students of sabellid polychaetes, beyond the treatment of these species, is the observation that some small members of *Euchone* do not have the avicular uncini thought to be typical for *Chone* Kröyer, *Euchone* Malmgren, and also *Laonome* Malmgren (as in Fig. 3d) in the anterior abdominal segments, but have uncini that are pectinate in side view (as in Fig. 3e). Among the Sabellidae, pectinate uncini are found only in the genera of the *Oriopsis* group of the same subfamily, *Fabriciinae*, but they are common in related sedentary families. In *E. arenae*, pectinate uncini occur with the "typical" ones in the same parapods. Significantly, the former sit in the dorsalmost position of the tori, *i.e.*, they are the ontogenetically first-formed uncini. The experience that the ontogeny can recapitulate the phylogeny suggests that the pectinate uncini are, indeed, primitive features as is already apparent from their shape. Species of *Euchone* having such uncini are primitive at least in this respect.

Curiously, many of these primitive species are small, having short abdomina. They show many features observed also in *Oriopsis*, thought to be near the basis of the Sabellidae (cf. Banse, 1957). Species of this genus have a branchial crown without palmate membranes; radioles are bordered by a flange and have proximal and distal pinnules ending at the same level; ventral shields are poorly developed or absent; gonads can be found only in the thorax, and the thoracic segments can be lengthened so that they are as long, or longer than they are wide; finally, some species of *Oriopsis* have a third series of thin notosetae as have *Euchone* and *Chone*. Likewise in *E. hancocki*, eggs occur only in the thorax. A concomitant increase in length of posterior thorax segments is found in several species (cf. *E. incolor*, Hartman, 1965a, pl. 51, fig. a), making the segments longer than they are wide. Also this feature causes the habitus of some small *Euchone* species to be quite similar to that of species of *Oriopsis* or *Fabricia*.

Excepting the hooks, much of the similarity may be the consequence of small size, *i.e.*, may represent convergence. Since, however, the *Chone* group shows other features primitive among the Sabellidae (Johansson, 1927; see also Orrhage, 1962), it may be worth investigating whether evolution might have proceeded from *Oriopsis* through the *Chone* group toward the *Sabellinae*, or whether *Oriopsis* is on a side branch (starting from near *Chone*—*Euchone*) of the line leading to the *Sabellinae*. The male reproductive system may provide a clue for the onset of internal specialization leading to the derived forms such as *Fabricia*. If the unique spermaduct of *Fabricia* and *Manayunkia* Leidy (see Zenkevitch, 1925) is found in *Oriopsis*, this genus is on the side branch that has led to the two first-named genera and their relatives and thus cannot be the ancestor of *Chone—Euchone*. A clue for primitiveness may be provided by the number of ciliary rows on the pinnules of the radioles. As pointed out by Lewis (1968), *Fabricia* and *Manayunkia* have only three rows, two laterofrontal ones and a frontal one, as have the Serpulidae; large Sabellidae, however, have an additional abfrontal row (Nicol, cited by Lewis, 1968) as has *Euchone papillosa* (Sars) according to Evenkamp (1931). Three instead of four rows would make *Oriopsis* in one more very general character, more primitive than *Euchone*.

Because of its specialized anal depression, *Euchone* itself is not likely to be the basic genus of Sabellidae, but because of its closeness to *Chone*, many observations on the former may hold for the latter. Indeed, uncini intermediate between the pectinate and the "typical" *Chone* shape have been reported for *C. filicaudata* Southern (Southern 1914, pl. 15, fig. 32L; somewhat similar to Fig. 3e), so that at least this species may not be too far removed from the situation prevailing in some small species of *Euchone* that led to this discussion. It may be noted that several small species of *Chone* have ventral shields rather than a glandularized tissue that surrounds the entire thorax. Ventral shields should be present in reasonably basic Sabellidae.

SUMMARY

Of the previously known species of *Euchone* with 12 or fewer abdominal setigers preceding the anal depression, only *E. arenae*, *E. incolor*, *E. limnicola*, *E. rosea* (restricted) and possibly *E. olegi* are regarded as valid. *Euchone hancocki* and *E. southerni*, with a new subspecies *E. southerni incisa*, are newly described. *Euchone trilobata* is a new combination.

The occurrence of pectinate abdominal uncini in some of these species is regarded as a primitive character, further suggesting relationships of the *Chone—Euchone* group with *Oriopsis* of the same subfamily, *Fabriciinae.*

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PROCEEDINGS
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BIOLOGICAL SOCIETY OF WASHINGTON

WESTERN ATLANTIC SPECIES OF THE PARASITIC GENUS *LEIDYA* (EPICARIDEA: BOPYRIDAE)

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The first species of *Leidya* was discovered on the fiddler crab *Uca pugilator* (Bosc) in New Jersey by Leidy (1855), who described it briefly under the name *Cepon distortus.* The differences between Leidy's species and the only other species of *Cepon* then known, *C. typus* Duvernoy from Mauritius, were great enough to lead Cornalia and Panceri (1858) to establish the genus *Leidya* for the American parasite. Richardson (1908) described as *Leidya distorta* specimens collected the same year by Verrill from the shore crab, *Pachygrapsus transversus* (Gibbes), in Bermuda. Other specimens of *Leidya* were reported by A. S. Pearse from *Uca pugilator* at Beaufort, North Carolina (Pearse, 1947), and from *Pachygrapsus transversus* at Bimini, Bahamas (Pearse, 1951). Pearse was obviously unaware of Richardson's (1908) Bermuda record and established a second species, *Leidya bimini,* for the parasites of *Pachygrapsus.* The diagnosis of *L. bimini* is very short and only the male was illustrated in toto. The characters that Pearse used to separate the 2 species are of little value and are also rather variable among individuals. In fact, the only one of Pearse's criteria that is not found in descriptions of *L. distorta* is the presence of medioventral tubercles on the male of *L. bimini,* not mentioned in the descriptions of *L. distorta* by Leidy and by Richardson, altho we have found them to be present in the later species.

The discovery of a pair of *L. bimini* on *Cyclograpsus integer*

(H. Milne-Edwards) at Jamaica by Hartnoll (1965) provided us the opportunity of examining the question of whether the 2 species are really distinct, a question that had remained unresolved because of the difficulty in obtaining specimens of *Leidya.* In the meantime, one of us (R. B.) received from Dr. L. B. Holthuis (Rijksmuseum van Natuurlijke Historie, Leiden) a specimen of *Uca vocator* (Herbst) from Trinidad collected by Dr. Von Hagen, parasitized by 2 pairs of bopyrids. Examination of these bopyrids raised a new problem. Altho the males with their characteristic long slender uropods unquestionably belonged to the genus *Leidya,* the presence of endopods on the pleopods of the females complicated matters, since the diagnosis of *Leidya* distinguished it from other genera of the *Cepon* group (except *Mesocepon*) by its lack of pleopodal endopods. However, as will be shown herein the pleopods of both *L. distorta* and *L. bimini* possess endopods, altho they are greatly reduced in the latter species.

Mr. Richard Heard, Jr. (Marine Institute, University of Georgia), learning of our interest in the genus *Leidya,* generously sent the junior author well preserved specimens that he had collected in North Carolina and Georgia from *Pachygrapsus transversus, Uca pugilator,* and 2 new hosts, *Uca minax* (Le Conte) and *Uca pugnax* (Smith). After study, these specimens were sent to the senior author, together with other specimens of *Leidya* in the collections of the Smithsonian Institution.

These collections of *Leidya,* comprising much more numerous and better preserved specimens than had been available to earlier authors have made it possible for us to describe and illustrate the 2 Western Atlantic species in greater detail than in previous accounts, to confirm their specific distinctiveness, and to point out the criteria by which they may be identified.

Leidya distorta (Leidy)

Figures 1–5

Cepon distortus Leidy, 1855, p. 150, pl. 10, fig. 26–32.—Harger, Verrill, and Smith, 1874, p. 573.—Harger, 1879, p. 157; 1881, p. 311.—Kossman, 1880, p. 122; 1881, p. 182.—Richardson, 1900, p. 309.

Leidya distorta (Leidy).—Cornalia and Panceri, 1861, p. 114.—Giard and Bonnier, 1887, p. 68, fig. 12.—Bonnier, 1900, pp. 255–257, fig.

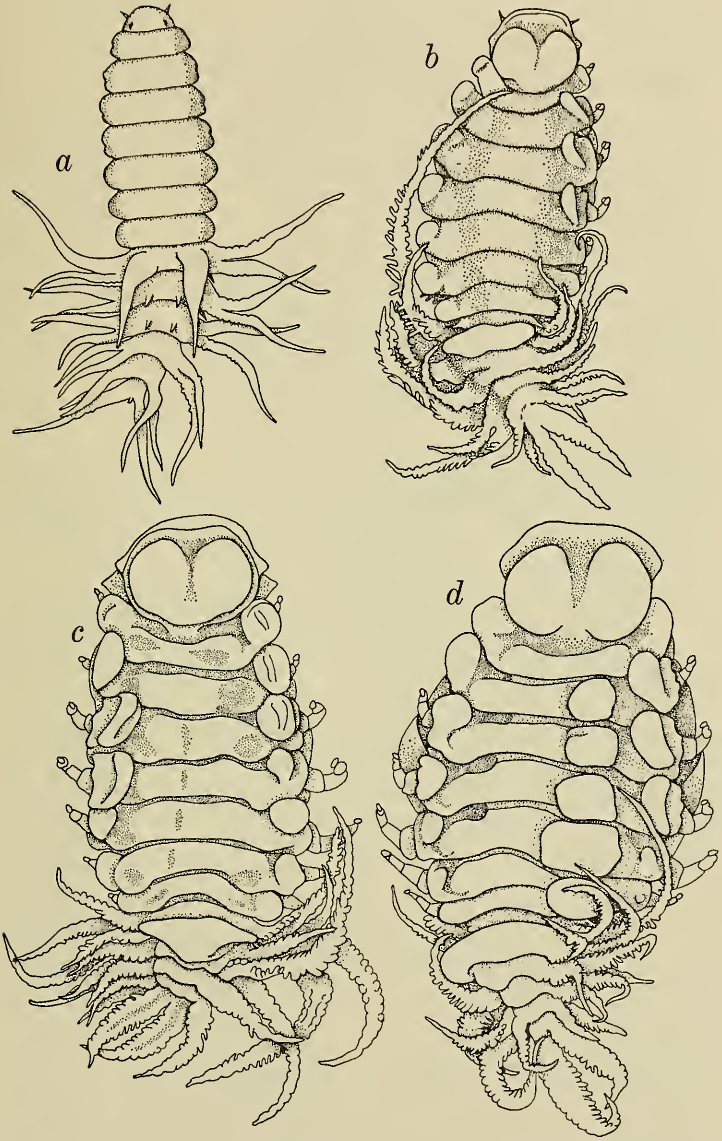

Fig. 1. *Leidya distorta* from *Uca pugilator*, females: a-b, juveniles; c. preadult; d, adult.


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c

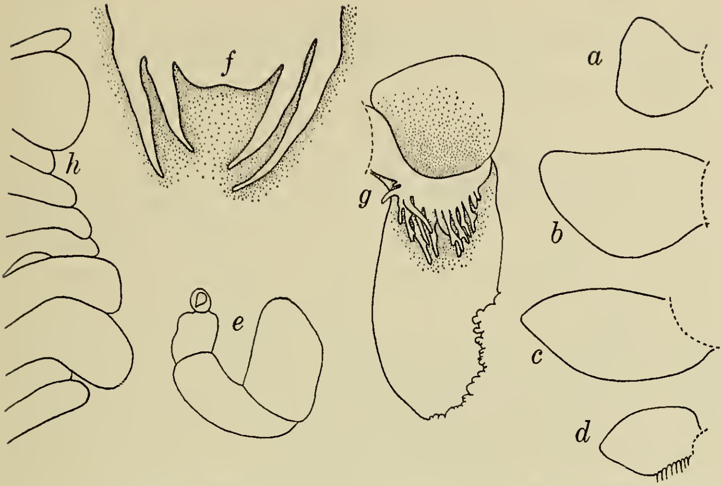

FIG. 3. *Leidya distorta* from *Uca pugilator*, adult female: a-d, oostegites 2–5; e, pereopod; f, posterior margin of head; g, 1st oostegite; h, dorsal thoracic bosses in profile.

45a-g.—Richardson, 1901, p. 579; 1904, pp. 74–75; 1905, pp. 511–512, fig. 559a-c, 560 a-d.—Pearse, 1947, p. 326.

Phryxus distortus (Leidy).—Walz, 1882, p. 183 (59).

nec *Leidya distorta* (Leidy).—Richardson, 1908, pp. 23–26, fig. 1–5 [= *Leidya bimini* Pearse].

Material examined: From *Uca pugilator* (Bosc): 2♀♀, Beaufort, North Carolina, 29 May 1946, A. S. Pearse, coll. (USNM 84046).—7♀♀, 1♂, same locality—collector, 10 July 1946 (USNM 84048).—5♀♀, 2♂♂, same locality, March 1963, R. Heard, coll. (USNM 128473).

From *Uca pugnax* (Smith): 3♀♀, Savannah, Georgia, March 1963, R. Heard, coll. (USNM 128472)

From *Uca minax* (Le Conte): 1♀, Savannah, Georgia, 15 March 1963, R. Heard, coll. (USNM 128470).

From *Uca* sp.: 1♀, Sapelo Island, Georgia, July 1961, R. Heard, coll. (USNM 128471). 1♀, Port-de-France, Guadeloupe, R. Bourdon collection.

From *Uca vocator* (Herbst): 2♀♀, 2♂♂, El Sodorro, Trinidad, Dr. Von Hagen, coll. (Rijksmuseum van Natuurlijke Historie, Leiden).

←

FIG. 2. *Leidya distorta* from *Uca pugilator*, females: a, ovigerous adult; b-g, juvenile; b, 1st antenna; c, pleonites 1–3, dorsal; d, maxilliped; e, 1st oostegite; f, pleon, ventral; g, posterior margin of head; h, preadult, maxilliped and posterior margin of head.

Description: The specimens are described below in the order of their maturity, judged from the development of the oostegites.

1. From *Uca pugilator*

Female:

1. Oostegites rudimentary (Fig. 1, a)

Length 4.8 mm. Dorsal surface of anterior half of body resembling that of male: Head not at all immersed in pereon; 2nd antennae visible in dorsal view; pereon narrow, with nearly parallel margins, differing from that of the male only in that pereonites 1–4 are laterally excavated and slightly inflated at the positions of the future pleural bosses. Vestiges of ocular pigment visible at posterior angles of head. Segments 1–2 of 1st antenna (Fig. 2b) with anterolateral apophysis bearing a few setae; segment 3 minute and unarmed. Second antenna 7-segmented. Maxillipeds represented by 2 triangular lamellae with 2–3 apical setae, not reaching the base of the oral cone. Oostegites rudimentary, scarcely larger than basipods of pereopods, which increase in size posteriorly. Pleon nearly as long as pereon, with 5 pairs of long slender lateral plates with slightly tuberculate margins. Pleopods similar to epimeral plates, all biramous, endopods very short, smaller on one side than on the other. 6th pleonite ending in an anal tube, bearing a pair of uropods one-fourth longer than exopods of 5th pleopods. Dorsal surface of 1st pleonite bearing 2 foliaceous pointed processes extending back to 4th pleonite; dorsal surface of 2nd and 3rd pleonites each with a pair of small short pointed processes. To our knowledge, such processes have not been reported previously in the Bopyridae.

2. Oostegites nearly meeting medially (Fig. 1b)

Length 4.6 and 5.2 mm. General aspect as in fig. 1b. Cephalogaster and frontal lamina already developed. Eyes completely lost. Maxillipeds elongate, with marginal setae, completely covering buccal cone. Lateral margins of pereonites elevated above central part of pereon. Oostegites cordate, 1st pair divided into 2 nearly equal parts. Pereopods 5–7 much larger than pereopods 1–4. Pleonites 1–3 each with 2 small lateral digitations, all filiform in one specimen, some blunt in the other (Fig. 2c). Epimeral plates and pleopods digitate. Pleopods with endopods smooth and distinctly shorter than exopods, although relatively more developed in anterior pairs; exopod of 1st pleopod of convex side longer than that of concave side, reaching anterior to 3rd pereonite in one specimen and to posterior margin of head in other. Anterior 4 pleopods of convex side of latter specimen each with blunt lobe between endopod and exopod. Uropods slightly broader than other pleonal appendages.

3. Oostegites slightly overlapping

Length 5.2 and 5.8 mm. Maxillipeds (Fig. 2d) similar to those of preceding stage. Pleural bosses very distinct on pereonites 1–6. First oostegite

(Fig. 2e) with lobulate posterior margin on transverse inner ridge and setae on outer margin of posterior lobe. Endopods of right pleopods (Fig. 2f) longer and with more digitation than those of left pleopods. Second pleonite more enlarged than other pleonites, with well defined lateral margins. Lateral digitations of pleon completely lost in one specimen, still visible on 1st pleonite of other specimen (Fig. 1b), which despite this juvenile character, has an absolutely identically developed marsupium and is in other respects more mature; e.g. posterior margin of head has a pair of short cephalic plates (Fig. 2g).

4. Oostegites forming a completely closed marsupium.

a. Female preadult (Fig. 1c)

Length 6.1 mm. Internal cephalic plates present, as tubercles; external cephalic plates more developed. Palp of maxilliped reduced, with setae on medial margin only (Fig. 2h). Pereonites 1–6 swollen on one side near pleural bosses. Posterior lobe of 1st oostegite elongate, reaching between pereopods 3 and 4; transverse ridge with about 10 long digitations.

b. Female adult (Fig. 1d)

Length 6.4 mm. The slight dorsal inflations of the pereon that were becoming evident at the approach of maturity have developed into conspicuous subquadrangular dorsal bosses, together forming a strong carina. Marsupium convex; oostegites varying in shape according to their position (Fig. 3, a-d); 5th pair only with fringed and tuberculate outer surface. Pereopods (Fig. 3e) increase in size posteriorly as in preceding stages, but differences in size are greater; 1st pereopods appear minute in comparison with 5th and 6th pereopods.

c. Older adult female (Fig. 2a)

Length up to 7.7 mm. As size of female increases, body becomes more and more globular, dorsal bosses more voluminous, lobes on posterior margin of head (Fig. 3f) and posterior lobe of 1st oostegite (Fig. 3g) more elongate; digitations of transverse ridge of 1st oostegite tend to develop branches.

Variation: Variations in the following characters have been observed in adult females:

—Cephalogaster sometimes very prominent.

—Internal cephalic plates may be as long as external cephalic plates; the latter may reach or even extend across the midline of the body. In one specimen the inner plate had 2 small secondary filiform digitations.

—1st oostegite may extend posteriad only to the level of the 3rd pereopods or as far as the level of the 5th pereopods.

—Dorsal bosses (Fig. 3h) of the pereon vary in number from 4 to 6, and vary in prominence. In the specimen illustrated in fig. 2a the

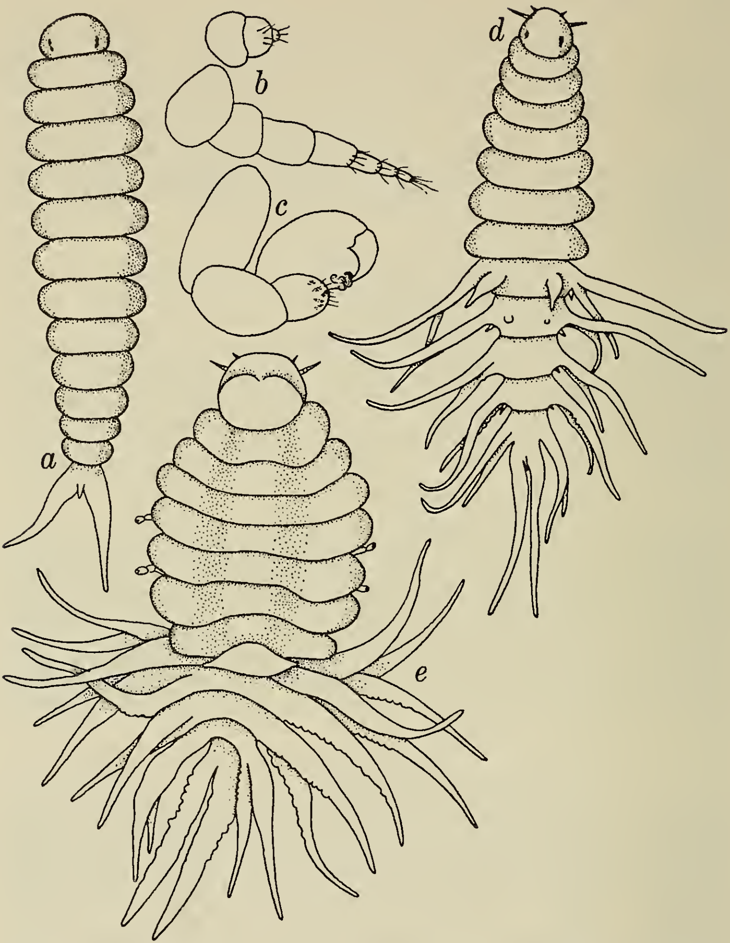

FIG. 4. *Leidya distorta*: a-c, male from *Uca pugilator*; a, habitus, dorsal; b, 1st and 2nd antennae; c, pereopod; d, juvenile female from *Uca pugnax*; e, juvenile female from *Uca minax*.

bosses form a median carina, but in all other specimens the carina is displaced to one side.

—The exopod of the longer 1st pleopods may reach anteriorly only to the 5th pereonite or as far as the posterior margin of the head.

—The large blunt lobes at the base of the rami may be present

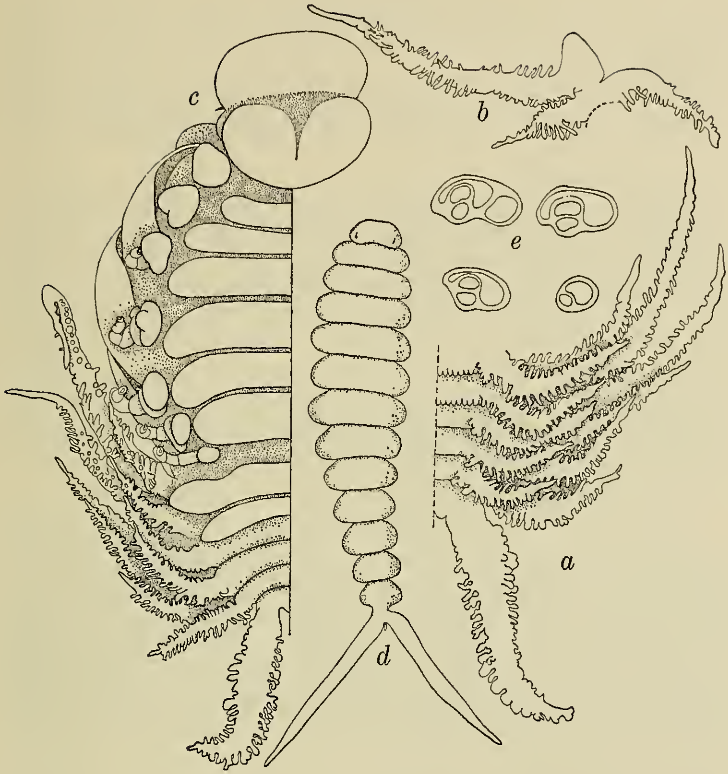

FIG. 5. *Leidya distorta* from *Uca vocator*; a-c, female; a, pleon, ventral; b, pleopod and epimeral plate of 1st pleonite; c, habitus, dorsal; d-e, male; d, habitus, dorsal; e, chitinous network of pleopods.

simultaneously on both right and left 1st and 2nd pleopods. In one specimen such a lobe was present on the 5th pleopod.

—Endopods are always present and well developed on the pleopods, more slender and from a third to a half as long as the exopod.

Male: (Figure 4a)

Length 1.8–2.7 mm. Head distinctly narrower and separate from 1st pereonite. Eyes present. First antenna 3-segmented; 2nd antenna 7-segmented (Fig. 4b). Maxilliped not observed. Pereopods (Fig. 4c) subequal, with scales on posterior margins of carpus and propodus. Pereonites

1–7 and pleonites 1–2 each with medioventral tubercle. Pleon 6-segmented. Pleopods tubercular, with a peculiar chitinous network (Fig. 5e) illustrated by Leidy (1855). Uropods long, filiform, with anal tube jutting out prominently at base.

Variation: The 2nd antenna may consist of from 5 to 8 segments. The medioventral tubercles may be present as far back as pleonite 4.

2. From *Uca pugnax*

Specimens collected from this host are all juveniles, 2 with rudimentary oostegites, the other with oostegites nearly meeting medially. Compared to parasites of similar maturity from *Uca pugilator*, the most mature female (7.1 mm) agrees closely with the description given above, and the others differ but little. The youngest (Fig. 4d), which measures 5.0 mm, has a narrower body, more slender pleonal appendages, reduced dorsal processes on pleonite 1, and those of pleonite 2 represented by blunt knobs. In the 3rd specimen (4.8 mm), in which the maxillipeds and the oostegites are slightly more developed, the pleon is enlarged and its appendages are very tuberculate and curved.

3. From *Uca minax* (Fig. 4e)

The elongate form of the maxillipeds, the degree of development of the oostegites, and regular increase in length of the pereopods indicate that this specimen is a very young female. Despite these characters, however, and the small size of the parasite (4.6 mm), it agrees in general appearance with the second specimen from *Uca pugilator* (oostegites nearly meeting medially) in having a relatively broad body, a cephalogaster and frontal plate already developed (the latter especially important), and elevated lateral margins on the pereonites.

4. From *Uca* spp.

The specimen from Guadeloupe is at the same stage of development as the specimen from *Uca minax* and in body form resembles Fig. 4e. However the pleural bosses are already present and the appendages of the pleon have many digitations on their borders. The specimen from Sapelo Island is an adult female.

5. From *Uca vocator*

The 2 adult pairs were on the same host, one pair in each gill chamber. The females have very broad frontal plates and the pleopods have relatively elongate endopods (Fig. 5a, b). One female agrees otherwise with the specimens from *U. pugilator*, especially in the gibbous digitations of the pleopodal exopods. The other female (Fig. 5c) differs in that the dorsal surface of the thorax is not raised into a longitudinal carina, and it has no dorsal bosses. The males (Fig. 5d, e) are identical with those of the parasites from the other species of *Uca* except for the greater length of the uropods.

Leidya bimini Pearse

Figures 6a-c

Leidya Rathbun, 1918, p. 248.

Leidya distorta (Leidy).—Richardson, 1908, pp. 22–26, fig. 1–5.—Verrill, 1908, p. 323 [Footnote].

Leidya bimini Pearse, 1951, p. 368–369, fig. 77a-i.—Hartnoll, 1965, p. 135.

Material examined: From *Pachygrapsus transversus* (Gibbes): 4♀♀, 1♂, Bermuda, 1901, A. E. Verrill, coll. (USNM 39246).—1♀, Bimini, Bahamas, 16 October 1948, A. S. Pearse, coll. (USNM 88598).—1♀, 1♂, Jamaica, R. Hartnoll, coll. (USNM 111346).—6♀♀, 4♂♂, Molasses Key, Florida, December 1968, R. Heard, coll. (USNM 128469).

Female:

a. Preadult.

Length 4.9 mm. The only specimen of this stage resembles closely, in dorsal view, the female of *L. distorta* shown in Fig. 1c, but the pleopods have distinct differences. The exopod of pleopod 1 does not reach beyond the epimeral plate; there is no blunt lobe between the exopod and endopod, and the endopods are very rudimentary.

b. Adult (Fig. 6a).

Length up to 6.6 mm. Cephalic plates, maxillipeds, pleural bosses, oostegites, and pereopods similar to those of *L. distorta*. Dorsal bosses, on pereonites 2–5, differ distinctly in being more or less bilobed posteriorly, especially pereonite 5 boss, which is deeply divided. Pereonites 6 divided in middle by longitudinal fissure. Pereopods relatively smaller. Biramous condition of pleopods (Fig. 6b) difficult to discern because of rudimentary condition of endopods: endopods of one side resemble exopods, but are much smaller; endopods of other side represented, at least in anterior pleonites, by small, slightly digitate processes which may be confused with base of exopod, to which they are closely attached. Epimeral plates about as long as exopods.

Variation:

—Cephalic plates (Fig. 6c) denticulate in several specimens.

—Dorsal bosses may vary in number from 2 to 4. Posteriormost boss always on pereonite 5, usually at midline, but in one specimen they are aligned diagonally from the pleural boss of pereonite 2.

Male:

Differs from *L. distorta* only in that medioventral tubercles are more strongly developed and are present on pleonites 1–5.

CONCLUSIONS

1. As stated in the introduction, the inadequate diagnoses, the doubtful value of the specific criteria used, and the different conclusions ar-

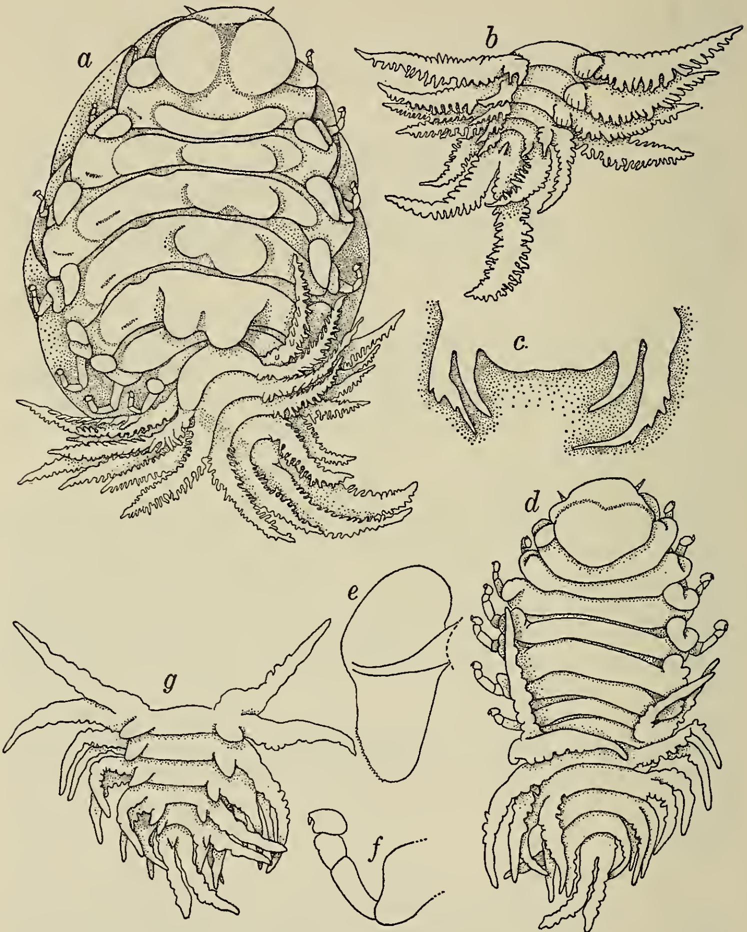

FIG. 6. a-c *Leidya bimini*, from *Pachygrapsus transversus*, adult female; a, habitus, dorsal; b, pleon, ventral; c, cephalic plates; d-g, bopyrid from *Cyclograpsus integer*, preadult female; d, habitus, dorsal; e, 1st oostegite; f, pereopod; g, pleon, ventral.

rived at by Richardson (1908) and Pearse (1951) made a reexamination of the parasites of *Uca pugilator* and *Pachygrapsus transversus* desirable. The study of the present material, which includes specimens used by Richardson and Pearse, has enabled us to confirm the heretofore uncertain validity and distinctness of *Leidya distorta* and *L. bimini.* As noted before, the only seemingly valid difference between the 2 species that can be derived from a comparison of previously published descriptions is the presence of medioventral tubercles in the male *L. bimini* and their apparent absence from *L. distorta,* since Leidy did not mention them. But, as we have indicated, males of both species have these tubercles on all pereonites; in *L. bimini* they are also present on pleonites 1–5, but in *L. distorta* they are limited to pleonites 1–2.

2. Our observations thus diminish the difference between the males of the 2 species, but fortunately the adult females may be easily distinguished by a number of characters, especially the following:

Character	*L. distorta*	*L. bimini*
Dorsal thoracic bosses	All simple, most often displaced to one side.	Posterior bosses bifid usually in middle of posterior margin
Exopods of pleopods of convex side	Much longer than epimeral plates, with blunt lobe at base.	Slightly longer than epimeral plates, without blunt lobe at base.
Endopod of pleopods	Relatively well developed and easily visible.	Rudimentary and difficult to distinguish.

Altho they differ slightly from corresponding stages taken from *Uca pugilator*, the young females found on *Uca* spp., *U. minax*, and *U. pugnax* all appear to belong to the same species, *Leidya distorta.* Differences in size, body form, more or less precocious development of the pleural bosses and the digitations of the pleopods can probably be attributed to an imperfect synchronization of the development of these characters with that of the marsupium, as is known to occur in *Cancricepon elegans* Giard and Bonnier (Bourdon, 1968).

3. Concerning the specimens from *Uca vocator*, the first is unquestionably *L. distorta,* in spite of the broad frontal plate. The second is referred to *L. distorta* with some reservations, for it is the only mature individual completely lacking dorsal thoracic bosses. The limited number of specimens of *Leidya* available makes it impossible for us to decide whether the absence of bosses represents an extreme degree of intraspecific variation or is a character of a distinct species of *Leidya.* The latter possibility cannot be rejected offhand; the presence of 2 parasites

on the same host does not prove that they belong to the same species, since instances of simultaneous infestation of a decapod by more than one species of bopyrid are known.

4. It is not possible to confirm that the parasite of *Cyclograpsus integer* (Fig. 6d-g), identified as *Leidya bimini* by the junior author (Hartnoll, 1965), actually belongs to this species. The 1st oostegite and the pereopods certainly agree with those of Hartnoll's bopyrid from *Pachygrapsus transversus*, but other characters show too many differences. Altho the specimen is already preadult its length is only 2.8 mm; the endopods of the pleopods are very distinct; the appendages of the pleon are coarsely tuberculate; the 5th oostegites are nearly as large as the 4th and have neither surface granules nor marginal setae.

5. Perhaps the most interesting result of the observations reported herein is that, contrary to previous descriptions, the females of both species of *Leidya* possess pleopodal endopods, and especially, that mediodorsal bosses are sometimes absent in this genus.

The significance of the latter variation is evident in view of the fact that the classification of the *Cepon* group of bopyrid genera is based upon the presence or absence of these bosses. Fortunately *Leidya* can be distinguished easily and with certainty from other crab parasites by the long filiform uropods of the male.

6. Two monospecific genera, *Megacepon* George and *Cardiocepon* Nobili, show particular affinities to *Leidya* that should be emphasized. The female of *Megacepon* differs from *Leidya* in having a large triangular dorsal boss on pereonite 7 (George, 1947; Shiino, 1958), and the female of *Cardiocepon* differs in that its pleon has biramous epimeral plates (Nobili, 1906). Otherwise both of these Indo-Pacific forms resemble certain specimens of *Leidya distorta* in their general habitus, the reduced frontal lamina, and the development and fimbriation of the pleon. The elongation of the posterior lamella of the 1st oostegite, unusual in the *Cepon*-group, is another important character shared by the 3 genera. Moreover all 3 genera infest catometopous crabs belonging to the families Gecarcinidae and Grapsidae. Both *Leidya sesarmae* Pearse (1930, known only from a single male, and *Megacepon choprae* George (1947), known only from the female, infest the same host, *Sesarma dehaani* H. Milne-Edwards, and it is quite possible that they are conspecific. The question of the identity of *Cardiocepon* and *Megacepon* with *Leidya* cannot be resolved until the characters of the males of the first 2 genera become fully known.

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PROCEEDINGS
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A NEW GENUS AND TWO NEW SPECIES OF SUBTERRANEAN AMPHIPOD CRUSTACEANS (GAMMARIDAE) FROM NORTHERN MÉXICO

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Although a number of blind, depigmented amphipod crustaceans have been recorded from subterranean waters of the Caribbean Region (Holsinger and Peck, 1968), only one, *Bogidiella tabascensis* Villalobos (1960) (family Bogidiellidae), from Gruta del Cocona, Tabasco, was previously known from México, or, for that matter, from any of the Central American mainland. The only other truly freshwater amphipod known from that country was the ubiquitous *Hyalella azteca* (Saussure) (family Hyalellidae). The latter is widely distributed over North America, and ranges through Central and South America as far south as southern Argentina.

Holsinger and Peck (1968) summarized information on interstitial and cavernicolous amphipods from the Caribbean Region, pointing out the general dearth of information on the subterranean fauna of that vast area, and suggesting that additional exploration would doubtless result in significant future discoveries. Collection of tiny, blind, depigmented amphipods from small groundwater outlets of the Bolsón de Cuatro Ciénegas, Central Coahuila, northern México, bears out their prediction. In August 1968, Gerald A. Cole, W. L. Minckley and sons, Dwight W. Taylor, and J. Jerry Landye obtained more than 40 specimens, which, when studied, were found to represent the new genus and two new species described herein. In addition to the unique new genus, this discovery also marks the first record of the family Gammaridae from the fresh waters of México, and as noted before is the second record of a subterranean amphipod from that country.

It should be noted that during the past several years members of the Mexican Association for Cave Studies have carefully searched many habitats in the limestone terranes of México for amphipod crustaceans, to no avail (J. R. Reddell, personal communication). In view of the over-all interest, competence, and experience of this association, it seems doubtful if such animals have been overlooked. However, the occurrence of the undescribed genus in tiny seepages and springs, rather than in caves, may offer a clue to the more specific biotopes at present occupied by subterranean faunas of this area.

Descriptions of the new genus and the first of the two new species were prepared by both of us, that for the second of the two new species by Holsinger alone; the remainder of the paper is the work of both authors.

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Mexiweckelia Holsinger and Minckley new genus

Diagnosis: Without eyes or pigmentation; size small; known only from groundwater-related habitats. Antenna 1 longer than antenna 2; accessory flagellum greatly reduced to single segment, or vestigial. Peduncular segment 4 of antenna 2 with several marginal spines; gland cone rather small, not prominent. Interantennal lobe distinct, rounded anteriorly. Upper lip symmetrical, rounded apically. Mandible with well-developed incisor, lacinia mobilis, and molar; spine row with several prominent spines; palp lacking. Maxilla 1 with inner plate rather broad and bearing numerous marginal setae; outer plate with 7 to 9 serrated spines apically; palp 2-segmented, bearing spines or thickened setae apically. Maxilla 2 with inner plate broader than outer, bearing row of long, obliquely-placed setae; apex of both inner and outer plates bearing numerous coarse setae. Inner plate of maxilliped subrectangular, with thick spines and setae apically and several plumose setae on inner margin; outer plate extending well beyond segment 1 of palp, armed with several blunt-tipped spines and few setae on inner margin; palp well developed, 4-segmented, segment 2 longest. Lower lip with well-developed outer lobes, long lateral processes, and vestigial inner lobes.

Gnathopod 1 with propod proportionately rather small, palmar margin armed with distally unnotched, peglike, spine teeth. Gnathopod 2 with propod proportionately larger than that of first gnathopod; propod palmar margin with double row of distally unnotched, peglike, spine teeth. Pereopods 3 and 4 about equal-sized, coxal plate of pereopod 4 not expanded. Pereopod 7 longest, at least half length of body, longer than pereopod 6 and significantly longer than pereopod 5. Coxal gills well developed, biarticulate, attached by distinct pedicels. Sternal processes absent. Brood plates small and narrow in sexually mature females.

Abdominal sideplates with posterior margins slightly convex, with at least 1 seta each; posterior corners tiny, rounded. Pleopods graduated in length, shorter posteriorly; inner rami slightly longer than outer; peduncles with coupling hooks on inner, distal margins. Uropods 1 and 2 unmodified. Uronites not fused, with 2 or more dorsolateral spines each. Uropod 3 biramous, rami well developed, outer without a second segment. Telson deeply cleft, but not to base.

Gender is feminine. The type species is *Mexiweckelia colei* Holsinger and Minckley new species.

Etymology: The generic name is derived by combination of "*Mexi*," which alludes to the geographic placement of the genus, and "*Weckelia*," the name of a related, Greater Antillean genus.

Affinities: Although *Mexiweckelia* is rather unique in the extreme reduction of the accessory flagellum of antenna 1, and in loss of its mandibular palp, its combined characters indicate a definite relationship with the *Hadzia* group of the family Gammaridae. This group was originally proposed by Ruffo (1956a) to include a small cluster of genera that demonstrated an unusual, circumtropical distribution (*Weckelia*, *Quadrivisio*, *Psammoniphargus*, *Hadzia*, and *Metaniphargus*). Stock and Nijssen (1965) synonymized *Metaniphargus* with *Hadzia*, discussed affinities of some genera of the *Hadzia* group, and pointed out the close similarities between another genus, *Eriopisa*, and *Hadzia*. On the basis of the last comparisons it is evident that *Eriopisa* should also be assigned to the *Hadzia* group. Two more genera, *Paraweckelia* and *Alloweckelia*, were added by Holsinger and Peck (1968), and with the present addition of *Mexiweckelia* the group is expanded to include eight genera, of which almost all are anopthalmous and inhabit interstitial or subterranean biotopes. Five of the eight are known exclusively from freshwaters, while

TABLE 1. Summary of diagnostic characters of *Mexiweckelia* new genus.

Structures	Diagnostic features
Accessory flagellum of antenna 1	Vestigial to 1-segmented
Gland cone of antenna 2	comparatively small
Maximum number of setae on inner plate of maxilla 1	7
Number of spines on outer plate of maxilla 1	7 to 9
Inner plate of maxilla 2	oblique row of 10 to 11 setae
Mandibular palp	absent
Molar seta	present on right, absent from left
Coxal plate of pereopod 4	not broadly expanded
Coxal gills	with pedicels
Outer ramus of uropod 3	1-segmented
Inner ramus of uropod 3	nearly as long (or as long) as outer
Apical margin of telson	cleft ⅔ or more to base
Number of spines per apical lobe of telson	3

the other three occur in marine, brackish, and fresh waters, but predominate in brackish habitats.

Both the reduction of the accessory flagellum of antenna 1 and the total loss of the mandibular palp in *Mexiweckelia* probably are secondary. Reduction to a single, tiny segment is found in the palps of *Weckelia* from Cuba (Shoemaker, 1942), and in *Psammoniphargus* from the Island of Reunion (Ruffo, 1956b). The number of accessory flagellar segments varies from 2 to 6 among other genera of the *Hadzia* group. In *Psammoniphargus*, for example, the biarticulate accessory flagellum is reduced to the point of having its second segment only rudimentary (Ruffo, 1956b). It therefore is not surprising to find this structure reduced to a stub in one species of *Mexiweckelia*, and to a simple segment in the other species.

A summary of diagnostic characteristics of *Mexiweckelia* is provided in Table 1, which may be compared to a similar table published by Holsinger and Peck (1968) to facilitate a critical evaluation of the new genus relative to the other, known Caribbean genera (*Weckelia*, *Paraweckelia*, *Alloweckelia*, and *Metaniphargus* [= *Hadzia*]). *Mexiweckelia* appears more similar, morphologically, to the generic complex composed of *Weckelia*, *Paraweckelia*, and *Alloweckelia*, than to *Hadzia*. Similarities in ecology, and perhaps geographic proximity, also tend to indicate this relationship. *Weckelia*, *Paraweckelia*, and *Alloweckelia* occupy subterranean, freshwater habitats of the Greater Antillean islands of Cuba and Puerto Rico, with the nearest known occurrence approximately 1,900 kilometers (km) east of the presently known range of *Mexiweckelia*

(*Weckelia*, in Modesta Cave, Pinar del Río Province, Cuba). *Hadzia*, represented by two species in the Caribbean, is predominately found in brackish water, interstitial habitats of the Lesser Antilles. *Hadzia curasavicus* (Stephensen) from the Island of Curaçao is the species geographically nearest to *Mexiweckelia*, about 3,700 km east-southeast.

Crustaceans, molluscs, and fishes have been relatively well studied in the Cuatro Ciénegas region. Numbers of families, genera, and known species of these groups, with the approximate percentages of endemism of some categories given in parentheses, are respectively as follows: molluscs—7, 22(27), and 34(50); crustaceans—7, 8(50), and 10(60); and fishes—8, 13(0), and 18(50). "Criteria based on 'degrees of difference' in all the groups presently produce a mosaic of indicated differentiation. Multiple invasions of the area, with differing time regimes resulting in varied differentiation, are clearly indicated [Minckley, 1969]."

Mexiweckelia belongs to a component of the Cuatro Ciénegas biota which must date from considerable antiquity. Its relationships to the Caribbean are roughly paralleled by the cirolanids (Rioja, 1953; Bowman, 1964; Cole and Minckley, 1966, 1970), which enjoy a much wider distribution, however, along the margins of the Gulf Coastal Plain, just inland from areas of mid-Tertiary inundations by the sea (West, 1964). A number of the molluscs show similar affinities, particularly the hydrobiid tribe Cochliopini (Taylor, 1966), and the hydrobiid genus *Pyrogophorus*, which was only recently discovered in fossil deposits of eastern Coahuila (Taylor, unpublished). Cirolanid isopods, at least, are thought to have produced freshwater, cavernicolous populations from marine forms relicted by marine regressions (Bowman, 1964), and the same is true for some other groups. The Cuatro Ciénegas area has not been inundated by the sea since late Cretaceous, or earlier Tertiary (Minckley, 1969), although parts of Coahuila were certainly flooded by shallow seas until early Tertiary times (Weidie and Murray, 1967), so that a tremendous time span is available for formation and persistence of aquatic habitats in that region. "Protection" of the area by a deep-lying Paleozoic mass, called the "Coahuilan Peninsula" (Murray, 1961, and references cited), seemingly minimized the influence of regional orogenies, after the Laramide Revolution and Tertiary deformations were terminated.

Affinities of some of the Cuatro Ciénegas fauna to biotas of the peri-Mediterranean region, in addition to those obviously demonstrated by the *Hadzia* group of Gammaridae, must also be mentioned. This is seen in the occurrence of an undescribed asellid genus of the subfamily Stenasellinae (Minckley, 1969; Cole and Minckley, unpublished), which is otherwise known from Europe, Turkamenia, and tropical Africa (Birstein, 1964; Magniez, 1966a–b, Straskraba, 1967; and others). Similar affinities may also occur in the isopod genus *Asellus* of eastern North America (Racovitza, 1920), which now is known to range south to the Puebla Plateau of México (Cole and Minckley, 1968), in cirolanid isopods (Bowman, 1964, 1966), perhaps in some inland sphaeromatid isopods (Vandel, 1964; Cole and Minckley, unpublished), and quite obviously in the recent discovery of the Old World crustacean order Thermosbaenacea in southern Texas (Maguire, 1964, 1965). Parallelisms also exist in the tribe Horatiini of the molluscan family Hydrobiidae, again involving subterranean or groundwater-related forms (Taylor, 1966, and unpublished).

Mexiweckelia colei Holsinger and Minckley new species (Figs. 1–3)

Material examined: Distances are from the center of the village of Cuatro Ciénegas de Carranza, Coahuila, México (Fig. 4). Place names here and in text are from the gazetteer of localities published by Minckley (1969) whenever possible, and alternative names that are used locally are provided in parentheses when appropriate.

Holotype and 15 paratopotypes: unnamed spring-pool, 8.84 km south and 3.96 km west, *ca.* 150 meters (m) west of *bajada* (talus slope) from Sierra de San Marcos, 19 August 1968, G. A. Cole. Additional paratypes: Churince (Laguna Churince, Posos Bonitos), 14.73 km south and 7.05 km west, 12 August 1968, Cole, D. W. Taylor, and J. J. Landye; unnamed, small *laguna* (spring-fed pond), 7.92 km west and 9.42 km south, 19 August 1968, Cole, W. L. and R. K. Minckley; unnamed spring 8.15 km south and 2.29 km west, 15 August 1968, Cole, R. L. and R. K. Minckley; unnamed seep in raised marsh at north tip of Sierra de San Marcos, 7.45 km south and 5.50 km west, 10 August 1968, Cole, W. L., R. L., and R. K. Minckley; and, unnamed, small spring in raised marsh at north tip of Sierra de San Marcos, 7.45 km south and 5.42 km west, 12 August 1968, Cole. The holotype and paratopotypes are deposited at the Smithsonian Institution. Additional paratypes are to be placed in the National Museum of Canada, the Museo Civico de Storia Naturale, Verona, Italy, the Coleccíon de Mexico, México, D. F., and the collections of the authors.

Diagnosis: A tiny, interstitial species, distinguished by a vestigial accessory flagellum on the first antenna, and the expanded and finely-haired posterior margins of segments 4, 5, and 6 of the first gnathopod, and of segment 5 of the second gnathopod. Largest male, 3.5 millimeters (mm); largest female, 3.8 mm.

Description: Male. Antenna 1 about 50 percent length of body, about 45 percent longer than antenna 2; peduncular segments 1–3 progressively smaller, with few setae and no spines; primary flagellum with up to 17 segments; accessory flagellum tiny rudiment or vestige; slender calceoli on many primary flagellar segments. Antenna 2 with peduncular segment 4 slightly broader and longer than 5, with several marginal spines; flagellum with up to 8 segments. Mandibular palp totally absent, mandible otherwise well developed; seta present on right molar, absent on left; spine row with 2 or 3 long, plumose spines. Maxilla 1, left and right differing in structure of palp: right with palp

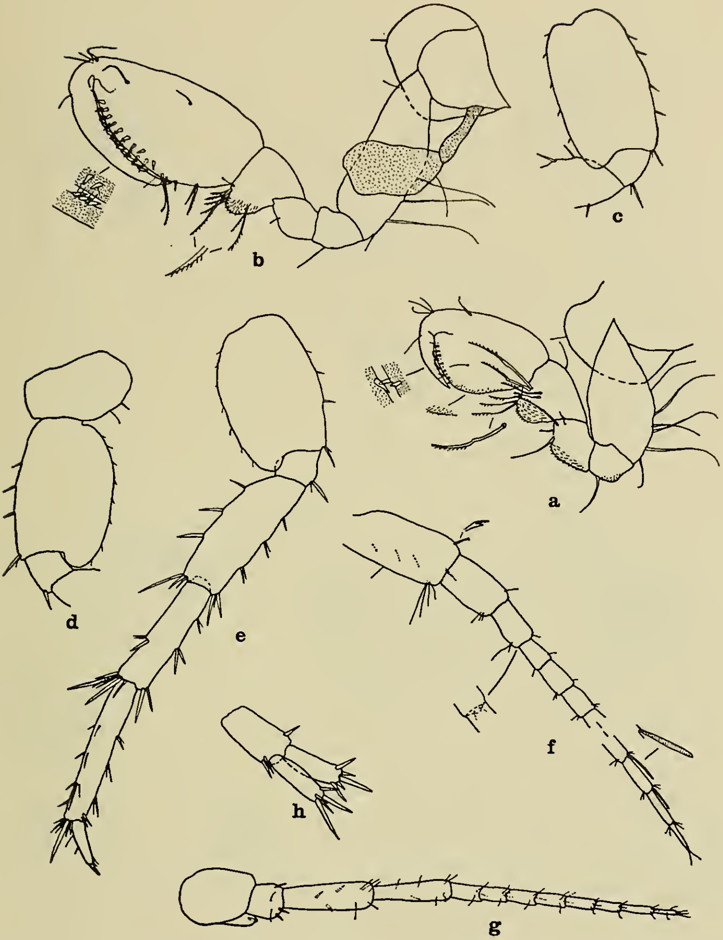

FIG. 1. *Mexiweckelia colei* new species. Male paratype (3.00 mm): a, b, gnathopod 1, 2; c, d, bases of pereopods 6, 7; e, pereopod 7; f, g, antennae 1, 2; h, uropod 2.

distally expanded and bearing 5 or 6 thick spines apically, outer plate with 7 unequal, serrated, apical spines, inner plate with 6 plumose setae on oblique, inner margin; left maxilla with palp scarcely expanded distally and bearing 4 coarse, apical setae. Maxilla 2 with inner plate longer than broad, with oblique row of 10 long setae on inner margin, and 10 or more long, distal setae. Maxilliped with palpal segment 2 longest, about twice as

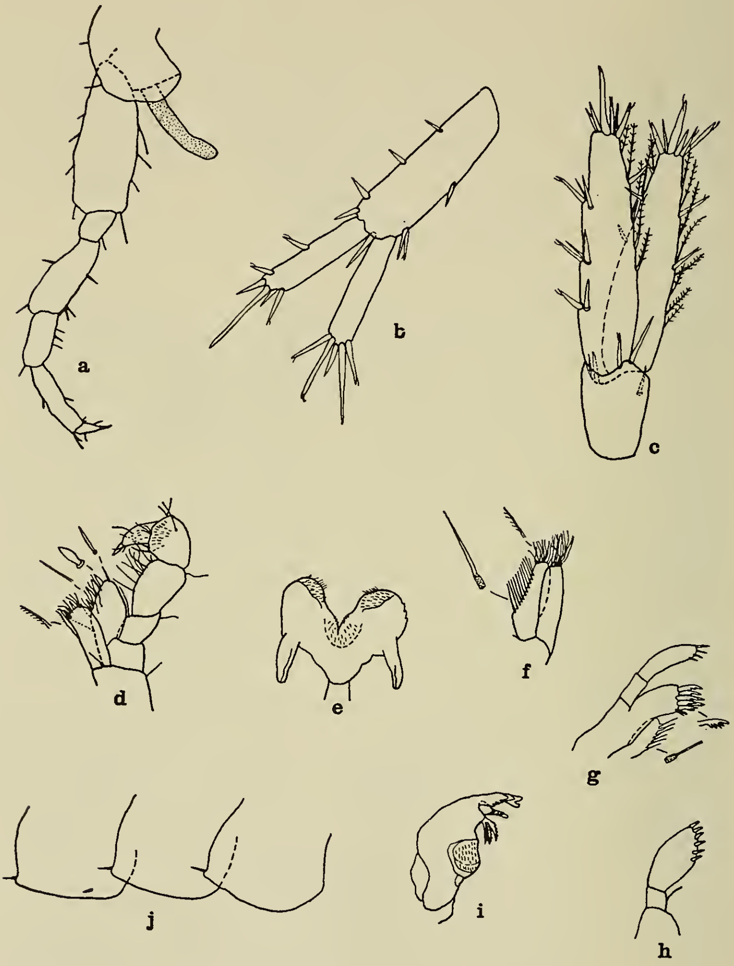

FIG. 2. *Mexiweckelia colei* new species. Female paratype (3.00 mm): a, pereopod 4; b, uropod 1; c, uropod 3. Male paratype (3.00 mm): d, maxilliped; e, lower lip; f, maxilla 2; g, left maxilla 1; h, palp of right maxilla 1; i, left mandible; j, abdominal sideplates.

long as first segment; outer plate expanded medially, extending beyond first segment of palp, bearing 3 or 4 thick, blunt-tipped spines, and several, sub-apical setae; inner plate subrectangular, with 3 or 4 thick spines and several thick setae apically, and 2 long, plumose setae

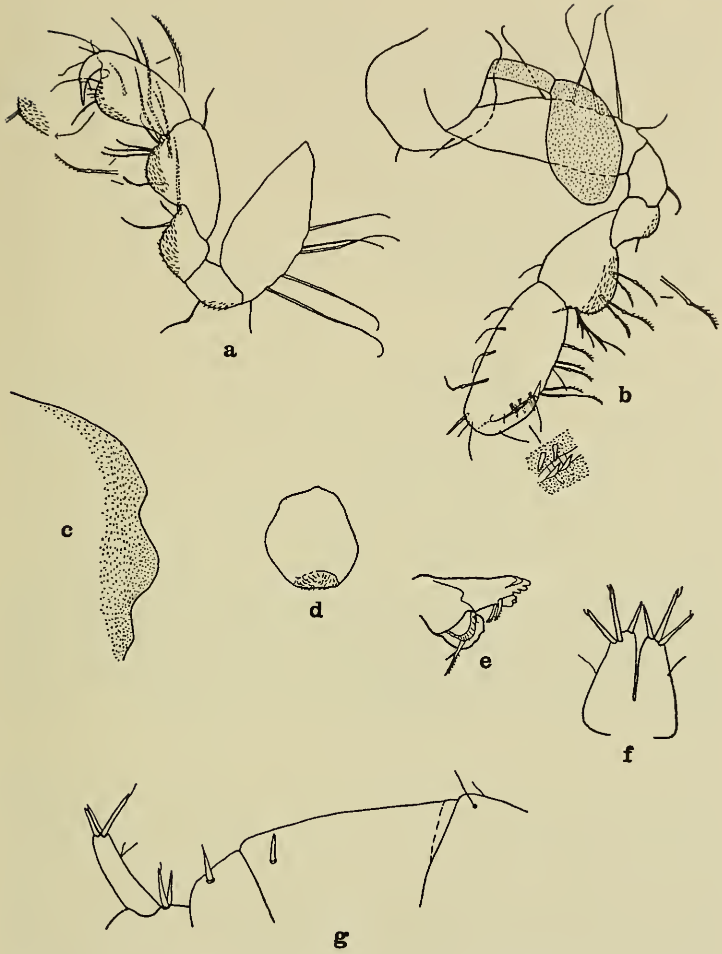

FIG. 3. *Mexiweckelia colei* new species. Female paratype (3.00 mm): a, b, gnathopods 1, 2; c, anterior margin of head; d, upper lip; e, right mandible; f, telson; g, upper urosomal region.

on inner margin. Lower lip with outer lobes narrowing apically to long, narrow, lateral processes; inner lobes indistinct, vestigial.

Gnathopod 1 with propod rather broad, palmar margin slightly convex, armed with double row of unnotched, or unevenly notched, spine teeth; posterior angle indistinct, rounded and unarmed; posterior margin long, convex, covered with very short, hairlike setae; lateral setae few in

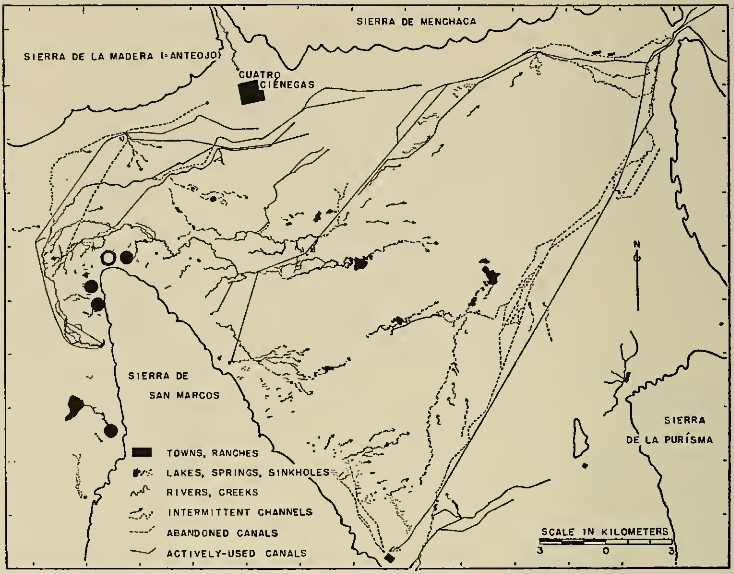

FIG. 4. Drainage map of the Bolsón of Cuatro Ciénegas (from Minckley, 1969, p. 50) showing the distribution of *Mexiweckelia.* Solid circles show localities for *M. colei* (some circles cover two localities) and the open circle shows sympatric locality for *M. colei* and *M. particeps.* The solid circle farthest east marks the type locality for *M. colei.*

number; dactyl with several bladelike spines on inner margin; dactyl nail moderately long. Combined lengths of segments 4 and 5 of first gnathopod equal to length of propod; posterior margins of segments 4 and 5 (especially 5) swollen and covered with numerous, short, hairlike setae. Coxal plate of gnathopod 1 subquadrate, with 1 marginal seta. Propod of gnathopod 2 proportionately larger than first, palmar margin rather long, nearly straight, armed with double row of 8, unnotched, peglike spine teeth; posterior angle with 2 long setae and 1 small spine; posterior margin with 1 set of 2 setae, 2 or 3 singly-inserted, superolateral setae, and lacking inferolateral setae; dactyl with inner row of bladelike spines, nail short. Posterior margin of segment 5 of second gnathopod swollen and covered with fine, hairlike setae. Coxal plate of gnathopod 2 small, subquadrate, with 2 marginal setae. Pereopod 7 about 55 percent long as body, slightly longer than pereopod 6, and longer than pereopod 5. Bases of pereopods 5, 6, and 7, 30 to 40 percent as long as corresponding propods. Coxal gills present on segments 2 through 6, absent on segment 7; pedicels rather narrow. Sternal processes absent.

Abdominal sideplates generally similar; posterior margins only slightly convex, posterior corners defined by 1 seta each; plate 3 with 1 small spine or stiff seta near ventral margin. Pleopods 1 and 2 subequal in length, 3 shorter; inner rami slightly longer than outer; peduncles with 3 coupling hooks each, on inner, distoposterior margins. Uronites 1 and 2 with 2 dorsolateral spines each; uronite 3 with 4 dorsolateral spines, in groups of 2. Uropod 1 with inner and outer rami about equal in length, with 5 or 6 spines each; peduncle a bit longer than rami, with 9 or 10 spines. Uropod 2 with inner ramus slightly longer than outer, but about equal in length to peduncle, armed with 5 spines; outer ramus with 5 spines; peduncle with 3 spines. Uropod 3 rather prominent, about 15 percent long as body; outer ramus 1-segmented, slightly longer than inner and bearing more spines. Telson cleft two-thirds way to base; apical lobes with 3 spines each.

Female. Propod of gnathopod 1 proportionately smaller than in male, subrectangular; palmar margin short and bearing several tiny spines and 3 or 4 setae; posterior angle rounded, indistinct; posterior margin elongate, expanded distally, covered on inner margin with short, hairlike setae; lateral setae few in number, rather long; dactyl short, thick, with rather large nail. Segment 5 of first gnathopod slightly longer and broader than corresponding propod. Gnathopod 2 with propod proportionately smaller than second gnathopodal propod of male, rather long, subrectangular; palmar margin with double row of 3, unnotched, peglike spine teeth; posterior angle defined by 2 long setae; posterior margin long, gently tapering proximally, with 2 marginal sets of long setae; superolateral setae few, inferolateral setae absent; dactyl nail rather long. Segment 5 of second gnathopod with broadly expanded posterior margin covered with short, hairlike setae. Second coxal plate subovate, rather small, with 2 marginal setae. Brood plates small and narrow.

Remarks: Of the collections available, only the one from the type locality includes females with completely developed brood plates (*i.e.*, fringed with setae). One female (3.0 mm) from that sample was ovigerous, containing two large eggs in the pouch. Another egg was floating free in the sample container, and may also have belonged to this female.

Etymology: It is a pleasure to name this novel species in honor of its original collector, Dr. Gerald A. Cole of the Department of Zoology, Arizona State University, in recognition of his substantial contributions to our knowledge of freshwater crustaceans of North America.

Mexiweckelia particeps Holsinger new species
(Figs. 5–6)

Material examined: Holotype and five paratopotypes: unnamed, small spring in raised marsh at north tip of Sierra de San Marcos, 7.45 km south and 5.42 km west (Fig. 4), 12 August 1968, G. A. Cole. The holotype and three paratopotypes are deposited in the Smithsonian Insti-

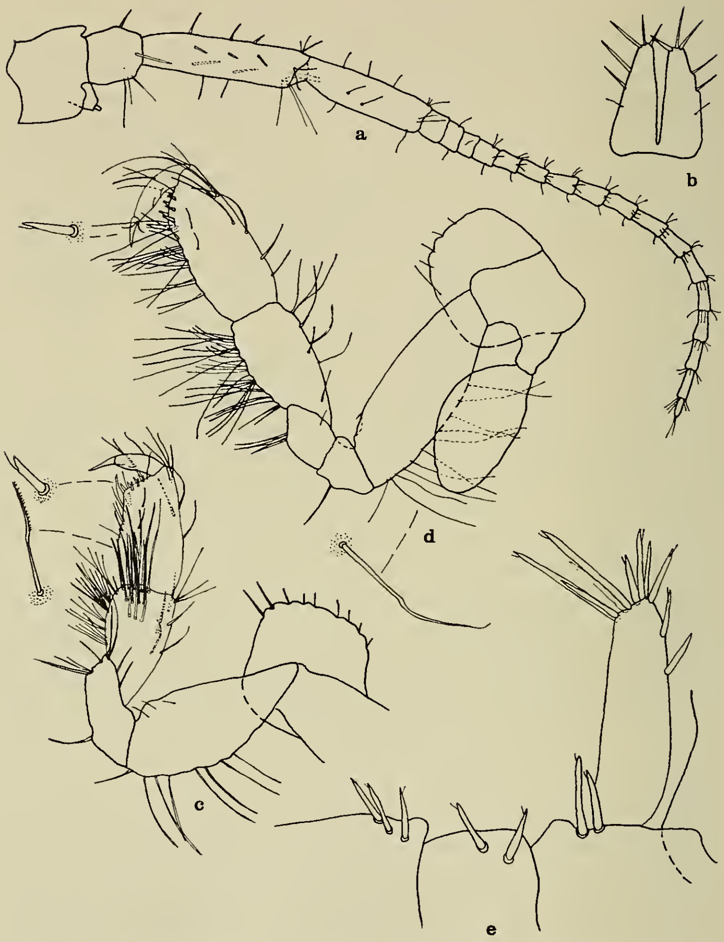

FIG. 5. *Mexiweckelia particeps* new species. Male paratype (5.50 mm): a, antenna 2; b, telson. Female paratype (5.00 mm): c, d, gnathopod 1 and 2; e, lateral view of uronites and telson.

tution, and slide mounts of two paratopotypes are retained in the collection of Holsinger.

Diagnosis: A small, interstitial species, readily distinguished from *Mexiweckelia colei* by its larger size; proportionately longer antennae; distinct, 1-segmented accessory flagellae on the first antennae; slightly more spines and setae on mouth parts; more slender fifth and sixth segments of gnathopods; more dorsolateral spines on uronites; more setae

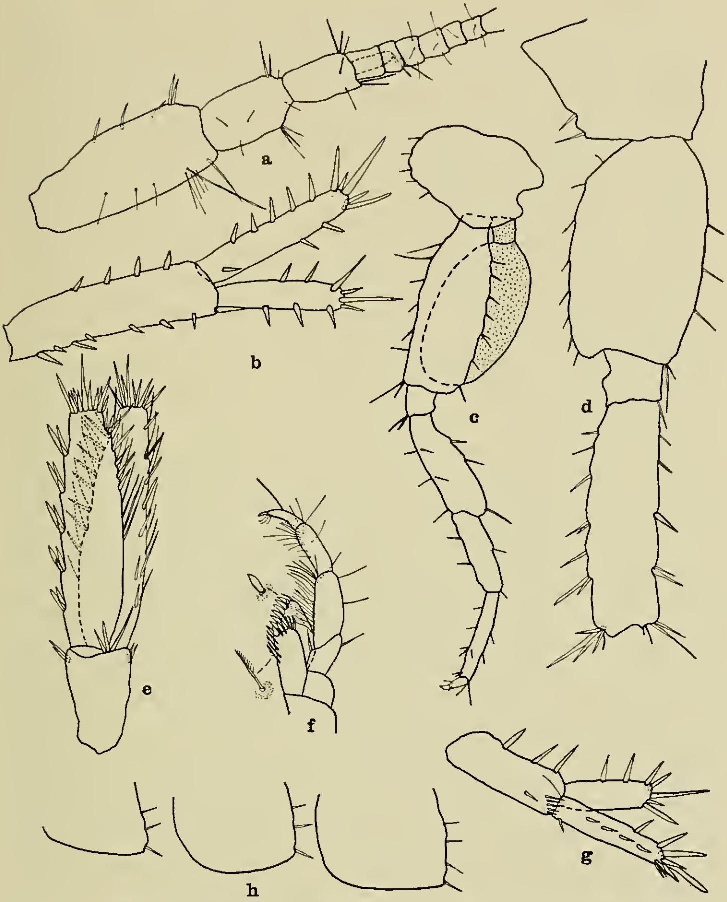

FIG. 6. *Mexiweckelia particeps* new species. Male paratype (5.50 mm): a, antenna 1; b, uropod 1; c, pereopod 4; d, upper part of pereopod 7. Female paratype (5.00 mm): e, uropod 3; f, maxilliped; g, uropod 2; h, abdominal sideplates.

on posterior margins of abdominal sideplates; proportionately longer third uropods; lateral spines on telson, and more deeply cleft telson. Largest male, 5.5 mm; largest female 5.0 mm.

Description: Male. Antenna 1 about 80 percent long as body, 15 to 20 percent longer than antenna 2; peduncular segments 1–3 progressively smaller, with few marginal spines and setae; primary flagellum with up to 40 segments; accessory flagellum 1-segmented; slender calceoli on some primary flagellar segments. Antenna 2 with peduncular segment 4 slightly broader and longer than segment 5, with several marginal spines; flagellum with up to 17 segments. Mandibular palp absent; mandible otherwise well-developed; seta present on right molar, absent from left; spine row with 3 or 4 setose spines on right mandible, 5 or 6 setose spines on left. Maxilla 1 generally similar to that of *Mexiweckelia colei*, with regard to difference in apex of palp, but with 9 apical, serrated spines on outer plate and 7 plumose setae on margin of inner plate. Maxilla 2 with inner plate bearing oblique row of 11 long setae on inner margin. Maxilliped with palpal segments rather slender, segment 2 the longest; outer plate expanded medially, extending beyond first segment of palp and bearing 6 or 7 blunt-tipped spines sub-apically; inner plate subrectangular, with 3 or 4 thick spines and several thick setae apically, and 4 long, plumose setae on inner margin. Lower lip similar to that of *M. colei.*

Gnathopod 1 with subrectangular propod, slightly broader proximally than distally, palmar margin rather short, armed with double row of 5 peglike spine teeth; posterior angle well defined with single, large spine; posterior margin long, uneven, with single spine and several long setae; lateral setae few in number; dactyl nail long. Segment 5 of gnathopod 1 rather long, long as propod, inner margin with 3 sets long, thick setae, distally. Coxal plate of gnathopod 1 subrectangular, with 9 or 10 marginal setae. Gnathopod 2 with propod proportionately larger than first, rather narrow, subrectangular; palmar margin oblique, armed with double row of 6 or 7 unnotched, or unevenly (but not distally) notched, spine teeth; posterior angle defined by 3 peglike spine teeth and several long setae; posterior margin comparatively long, with 2 sets of long setae; lateral setae few in number, singly-inserted; dactyl nail rather long. Second coxal plate with 5 or 6 marginal setae. Pereopod 7 between 60 and 65 percent long as body, equal to, or slightly longer than, pereopod 6, longer than pereopod 5. Structure of pereopods generally similar to those of *M. colei*, except for presence of few more spines. Coxal gills present on segments 2 through 6, absent from 7; pedicels shorter and broader than in *M. colei.* Sternal process absent.

Abdominal sideplates 1 and 2 with stiff, posteromarginal setae, and plate 3 with 4 such setae; ventral margins without spines or stiff setae. Pleopods generally similar to those of *M. colei*, except that peduncles have 4 or 5 coupling hooks. Uronite 1 with 6 dorsolateral spines (in groups of 3); uronites 2 and 3 with 4 dorsolateral spines each (in pairs). Uropod 1 with outer ramus shorter than inner and peduncle, armed with 9 spines; inner ramus shorter than peduncle, armed with 12 to 13 spines; peduncle with 12 spines. Uropod 2 with outer ramus a little longer than inner and peduncle, armed with 11 spines; inner ramus with 7 spines; peduncle with 3 to 5 rather large spines on dorsal margin and 6 to 8 smaller ones in cluster on distal, outer margin. Uropod 3 prominent, 18 to 20 percent long as body; inner ramus often slightly longer than outer, with an inner and outer marginal row of setae singly-inserted setae and spines; outer ramus with clusters of spines on lateral margin and a row of singly-inserted spines and setae on inner margin; both rami armed apically with numerous slender spines. Telson cleft nearly to base; apical lobes with 3 spines each, outer margins with 2 lateral spines each.

Females. Gnathopod 1 has propod palmar margin slightly shorter than male, armed with double row of 3, peglike spine teeth; posterior margin lacking spine. Propod palmar margin of gnathopod 2 slightly shorter than in male, armed with double row of 3 spine teeth; posterior angle defined by 1 spine; posterior margin with 3 or 4 sets of setae.

Remarks: Although the two largest females (5.0 mm each) in the sample appear well-developed, they are not ovigerous, and had small, non-setose, brood plates. This species is presently known from only the type locality, where the series of six specimens (1 male and 5 females) was collected along with three specimens of *Mexiweckelia colei.*

Etymology: The name, "*particeps*," is Latin, meaning comrade, partner, or sharer. The species is so named because of its syntopic association with *Mexiweckelia colei.*

Ecological considerations: All habitats from which *Mexiweckelia* has been collected are positioned near the lower *bajada* of Sierra de San Marcos (Fig. 4), in a zone of thermal springs which are markedly constant in physical and chemical conditions. For example, temperatures at the points of collection of the amphipods ranged from 30° to 33°, all had a *p*H of 7.2, and total alkalinities (expressed as calcium carbonate) were from 190 to 220 milligrams per liter (mg/l). The principal ions in such waters of the Cuatro Ciénegas basin are calcium and sulfate, each making up more than 50 percent of their respective groups (cations and anions) by weight. Other cations are arranged as follows: magnesium > sodium > potassium, and anions; carbonates > chlorides. Total dissolved solids in the spring sources usually range between 2.1 and 2.4 grams per liter. There is no residual acidity, and the water quickly attains *p*H 8.3 when aerated. Only one determination of dissolved oxygen concentration was made directly in a *Mexiweckelia* habitat, and this was about 3.3 mg/l. Other spring sources had comparable concentrations, ranging from 1.7 to 4.1 mg/l, often less than 50 percent of saturation. Turbidities are not detectable except when local rainfalls, which are infrequent, move surface waters into the springs, and this is only transitory (Minckley and Cole, 1968a, and unpublished data). Flow of water in places where *Mexiweckelia* was taken ranged from mere seepages of a few liters per minute, to about 12 cubic meters per minute at the outlet of Laguna Churince.

Almost all specimens of *Mexiweckelia* were taken in association with, or within, dark, soft, fine-grained or fibrous, detrital sediments, notwithstanding the size or morphometry of the overall habitat involved. In two instances, small seeps had water upwelling through such materials. The bottom was carefully stirred and seived to collect the animals, or was vigorously stirred, causing the amphipods to become trapped in the surface film, and they were secured by hand, with forceps, or by fine-meshed seives. Two other habitats were the outlets of small springs, which emerged from tiny (10- to 30-centimeter) caves. The animals were far rarer there, but a few were taken from detrital sediments accumulated in and around roots of riparian plants. A third habitat was in a senescent, almost vegetation-filled pit-spring, or *pozo* (hole or pit) in local terms, about 2.5 m across and of unknown depth, where *Mexiweckelia colei* was abundant in soft, fibrous detritus accumulated beneath a floating sedge mat. All the preceding habitats lacked fishes, or other larger predatory animals (except a few naucorid hemipterans). *Mexiweckelia colei* was not uncommon, however, in organic sediments about the roots of aquatic and semiaquatic plants and along the shorelines, in two larger spring-pools (*laqunas*) that were abundantly occupied by a number of fish species. *Mexiweckelia particeps* was caught in one of the smaller seepage-springs described first. It was not recognized as distinct in the field, and details of habitat differences between the two sympatric amphipods, if such exist, are therefore unknown.

The small sizes, and transparency in life, of the species of *Mexiweckelia* (and some other subterranean crustaceans) make them especially difficult to collect, and their extreme fragility necessitates careful handling and preservation. Cole achieved considerable success in trapping less mobile crustaceans (principally cirolanid isopods) in jars buried with their mouths flush with the surface of bottom sediments in the mouths of springs, and also by placing "wads" of gauze in the spring sources. The last technique attracted some amphipods, many *Hyalella* and a few *Mexiweckelia*, and isopods, and should be tested further by using synthetic fibers that could be placed in springs for days or weeks, then re-checked periodically. The artificial substrate may be gently examined manually in the field, simply preserved *in toto* and returned to the laboratory, or the animals may be driven from it by judicious application of ethanol or some other substance in sublethal amounts, and then preserved.

Associates: The abundance of the ubiquitous *Hyalella* in many springs of the Cuatro Ciénegas basin also confuses the issue of collecting *Mexiweckelia*. This results from the physical presence of large numbers of animals, and also from some of the *Hyalella* being depigmented. Color variation of this amphipod is impressive, ranging from almost totally white, through the more typical grayish-tan or bluish, to almost golden. All the *Hyalella* have well-developed eyes, but depigmented individuals are closely linked to springs, interstices of travertines, detrital bottoms, or other quasi-subterranean habitats of the Cuatro Ciénegas area. The amphipod achieves its greatest abundance in closely-spaced vegetation of open waters of the basin. Another common crustacean of the head-springs, in or on detrital sediments, is the ostracod *Chlamydotheca*.

All four of the eyeless, locally endemic, isopod crustaceans known from the Cuatro Ciénegas basin (Minckley, 1969) have been taken in close association with *Mexiweckelia.* The cirolanid species *Speocirolana thermydronis* Cole and Minckley (1966) is a relatively large, active form, widespread in open channels of springs and in the more loosely constituted travertines and detrital deposits (Minckley and Cole, 1968b). Two other cirolanids, *Sphaerolana interstitialis* Cole and Minckley and *S. affinis* Cole and Minckley (1970), are perhaps more characteristic of the *Mexiweckelia* habitat, often living in identical, fibrous, detrital sediments along the margins of spring runs and in the springs themselves. The fourth isopod is the new, undescribed genus of the asellid subfamily Stenasellinae, which is rare in collections. Three of the nine known specimens of this species occurred along with *Mexiweckelia* (Cole and Minckley, unpublished data).

The molluscan fauna includes a number of species which are closely associated with groundwater habitats, or are essentially subterranean (Taylor, 1966, and unpublished). Forms notably associated with the new amphipods include undescribed species of *Durangonella* and *Hauffenia,* and *Paludiscala caramba* Taylor, all of the family Hydrobiidae.

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PROCEEDINGS
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NEW SPECIES OF GORYTINI FROM WESTERN NORTH AMERICA (HYMENOPTERA: SPHECIDAE)

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Descriptions of several new species in three related genera are needed to facilitate a revisional study now in progress. Holotypes are deposited in the Entomology Museum of the University of California at Davis. Paratypes will be distributed as far as possible to the University of California, California Insect Survey, Berkeley; California Academy of Sciences; National Museum of Natural History; and Academy of Natural Sciences at Philadelphia.

Arigorytes coachellae Bohart new species

Male holotype: Length 6.5 mm. Black marked with ivory and red. Ivory are: mandible mostly, two spots on clypeus (one large one in many paratypes), spot on scape, flagellum broadly in front, pronotal ridge and lobe, median scutellar spot, outer apical spots on midfemora and hindfemora, outer stripes on all tibiae, first and last articles of foretarsus, most of basal three articles of midtarsus, undulate apical bands on first five tergites; red are: distal one-half of hindfemur, tinges along tergal bands; wings lightly smoky. Pubescence silvery, conspicuous on clypeus and frons, rather inconspicuous elsewhere except for dense fulvous hair mats covering sternites III to V. Punctation fine, mostly close, punctures of mesopleuron nearly contiguous, those of propodeum laterally 2 to 4 puncture diameters apart. Least interocular distance about 1.8 times median clypeal length; flagellomere I about 1.5 times as long as broad, equal in length to II and III in front view, propodeal enclosure rather coarsely and obliquely striate, median groove distinct, rest of propodeum without obvious striae; front basitarsus a little more than twice as long as broad, without pecten spines before apex; hindtarsus appearing inflated, all articles much more robust than those of midtarsus; sternaulus complete; sternite VII shiny with scattered macropunctures.

Female: About as in male. Length 5.5 to 7.0 mm, clypeus varying from mostly white to all black, flagellomere I from 1.7 to 1.9 times as long as broad, least interocular distance about 1.3 times as great as median clypeal length, pecten well developed on foretarsus, hind basitarsus stouter than mid basitarsus but less markedly so than in male.

Material: Holotype male (UCD), Borrego Valley, San Diego Co., CALIFORNIA, 26 March 1959 (R. M. Bohart). Paratypes, 23 male and 9 female topotypes. Other paratypes, from CALIFORNIA, 36 males, 24 females, Mono Co.: Paradise Camp; Inyo Co.: Surprise Canyon, Towns Pass, Westgard Pass, Big Pine, Lone Pine, Brown; San Benito Co.: Pinnacles; San Bernardino Co.: Apple Valley, Morongo Valley, Llano, Kramer Hills, Phelan; Ventura Co.: Hungry Valley near Gorman; San Luis Obispo Co.: Simmler; Kern Co.: near Inyokern, 18 mi. w. Bakersfield; Riverside Co.: near Whitewater, Palm Springs, Thousand Palms Canyon, Lost Palm Canyon, Joshua Tree National Monument, near Blythe, San Jacinto Mts.; San Diego Co.: near Buckman Springs. Not types, 5 females, Wendover, NEVADA (G. Bohart); Florence Junction, Pinal Co., ARIZONA (T. Haig); Delta, COLORADO (U. Lanham); Sierra San Pedro Martir, Baja California, MEXICO (J. Powell).

The present species differs as indicated in the key.

Arigorytes ruficrus Bohart new species

Male holotype: Length 6.5 mm. Black marked with ivory, hindleg extensively red. Ivory are: spot on mandible base, clypeus except free rim and transverse basal spot, scape partly, pronotal ridge narrowly, pronotal lobe, median scutellar spot, outer apical spot on forefemur, foretibia, midtibia and tarsi in front, narrow apical bands (enlarged laterally) on tergites I to VI; reddish are: flagellum in front, distal three-fourths of hindfemur, practically all of hindtibia; wings lightly smoky. Pubescence pale and inconspicuous except for dense fulvous hair mats covering sternites III to V. Punctation fine, mostly close, punctures of mesopleuron mostly separated by a puncture's diameter, those of propodeum laterally by 5 or 6 diameters. Least interocular distance slightly more than twice median clypeal length; flagellomere I about 1.5 times as long as broad, equal in length to II or III in most views; propodeal enclosure finely and longitudinally striatopunctate, median groove linear, rest of propodeum without obvious striae; front basitarsus about 3.0 times as long as broad, with three pecten spines before apex, some of spines longer than breadth of basitarsus; hindtarsus appearing inflated, all articles much more robust than those of midtarsus; sternaulus absent; sternite VII micropunctate and with a few scattered macropunctures.

Female: About as in male. Length 7.5 mm, clypeus all black, flagellum ivory to pale fulvous in front, mandible and tergite VI all dark. Flagellomere I about 1.7 times as long as broad; least interocular distance a little greater than median length of clypeus; hind basitarsus stouter than mid basitarsus, but less markedly so than in male.

Material: Holotype male (UCD), Sagehen Creek, near Hobart Mills, Nevada Co., *California*, 1 July 1964, (M. E. Irwin). Paratypes, 5 male and 4 female topotypes (M. Irwin, R. Bohart). Other paratypes, 1 male and 6 females from CALIFORNIA: Donner Pass, Nevada Co. (J. Powell); Yuba Pass, Sierra Co. (M. Irwin); Sattley (R. Bohart); near Clio (J. E. Slansky); Independence Lake, Sierra Co. (R. Bohart); Carnelian Bay, Lake Tahoe, Placer Co. (R. Bohart). Type series collected from 23 June to 11 July, all at elevations of 5,000 to 7,000 feet in the central Sierra.

The differentiating characteristics of *ruficrus* are indicated in the following key.

Key to the species of *Arigorytes* Rohwer

1. Male front basitarsus less than twice as long as broad, usually white in front with black spot on outer apical angle; female flagellomere I less than 1.5 times as long as broad; male hindtarsus much stouter than midtarsus 2
   Male front basitarsus more than 2.0 times as long as broad, usually all pale or all dark in front; female flagellomere I at least 1.5 times as long as broad 3
2. Mesopleural pubescence fine, inconspicuous, somewhat fulvous, abdominal and leg markings essentially black and yellow or whitish, hindfemur all black or practically so (Pacific Coast) .... *insolitus* (W. Fox)
   Mesopleural pubescence coarse, silvery; abdominal and leg markings usually extensively red (California) .... *coquilletti* (W. Fox)
3. Male hindtarsus not much stouter than midtarsus; female with least interocular distance less than twice median clypeal length, and female abdomen not marked with red dorsally; propodeum coarsely striate laterally (Pacific states and Idaho) .... *smohalla* Pate
   Male hindtarsus much stouter than midtarsus; female least interocular distance more than twice median clypeal length, or female abdomen with at least some red dorsally 4
4. Male front basitarsus with 2 or 3 long bristles before apex; female least interocular distance more than twice median clypeal length; hindtibia usually without yellow or whitish; sternaulus in female practically absent (central Sierra of California) .... *ruficrus* R. Bohart
   Male front basitarsus without obvious bristles before apex; female least interocular distance less than twice median clypeal length; hindtibia usually whitish posteriorly; sternaulus complete (California, Utah, Arizona, Baja California) .... *coachellae* R. Bohart

Gorytes limbellus Bohart new species

Male holotype: Length 9.5 mm. Black marked with yellow as follows: mandible mostly, labrum, clypeus, lower frons, scape mostly, pronotal ridge, spot on lobe, two mesopleural spots, band across scutellum, large spots on propodeal cheeks, legs extensively but on brown hindtarsus only an inferior stripe on basal article, posterior bands on tergites I–VI and sternites II–V, tergal bands with anterior edge irregularly incurved on I–II, more squarely and broadly emarginate in III–VI; wings lightly stained, stigma yellow, marginal cell light brown. Pubescence silvery to off-silvery, inconspicuous, longer hairs of propodeum about 1.5 times as long as diameter of midocellus. Punctation mostly fine, weak, macropunctures small and well separated, imparting a feebly granulate appearance to clypeus, frons, and propodeal cheeks. Flagellum with cariniform tyloides beneath from apex of article I to base of article X; least interocular distance about equal to eye breadth, clypeus nearly twice as broad as long, subantennal sclerite as broad as high; metapleural suture pitted above; propodeal enclosure completely, coarsely, longitudinally carinulate.

Female: About as in male. Length 11 mm. Pedicel yellow in front, clypeus with black apical rim, metanotum yellow banded, hindtarsus mostly yellow, pygidium yellow except at tip. Clypeus 2.5 times as broad as long, flagellomere VIII about 1.7 times as broad as I, flagellomere VI nearly as broad as median length; pygidium sparsely striatopunctate, sides angled at about 45 degrees.

Material: Holotype male (UCD), Samuel Springs (now Lake Berryessa), Napa Co., CALIFORNIA, 9 May 1955 (R. M. Bohart). Paratypes (all from CALIFORNIA), 25 males, 11 females (two females carrying nymphal cicadellids), Mendocino Co.: Calpella; Lake Co.: Lakeport, Lower Lake, Blue Lakes, Cache Creek, Hopland Grade; Sierra Co.: Sardine Lakes; Nevada Co.: Boca; Placer Co.: Dutch Flat; Napa Co.: Samuel Springs; Contra Costa Co.: Mt. Diablo; Alameda Co.: Tesla; Mariposa Co.: Briceburg; Tulare Co.: Sequoia National Park, Kaweah; Ventura Co.: near Gorman, Quatal Canyon; Riverside Co.: Riverside, The Gavilan. Paratype dates range from April to June in the lowlands, June through July in the Sierra.

Paratypes vary slightly in extent of yellow markings. Some specimens have the anterior yellow margins of the tergites more V-shaped on tergites I–II and more roundly emarginate on III and following. A few specimens show weak reticulation on the propodeum.

G. limbellus seems closest to *G. flagellatus* which also has male flagellomeres I–X with carinate tyloides. *G. limbellus* differs by the yellow-marked mandibles and much less coarsely sculptured propodeum. In the female the clubbed antennae, slightly narrower pygidium and dark hindtarsi are distinguishing, also. In the male the subantennal sclerite is higher (longer).

Gorytes flagellatus Bohart new species

Male holotype: Length 10 mm. Black marked with yellow as follows: labrum, clypeus except apical band, scape in front, pronotal ridge, spot on lobe, an upper mesopleural spot, band across scutellum, spots high on propodeal cheeks, legs extensively but only an inferior basal stripe on dark brown hindtarsus, posterior irregular bands on tergites I–VI and sternites II–IV, tergal bands irregular anteriorly, V-notched on I; wings lightly stained, stigma orange-yellow, marginal cell brown. Pubescence pale to fulvous; longest on frons, propodeum and interocellar area where it may reach 2.0 times as long as diameter of midocellus. Punctation mostly fine, macropunctures small and sparse, clypeus and frons granulate. Flagellum with cariniform tyloides beneath from apex of article I to base of X; least interocular distance about equal to eye breadth, clypeus about 1.8 times as broad as long, subantennal sclerite 1.4 times broader than high; metapleural suture pitted above; propodeal enclosure with complete, coarse, slightly irregular, longitudinal striae; rest of propodeum coarsely reticulate.

Female: About as in male. Length 11 mm. Clypeus entirely black, flagellomeres I–V or VI reddish within, tarsi mostly dark, pygidium from half to all black. Clypeus 2.6 times as broad as long, subantennal sclerite nearly twice as broad as high, flagellum nearly cylindrical, article VIII as broad as I, article VI twice as long as broad, pygidium with irregular but mostly well separated punctures, sides angled at about 40 degrees.

Material: Holotype male (UCD), Sagehen, Nevada Co., CALIFORNIA, 26 August 1952 (R. F. Smith). Paratypes, 14 males, 6 females, Sagehen, CALIFORNIA; Moran and Snake River near Elk, WYOMING; Moscow Mt., IDAHO; Lamoille Canyon near Elko, NEVADA; Bly Mt., Klamath Co., OREGON.

The black mandibles and coarsely sculptured propodeum differentiate this species from *limbellus*. Other features are the all black clypeus and cylindrical flagellum in the female as well as the low subantennal sclerite in the male. The presence of tyloides on flagellomeres I–X of the male distinguish the species from all others in North America except *limbellus*.

Gorytes prosopis Bohart new species

Female holotype: Length 11 mm. Black marked with yellow as follows: mandible basally, labrum medially, clypeus with 2 small discal spots and basolateral curved spots, lower orbital stripes and subantennal dot, antenna within to base of last article, pronotal ridge, anterolateral scutal spot, 2 mesopleural spots, scutellum mostly, large spots on propodeal cheeks, legs extensively (hindtarsus mostly brown), posterior bands on tergites I–V and sternite II, lateral spots on sternites III–V; wings lightly brown stained, stigma orange, marginal cell brown. Pubescence pale to fulvous, inconspicuous, longer hairs of propodeum about equal to diameter of midocellus. Punctation mostly fine but rather coarse and uneven on clypeus; propodeal cheeks granulate and a little microstriate, frons finely granulate. Clypeus appearing swollen, nearly 3 times as broad as long; least interocular distance twice clypeal length and 1.5

times eye breadth; subantennal sclerite 1.7 times as broad as long; metapleural suture pitted above; propodeal enclosure completely, longitudinally striate; flagellum slender, gradually enlarged toward article VIII which is 1.5 times as long as broad in lateral view and 1.5 times as broad as article I, last-named article fully 4 times as long as broad; pygidium striatopunctate with intervening areas microsculptured, sides angled at 45 degrees.

Material: Holotype female (UCD), Samuel Springs (now Lake Berryessa), Napa Co., CALIFORNIA, 13 May 1956 (R. M. Bohart). Paratypes, 8 females from CALIFORNIA: Lake Co.: Cache Creek; Mono Co.: June Lake; Nevada Co.: Sagehen Creek; Santa Clara Co.: San Antonio Valley; Santa Cruz Co.: near Soquel; Los Angeles Co.: Tanbark Flat; San Bernardino Co.: Lake Arrowhead; Riverside Co.: Tahquitz Canyon; 1 female from Oregon: Lake Co.: Drake Peak.

Paratypes vary in facial markings but all have 5 to 8 yellow spots or stripes on the clypeus and frons. Most of them have 2 small spots on the clypeus and a narrow basal cross stripe. All have the pygidium black and the Oregon specimen has tergite V black as well. Most characteristic is the slender antenna, gradually and slightly clubbed, and lemon yellow in front to the base of the terminal article. The swollen appearance of the clypeus, broad frons at its narrowest point, black pronotal lobe, moderately roughened propodeum except for the completely striate enclosure, and the striatopunctate pygidium with considerable microsculpture are distinguishing features, also.

Gorytes umatillae Bohart new name

Gorytes vicinus Handlirsch, 1893, preoccupied by Lepeletier, 1832.

This species, of which I have seen the holotype female, has whitish markings and moderately roughened propodeum. The male resembles *albosignatus* W. Fox except for the less sculptured propodeum. The female is similar to *atrifrons* W. Fox but has pygidial punctures well spaced apically. I have seen specimens from Washington, Wyoming and Colorado.

Gorytes cochisensis Bohart new species

Female holotype: Length 10 mm. Black marked with yellow as follows: mandible basally, clypeus, subantennal sclerite and lower orbits, antenna in front but turning pale reddish on flagellum, pronotal ridge and lobe, upper mesopleural spot, lateral scutal dot, band across scutellum, small spots high on propodeal cheeks and a small dot on each side below, legs extensively but edged with reddish, transverse apical bands on tergites I–V and sternites II–III, those on tergites I–II broadly V-shaped anteriorly; wings lightly yellowed except for brown marginal cell and light orange stigma. Pubescence mostly very short, inconspicuous, pale to fulvous (on scutum), longer hair of propodeum about 0.5 midocellus diameters. Punctures moderate to large; sparse on scutum, pleuron, propodeum; mostly separated by a puncture diameter on clypeus, frons, across middle of tergites, on sternites; dense toward apices of tergites II–IV. Clypeus moderately convex, fully half as long as broad; least interocular distance slightly more than clypeal length and 0.7 times eye breadth; subantennal sclerite 1.5 times as broad as long; metapleural suture finely pitted below, coarsely above; longitudinal striae of propodeal enclosure shallow and fading out posteriorly; flagellum clubbed, article VIII a little broader than long, twice as broad as I which is 2.5 times as long as broad; pygidium coarsely and fairly closely striatopunctate, sides angled at 45 degrees.

Male: About as in female. Flagellum all dark, scutum with 2 lateral dots, pleuron more yellow, a pair of large spots on propodeal cheeks. Clypeal length 0.7 times breadth and greater than least interocular distance which is 0.6 times eye breadth; subantennal sclerite as long as broad; flagellum with tyloides beneath from apex of I to base of VI; flagellomeres II–V noticeably convex beneath in profile, I about 1.6 times as long as broad, VIII about as long as broad; propodeal enclosure broadly smooth posteriorly except for median groove.

Material: Holotype female (UCD) 9 miles west of Portal, Cochise Co., ARIZONA, 5 June 1959 at flowers of *Senecio longilobus* (L. A. Stange collector). Paratypes, 1 male, Prescott, ARIZONA, July 1947 (R. M. Bohart, UCD); 1 male, E. Verde River, nw. of Payson, ARIZONA, 15 June 1968 (Flint and Menke, USNM).

The coarse punctation of the clypeus, frons, pleuron, propodeum and abdomen distinguish this species from all others described from North America. In some respects it resembles species of *Pseudoplisus* but the propodeal enclosure is plainly striate towards the base.

Hapalomellinus pulvis Bohart new species

Female holotype: Length 5 mm. Black with extensive red and some ivory markings. Red are: pronotum partly, metapleuron, propodeum except dorsally, legs mostly, abdominal segments I–III mostly; pale red are: flagellomeres broadly in front; ivory are: mandible basally, clypeus laterally and apically, scape in front, foretarsi mostly, other tarsi partly, forewing basally, moderately wide apical bands on tergites I–III; wings nearly clear, stigma brown. Pubescence appressed and dense over much of body, snowy white on clypeus, lower frons, genae, mesopleuron, inferior propodeal lobes, coxae, apical bands on abdominal segments I–III (covering ivory tergal bands), large apicomedial spots on tergites IV–V; pubescence becoming yellowish brown on upper frons, vertex and scutum; light brown on pronotum, scutellum and metanotum, tan and fine but completely covering propodeal dorsum, yellowish but inconspicuous on sides of propodeum and bases of tergites I–III, minute and nearly black on abdominal segments IV–V (except white tergal spots). Punctation mostly inconspicuous and obscured by pubescence; frons and interocellar area with irregular macropunctures; propodeal enclosure polished beneath pubescence. Clypeal length about one-third breadth, one-half least interocular distance which is about equal to eye breadth; flagellomere I a little longer than broad and slightly longer than II–IX which are about as broad as long; pygidium polished, with scattered large punctures, apex rounded, sides angled at about 45 degrees.

Male: About as in female. Areas of brownish pubescence in female much less deeply colored in male, more yellowish gray. Flagellomeres VIII–X with undersurface only faintly depressed, VIII as broad at middle as long.

Material: Holotype female (UCD), 18 miles north of Rodeo, Hidalgo Co., NEW MEXICO, 25 August 1958 (R. M. Bohart). Paratypes, 19 males, 13 females from NEW MEXICO: Rodeo to 18 mi. north of Rodeo (P. D. Hurd, C. G. Moore, P. M. Marsh, J. G. Rozen, M. Statham, S. J. Hessel, M. A. Cazier, M. Mortenson, D. D. Linsdale), 5 mi. east of Las Cruces (R. W. Thorp); 5 males, 3 females from ARIZONA: Willcox, on *Euphorbia* (R. M. Bohart); 2 males, 12 females from CALIFORNIA: 18–20 mi. west of Blythe, on *Pectis papposa* (F. D. Parker, J. W. MacSwain, R. M. Bohart). Paratype dates were August 18 to September 23 in New Mexico, August 14 in Arizona, October 14 to 17 in California (all 1958).

The brownish notal pubescence is subject to some variation: California specimens are least deeply colored. The clypeal integument is occasionally all white in both sexes or with the white reduced to two spots.

The pubescent propodeal enclosure, mostly red tergites I–III and only faintly depressed male flagellomere VIII separate *pulvis* from the two other known species of the genus. There are many other differences, however, as indicated in the following key:

Key to the species of *Hapalomellinus*

1. Propodeum with a dense whitish fringe of appressed hair bordering enclosure which is at most feebly pubescent; tergites I–II (or only II) mostly red; female tergite IV mostly black pubescent; male clypeal integument black or mostly so; no definitive male pygidium (sw. U.S., Mexico) .... *albitomentosus* (Bradley)

   Propodeum not fringed around enclosure, tergites I–III or more mostly red; male clypeal integument not mostly black 2

2. Thorax almost wholly red; clypeal integument yellow; discrete punctures of frons and interocellar area inconspicuous; notal pubescence inconspicuous; female tergite IV with a weak pubescent band; male pygidium definitive, similar to that of female (se. Calif., Yuma and Tucson, Ariz., in October) .... *teren* Pate

   Thorax partly black; clypeal integument at least partly white; discrete punctures of frons and interocellar area conspicuous; notal pubescence abundant and yellowed or brownish; female tergite IV with a prominent white pubescent spot; no definitive male pygidium (New Mexico to se. Calif.) .... *pulvis* R. Bohart

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PROCEEDINGS
OF THE
BIOLOGICAL SOCIETY OF WASHINGTON

THE IDENTITY OF *ERGETHUS PERDITUS* CHAMBERLIN (DIPLOPODA, POLYDESMIDA, PARADOXOSOMATIDAE)[1]

By William A. Shear
Museum of Comparative Zoology, Cambridge, Massachusetts

Among the most frustrating problems in diplopod taxonomy are names accompanied by inadequate or misleading descriptions and illustrations. If undiscovered, these errors can lead to a great deal of confusion. One such error was recently brought to light by Hoffman (1966), who examined the holotype of *Sinostemmiulus simplicior* Chamberlin and Wang, and found it to belong to the order Julida (Nemasomatidae) rather than to the order Stemmiulida under which it had been described.

In 1949, Chamberlin described a remarkable new family of chordeumid millipeds, the family Ergethidae, based on the single species *Ergethus perditus,* supposedly collected near Kerrville, Texas. The description is inadequate for recognition of the species, except for the fact that the animal is described as having *both* 17 ocelli on each side of the head *and* 20 body segments. The presence of ocelli excludes it from the order Polydesmida, and the presence of only 20 body segments makes the family unique among the Chordeumida, in which the number of body segments ranges from 26 to 32.

Illustrations of the gonopod, though crude, were totally unlike any known family of Chordeumida.

Because of the possibility of the Chordeumida and the Polydesmida having a common origin, this supposedly polydesmid-like chordeumid promised to be of unusual interest. Through Dr. H. W. Levi of the Museum of Comparative Zoology, I

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[1] Work done while supported by a Richmond Fellowship at Harvard University.

borrowed the types from the University of Utah collection. I thank Mr. Thomas Lorenz and Dr. George Edmunds for loaning them to me, and Dr. Richard L. Hoffman, Radford, Va., for valuable suggestions on the synonymy presented below.

The types are totally devoid of any chordeumoid characters—there are no spinnerets, no ocelli and no segment setae. The gonopods and nonsexual characters are typical of a member of the order Polydesmida, Family Paradoxosomatidae. The pertinent synonymy is given below, with a brief redescription of the male holotype.

ORDER POLYDESMIDA

Suborder Paradoxosomatidea

Family Paradoxosomatidae Daday, 1889

Paradoxosomatidae, Jeekel, 1963, Stud. Fauna Suriname 4(11):7.
Ergethidae Chamberlin, 1949, Proc. Biol. Soc. Washington 62:7. Type genus, *Ergethus* Chamberlin, 1949. NEW SYNONYMY.

Genus *Ergethus* Chamberlin, 1949

Ergethus Chamberlin, 1949, Proc. Biol. Soc. Washington 62:7. Type species, *Ergethus perditus* Chamberlin, 1949, by monotypy and original designation.
Porcullosoma Kraus, 1956, Senck. Biol. 37:411. Type species, *Catharosoma castaneum* Kraus, 1954, by original designation.

Diagnosis: (From Kraus, 1956, translated from German) "Small animals (Males 1.4–1.8 mm wide). 20 segments. Pore formula normal. No lateral swellings or grooves. No paranota. Coxae of legpair 2 normal. Sternites 4 to 6-posterior modified in different ways, or normal. Femora of anterior legs without gland openings. Sternites of posterior segments with anterior pair of blunt tubercles and posterior pair of short processes. Anal scales normal. Gonopods: Prefemur long and straight, about half the length of the whole gonopod. Femoral region with a large, more or less irregular, accessory lamella, directed mesally. Tibiotarsus thin-branched, bent over towards median line, one of the two branches bearing the solenophore and solenomerite."

Species and distribution: All seven species of *Ergethus* except *perditus* are known for certain to occur in Peru.

Ergethus perditus Chamberlin

Ergethus perditus Chamberlin, 1949, Proc. Biol. Soc. Washington 62: 7–8, figs. 1, 2.

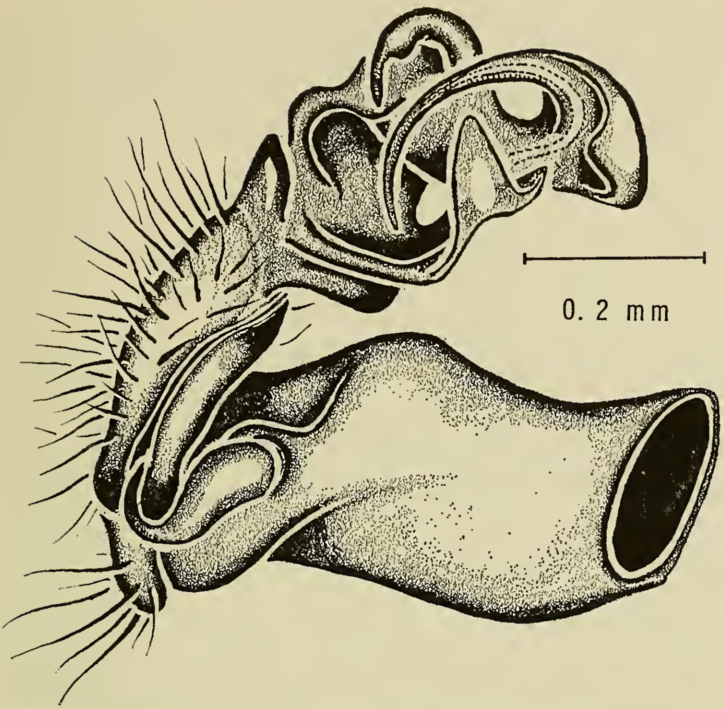

Fig. 1. Right gonopod of *Ergethus perditus*, mesal view, ventral side to the left.

Types: Male holotype, male, female, and juvenile paratypes supposedly from Kerrville, Texas, but probably from an undeterminable locality in Peru. Chamberlin had a large collection of Peruvian millipeds on hand at the same time (Chamberlin, 1955) that *Ergethus* was described. It is possible a mistake was made while sorting this material, and the types of *E. perditus* became mixed with some genuine Texas material. Aside from the ubiquitous introduced *Oxidus gracilis*, no paradoxosomatids occur in the United States. The name *perditus* ("lost") is also puzzling.

Description of holotype male: Length, 11.5 mm, width 1.3 mm. With the characters of the genus. Median setose knobs between legpairs 3–5, two smaller setose knobs between legpair 6, two still smaller setose knobs widely spaced between legpair 7. Gonopods (Fig. 1) with femoral lamella large, thin, projecting first mesally, then slightly curved ventrally *in situ*. Basal tibiotarsal branch roughly cylindrical, arising from laterally swollen area, sharply elbowed mesally then dorsally. Solenophore branch flattened, broadly expanded, curved lamella. Solenomorite cylindrical, evenly tapered, acute. Gonopods subtended by elongate setose processes arising near coxal sockets of legpair 9 from metasternite. Coloration: completely bleached by preservation. Usual color in genus ranges from light brown to nearly black (Kraus, 1959). Original description gives color as "in general, brown, paler beneath and in more or less distinct annuli. Legs yellow (Chamberlin, 1949)."

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PROCEEDINGS
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A NEW CRAYFISH OF THE GENUS *PROCAMBARUS* FROM MISSISSIPPI (DECAPODA: ASTACIDAE)

By Horton H. Hobbs, Jr.
Smithsonian Institution, Washington, D.C.

The existence of the remarkable crayfish described below was first reported by Lyle (1938: 76), who in presenting an abstract of his doctoral dissertation, listed *Cambarus* (*Paracambarus*) *harnedi* [nomen nudum] among the crayfishes occurring in the State of Mississippi. The collection on which Lyle's dissertation was based was housed at Mississippi State University where, for a number of years, it was unavailable for study. Not until Joseph F. Fitzpatrick, Jr. joined the staff of that institution and refurbished the Lyle collection did it become accessible. Through the efforts of Dr. Fitzpatrick and his students, a much larger quantity of material, including collections from all parts of the State, was assembled, and this, together with the Lyle collection, has been deposited in the Smithsonian Institution.

Among the specimens that Lyle had accumulated were two lots (see below) collected from the vicinity of Bayou Barnard by R. N. Lobdell, in which there was a single first form male that bears hooks on the ischia of the fourth pereiopods only. Because the limitation of such hooks to this pair of appendages was unique to the then lone member of Ortmann's subgenus *Paracambarus*, *Cambarus* (*P.*) *paradoxus* Ortmann, 1906: 3, Lyle assumed a closer relationship between his species and that of Ortmann than seems probable at the present time. There are several Mexican members of the genus *Procambarus* (= Ortmann's subgenus *Procambarus*), which have been described subsequently, that exhibit this characteristic, and Lyle's

FIG. 1. *Procambarus fitzpatricki* new species (pubescence removed from all structures illustrated). a, Lateral view of carapace of holotype. b, Mesial view of first pleopod of holotype. c, Mesial view of first pleopod of morphotypic male, form II. d, Caudal view of first pleopods of holotype. e, Cephalolateral view of distal portion of sinistral first pleopod of holotype. f, Basal podomeres of third, fourth, and fifth pereiopods of holotype. g, Lateral view of first pleopod of morphotypic male, form II. h, Lateral view of first pleopod of holotype. i, Cephalic portion of epistome of holotype. j, Dorsal view of caudal portion of abdomen of holotype. k, Lateral view of abdomen of holotype. l, Basis and ischium of fourth pereiopod of holotype. m, Dorsal view of carapace of holotype.

species seems definitely more closely allied to them than to the two crayfishes currently assigned to the genus *Paracambarus*.

An additional character, which is shared only with *Procambarus hagenianus* (Faxon, 1884: 141), also deserves mention. The inner ramus of the uropod bears a prominent distomedian spine which extends much beyond its distal margin (Fig. 1j, k). Whereas the homolog of this spine is occasionally moderately prominent in other crayfishes, in no other members of the genus does it project beyond the margin of the ramus; too, the laterodistal spine is conspicuously longer than in most other species. Other outstanding characteristics are cited in the discussion of relationships.

It is a pleasure to name this distinctive crayfish in honor of Dr. Fitzpatrick in token of his outstanding contributions to our knowledge of the cambarine crayfishes. I am also grateful to him for making the material on which the description is based available to me, as well as for his criticisms of the manuscript. For his helpful suggestions, I am also indebted to Fenner A. Chace, Jr., and for assistance in the preparation of the illustrations, I acknowledge with gratitude the aid of Carolyn B. Gast.

Procambarus fitzpatricki new species

Cambarus (*Paracambarus*) *harnedi* Lyle, 1938: 76 (*nomen nudum*).

Diagnosis: Body pigmented, eyes small but well developed. Rostrum with subparallel to gently convergent margins, lacking marginal spines; acumen short and indistinctly delimited basally. Areola 16 to 27.4 times longer than wide and constituting 31.1 to 35.8 percent of entire length of carapace. Carapace devoid of cervical spines, cervical tubercles very small or absent. Suborbital angle prominent and subacute. Postorbital ridges without spines or tubercles. Antennal scale approximately 1.9 times longer than wide, broadest distal to midlength. Mesial margin of palm of chela with row of nine to 11 tubercles, both fingers with poorly delimited, but massive, longitudinal ridges. Ischia of fourth pereiopods only bearing simple hooks; coxae of fourth and fifth pereiopods bearing

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n, Annulus ventralis and associated sternites of allotype. o, Antennal scale of holotype. p, Dorsal view of distal podomeres of cheliped of holotype.

Table 1. Measurements (mm) of *Procambarus fitzpatricki*

	Holotype	Allotype	Morphotype
Carapace:			
Height	11.6	10.3	11.3
Width	11.7	10.5	11.4
Length	25.0	22.9	24.7
Areola:			
Width	0.4	0.3	0.4
Length	8.6	7.9	8.7
Rostrum:			
Width	3.6	3.5	3.8
Length	4.7	4.6	4.7
Chela:			
Length of inner margin of palm	10.0	6.3	7.8
Width of palm	7.8	5.9	6.6
Length of outer margin of chela	19.0	14.1	17.1
Length of dactyl	9.7	6.7	8.6

prominences. Inner ramus of uropod with two conspicuous spines projecting distally beyond margin. First pleopods slightly asymmetrical, both with well developed proximal lobe and sinistral member with strong subacute proximomesial lobe overlapping caudally corresponding weaker lobe of dextral member; shoulder present at base of cephalic process; pleopods reaching cephalad to or almost to level of second pereiopods and bearing subterminal setae; distal extremity bearing (1) prominent, long, subacute mesial process directed distolaterally, extending distally beyond other terminal elements; (2) well developed, distally rounded, corneous-tipped cephalic process directed distally, its apical portion bent slightly laterally; and (3) conspicuous corneous central projection consisting of broad subrectangular, almost bladelike centrocaudal process and narrower curved centrocephalic process; caudal element represented by ridge around caudal base of centrocaudal process. (See *Remarks.*) Sternum of female immediately cephalic to annulus ventralis unadorned, latter with median longitudinal furrow in cephalic half, flanked cephalically by one to four pairs of prominent tubercles.

Holotypic Male, Form I: Body subovate, distinctly compressed. Abdomen narrower than thorax (10.1 and 11.7 mm). Width and height of carapace at caudodorsal margin of cervical groove subequal (11.7 and 11.6 mm). Areola 21.5 times longer than wide with single row of punctations in narrowest part. Cephalic section of carapace 1.9 times as long as areola (length 34.4 percent of entire length of carapace). Rostrum inclined cephaloventrally, deeply excavate dorsally, with thickened subparallel margins basally, and rather gently convergent cephalically to apex, marginal spines lacking, and acumen indistinctly delimited basally; upper surface sparsely punctate except basally, usual submarginal row of setiferous punctations present. Subrostral ridges moderately well developed to level of suborbital angle and visible dorsally to base of apical third of rostrum. Postorbital ridges moderately prominent, grooved dorsolaterally, but terminating abruptly cephalically without spines or tubercles. Suborbital angle prominent and acute. Branchiostegal spine moderately large and acute. Carapace punctate dorsally except in polished gastric area and granulate laterally, granules best developed in hepatic area and along cephaloventral margin of cervical groove. Cervical spines absent and tubercles in area only slightly larger than branchiostegal granules. Cephalic section of telson (Fig. 1j, k) with two spines in each caudolateral corner. Cephalic portion of epistome (Fig. 1i) slightly broader than long, resembling isosceles trapezoid, bearing small subacute cephalomedian prominence and with lateral margins elevated (ventrally). Antennules of usual form with well developed spine on ventral surface of basal segment slightly distal to midlength. Antennae extending caudad to second abdominal tergum. Antennal scale (Fig. 1o) about 1.9 times longer than broad, broadest distal to midlength, with widest lamellar area approximately seven times width of thickened lateral portion, latter terminating in strong acute spine.

Ischium of third maxilliped with prominent, simple, stiff setae, not matted.

Right chela (Fig. 1p) with palm inflated, not strongly depressed; lateral margin rounded, not costate; entire palmar area and basal portions of fingers tuberculate, mesial elevated tubercles grading laterally to squamous ones; mesialmost row on palm consisting of 10 projecting tubercles with sublinear series both above and below it; remaining tubercles somewhat scattered; lower surface of palm with moderately prominent tubercle lateral to articular condyle at base of dactyl. Fixed finger with rounded, strongly inflated ridge paralleling general contour of opposable margin, flanked proximally by squamous tubercles and more distally by setiferous punctations; opposable margin with row of five tubercles, third from base much larger than remaining four; row of minute denticles between and distal to tubercles, extending to base of corneous tip of finger; ventral surface with submedian longitudinal groove flanked by setiferous tubercles, and lateral surface with squamous tubercles proximally, grading distally to setiferous punctations. Dactyl, except for being narrower and bearing cluster of tubercles proximomesially, essentially like fixed finger with submedian longitudinal ridges dorsally and ventrally, five tubercles on opposable margin, and mesial margin tuberculate proximally and with punctations distally. Fingers subequal in length to mesial margin of palm.

Carpus of right cheliped longer than broad (7.8 and 5.1 mm) with mesial portion tuberculate, remainder mostly punctate; oblique excavation on dorsal surface very shallow and flanked by punctations; distal dorsomesial surface lacking spine; mesial surface with number of tubercles, distalmost larger than others; ventral and lateral surfaces punctate, ventral mesiodistal angle with one spiniform tubercle, and tuberculiform prominence on ventral articular condyle.

Merus of right cheliped tuberculate dorsally and ventrally; dorsodistal surface with two spiniform tubercules; ventromesial margin with row of 11 spikelike tubercles and ventrolateral margin with row of nine, row branching at articular membrane with three tubercles extending distomesially and four distolaterally; few additional tubercles scattered between former two mentioned rows. Ischium with mesial row of three tubercles.

Hooks on ischia of fourth pereiopods (Fig. 1l) only; hooks simple, directed proximally, and projecting proximal to distal end of basis. Coxae of fourth and fifth pairs of pereiopods with prominences (Fig. 1f); that on fourth heavy, aligned primarily on longitudinal axis of body with caudal subacute portion directed slightly laterally; that on fifth much less massive, somewhat compressed and directed ventrally from caudomesial angle of coxa.

First pleopods (Fig. 1b, d, e, h) as described in diagnosis.

Uropods (Fig. 1j, k) with protopodite bearing two prominent spines; inner ramus with two spines projecting from distal margin, one from lateral angle and longer, stronger one from median ridge.

Sternum between caudal four pairs of pereiopods moderately deep and bearing long plumose setae obscuring, for most part, first pair of pleopods.

Allotypic Female: Differs from holotype in following respects: areola 26.3 times longer than broad with two punctations across narrowest part; carapace with widely spaced punctations in polished gastric area; sinistral cephalolateral margin of cephalic portion of epistome with two small angular prominences; chela proportionately shorter and less inflated in area of base of fixed finger, opposable margin of latter with fourth tubercle from base largest and those on opposable margin of dactyl as in morphotype; merus of cheliped with 13 and 17 tubercles in ventromesial row on left and right members, respectively, ventrolateral row with 10 tubercles along basal portion and four in mesial and five in lateral branches, respectively; ischium with ventral row of four tubercles. See measurements.

Sternum cephalic to annulus ventralis (Fig. 1n) broad, shallow, and winglike, without ornamentations but bearing short plumose marginal and submarginal setae, and underlying (dorsally) cephalic portion of annulus ventralis. Annulus subcircular in outline with deep median trough in cephalic three-fifths, flanked cephalically by two pairs of tubercles; sinus originating near median line at caudal end of trough, forming broad sinistral arc across thick caudal wall, and terminating on mid-caudal margin of latter; fossa extending sinistrally near cephalic end of sinus. Median sternite between fifth pereiopods evenly rounded cephalically and without central elevation or prominent punctations on ventral surface.

Morphotypic Male, Form II: Differs from holotype in following respects: cephalothorax not so strongly compressed; cephalic portion of epistome less angular but basically similar; opposable margin of dactyl of chela with third tubercle from base only slightly larger than adjacent ones; tubercles on carpus of cheliped less acute and somewhat reduced in size, with penultimate tubercle on mesial surface largest; merus with non-spiniform tubercles on dorsodistal surface, ventromesial row with 12 and 14 tubercles on left and right members, respectively, ventrolateral row with eight tubercles along basal portion and six in each branch; ischium with row of four tubercles; hooks on ischia of fourth pereiopods less prominent but equally well defined; coxae of fourth and fifth pereiopods only slightly reduced. See measurements.

First pleopods (Fig. 1c, g) slightly asymmetrical, reaching coxae of second pereiopods; proximal and proximomesial lobes prominent, with sinistral member more prominent and acute than in holotype; cephalic surface without prominent shoulder at base of cephalic process; non-corneous terminal elements consisting of distolaterally projecting mesial process and distally directed, broad cephalic process projecting clearly beyond tip of compound, extremely broad projection: centrocaudal process forming truncate ridge along distal caudolateral margin, centrocephalic process slightly broader than distal portion of mesial process, and situated between cephalic process and centrocaudal process, projecting distally slightly beyond latter; caudal element not distinctly delimited from centrocaudal process. Subterminal setae weak.

Color Notes: Ground color greenish brown with carapace and chelipeds darker brown than abdomen and remaining pereiopods. Dorsum of carapace chocolate brown, becoming olive toward ventral margin of branchiostegites. Both hepatic and branchiostegal areas with small, irregular, dark brown spots. Dorsum of abdomen with narrow, median longitudinal, pale chocolate band tapering caudally to end on base of telson. First abdominal tergum with pair of short, almost black, bars flanking median stripe; remaining terga with paired oblique (cephalomesial to caudolateral) dark bands flanking median stripe, successively paler toward telson; second through sixth epimera also with narrow, dark, longitudinal stripe at base, and each epimeron darker caudoventrally. Both rami of uropods with dark lateral margins, median ridges, and distal spines. Chela dark brown dorsally with even darker tubercles; upper surface of merus and carpus also dark brown, former fading to olive proximally and to pale green below; remaining pereiopods pale green below, darker green above, and with irregular brown areas along upper margins of merus and more distal podomeres.

A second color phase of yellowish tan and dark brown exists in some individuals; however, there seems to be little variation in the pattern.

Type-locality: Roadside ditch at junction of State Rte. 67 and Woolmarket Road, just north of D'Iberville, Harrison County, Mississippi.

Disposition of Types: The holotypic male, allotypic female, and morphotypic male are deposited in the National Museum of Natural History (Smithsonian Institution), nos. 131205, 131206, and 131207, respectively. The paratypes, consisting of three males, form I, three males, form II, nine females, one juvenile male, and two juvenile females are also in the Smithsonian collection.

Size: The largest specimen available is a female having a carapace length of 27.4 mm. The largest first form male, the holotype, has a corresponding length of 25.0 mm, and the smallest first form male, 21.5 mm.

Range and Specimens Examined: *Procambarus fitzpatricki* is known only from the southern part of Mississippi between the Wolf and Pascagoula rivers. HARRISON COUNTY—Type-locality, 18 July 1968 (2♂I, 1 juv. ♀); 8 August 1968 (1♂II) H. H. Hobbs III, coll. Strawberry field near Bayou Bernard, 15 February 1933 (1 ♂I, 4 ♀, 1 juv. ♂, 1 juv. ♀) R. N. Lobdell, coll.; date unknown (4♀) collector unknown. GEORGE COUNTY—3.2 mi. N of Black Creek on State Rte. 57, 11 June 1968 (1♂II) H.H.H. III, coll. STONE COUNTY—8.9 mi. W of Wiggins on State Rte. 26 at junction with U.S. Hwy. 49, 12 June 1968 (1♂I, 1♀) 30 July 1968 (2♂II, 1♀) H.H.H. III, coll.

Variations: The chief variations noted are in the arrangement of the tubercles along the opposable margins of the fingers of the chelae; in a few specimens they are more numerous than in the holotype, and, in some, in which the larger tubercle on the fixed finger is even more strongly developed than in the latter, the opposing tubercle on the dactyl may be suppressed, resulting in hardly a trace of a gap between the fingers when they are brought together; also in some specimens, the usual distal tubercle (lacking in the holotype and morphotype) at a lower level on the fixed finger is present. Variable also is the outline of the cephalic portion of the epistome, which while generally retaining the isosceles trapezoidal contour, may bear secondary angles laterally, and in one specimen a small projection is situated lateral to the cephalomedian one. An examination of the measurements presented for the allotype indicates a shorter and less robust chela than that in the holotype, and this is typical of the females of the species. The annulus ventralis has from one to four pairs of tubercles cephalically, flanking the longitudinal trough.

Relationships: *Procambarus fitzpatricki* has its closest affinities with members of the Gracilis Section of the genus: *P. gracilis* (Bundy, 1876: 5), *P. hagenianus* (Faxon, 1884: 141), *P. simulans simulans* (Faxon, 1884: 112), *P. simulans regiomontanus* Villalobos, 1954: 289, and *P. tulanei* Penn, 1953: 163. This is evident in the conformation of the carapace, and, to a lesser degree, in that of the chela. As in most members of the genus, the strongest evidence of relationship is seen in the structure of the first pleopods and the annulus ventralis. Even though the pleopods are somewhat asymmetrical, and in other respects slightly atypical of the Section, they share a very prominent proximal lobe, a shoulder at the base of the cephalic process, and a conspicuous bladelike centrocaudal process. *Procambarus fitzpatricki* lacks the dense, matted setation of the ventral surface of the third maxillipeds, in that respect resembling *P. gracilis*. With *P. hagenianus* alone, it shares two spines projecting beyond the distal margin of the inner ramus of the uropods. Its suborbital angle allies it with all of the members of the Section except *P. hagenianus*.

It may be readily distinguished from all of its relatives by the following: the short fingers of the chela which are subequal in length to the mesial margin of the palm; in the males, hooks are present on the ischia of the fourth pereiopods rather than on the third, and the coxae of the fourth pereiopods bear prominent caudally projecting prominences; the pleopod of the first form male lacks a distinct caudal process, and the centrocephalic process is broad and bladelike.

Life History Notes: First form males have been collected in February, June, and July; no females carrying eggs or young have been found.

Habits: All of the specimens for which detailed data are available were collected from comparatively simple burrows which are subject to being flooded following rains. Whether or not the species is largely confined to burrows, as is the neighboring *P. hagenianus*, is not known.

Remarks: Deciphering the identity of one of the four elements constituting the terminal portion of the first pleopod has been difficult. There seems to be no question as to the homologies of three of them (mesial, cephalic, and centrocephalic processes); however, the relationship of the remaining terminal to the centrocephalic process and its superficial, at least, resemblance to the caudal process of the pleopods of the members of the Gracilis Section, presents a real problem of interpretation: Is it the caudal or centrocaudal process? In the usual sequence in which the processes appear (Hobbs, 1940) spiraling from the mesial surface, they are as follows: mesial, cephalic, centrocaudal, caudal, and centrocephalic; generally, if any element is lacking, it is either the cephalic or caudal process, and, in all previously described species of the subfamily, the centrocaudal and centrocephalic elements are so arranged that the sperm groove passes between their tips. In *P. fitzpatricki*, the sperm groove does indeed pass between the centrocephalic process and the broad bladelike element (the identity of which is uncertain). Its resemblance to the caudal process of other relatives composing the Gracilis Section tempts one to interpret it as such in spite of its relationship to the centrocephalic process. In making such an interpretation, however, one must concede that it is taking over a function, and absorbing the usual position, both relatively and actually, of the centrocaudal process, thus either replacing or being imperceptibly fused with the latter. To assume that the centrocaudal process is lost would be to attribute to this pleopod an arrangement of the terminal elements which would be unique in the subfamilies Cambarinae and Cambarellinae. Inasmuch as there are many examples of pleopods in which the caudal process is reduced or entirely absent, but none in which the centrocaudal element is lacking, the process, even though disproportionately large, is adjudged to correspond to the centrocaudal process, and is so treated in the diagnosis and discussion of relationships above. Thus, the caudal element, according to this interpretation, is represented by the narrow ridge at the caudal base of the centrocaudal process.

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Vol. 83, No. 41, pp. 469–476 9 February 1971

PROCEEDINGS
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BIOLOGICAL SOCIETY OF WASHINGTON

REDISCOVERY AND DESCRIPTION OF THE ICTALURID CATFISH, *NOTURUS FLAVIPINNIS*

By William R. Taylor, Robert E. Jenkins, and
Ernest A. Lachner
Smithsonian Institution, Washington, D.C., and
Roanoke College, Salem, Virginia

Noturus flavipinnis, the yellowfin madtom, was described (Taylor, 1969: 201) from specimens collected between 1884 and 1893. Specimens were known with certainty from only three widely separated localities in the Tennessee River drainage of Georgia, Tennessee, and Virginia. Lack of recent collections led to the suggestion that it might be extinct. In May 1969, Jenkins took one adult specimen from Copper Creek, Virginia, a tributary of the Clinch River in the upper Tennessee drainage. Subsequently we have found, particularly from night collecting, that *Noturus flavipinnis* is fairly common in lower Copper Creek. Another specimen taken in the Powell River, also upper Tennessee River drainage, during 1968 was received from Richard B. Fitz.

Because the species is known from only 13 faded specimens, our purpose herein is to present further descriptive, distributional, and ecological data and to illustrate the species from recently collected material.

New Material Studied: Tennessee: Hancock County: Powell River, mile 106, Alanthus Hill, 4 October 1968, Richard B. Fitz, USNM 204864 (1 specimen, 34 mm standard length). Virginia: Scott County: Copper Creek localities: along route 627, 1.1 road mi. upstream from jct. routes 627 and 665, 11 October 1969, USNM 204856 (11, 24–65 mm); along route 627, 1.3 road mi. downstream from jct. routes 627 and 665, 10–11 October 1969, USNM 204857 (17, 24–84 mm); at route 665 bridge, at Spivey Mills, 9 May 1969, USNM 204858 (1, 67 mm); at route 671 bridge, about 7.2 mi. NE. Gate City, 13 September 1969, USNM 204859 (1, 26 mm). See Taylor (1969: 201) for data concerning the early collections.

General Description: The following summary of meristic characteristics includes the data from the old material (see Taylor, 1969: 201–204; original description) and from the recently obtained specimens. A study of the data from each locality does not indicate significant geographic variation: dorsal rays I,6 (44 specimens); anal rays 14 (14), 15 (23), 16 (7), mean 14.8; lower-half caudal rays 25 (11), 26 (9), 27 (15), 28 (9), mean 26.5; upper-half caudal rays 29 (4), 30 (7), 31 (11), 32 (9), 33 (9), 34 (3), 35 (1), mean 31.6; total caudal rays 54 (3), 55 (3), 56 (5), 57 (9), 58 (5), 59 (8), 60 (3), 61 (4), 62 (3), 63 (1), mean 58.1; vertebrae, excluding the anterior fused vertebrae, 33 (2), 34 (21), 35 (21), mean 34.4; preanal vertebrae, except fused vertebrae, 12 (16), 13 (14), mean 12.5; pelvic rays i,7 (2 sides), i,8 (86), mean i,8.0; pectoral rays I,7 (21 sides), I,8 (66), I,9 (1), mean I,7.8; preoperculomandibular pores 9 (2 sides), 10 (16), 11 (69), 12 (1), mean 10.8; internasal pores 1 (4 sides), 2 (84), mean 2.0.

We find one epural in 22 specimens counted and six hypurals (17 specimens; see Taylor, 1969: 8 for definition). The hypurals remain separate in small specimens, but in those larger than 60 mm in standard length there is considerable fusion. In all cases (15 examples) hypurals 2 and 3 are fused in these larger specimens and hypurals 4 and 5 are joined or tend to join; in one case hypurals 4 and 5 join with hypural 6.

The upper simple rays of the caudal fin number 22 to 27, modally 24, mean 23.7; 7 or 8, exceptionally 11, modally 8, mean 7.7 are upper branched rays and 9 to 13, modally 11, mean 10.8 are lower branched rays, totalling 16 to 22, mean 18.5 branched rays; and 13 to 18, modally 15, mean 15.5 are lower simple rays.

The caudal fin of the fresh material is best described as truncate, rather than rounded or pointed behind, with rounded corners. The mouth is definitely included with the lower jaw inferior. Many of our present specimens are large but they do not exceed the maximum size stated in the original description.

Color in Preservation: Side of body moderately light to darkly pigmented, brownish tan, except where overlain by the four prominent dorsal saddles or bars; dark brown saddle beneath dorsal fin extending from about midway between head and dorsal spine backward to beneath the third, almost to the fourth, dorsal ray and downward variably to below the lateral line; this saddle encloses, except in large dark specimens where obscured, a pair of light spots just anterior to the dorsal fin; the spots are similar to those found in *Noturus stigmosus* Taylor and *Noturus munitus* Suttkus and Taylor; a second saddle, rectangular and of same color, with greatest dimension longitudinal, between dorsal and adipose fins; the dark brown to black adipose bar extends to the virtual margin of the adipose fin except in some juveniles where the outer third of the fin may be unpigmented; a dark brown obovate patch on the posterior end of the caudal peduncle extends almost vertically above and below, across the procurrent rays as a black bar; caudal fin yellowish to light brown basally with a broad crescentic brown band near margin and one or more narrow ones more proximally; distal margin of caudal fin and upper and lower areas on procurrent rays behind basicaudal bar immaculate; adipose fin, outside the saddle, yellowish with some scattered chromatophores, especially anteriorly, its posterior flap without or with little pigment; anal fin lightly pigmented on basal one-fourth, with a dark brown to blackish spot, similar to that in *Noturus flavater*, near middle of anal fin base and on adjacent caudal peduncle in most specimens; a narrow blackish band across rays, at junction of basal two-thirds and distal one-third of anal fin; pelvic fin unpigmented except base which has scattered chromatophores; pectoral fin with clear tips of rays, brownish basally and near spine which is grayish brown; basal one-fourth of dorsal fin and dorsal spine, except tip, grayish brown; one or two narrow brown bands extend through the approximate middle of the dorsal fin from the first to the last soft ray; distal one-fourth of dorsal fin, tip of dorsal spine, and its filament immaculate; top of head dark grayish; a light spot, size of eye, behind eye; scattered chromatophores on cheek; a dark brown bar at posterior end of head extending downward to the branchiostegal membrane; another from the operculum through the eye to the nares; anterior nares pigmented about base, clear distally; upper barbels brown; lower outer barbels with scattered brown pigment, the inner ones with little or no pigment; undersurface unpigmented except brownish chromatophores anterior to barbels and in a faint band across abdomen just in front of pelvic fins; about half the specimens have a dark brown wedge-shaped spot on lower side just above the vent.

The greatest contrast in color pattern exists between young and adult specimens collected at night which is apparently also typical of most mottled forms of *Noturus*. Specimens collected in daylight are more uniformly pigmented with less contrast between the lighter and darker areas of pigmentation. In general young specimens have the characteristic pigmentation of older, non-breeding specimens but sometimes the pattern may be incompletely developed, as in some of the present small specimens in which the adipose bar extends variably across that fin.

Life Colors (from specimens observed at night in October, 1969, collected with seine and recorded some two to three hours after preservation): axial streak pinkish orange; adipose bar and basicaudal bar jet black; two anterior saddles dark gray to dark grayish black; pelvic fins whitish; lower surface body and head whitish, faintly tinged with yellowish; side of body where lightest tinged with yellow, yellowish tan to yellowish gray; yellow most intense on upper surface of body where darker yellowish tan to yellowish gray; cheek yellow; clear and lightly pigmented area of adipose fin medium lemon yellow; basal half caudal fin medium yellow, the caudal crescents dark grayish black, and the distal

Fig. 1 [Dorsal view]. *Noturus miurus* Jordan (male; 52.4 mm standard length) UMMZ 165840; Michigan: Huron River, 1.75 mi. above Dexter, Washtenaw County.

margin whitish; dorsal fin light yellowish gray basally and light yellow distally; tips and filaments of dorsal and pectoral spines bright lemon yellow; light area of pectoral fin light yellowish white; anal fin light yellowish gray basally and medium yellow distally; bands through dorsal and anal fins dark brownish black.

Ecology: Copper Creek flows through a rather narrow U-shaped valley. It consists of generally short, rather swift riffles and moderate to moderately long, shallow pools, which are normally not more than four feet deep, mostly less than three feet. The stream width ranges up to about 60 feet with riffles 30 to 60 feet wide. The water is white, without evidence of harmful waste or pollution. Higher vegetation is sparse and at most provides only limited cover for fishes. The bottom is mostly of gravel and rubble, with some boulders and bedrock. Small areas of fine sand are present, but there is no shifting sand. The current

Fig. 2 [Dorsal view]. *Noturus flavater* Taylor (male, holotype; 102.9 mm standard length) UMMZ 151322; Missouri: Flat Creek, Hwy. M39, 12 mi. NE. Cassville, Barry County.

Fig. 3 [Dorsal view]. *Noturus flavipinnis* Taylor (male; 65 mm standard length) USNM 204857; Virginia: Copper Creek, 1.3 mi. below junction routes 627 and 665, Scott County.

in the pools is slow to still. A very thin layer of fine silt covers the bottom of some of the pools, causing the water to become slightly turbid when roiled.

The fauna of Copper Creek is comparatively rich. We were able to collect 44 species of fishes from the lower locality (see data for USNM 204857) in a night and short day collection. Significant new records from Copper Creek for the upper Clinch River system in Virginia are *Ichthyomyzon bdellium* (Jordan), *Notropis lirus* (Jordan), *Ictalurus melas* (Rafinesque) (introduced?), *Noturus eleutherus* Jordan, *Noturus flavus* Rafinesque, *Etheostoma camurum* (Cope), *Etheostoma maculatum* Kirtland, *Etheostoma stigmaeum* (Jordan), *Etheostoma tippecanoe* Jordan and Evermann, *Etheostoma* (*Catonotus*) species, *Percina aurantiaca* (Cope), *Percina burtoni* Fowler, *Percina caprodes* (Rafinesque), *Percina evides* (Jordan and Copeland), *Percina macrocephala* (Cope), and *Percina sciera* (Swain).

Fig. 4. *Noturus flavipinnis* Taylor (female; 62 mm standard length) USNM 204856; Virginia: Copper Creek, 1.1 mi. above junction routes 627 and 665, Scott County.

The one specimen of *Noturus flavus* from Copper Creek was collected among large rubble from a swift riffle at our lower locality. Fourteen *Noturus eleutherus* were obtained in our two night collections on 10 and 11 October 1969. Large individuals of *N. eleutherus* were obtained only from the swifter gravel and rubble riffles. The young of *N. eleutherus* were taken mainly from the riffles, but some may have been collected from pools.

Noturus flavipinnis appears to be characteristically a species of the pools and slow running water. None was taken from riffles. Adults and young were often taken from shallow areas, among felled trees, or with detritus. Jordan (1890: 143, as *Noturus miurus*) found *N. flavipinnis* to be "Not rare in the weeds . . ." We found very little vegetation in Copper Creek and conclude that it does not furnish an effective hiding place.

The success of seining *N. flavipinnis* (as well as other *Noturus*) at night sharply contrasts with that during daylight. A total of only two specimens was taken in the approximately 26 daylight collections from lower Copper Creek, made from 1965 through 1969. In contrast, our two night collections yielded 28 specimens. Although the vast majority of the many Tennessee drainage collections, by others, were made during the day, we still regard *N. flavipinnis* as a rare and endangered species that has probably disappeared from much of its former range.

The past occurrence of *N. flavipinnis* in the Clinch River is based on its capture in 1893. Recently, a devastating alkaline waste kill of fishes during June 1967 that began at Carbo, Russell County, Virginia may have wiped out any existing populations in the main stream down to the Virginia-Tennessee state line.

Remarks: In most of the newly collected specimens the black bar extends to the margin or submargin of the adipose fin, but in several of the medium size specimens USNM 204857, the bar shows various extensions into that fin; these data thus disagree with statements made by Taylor (1969: 131, 201, 202) in his key and description.

The relationship of *flavipinnis* appears closest to *Noturus miurus* Jordan and secondly to *Noturus flavater* Taylor but several features suggest members of the *furiosus* species group as described by Taylor (1969: 130, 167). Characteristics which suggest the *furiosus* group are the similarly colored dorsal fins in the absence of a terminal black blotch but with variously developed medial brownish bands, typically two lightly pigmented spots in the dorsal saddle just anterior to the dorsal spine (compare figs. 1–3 and Taylor, 1969: pl. 18), a fairly truncate posterior margin of the caudal fin rather than rounded to pointed, and the increased frequency of seven soft pectoral rays. The general coloration, however, especially the color patterns of the caudal fin, the caudal peduncle, and the adipose fin, and the increased number of caudal rays point strongly to relationship with the *miurus* species group (Taylor, 1969: 131, 188).

Acknowledgments: We are grateful to Richard B. Fitz, Tennessee Valley Authority, Norris, Tennessee, for sending us a specimen from the Powell River. Noel M. Burkhead and William T. Shuler, Roanoke College students, assisted in field work. The photographs of *Noturus miurus* and *Noturus flavater* were made by the University of Michigan Photographic Services and those of *Noturus flavipinnis* by the Photographic Services Division, Smithsonian Institution.

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PROCEEDINGS
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REDISCOVERY AND REDESCRIPTION OF THE KHUZISTAN DWARF GECKO, *MICROGECKO HELENAE* NIKOLSKY (SAURIA: GEKKONIDAE)

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Nikolsky (1907: 264–268) described the genus and species *Microgecko helenae* based on nine specimens from what is now Khuzistan Province, Iran. The syntypes have been lost or destroyed. The taxon has been mentioned several times in the literature since Nikolsky, 1907. Werner (1936: 200) listed *Microgecko helenae* Nikolsky from Iran without seeing additional specimens. Mertens (1956: 92–93) used the name *Tropiocolotes helenae* (Nikolsky) for a single gecko from near Pip (= Pib), Baluchistan Province, Iran, and placed *Microgecko* in the synonymy of *Tropiocolotes* Peters. Romer (1956: 542) listed the genus *Microgecko* as valid but doubtful. Anderson (1961) identified a small male gecko from between Masjid-i-Suleiman and Sar-i-Gach, Khuzistan Province, Iran, as *Tropiocolotes helenae.* He questioned Mertens' tentative identification of the southeastern Iranian specimen. Later, Anderson (1963: 440–441) returned *helenae* to *Microgecko* and stated that the species, although cogeneric with *Tropiocolotes steudneri* Peters, is probably generically distinct from *T. tripolitanus* Peters, the type species of *Tropiocolotes.*

Minton (1962: 11) included *Tropicalotes helenae* (sic) in the West Pakistan herpetofauna, based on specimens from the desert west of the Indus River. He (1966: 81–82) described the specimens under the name *Tropiocolotes helenae* (Nikolsky) and suggested (1966: 82) that his and Anderson's specimens might be subspecifically related. Wermuth (1965: 184) listed *Tropiocolotes helenae* (Nikolsky) in his review of the

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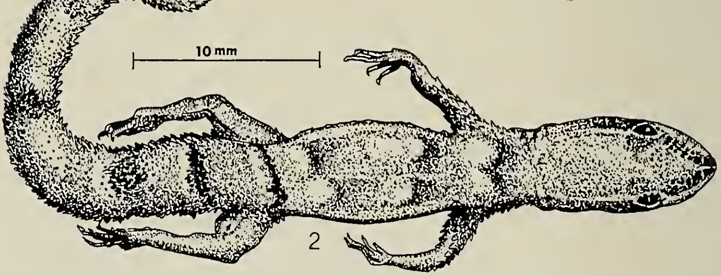

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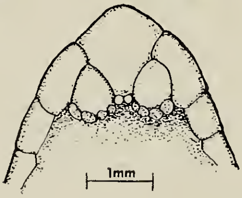

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FIG. 1. Outline map of Iran, showing approximate locations of major cities and of collecting sites of *Microgecko helenae* in Khuzistan Province: A, 35 km east of Gachsaran (see Fig. 4); B, 16 km south of Masjid-i-Suleiman.

Fig. 4. Habitat of *Microgecko helenae* (see Fig. 1, A). Geckos were collected from under small stones along wadi in left foreground, indicated by arrows. Gachsaran-Kazeroun Road crosses center of photograph. View faces south-southwest.

Gekkonidae and gave the distribution as southern and southwestern Iran. Guibé (1966a: 184) identified as *Microgecko helenae* a single female gecko from 100 km north of Iranshahr, Baluchistan Province, Iran. Guibé (1966b: 338) recognized *Microgecko* Nikolsky but questioned Anderson's referral of *T. steudneri* to it. Kluge (1967: 9) cited only Wermuth (1965) but removed *Microgecko* from *Tropiocolotes*, referring it to his Group I of the Gekkoninae.

In addition to being from the same Province as the syntypes, 20 recently collected specimens of dwarf gecko agree in detail

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Fig. 2. *Microgecko helenae*, USNM 153701, dorsal view. Tip of tail is regenerated.

Fig. 3. *Microgecko helenae*, USNM 153701, ventral view of anterior chinshields.

with Nikolsky's description and figures (1907: Plate 1, Figs. 4, 4a). They differ from the material seen by Anderson and Minton in scale counts, configuration of the chinshields, and in details of the pattern. They also differ from Minton's specimens in having the regenerated portion of the tail black, as in Nikolsky's Fig. 4, rather than yellow, as described by Minton. Anderson's specimen (CAS 86408) possesses a full, slender tail, while seven of the present specimens show regenerated tails to varying degrees, one has a healed stump, and ten have lost their tails since preservation. They differ from Mertens' tailless example in having six or seven supralabials, versus eight or nine, and five or six infralabials, versus seven. Guibé apparently identified his specimen by comparing it with Mertens', although his re-evaluation of *Microgecko* was based on Nikolsky's original description. It thus seems apparent that the 20 new specimens of *M. helenae* are the first collected since the discovery of the Khuzistan dwarf gecko. A redescription of the species follows (Figs. 2, 3):

A small gecko, snout–vent length 15.0–26.2 mm, with smooth, homogeneous, juxtaposed dorsal scales, 62–76 along midline between axilla and groin; nostril bordered by 4–5 scales; internasals large, followed by a second pair of enlarged shields; rostral about three-quarters cleft by a distinct, vertical groove; pupil vertical; supralabials 6–7, usually 7; infralabials 5–6, usually 6; mental pentagonal, followed by two large postmentals, which are separated by 1–3, usually 2, small scales at apex of mental (Fig. 3); dorsal body pattern (in preserved specimens) absent or indistinct, when present consisting of 4–5 undulating transverse brown bands, narrower than interspaces, each followed by a pair of poorly-defined white blotches; laterally, a brown line on either side from rostral passing through eye to ear, where it may end, or continuing onto shoulder; venter white, unpatterned; ventral scales smooth, homogeneous, imbricate, larger than dorsals; digits not dilated, compressed, clawed, with slight angular bend; subdigital lamellae smooth, 13–15 under fourth toe; scales of tail smooth, homogeneous, imbricate, larger than dorsals, subequal dorsally and ventrally; tail thick, fragile, four-fifths, or more, snout–vent length; dorsal pattern always present on tail, consisting of 8–10 transverse straight or undulating brown bands narrower than interspaces, each followed by a pair of poorly-defined white blotches or indistinct white band of about equal width; interspaces indistinctly speckled with black pigment; ventral surface of unregenerated tail white, may be indistinctly speckled with black pigment; regenerated portion of tail uniformly black dorsally and ventrally; sexual dimorphism not obvious, males lacking preanal pores; peritoneum unpigmented. Specimens examined (CAS, California Academy of Sciences; USNM, National Museum of Natural History, Smithsonian Institution):

Microgecko helenae (20)—CAS 120795, USNM 153693–97, Iran: Khuzistan Province; 35 km E Gachsaran, 8 February 1964, J. W. Neal, Jr., collector; USNM 153698–703, CAS 120796, USNM 153705–10, as above, except 10 February 1964; USNM 153731, Iran: Khuzistan Province; 16 km S Masjid-i-Suleiman, 25 February 1964, J. W. Neal, Jr., collector.

Provisionally referred to *Alsophylax persicus* (3)—CAS 86408, Iran: Khuzistan Province; Sar-i-Gach, on road between Masjid-i-Suleiman and Sar-i-Gach, 13 May 1958, S. C. Anderson, collector; USNM 166177–78, West Pakistan: Las Bela Province; Hub Chowki, lower Pub hills, 27 December 1963, J. A. Anderson, collector.

The camp where Neal collected the series of Khuzistan dwarf geckos was situated along a wadi, or dry watercourse, in the western foothills of the Zagros Mountains near the Gachsaran-Kazeroun Road (Fig. 4). The area was characterized by rolling hills with limestone and gypsum outcroppings, and, in the immediate environs of camp, the ground was paved with small, flat stones, under which scorpions, centipedes, and solpugids abounded. Vegetation consisted of scattered grasses, mosses, thorny shrubs and cactus like euphorbs, and an occasional oak. Daily temperatures ranged from a low of 33°F (7 February) to a high of 78°F (6 February), the mean low of seven successive daily recordings being 40°F and the mean high 65°F. Rain, drizzle, and high relative humidity were experienced during four days, but the wadi remained dry. The geckos were taken from under small stones along the wadi on 8 February (low 34°F, high 75°F, relative humidity 89%) and on 10 February (low 38°F, high 52°F, rain). None of the eight females appears to be gravid. In addition to the geckos, we collected one *Bufo v. arabicus*, 22 *Agama nupta*, three *Ophisops e. elegans*, two *Mabuya aurata affinis*, two *Eumeces schneideri*, one *Varanus griseus*, one *Eirenis persica*, one *E. punctatolineata*, and one *Echis carinatus pyramidum*.

The other camp, south of Masjid-i-Suleiman, was also in the Western Zagros foothills and was characterized by sandstone outcroppings and sparser, less varied, vegetation. The area was also dissected by wadis. The maximum recorded air temperature was 80°F (25 February) and the minimum was 43°F (22 February). The mean low temperature of four successive daily recordings was 47°F, and the mean high of three successive daily readings was 76°F. The single juvenile *M. helenae* was collected on 25 February (low 50°F, high 80°F, relative humidity not recorded). Other amphibians and reptiles taken at this site were: two *Bufo v. arabicus*, one *Agama nupta*, one *Eremias guttulata watsonana*, and one *Spalerosophis diadema cliffordi*.

The Khuzistan dwarf gecko, *Microgecko helenae* Nikolsky, a nocturnal, terricolous creature, appears to be endemic to the western foothills of the Zagros Mountains in southwestern Iran.

The specimens described here were collected during field work directed by Dr. Henry W. Setzer, National Museum of Natural History, under U.S. Army Medical Research and Development Command, Office of Surgeon General Grant Number DA-MD-49-193-63-G74(645-M). The author wishes to acknowledge the aid and encouragement of Steven C. Anderson, Henry W. Setzer, Duane A. Schlitter, George R. Zug, and James A. Peters. Mr. John W. Neal, Jr., read and criticized parts of the manuscript and supplied the Kodachrome from which Fig. 4 is taken. The drawings were made by Mr. Thomas G. Yuskiw.

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NORTH AMERICAN HARPACTICOID COPEPODS 9. A NEW *MESOCHRA* (CANTHOCAMPTIDAE) FROM THE GULF OF MEXICO WITH NOTES ON A RELATED MEDITERRANEAN FORM

By Mildred Stratton Wilson[1]
Institute of Marine Science, University of Alaska and
Smithsonian Institution

The cosmopolitan genus *Mesochra* includes a few species seemingly restricted to marine, brackish or fresh waters, and many others exhibiting varying degrees of euryhalinity. Since the genus belongs to a family dominated by freshwater genera either cosmopolitan or hemispherical in their distribution, it is one of considerable ecological and phylogenetic interest.

The new species described herein is from a collection made by Dr. Joel W. Hedgpeth and deposited in the Smithsonian Institution (accession no. 179561). An unnamed species recognized as "probablemente nueva" was briefly described by Margalef (1953) from a Mediterranean island. This form appears to be either a variant of the new Gulf of Mexico species or the two constitute a geographically separate taxonomic species-pair. I am indebted to Dr. Margalef (Barcelona) for sending me a prepared slide of one of his specimens. Characters ascertained from this slide are given below.

Canthocamptidae sensu Lang, 1948
Mesochra Boeck

Mesochra mexicana new species
Figs. 1–15

Occurrence and Type Locality: Pond, Harbor Island, Aransas Bay,

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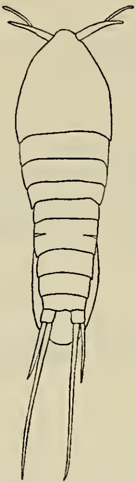
[1] Address: P.O. Box 4-1522, Anchorage, Alaska 99503. Financial support by the National Science Foundation is acknowledged (NSF-G21643 to the Smithsonian Institution; GB7478 to the University of Alaska).



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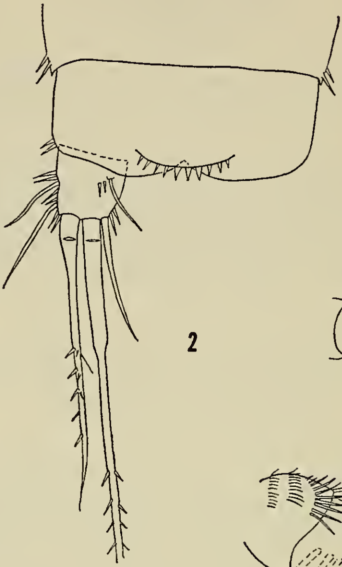

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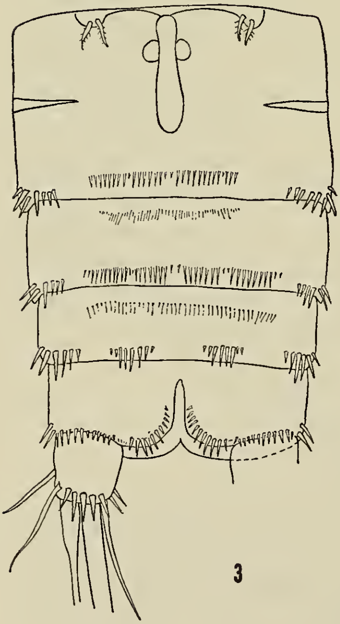

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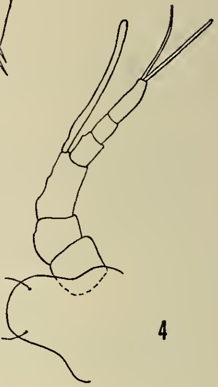

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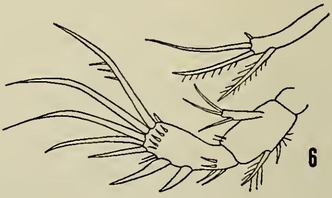

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Aransas Co., Texas, U.S.A., about 28°N, 97°W; 24 March 1948; J. W. Hedgpeth, collector. Occurring with *Nitocra lacustris* (Schmankewitsch) and *Halicyclops fosteri* M. S. Wilson.

Specimens: 3 ♀, ovigerous. Holotype (whole, alcoholic), USNM 127666. Two paratypes dissected, USNM 127667.

Definition (♀): With characters of Group I of Lang (1948): Legs 2–4, exopod segment 3 with 3 spines; leg 1, endopod 3–segmented. Specific characters: Antennule 6-segmented, aesthete on third segment; leg 1, exopod segment 2 with inner seta, endopod segment 1 reduced, its actual length less than that of exopod segments 1 + 2; legs 2–4, endopod segment 2 with total of 5,6,5 setae of which 2,3,2 are on the inner margin; leg 5, exopod with 5 and basal expansion with 6 setae. Male unknown.

Description (♀): Total body length, dorsal midline (base of rostrum to apex of caudal rami): 0.45–0.495 mm.

Body (Fig. 1) robust, gradually tapered posteriorly; cuticle dark brown and thick obscuring any cuticular discs (defined areas of thin cuticle). Genital segment with transverse lateral sclerotizations at midpoint of length; external genital area, including leg 6, as shown in Figure 3; ovisac with 14–15 large ova.

Ornamentation of urosome (genital and succeeding posterior segments, the latter referred to here as segments 2–4): Dorsally and ventrally, distal membrane of segments finely serrate and lateral edges with stout spinules. Ventrally (Fig. 3), a row of spinulose hairs in proximal center portions of segments 2 and 3; fine spinules of varying sizes at distal centers of genital and segments 2–3, those of segment 3 placed in two groups with gap at center of segment; groups of stout spinules of varied lengths continued from lateral groups over bases of caudal rami and along medial incision of last segment. Anal operculum (Fig. 2) with 10 stout spinules.

Caudal ramus (Figs. 2–3) a little longer than broad and a little shorter than outer margin of last body segment; tapered but not constricted distally; dorsal seta accompanied by a few spinules; stout spinules along outer margin, at distal inner margin and overlying caudal setae ventrally. Caudal setae well-developed, relative lengths (outer to inner): 3.2:7.4:1.0; both outer and middle setae swollen and jointed at bases and armed with stout spinules.

Rostrum (Fig. 4) broad throughout, produced forwards from base and prominent in dorsal view, the apex rounded. Antennule (Figs. 4–5) 6-

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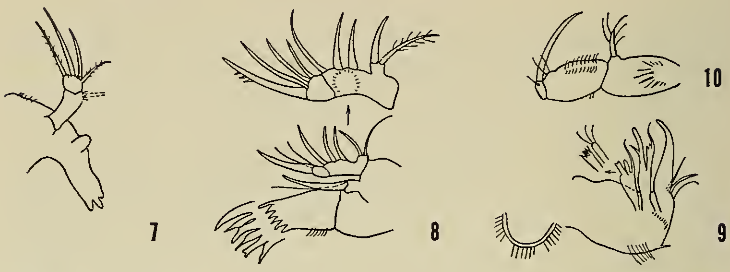
Figs. 1–6. *Mesochra mexicana* n. sp., female, all appendages (figs. 4–15), except fig. 5, drawn to same scale: 1, Habitus, outline of dorsum and ovisac; 2, anal segment with operculum and left caudal ramus with setae; 3, urosome, ventral, with legs 6, external genital area and detail spination of segments and caudal rami; 4, outline rostrum and antennule; 5, antennule with seta, enlarged; 6, antenna with detail exopod.



Figs. 7–10. *Mesochra mexicana* n. sp., female: 7, Mandible (seta of segment 1 of palp shown by dashed lines); 8, maxillule, with enlarged detail apices gnathal lobe and second lacinia; 9, maxilla and sternal plate; 10, maxilliped.

segmented; the third segment (representing fused segments 3 and 4 of the normal canthocamptid antennule) the longest, subequal in length to segments 1 + 2; aesthete on third segment, reaching beyond apex of antennule by about one-third of its own length; segment 1 ornamented with groups of hairs and spinules, its single seta non-plumose; lateral setae of apical segment on basal joints, apical aesthete shorter than that of segment 3. Number of setae on segments of antennule:

1	2	3	4	5	6
1	10 (or 11)	7 (or 8)	1	2 (or 3)	7 (or 8)

(The variation in the number of setae was found on one side of a pair of appendages of one of the two dissected specimens. Because of the thickness of the cuticle and extraneous threadlike debris, it was not easy to make out the exact number of setae and the summary and illustration are presented as tentative.) Antenna (Fig. 6) with 2 setae on allobasis, the proximal spinelike, the distal the longer, plumose; palp (exopod) unsegmented, with 3 setae.

Oral appendages as characteristic for the genus, conforming to the canthocamptid type. Mandible (Fig. 7): Blade with the usual apical teeth and lateral seta; palp 2-segmented, seta of segment 1 probably present but broken in dissected specimens, segment 2 with 4 setae. Maxillule (Fig. 8): Gnathal lobe with 6 apical teeth modified as shown in illustration; first lacinia a simple lobe with 2 setae of unequal thickness; second lacinia elongate and 2-segmented, its first segment having near the base a lobe bearing 2 setae and 3 spinelike setae inserted singly along margin of segment, its second segment with 4 setae of which the apical is the stoutest and spiniform. Maxilla (Fig. 9) with 3 endites, the apices of the first two modified as illustrated, the third clawlike with 3 lateral setae. Maxilliped (Fig. 10) well-developed, basal segment and base of claw each bearing a seta. Sternal plate present between bases of maxilla and maxilliped (Fig. 9).

Leg 1 (Fig. 11): Exopod segment 2 with inner seta. Endopod segments 1 and 2 with inner setae, that of 1 stout basally, placed just below middle of segment; apex of segment 3 with stout outer spine, elongate seta that exceeds length of longest seta of exopod, and a shorter, plumose seta placed subapically. Endopod segment 1 broadened in midregion, reaching to near end of exopod segment 2, its actual length less than combined lengths of exopod segments 1 + 2 (about 1:1.4) and of endopod segments 2 + 3 (about 1:1.6); endopod segments 2 and 3 subequal in length to one another (along inner margin), each much narrower than segment 1.

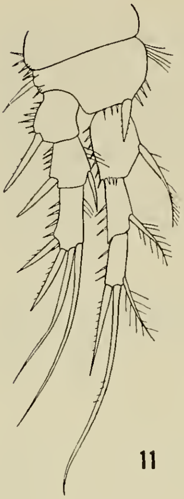
Legs 2–4 (Figs. 12–14): Exopod segment 3 with 3 outer spines; endopods 2-segmented, length decreasing regularly from legs 2–4. Summary of setation of legs 1–4, outer to inner margin (Sp = spine; s = seta; position on segment 3 indicated by the marks – or , : – = separation of outer, apical and inner margins; the , divides spine and setae of apex of endopod 3):

	Exopod				Endopod			
	1	2	3	Total Exo. 3	1	2	3	Total Apical Seg.
Leg 1	Sp–0	Sp–s	2Sp–2s–0	4	0–s	0–s	0–Sp,s–s	3
Leg 2	Sp–0	Sp–s	3Sp–2s–1s	6	0–s	Sp–2s–2s		5
Leg 3	Sp–0	Sp–s	3Sp–2s–2s	7	0–s	Sp–2s–3s		6
Leg 4	Sp–0	Sp–s	3Sp–2s–2s	7	0–s	Sp–2s–2s		5

(In leg 3 of one paratype specimen, shown in Figure 13, endopod segment 2 had one less seta on one side than on the other. This seems to be an anomaly since the loss was that of the innermost apical seta present in other species of *Mesochra*, rather than one of the three setae of the inner margin where two setae are present in most of the known species. This has therefore not been recorded as a variation in the above summary.)

Leg 5 (Fig. 15): Exopod segment, length to width about 1.5:1; with 5 setae, the three outermost spiniform and shorter than the segment, the other two longer than the segment, the innermost about half as long as the fourth seta. Basal expansion produced a little beyond exopod; with 6 stout setae, the first (outermost) and three innermost spiniform and short, these last three graduated in length and placed on inner margin of the segment; setae 2 and 3 (from outer margin) the longest of the setae, seta 3 reaching to about end of longest exopod seta, seta 2 about half its length and similar to the innermost seta of exopod.

Ecology: *Mesochra mexicana* can be considered as only a brackish water species, with a probable variable euryhalinity. Neither of the species associated with it are known to be marine. *Nitocra lacustris* ranges from brackish to fresh water (Lang, 1948; Noodt, 1957). *Halicyclops fosteri* is known otherwise only from brackish water, as is common for the genus. The specimens of both of these associated species from the Harbor Island pond have been previously described or illus-



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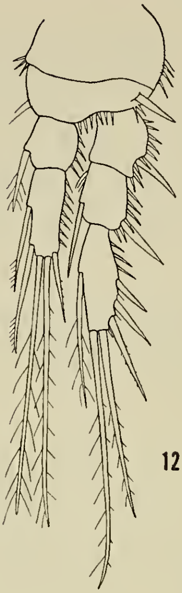

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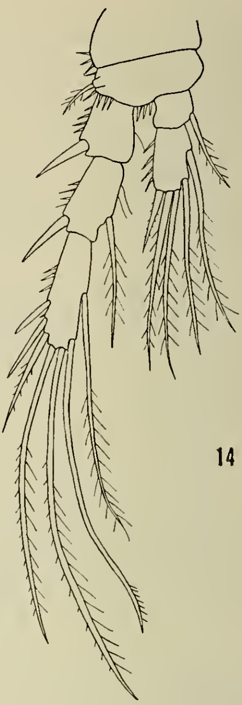

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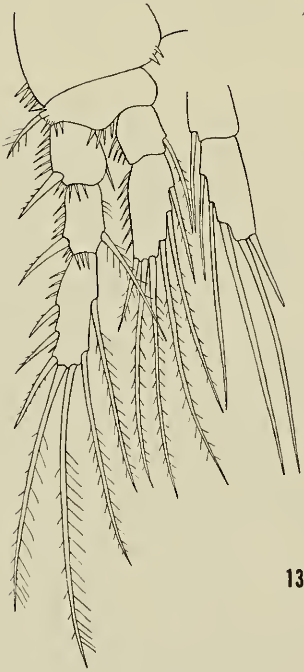

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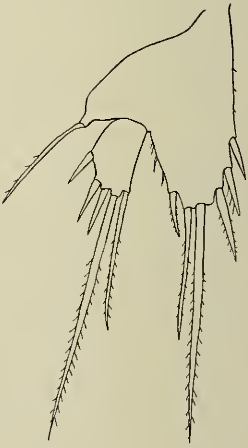

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trated in literature (Wilson, 1958b; Wilson and Yeatman, 1959, fig. 29.168). All specimens of the three species in the sample were dark brown in color and had thickened cuticle, a condition probably due to environmental factors.

Mesochra sp. or *M. mexicana* variant

Mesochra sp., Margalef, 1953: 102, fig. 6V–W (descriptive notes; figs. of legs 1, 5 ♀).
Mesochra cf. *heldti* Monard: Margalef, 1953, in legends for fig. 6 and table 12.
Mesochra sp. conf. *heldti* Monard, Margalef, 1953: Bodin, 1967, p. 41 (catalog list).

Material examined: 1 undissected ♀, mounted in ventral view; slide from Margalef collection, deposited Smithsonian Institution.

Descriptive notes: Margalef compared a few characters with specimens of *M. heldti* from Menorca. His notes (translated) state: "Female 0.425–0.45 mm, with 9 eggs in sac. Operculum with 5 spines; first segment of endopod of the first leg somewhat shorter than segments 1 and 2 combined and without inner seta (?)."

Since the single mounted specimen is undissected it was possible to discern only some characters. The following observations confirm or add to Margalef's notes and illustrations: Caudal ramus similar to that of *M. mexicana* but apical caudal setae not enlarged. Urosome ventral armature similar so far as could be observed; operculum with 5 very stout spinules. Antennule not in good position but appearing to be 6-segmented. Leg 1 mostly discernible, shape and size as in Margalef's Figure 6V but setae of exopod longer, similar to those of *M. mexicana*; inner seta of endopod segment 1 present; Margalef shows no inner seta on exopod segment 2 but one may be present since there is a characteristic indentation of the segment where it should originate. The exopods of legs 2–4 can be seen in the mount and have armature like those of *M. mexicana* but the more important characters of the endopods cannot be distinguished. Leg 5 agrees with Margalef's 6W, closely resembling that of *M. mexicana.*

Before the status of this form, either as a separate but closely related species or subspecies, can be determined, it will be necessary to know the setation of the endopods of legs 2–4. If it agrees with that of *M. mexicana,* the two may be variants of the same species or subspecies. It may also be necessary to know the characters of the males of both before final determination can be made.

Ecology and Occurrence: This form was collected on 5 June 1950 from a pool ("charco junto" in Spanish) near a salt-mine south of a

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FIGS. 11–15. *Mesochra mexicana* n. sp., female: 11, Leg 1; 12, leg 2; 13, leg 3, with outline anomalous endopod (see text); 14, leg 4; 15, leg 5.

large lake formed by the sea, near Alcudia, Mallorca, one of the Balearic Islands off the Mediterranean coast of Spain, about 39°51′ N, 3°8′ E. Margalef has discussed the characteristics of the habitats studied on the island and given long lists of organisms from them. One other species of *Mesochra* (*M. lilljeborgi*) was found. All harpacticoid copepods listed are those found in coastal bodies of brackish water of comparatively low salinity.

TAXONOMY

There is no question that the geographically separated *M. mexicana* and the Mediterranean form are properly placed in *Mesochra* as now defined. All of the appendages, the rostrum, and the genital region are highly characteristic of the genus. The two forms are closely allied through a character rare in the genus—the short, broad first segment of the endopod of leg 1. Otherwise, *M. mexicana* seems to be allied to *M. armoricana* Monard (1935). Both are similar in the form of leg 5, the enlarged caudal setae, and the ventral spinal ornamentation of the urosome. Also, both have a character not widely known in *Mesochra*—the presence of three setae on the inner margin of endopod 2 of leg 3.

Bodin's (1967) list of species of *Mesochra* described since Lang (1948) includes all but two of those known to me. These are:

M. suifunensis Borutskii (1952) ♀, ♂, Suifun River, Asian U.S.S.R.;
M. alaskana M. S. Wilson (1958a; illustrated in M. S. Wilson and Yeatman, 1959) ♀, ♂, Alaska, U.S.A.

The nomenclatural status of two names in Bodin's list will have to be considered in future revisions. *M. pygmaea* var. *meridionalis* Steuer, 1943, if raised to a subspecies or species, would become a primary homonym of *M. meridionalis* Sars, 1905. *M. parva* Thomson, 1946, is a secondary homonym of *Mesochra parva* (T. and A. Scott, 1896), originally described as *Canthocamptus parvus* and long recognized as a synonym of *M. pygmaea* (Claus) (Lang, 1948). From Thomson's description, it appears that his species is closely allied to *M. meridionalis* Sars from the Chatham Islands, and the conspecificity of the two should be carefully considered before a replacement name (nomen novum) is proposed.

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Addendum: Another species to be added to Bodin's 1967 list is: *M. quadrispinosa* Shen and Tai, 1965, ♀, ♂, China (Acta Zootaxonomica Sinica 2(2):126–140).

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PROCEEDINGS
OF THE
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A NEW SHRIMP OF THE GENUS *GNATHOPHYLLUM* (DECAPODA, CARIDEA) FROM PUERTO RICO

By Fenner A. Chace, Jr., and Samuel L. H. Fuller
Smithsonian Institution and Academy of Natural Sciences of Philadelphia

The bizarre color patterns displayed by the species of the genus *Gnathophyllum* Latreille, 1819, command attention whenever these stocky little shrimps are encountered. Except for the nearly pantropical and relatively common *G. americanum*, however, sufficient material has not yet become available to permit reliable evaluation of specific characters in the genus. The following description is offered in the hope that it may contribute in a small way to a better understanding of these criteria.

This shrimp was collected during a biological survey on the southeastern coast of Puerto Rico conducted by members of the Limnology Department, Academy of Natural Sciences of Philadelphia, at the request of the Sun Oil Company, without whose support the discovery at this time would have been impossible. The chemical data discussed below were compiled by Robert W. Haug, Chemist in the Limnology Department, and his associates, H. Jesse Steelman and James M. Chance.

Gnathophyllum splendens new species

Figures 1–5

Material: Puerto Yabucoa, one-half mile east of Playa de Guayanés, Municipio de Yabucoa, Puerto Rico; 14–15 July 1969; S. L. H. Fuller: 1 male holotype (USNM cat. no. 134422).

Description: Rostrum (Fig. 2*a*) sloping ventrad, slightly concave dorsally, reaching about as far as end of antennular peduncle; dorsal margin armed with five teeth, posteriormost situated on carapace behind level of orbital margin, distal two-fifths of margin unarmed, faintly convex and nearly horizontal; ventral margin armed with small but

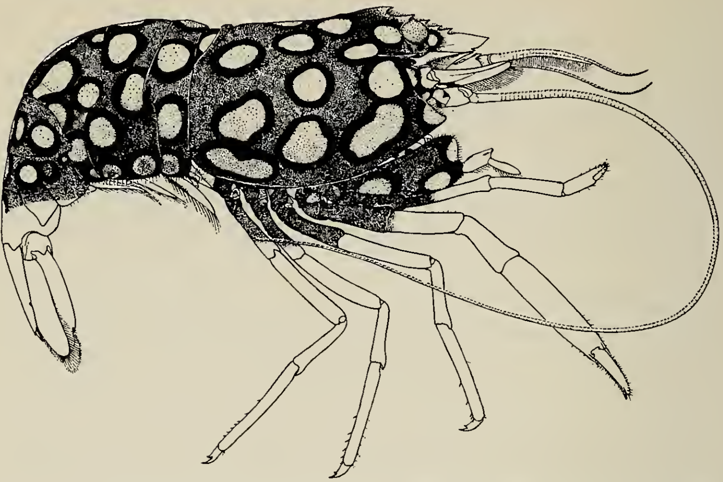

FIG. 1. *Gnathophyllum splendens* new species, male holotype, × 3.4.

distinct tooth nearly opposite midpoint of unarmed portion of dorsal margin; lateral carina near but diverging slightly from ventral margin anteriorly, terminating at about level of anterior dorsal tooth. Middorsal carina extending posteriorly from posterior dorsal tooth, disappearing slightly posterior to midlength of carapace, and surmounted by inconspicuous obtuse prominence at about midlength of carina. Antennal spine large and sharp, directed slightly dorsad and terminating dorsal to orbital angle in lateral view. Anteroventral angle of carapace acutely but bluntly triangular, produced anteriorly nearly to level of anterior rostral tooth. Sternum with pair of subquadrate flaps extending ventrad between coxae of second pereiopods.

Pleura of first three abdominal somites rounded, that of fourth subrectangular, of fifth narrowly but bluntly acute with posterior margin sinuous; sixth somite (Fig. 2*b*) with posteroventral angle sharply acute on left side, rounded (probably abnormal) on right side. Sixth somite nearly one and two-thirds times as long as fifth, slightly more than half as long as telson not including terminal spines; ventral surface smooth, without projection between bases of uropods. Telson (Fig. 2c) armed with two pairs of small lateral spines, anterior pair arising nearly two-thirds of length of telson from anterior end, posterior pair nearly in line with and barely distinguishable from series of posterior spines; posterior margin (Fig. 2*d*) with acute median point and armed with two pairs of stout spines, separated by single (perhaps abnormal) slender median spine, lateral pair of posterior spines somewhat longer and stronger than posterior pair of lateral spines but no more than two-fifths as long as intermediate spines of posterior series.

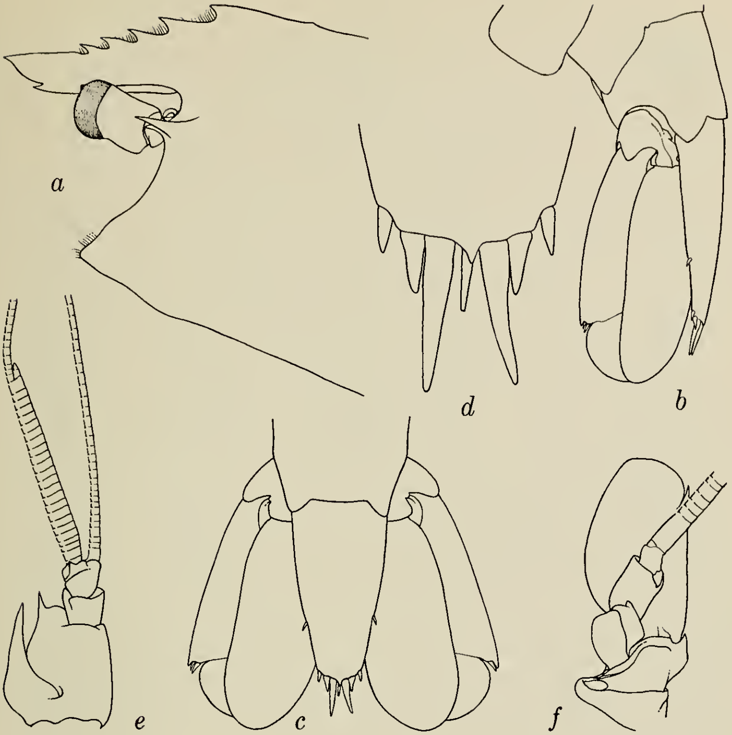

FIG. 2. *Gnathophyllum splendens* new species, male holotype. *a*, anterior region. *b*, telson and uropods, lateral view. *c*, same, dorsal view (telson slightly foreshortened). *d*, tip of telson. *e*, left antennule. *f*, left antenna. (*a–c*, *e*, *f*, × 6.5; *d*, × 27.)

Eye (Fig. 2*a*) robust, cornea considerably shorter than stalk and bearing distinct papilla on distal surface.

Antennular peduncle (Fig. 2*e*) with stylocerite tapering to sharp tip, overreaching midlength of second segment; basal segment fully as broad as long not including spinose lateral lobe, distolateral spine slightly overreaching stylocerite, distinct tooth on ventromesial surface. Antennular flagella subequal, slightly shorter than carapace; dorsolateral flagellum with about 24 articles in thickened, setigerous basal portion; accessory flagellum composed of two indistinct articles.

Antennal scale (Fig. 2*f*) broad, little more than one and three-fourths times as long as broad; lateral margin nearly straight, distal tooth sharp, falling far short of faintly angulate distal margin of blade. Antennal

FIG. 3. *Gnathophyllum splendens* new species, male holotype. *a*, left mandible. *b*, same. *c*, left first maxilla, *d*, left second maxilla. *e*, left first maxilliped. *f*, left second maxilliped, posterior surface. *g*, same, anterior surface. *h*, same, portion of extensor margin of terminal segment. *i*, left third maxilliped. *j*, same, spoon-tipped seta from mesial margin of terminal segment. *k*, same, setae near notch in mesial margin of antepenultimate segment. (*a*, *c*–*g*, *i*, × 6.5; *b*, × 27; *h*, *k*, × 68; *j*, × 280.)

peduncle robust and short, reaching about midlength of scale; basal segment with sharp tooth below base of scale.

Mandible (Figs. 3*a*, *b*) much reduced in comparison with other mouth parts, incisor process represented by sharp toothlike lobe. First maxilla (Fig. 3*c*) with characteristically enlarged distal endite armed with double row of stout spines; palp bearing two curved spines distally.

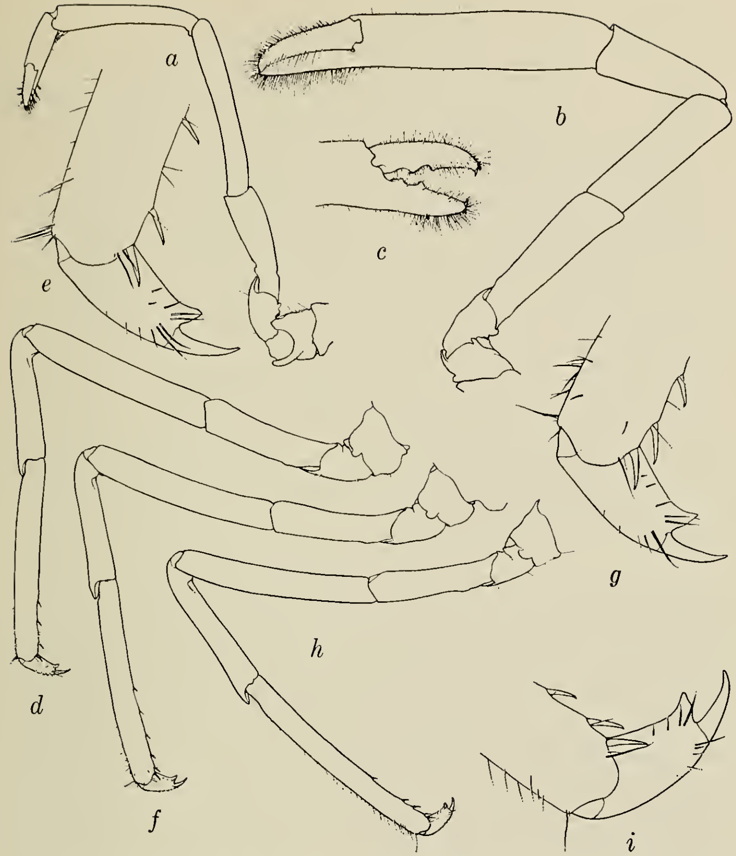

FIG. 4. *Gnathophyllum splendens* new species, male holotype. *a*, left first pereiopod. *b*, left second pereiopod. *c*, same, fingers in lateral view. *d*, left third pereiopod. *e*, same, dactyl. *f*, left fourth pereiopod. *g*, same, dactyl. *h*, left fifth pereiopod. *i*, same, dactyl. (*a–d*, *f*, *h*, × 6.1; *e*, *g*, *i*, × 25.)

Second maxilla (Fig. 3*d*) without endites. Maxillipeds (Figs. 3*e–i*) typical of genus; extensor margin of distal segment of second maxilliped armed with partially double row of S-shaped, denticulate spines and curved setae (Fig. 3*h*); terminal segment of third maxilliped bearing variably spoon-tipped setae (Fig. 3j) on mesial margin, antepenultimate segment bearing broad-based, denticulate setae (Fig. 3*k*) on mesial margin.

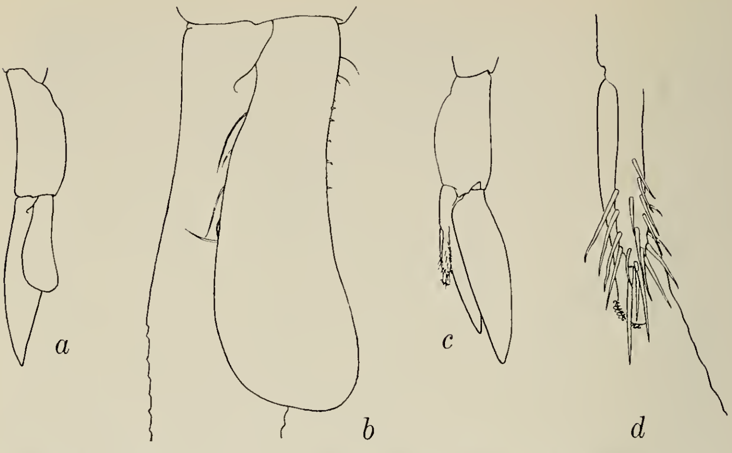

FIG. 5. *Gnathophyllum splendens* new species, male holotype. *a*, left first pleopod. *b*, same, endopod. *c*, left second pleopod. *d*, appendix masculina. (*a*, *c*, × 7; *b*, *d*, × 29.)

First pereiopod (Fig. 4*a*) overreaching antennal scale by length of chela and two-thirds of carpus; fingers slightly shorter than palm; carpus nearly one and two-fifths times as long as chela and about four-fifths as long as merus. Second pereiopod (Fig. 4*b*) also overreaching antennal scale by length of chela and two-thirds of carpus; fingers (Fig. 4*c*) about two-fifths as long as palm, each armed with two prominent teeth; carpus little more than one-third as long as chela and slightly shorter than merus; ischium slightly longer than merus. Third pereiopod (Fig. 4*d*) overreaching antennal scale by dactyl, propodus, and one-third of carpus; dactyl (Fig. 4*e*) with accessory tooth on flexor margin forming broadly acute triangle; propodus little more than seven and one-half times as long as wide, more than three and three-fourths times as long as dactyl, nearly one and one-third times as long as carpus, and slightly shorter than merus. Fourth pereiopod (Figs. 4*f*, *g*) similar to third, overreaching antennal scale by dactyl and nearly entire propodus. Fifth pereiopod (Figs. 4*h*, *i*) overreaching antennal scale by dactyl and at least three-fourths of propodus; propodus about nine and one-half times as long as wide, four and two-thirds times as long as dactyl, one and one-third times as long as carpus, and one-tenth longer than merus.

Endopod of first pleopod (Figs. 5*a*, *b*) more than half as long as exopod, broadest near distal end, bare except for few setae on proximal halves of both margins. Appendix masculina on endopod of second pleopod (Figs. 5*c*, *d*) shorter than appendix interna, bearing about 20 spinelike setae in distal half. Lateral branch of uropod (Fig. 2*c*) with one or two movable spines mesial to distal tooth of lateral margin.

Color and pattern in life (Fig. 1): Color absent from anterior half of rostrum, tips of pleura of fourth and fifth abdominal somites, most of sixth somite, and tail fan. Remainder of body brilliant orange, with superimposed cream-colored spots outlined in dark brown or black. Spots arranged rather symmetrically on each side of body except that anterodorsal spot on right side of third abdominal tergite not duplicated on left side, and orange spot on right pleuron of fourth somite cream-colored on left. Spots in dorsal midline numbering one on cardiac region of carapace, one each on first, second, fourth, fifth, and sixth abdominal terga, and two on third. Three spots adjacent to margins of pleura of first and second somites with reddish centers, hence tricolored. Spots somewhat lighter cream dorsally than ventrolaterally. Cornea of eye not very dark. Antennular peduncle with dark-ringed spot on dorsal surface of basal segment, stylocerite mostly orange, remainder without color. Color pattern continuing onto basal segments of antennal peduncle and proximal third of antennal scale. Antepenultimate segment of third maxilliped conspicuously colored with two and one-half spots on orange background. Orange color extending onto first pereiopod as far as median third of merus, on second pereiopod to base of merus, on third to distal end of ischium, and on fourth and fifth to near end of ischium.

Size: Carapace length from orbital margin 7.0 mm.

Remarks: There is little doubt that this species is most closely related to *G. circellum* Manning, 1963, from the Florida Keys and the Bahamas, the only other species of the genus marked with rings on the carapace and abdomen. In that species, however, both the background color and the ringed spots are uniformly brown, with the rings darker brown. *Gnathophyllum splendens* has the background color bright orange and the spots light colored and more numerous, but it may be significant that most of the spots that are duplicated in the two species are similarly positioned. For that reason, we would be most reluctant to consider the Puerto Rico specimen distinct were it not for the much less slender pereiopods.

The specimen has been compared with the male holotype of *G. circellum*, which has a carapace length of 5.6 mm, with a smaller male paratype having a carapace length of 3.6 mm, and with an ovigerous female paratype, in which the carapace measures 7.2 mm. The most striking differences in the proportions of the pereiopods are indicated in the following tabulation of the propodal length-width ratios:

	Pereiopods			
	2	3	4	5
G. splendens, ♂ holotype	5.3	7.6	7.8	9.5
G. circellum, ♂ holotype	7.4	12.6	14.3	16.9
G. circellum, ♂ paratype	6.6	–	15.3	14.4
G. circellum, ovigerous ♀ paratype	–	–	–	14.4

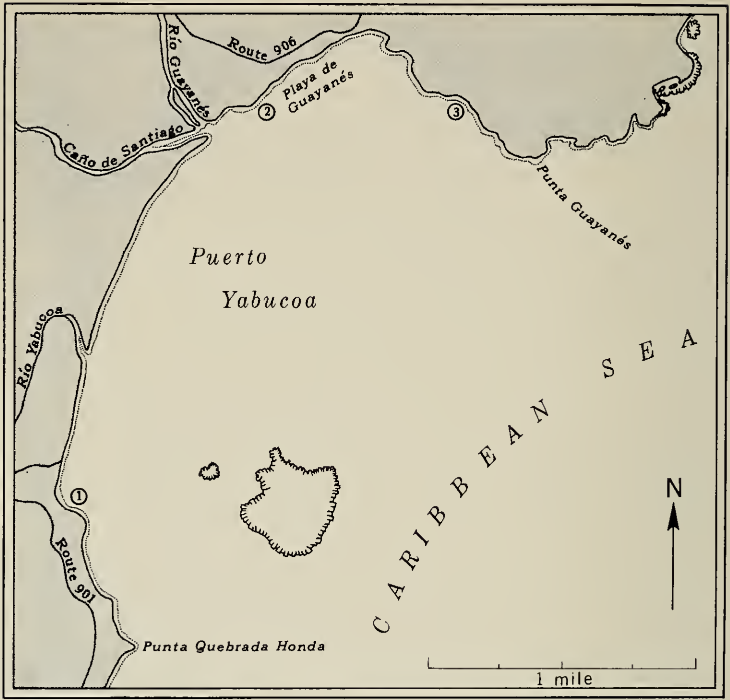

Fig. 6. Map of Puerto Yabucoa in Municipio de Yabucoa, approximately three miles east of Yabucoa, southeastern Puerto Rico, showing influent fresh-water streams, locations of coral reefs, and the three stations (circled numbers) where Philadelphia Academy of Natural Sciences macroinvertebrate collections were made. Station 3, one-half mile east of Playa de Guayanés, is the type-locality of *Gnathophyllum splendens.*

Gnathophyllum circellum differs from all other recognized species of the genus, including *G. splendens,* not only in the unusually slender pereiopods but also in the more marked curvature of the propodus of the three posterior pairs and the more elongate dactyls, with the accessory tooth more narrowly acute.

The other differences noted between the Puerto Rican specimen and the type-specimens of *G. circellum* are certainly less important and probably represent only individual variations or abnormal characteristics. None of the specimens of *G. circellum* has any indication of a prominence on the middorsal carina of the carapace; all have three pairs of posterior spines on the telson, rather than having the median pair represented by a single spine; the palp of the first maxilla is armed with one, rather than two, curved spines; and the fingers of the second pereiopod are more than half as long as the palm and obscurely dentate on the opposable margins, rather than less than half as long as the palm and armed with prominent teeth.

The three species that have the body covered with innumerable light dots on a dark background—*G. elegans* (Risso, 1816) from the Mediterranean; *G. modestum* Hay, 1917, from the western Atlantic; and *G. panamense* Faxon, 1893, from the eastern Pacific—are closely related to each other and they may prove to be indistinguishable when more comparative material becomes available from the three regions. *Gnathophyllum splendens* agrees with all three in the proportions of the pereiopods but differs from them, in addition to the distinctive color pattern, in at least two apparently reliable characters: (1) the first segment of the antennular peduncle is shorter and broader, so that the stylocerite reaches far beyond the articulation with the second segment, rather than falling short of that level, and (2) the posterior pair of lateral telson spines is nearly in line with the spines of the posterior margin, rather than separated from them by a variable but distinct gap.

Gnathophyllum splendens differs from *G. americanum* Guérin Méneville, 1856, fom the western and eastern Atlantic and the Indo-Pacific region from the Red Sea and South Africa to Japan and Oceania, in having the posterior tooth of the rostral series situated posterior, rather than anterior, to the level of the orbital margin, as well as in having the antennal scale broader and less triangular and the posterior pair of lateral telson spines not far removed from the series of posterior spines.

The specific name is derived from *splendeo*, L., = to be bright and shining.

The type-locality of the new shrimp is located on Puerto Yabucoa, a sandy bay along the southeastern coast of Puerto Rico some three miles east of Yabucoa, the nearest town of any size. The bay is shallow in outline (Fig. 6) and in depth. The shoreline is chiefly a monotony of gently sloping beach, broken occasionally by low cliffs and scattered boulders (Fig. 7). Although true coral reef occurs in six to 10 feet of water at the mouth of Puerto Yabucoa, there is none close to shore except for limited areas facing the open sea just northeast of Punta Guayanés (Fig. 6). Macroinvertebrate collections were made in three areas (designated as Stations 1, 2, and 3 in Fig. 6), but these are all well within the bay. Only the third station—the type-locality of *Gnathophyllum splendens*—exhibits in any quantity the sorts of habitats where one might expect to encounter members of the genus, which are evidently of exclusively secretive habits.

Manning (1963) states that species of *Gnathophyllum* and of allied genera are thought to frequent the innermost recesses of coral heads and are known to be in some manner symbiotic with sea urchins and, possibly, with certain sponges and coelenterates (especially sea anemones,

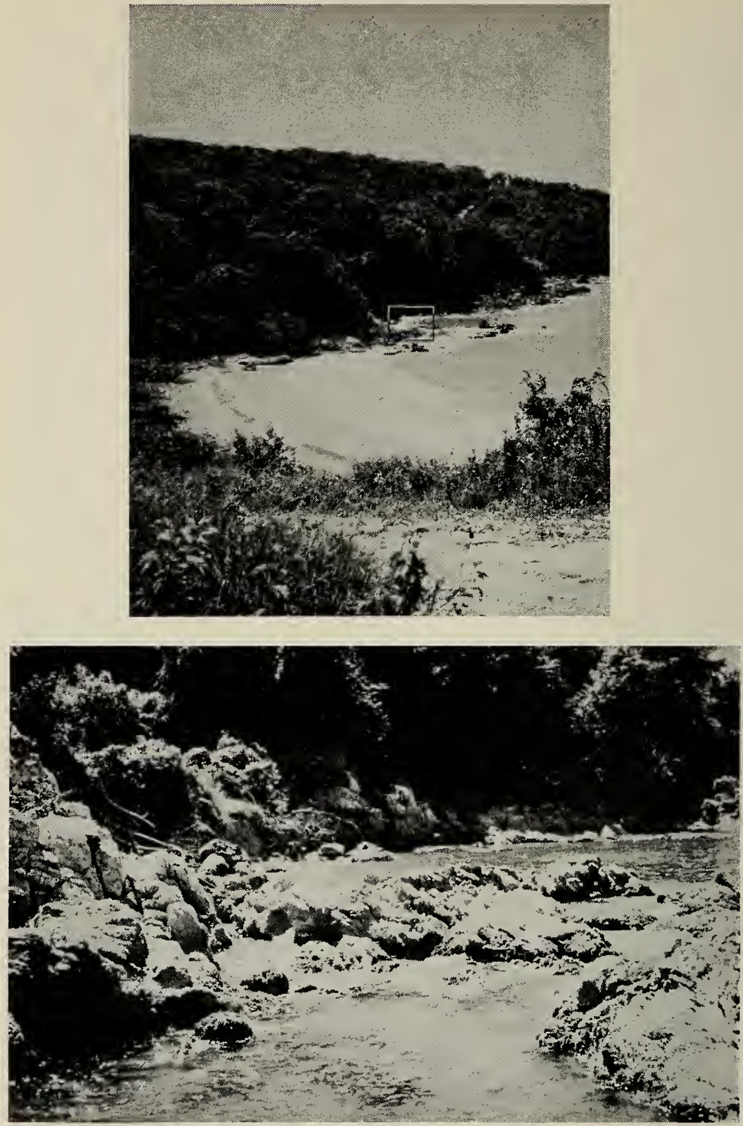

FIG. 7. Upper, Station 3 (see Fig. 6).—lower, enlargement of rectangle in upper photograph, showing rocky pools where holotype of *Gnathophyllum splendens* was taken.

Anthozoa: Actiniaria). The lone specimen of *G. splendens* was secured in the wake of fish poisoning in the area of tide pools shown in Fig. 7. Here there is an abundance of anemones, urchins, and sponges living among pockets in the friable rock that extends bayward some 20 to 40 feet from shore.

Neither physical habitats of these types nor extensive opportunities for symbiotic life are available to *Gnathophyllum* at the other two stations set on Puerto Yabucoa. Moreover, riverine influence is conspicuous in those areas. Station 2 receives sugar-refinery wastes from the confluence of Río Guayanés and Caño de Santiago. A tiny fishing village contributes additional organic refuse at Station 1, where the coliform count was twice the levels elsewhere in the bay. At both stations, the silicon concentrations were twice the level at Station 3; turbidity, conductivity, and other physical and chemical qualities of the water were often very different from those at the type-locality. No fewer than four fresh-water streams serve to lower salinities in the western portion of Yabucoa Bay (Fig. 6).

The specific compositions of the macroinvertebrate faunas at Stations 1 and 2 reflect these differences. The first is the best sheltered of the three areas, and, despite the heavy organic load, its fauna is numerically comparable to the species total at the type-locality. The second station, on the other hand, is directly exposed to rollers from the open sea and suffers an impoverished habitat diversity: its fauna comprises only one half of the number of species recorded elsewhere. In spite of fish poisoning and exhaustive search, no species of *Gnathophyllum* was taken at these two stations. A combination of physical, chemical, and biological factors appears to have excluded the new species, which possibly prefers sheltered waters that are relatively free of mechanical and chemical pollutants.

The type-locality is a truly marine environment (the average salinity was 36.7 ppm), with a healthy pH (8.5) and dissolved oxygen concentration (6.4 ppm). However, the quantities of certain elements (such as potassium and phosphorus) were atypical of ordinary marine values, and riverine influence from the western shore of the bay is apparent.

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PROCEEDINGS
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PARASTEPHOS OCCATUM, A NEW SPECIES OF HYPERBENTHIC COPEPOD (CALANOIDA: STEPHIDAE) FROM THE INLAND MARINE WATERS OF WATERS OF WASHINGTON STATE[1]

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Sars (1902) described the first species of *Parastephos*, *P. pallidus.* Additional descriptions of this species have been given by Sars (1903, 1919) and Scott (1903). More than a dozen species of the closely related *Stephos* Scott, 1892, have been described, but I am aware of no other *Parastephos* in the literature.

Most marine calanoid copepods are planktonic and not associated with the bottom. A few have been referred to as bottom-living, since they have been obtained almost exclusively on or near the bottom. Beyer (1958) used "hyperbenthos" in referring to animals living just above the bottom. He differentiated between those animals that are bound to this region and those that are not. Hyperbenthic animals are distinct from those living on (epibenthos) or in (endobenthos) the bottom. The hyperbenthic animals exist in a region about which relatively little is known.

Hyperbenthic calanoid copepods are seldom taken in plankton collections. Specially constructed dredges have been used to sample just above the sediment; such collections have yielded species encountered infrequently (Sars, 1902; Beyer, 1958; Matthews, 1961). However, hyperbenthic species may move upward and be captured with conventional nets.

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Certain calanoid families seem to contain mostly, if not entirely, hyperbenthic species. Other families of mostly planktonic species have genera of hyperbenthic species. Bradford (1969) has summarized many records of hyperbenthic calanoids. With the development of new techniques to sample the near-bottom plankton, previously unknown calanoids will be found. Such samples may also reveal unusual groups of other copepods, as Wilson (1965) suggested for harpacticoids.

The present species was first found during a study of the vertical distributions of Copepoda in Dabob Bay in 1960. Dabob Bay is an inlet with a maximum depth of 190 m, which joins Hood Canal about 20 miles southwest of its connection to Puget Sound, Washington. Bottom depth at station 1 was about 160 m; the sample was collected 29 October at 1430 hr. Bottom depth at station 2 was about 150 m; the sample was collected 27 December at 1620 hr. Samples were collected with Clarke-Bumpus quantitative plankton samplers (Paquette and Frolander, 1957) using nets with a mesh aperture of 215 μ. Samples were obtained by towing the net 20 min as close to the bottom as practicable; there was no indication that the bottom was struck. Wire-angle calculations indicated that the samples were taken not farther than a few meters from the bottom. From 10 to 20 m^3 of water were filtered for each sample.

The species was found again, in 1965, at Port Madison, Puget Sound; bottom depth at station 3 was about 20 m; this locality is described in detail by Lie (1968) as station 3. This sample was collected 28 February at 1115 hr, with a Beyer "plankton sled" towed on the bottom for 10 min. The design of the sled prevented sampling while it was being lowered or raised. The center of the net, a 0.5-m ring net with 215-μ mesh aperture, was towed about 55 cm above the bottom.

Body length measurements are from anterior border of prosome to posterior edge of caudal rami. Figures were drawn with the aid of a Wild M20 drawing tube. The letter after each

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FIG. 1. *Parastephos occatum* female: *a*, habitus, dorsal view (A); *b*, habitus, lateral view (A); *c*, first antenna (D); *d*, left leg 1 (F); *e*, leg 5 (F).

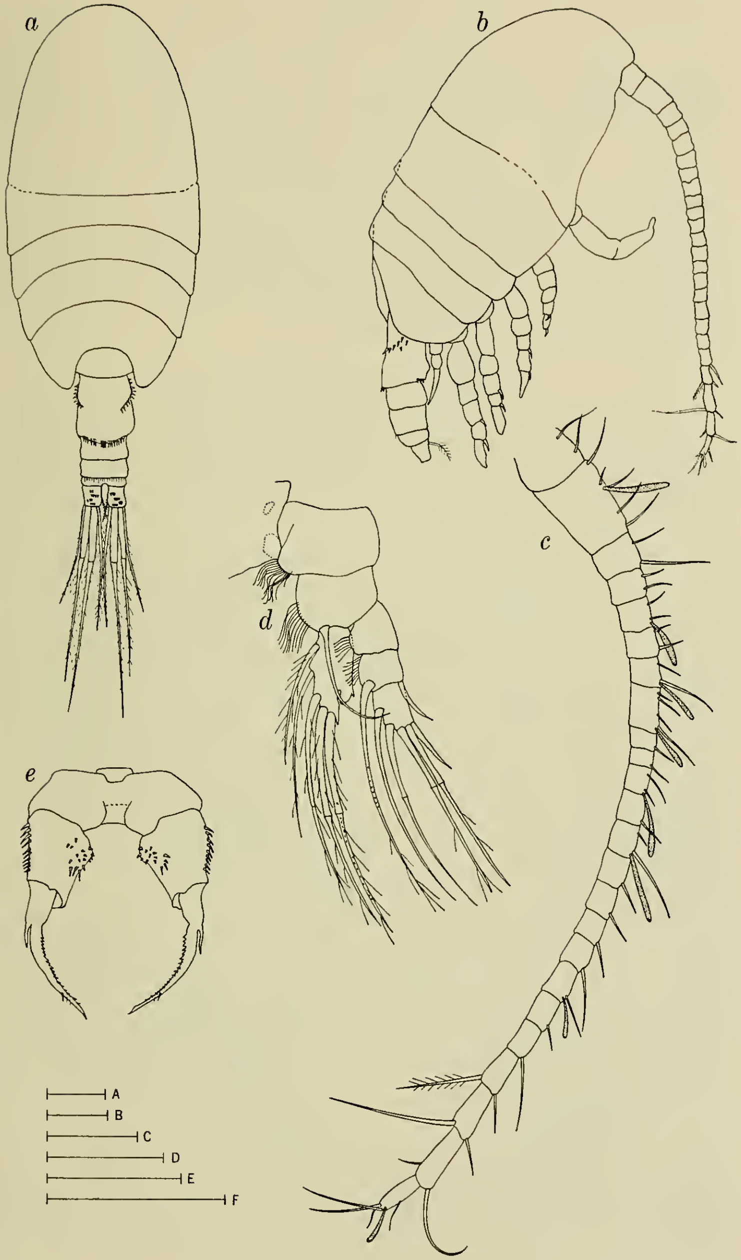
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figure legend refers to the scale to which the figure was drawn; each scale represents 0.1 mm. Legs are illustrated in anterior view; armature is shown in the text by Sewell's (1949) method; setae are represented by Arabic and spines by Roman numerals; Si = inner border of segments, St = terminal border of segments, Se = outer border of segments. Type-specimens have been deposited in the United States National Museum (USNM).

Dr. Thomas E. Bowman, Dr. T. Saunders English, and Miss Gayle A. Heron read the manuscript critically; I appreciate the assistance of Mrs. Janet Griffin Kiefer and Mr. Ion Manta in final preparation of the figures.

Parastephos occatum new species

Material Studied: 3 females from Dabob Bay, station 1, body lengths 0.85, 0.9, 0.9 mm (holotype, USNM 134480); 1 female from Dabob Bay, station 2, 0.9 mm; 1 female from Puget Sound, station 3, 1.0 mm. Four males from Dabob Bay, station 1, 0.85 (allotype, USNM 134481), 0.85, 0.9, 0.9 mm.

Female: Body (Fig. 1*a,b*) robust, urosome about ⅓ length of prosome. Cephalosome vaulted in lateral view; rostrum absent. Faint transverse suture mid-length on prosome; last 2 prosomal segments fused and posteriorly rounded in lateral view. Urosome 4-segmented. Genital segment asymmetrical, slightly swollen, with 2 semi-encircling mid-lateral ridges with teeth; slightly protuberant ventrally; dorsal and ventral posterior margins with teeth. Urosomal segments 2–3 about equal, the posterior edge of segment 3 with stiff hairs. Anal segment short but clearly defined. Caudal rami about as wide as long, with several rows of teeth on dorsal surface. Caudal ramus with 4 plumose terminal setae, middle 2 thickened for ⅓ of length. A small inwardly directed plumose seta on anterior ventral surface of caudal ramus.

First antenna (Fig. 1*c*) of 24 segments; extends nearly to end of urosome; similar in structure and about equal in armament to that of male. Armature: segment I-2; II-5, 1 esthete; III-2; IV-2; V-2, 1 esthete; VI-2; VII-2, 1 esthete; VIII-4, 1 esthete; IX-1; X-1; XI-2, 1 esthete; XII-1; XIII-2, 1 esthete; XIV-1; XV-1; XVI-1; XVII-1; XVIII-1, 1 esthete; XIX-1; XX-1; XXI-2; XXII-2; XXIII-2; XXIV-4, 1 esthete.

Second antenna, mandible, first maxilla, second maxilla, and maxilliped as in male.

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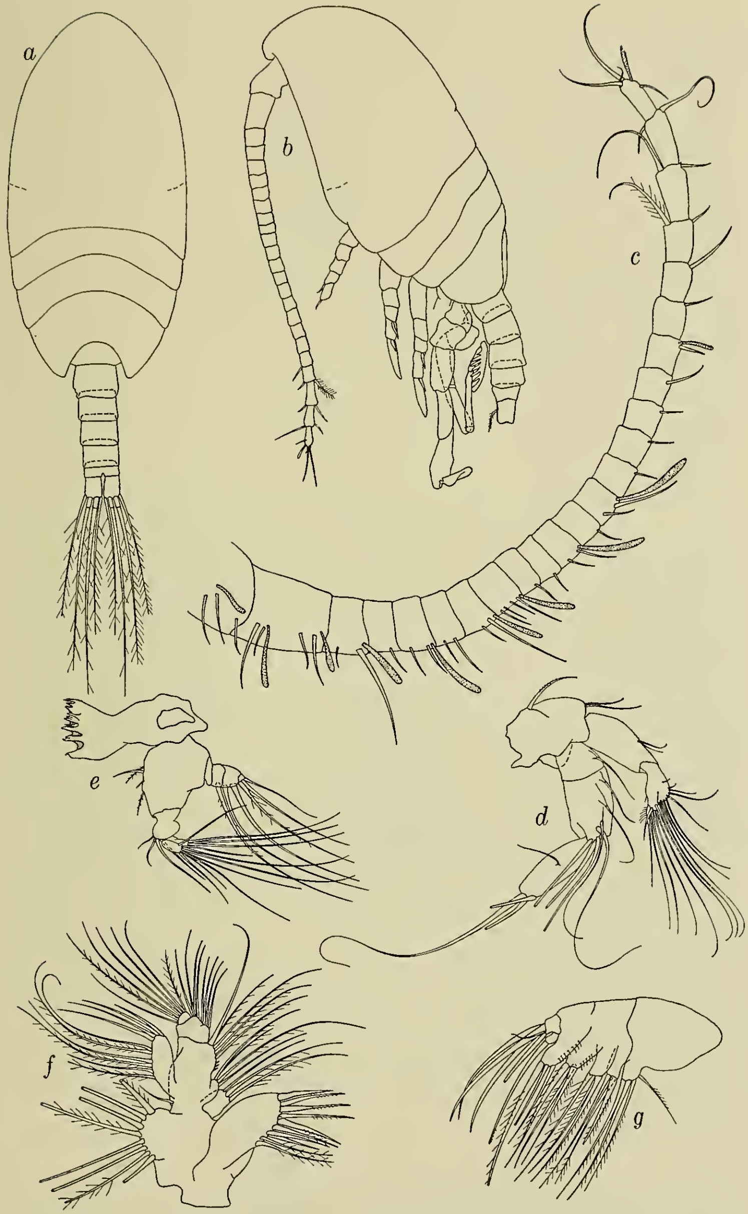
FIG. 2. *Parastephos occatum* male: *a*, habitus, dorsal view (B); *b*, habitus, lateral view, leg 4 omitted (A); *c*, first antenna (E); *d*, second antenna (E); *e*, mandible (D); *f*, first maxilla (F); *g*, second maxilla (F).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Legs 1–4 with trimerous exopods. Leg 1 (Fig. 1*d*) with 1-segmented endopod; outer margin of endopod deeply incised, forming a notched, lobelike distal process. Leg 2 with 2-segmented endopod. Legs 3–4 with 3-segmented endopods. Legs 2–3 similar to those of male, except strong outer exopod spines not as strongly serrate as in male; there are also slight differences in the pattern of spinulation over the surface of the legs. Legs 2–4 have a few strong spines on the anterior surface of protopods 1–2; these spines were not seen on the male. Leg 4 symmetrical, similar to left leg 4 of male with slight differences as noted above for legs 2–3. Armature of swimming legs as in male.

Leg 5 (Fig. 1*e*) somewhat reduced, uniramous; protopod 1 without armature; protopod 2 armed with outer row of strong thin spines, and inner cluster of teeth and spines. Terminal segment, except for sharp lateral projection near base, a serrate curve; outer distal margin with small spine and a few hairs. The asymmetry of leg 5 in female *P. pallidus*, not found in *P. occatum*, cannot be considered diagnostic of this genus.

Male: Body (Fig. 2*a,b*) less robust than female; urosome slightly more than ⅓ length of prosome. Cephalosome vaulted in lateral view; rostrum absent. Incomplete transverse suture mid-length on prosome; last 2 prosomal segments fused and posteriorly rounded in lateral view. Urosome 5-segmented; segments 1–4 about equal; genital segment slightly asymmetrical. Caudal rami slightly longer than wide; 4 plumose terminal setae. A small inwardly directed plumose seta on anterior ventral surface of caudal ramus.

First antenna (Fig. 2*c*) of 24 segments; extends nearly to end of urosome; similar in structure and about equal in armature to that of female. Armature: I-3, 1 esthete; II-4, 2 esthetes; III-2, 1 esthete; IV-1; V-2, 1 esthete; VI-2; VII-2, 1 esthete; VIII–4, 1 esthete; IX-1; X-1; XI-2, 1 esthete; XII-1; XIII-2, 1 esthete; XIV-1; XV-1; XVI-1; XVII-1; XVIII-1, 1 esthete; XIX-1; XX-1; XXI-2; XXII-2; XXIII-2; XXIV-4, 1 esthete.

Second antenna (Fig. 2*d*) with basipod bearing 1 proximal and 2 distal setae. Exopod reaching beyond endopod by length of 3rd segment. First exopod segment with 1 seta; 2nd segment with 2 proximal setae and 5 setae on a distal protuberance. Third segment with 1 small seta at mid-length and 3 long apical setae. Endopod 2-segmented; 1st segment with 2 small setae. Second segment with outer lobe bearing 7 setae and a stiff hair; inner portion of segment with 8 setae and a stiff hair.

Mandible (Fig. 2*e*) with apex of blade only slightly expanded and with moderately strongly incised teeth. Palp with expanded basipod armed

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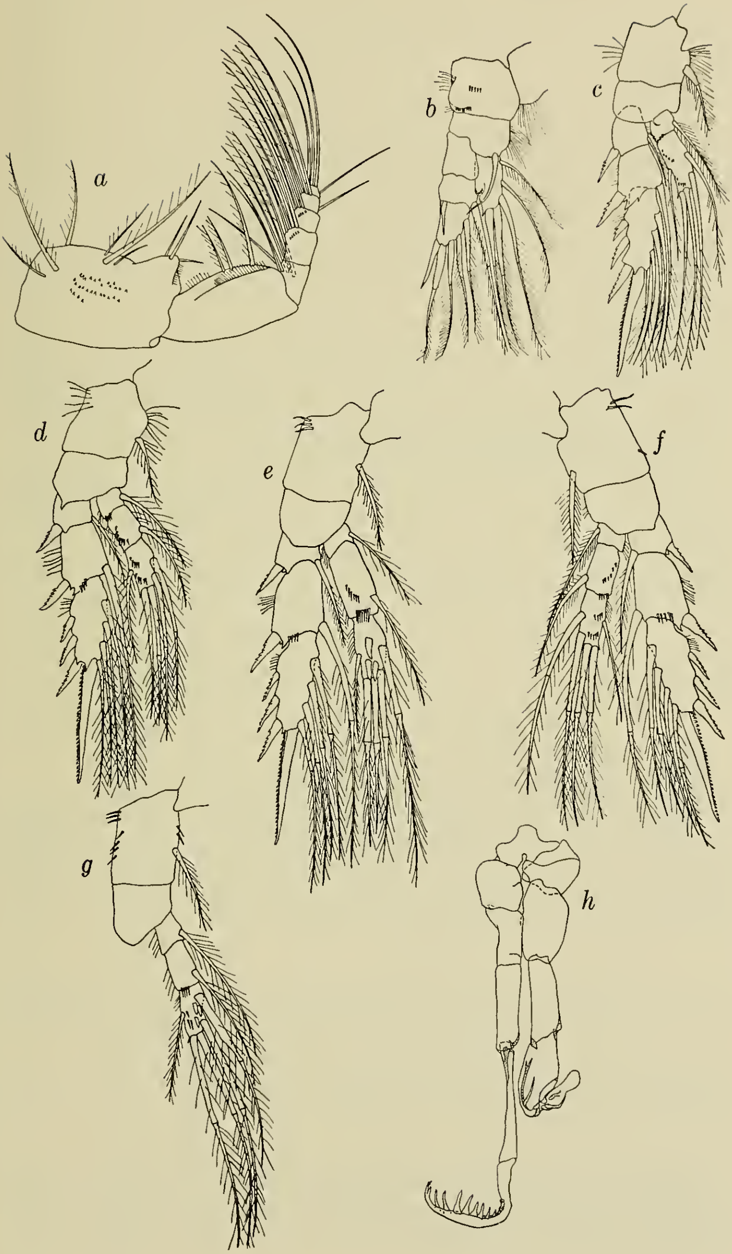
FIG. 3. *Parastephos occatum* male: *a*, maxilliped (F); *b*, right leg 1 (E); *c*, right leg 2 (E); *d*, right leg 3 (E); *e*, right leg 4 (E); *f*, left leg 4 (E); *g*, right leg 4, exopod omitted (E); *h*, leg 5 (C).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with 4 inner setae; the 4 segments of exopod well-defined, the 1st naked, the 2nd with 1, the 3rd with 2, and the last with 3 setae. First segment of the 2-segmented endopod wide, with 4 setae; apical segment with 11 terminal setae.

First maxilla (Fig. 2*f*) with well-developed basipod. Gnathobase large and distinct, bearing 8 stout spines and 2 subapical plumose setae. Distal to gnathobase are 2 laciniae, the 1st with 3 setae, the 2nd with 4. The proximal outer lobe of this appendage an expanded plate bearing 8 stout long setae. Between this lobe and the exopod is a single seta. Exopod and endopod arise from distal narrowed portion of basipod, which bears 5 setae and a few spinules on the inner edge. Endopod 2-segmented; the 1st with 8, the 2nd with 7 setae. Exopod with 6 lateral and 4 terminal setae.

Second maxilla (Fig. 2*g*) with 6 distinctly developed lobes; the 1st with 4 thin plumose setae, the 2nd with 1 stout and 2 thin plumose setae. The next 3 distal lobes each with 3 setae; the 6th lobe with 1 seta. The reduced terminal portion of this appendage distinctly separated, with 4 moderately stout long setae and 1 thin short seta.

Maxilliped (Fig. 3*a*) 7-segmented, with moderately large basal segment with 3 groups of 3 setae each, the distal group on a knoblike process fringed with hairs. Stout teeth on central area of basal segment. Second segment as long as the 1st, somewhat thinner, with 3 plumose setae and 2 rows of hairs. Segments 3–7 armed as follows:

	Segment				
	3	4	5	6	7
Apical setae	6	4	3	3	3
Basal setae				1	1

Segments 4 and 5 also with stout teeth on surface.

Legs 1–4 (Fig. 3*b*–*g*) with trimerous exopods. Leg 1 with 1-segmented endopod; outer margin of endopod deeply incised, forming a lobelike process which bears a row of small teeth. Leg 2 with 2-segmented endopod. Legs 3–4 with 3-segmented endopods. Armature of swimming legs:

Leg	Protopod		Endopod								Exopod						
	1	2	1		2			3			1		2		3		
	Si	Si	Si	St	Si	St	Se	Si	St	Se	Si	Se	Si	Se	Si	St	Se
1	0	1	3	2	–	–	–	–	–	–	0	0	1	I	3	1	I
2	1	0	1	–	2	2	1	–	–	–	1	I	1	I	4	I	III
3	1	0	1	–	1	–	0	2	2	1	1	I	1	I	4	I	III
4	1	0	1	–	1	–	0	2	2	1	1	I	1	I	4	I	III

Leg 4 shows tendency toward asymmetry. On 2 specimens the right endopod (Fig. 3*e*) differed considerably from the left; middle segment longer and wider than middle segment on left endopod (Fig. 3*f*). Terminal segment of right endopod armed with 3 bladelike processes that appear to be a fused series of spinules, present in a reduced, non-fused, typical state on the terminal segment of left endopod. The 2 other specimens with less-modified right endopod 4 (Fig. 3g); middle segment similar to that on left endopod; terminal segment, however, with bladelike processes and a thickened inner seta not present on left endopod.

Sars (1902) noted the same asymmetry of leg 4 on the original male *Parastephos pallidus*. Sars (1919), however, did not find this asymmetry in a second male collected later at another locality.

Leg 5 (Fig. 3*h*) elongate, uniramous, markedly asymmetrical. Right leg with 5 distinct segments; segments 1–4 progressively longer and thinner. Fifth segment curved sharply, armed with row of strong large teeth on concave edge. Left leg ⅔ length of extended right leg; 5-segmented. Fourth segment spoon-shaped, with lappetlike 5th segment tending to flex back upon it.

Three specimens with right leg 5 flexed at joint between segments 3 and 4 (see figure 2*b*); one specimen with leg extended (Fig. 3*h*).

Etymology: The specific name *occatum*, from occo (L.), to harrow, refers to male right leg 5.

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PROCEEDINGS
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STUDIES OF NEOTROPICAL CADDIS FLIES, XI: THE GENUS *RHYACOPSYCHE* IN CENTRAL AMERICA (HYDROPTILIDAE).[1]

By Oliver S. Flint, Jr.
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Fritz Müller in a series of papers (1879b, 1880, 1881) proposed a number of generic names for Brazilian Trichoptera based almost exclusively on the morphology of the larval cases. Over the years the identity of many of these genera has been established, but a number have remained nomina dubia. The hydroptilid genus *Rhyacopsyche* is one whose identity has never been fully established, although more is known about it than about certain others.

Müller first used the name *Rhyacopsyche* in 1879a, without an included species or figures, stating only that the case is attached by a versatile stalk. Later in 1879b, an English version and condensation of his later works appeared, but without figures. In this paper the species is referred to as *R. hageni* and a full description of the larval and pupal cases and habits is given. The full description and figures of the curious cases of *R. hageni* appeared in 1880 and 1881. In none of these works is any description given of the larvae or adults of the species.

The first description of the larval and adult morphology was given by Thienemann (1905) who had obtained some of Müller's material containing larvae, pupae and pharate adults. He mentions that the larva is a typical hydroptilid, and describes and figures the odd ventral spine of the tarsi and the hooked and basally enlarged claw. He also describes, with primitive figures of the genitalia, the adult male. Möller published (1921)

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[1] Field work of the author was supported by National Science Foundation grant GB-2616.

a previously unpublished figure from Müller showing the general larval habitus.

Ulmer in 1913 doubtfully referred some Paraguayan hydroptilids to this species. These are clearly not *hageni*, but apparently a species of *Neotrichia.* Thus has our knowledge of the genus remained.

In 1967 I described *Metrichia mexicana*, noting that it agreed with the genus *Metrichia* in key adult characters, but that the pattern of the genitalia was radically different. Later I discovered larvae, pupae and metamorphotypes of this species had been collected at Finca Mocá, Guatemala. The pupal cases were attached by short stalks, and appeared identical to those described and figured by Müller for *R. hageni.* Further the habitus and the structure of the larval tarsi (with the possible exception of having only 1 enlarged seta) and the claw was identical to that shown by Müller and Thienemann. The larval cases differed in not being attached by a long thread, but were very similar otherwise. Further study of Thienemann's adult description disclosed agreement in structure of the head, its appendages and ocelli, the spur count, and a correlation of general form of the genitalia.

On the basis of these correlations of larva, case and adult, I believe the species *mexicana* Flint is congeneric with *hageni* Müller. Because the knowledge of *Rhyacopsyche* has been so fragmentary, a diagnosis of the genus is presented here, together with descriptions of those species found to date in Central America.

Genus *Rhyacopsyche* Müller

Rhyacopsyche Müller, 1879a, p. 40 (Nom. nud.)

Rhyacopsyche Müller, 1879b, p. 143; 1880, p. 121; 1881, p. 72—Thienemann, 1905, p. 287.—Möller, 1921, p. 525.—Nielsen, 1948, p. 10.—Ulmer, 1957, p. 172.—Fischer, 1961, p. 81.

Type species: *Rhyacopsyche hageni* Müller, 1879b, monobasic.

Adult: Ocelli 3. Head with posterior warts open beneath, but without specialized structures. Antennae unmodified. Spurs 1,3,4. Mesonotum with scutellum divided transversely, with vertical posterior margin obsolete mesally; metascutellum roughly pentagonal in shape. Wings narrow and acuminate. Male genitalia with ninth segment produced into dorsolateral lobes. Tenth tergum mostly contracted inside the ninth tergal lobes. Claspers distinct, paired. Subgenital sclerite present, often reduced to linear structures mesad of claspers. Female genitalia with eighth tergum bearing from posterior margin a setate lobe (or lobes) surmounting a more ventral flap. Eighth and ninth segments with very long internal rods.

Larva: Head without special ornamentation. Thoracic nota divided mesally; metanotum without anterolateral enlargement; no apparent sternal sclerites. Legs all short and similar in structure; apex of tibia expanded and bearing several enlarged setae; tarsus short and broad with one (or possibly two) enlarged, platelike ventral seta; claw angled ventrad, inflated basally. Abdomen slightly compressed, segments 4–7 enlarged slightly. Anal prolegs united to sides of tenth segment, claw free.

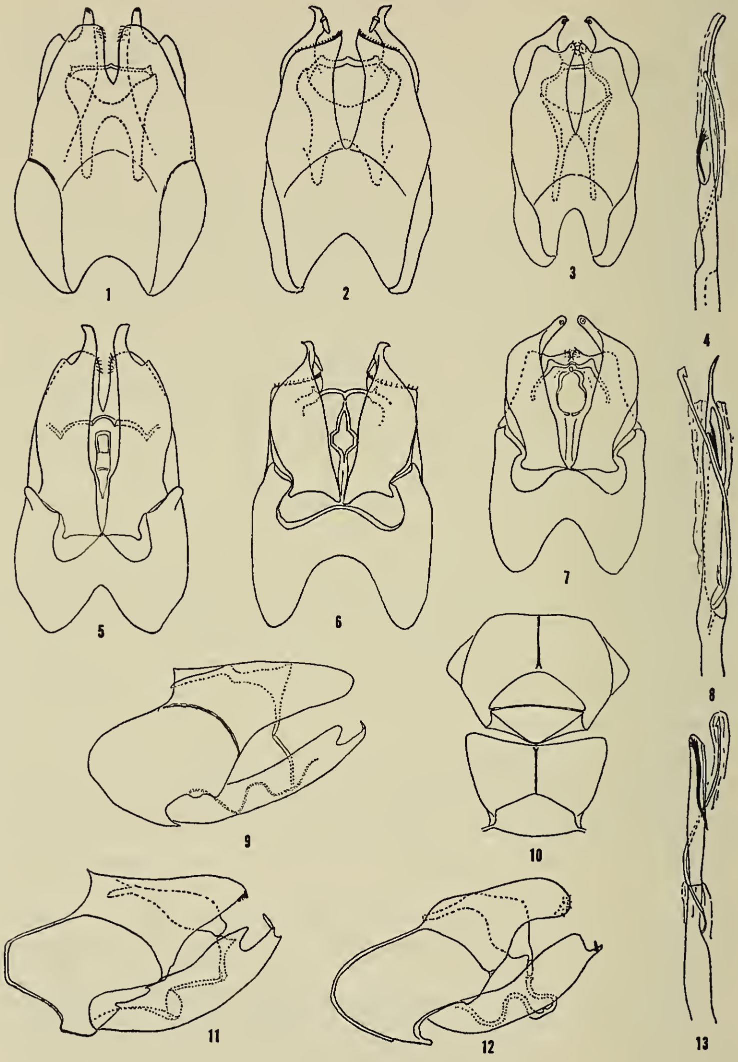
Case: Larval case elongate, basically tubular. Anterior end tubular, strongly rimmed with silk; at midlength becoming larger and slightly compressed; posterior end tubular and slightly curved. (In some species anterior end attached to substrate by a long silken thread.) Pupal case with anterior end closed by silk and attached by a short silken stalk to a silken holdfast on the substrate.

The adults of this genus will key to *Metrichia* in Ross (1944). They may be separated from this subgenus of *Ochrotrichia* only by the very different structure of the male and female genitalia. Although both genera have well-developed claspers, *Metrichia* lacks both the large lobes of the ninth tergum, and the internal placement of the tenth tergum, but does possess a strong spine above the clasper bases, and two large hooks on the aedeagus. The females of *Rhyacopsyche* may immediately be distinguished by the lobes from the eighth tergum which are lacking in *Metrichia.*

The larvae of *Rhyacopsyche* show a clear relationship to those of *Ochrotrichia* (including *Metrichia*) and *Hydroptila.* From both, *Rhyacopsyche* larvae may be distinguished by the large, platelike seta of the tarsus and the hook claw. From *Ochrotrichia* they may also be distinguished by the lack of anterolateral expansion on the metanotum.

The cases of *Rhyacopsyche* are very distinctive. The cases of *Ochrotrichia* and *Hydroptila,* which would appear to be the most closely related genera, are compressed and purselike, with a slitlike opening at both ends.

The Central American species of *Rhyacopsyche* fall easily into two groups (the lack of specimens prevents the placement of *R. hageni*). One, the *mexicana* group, contains *R. mexicana* (Flint), *R. obliqua* n. sp., and *R. torulosa* n. sp. The claspers of this group are elongate and the subgenital plate has been modified to narrow, ribbonlike sclerites lying between the claspers. The females have a simple eighth sternum. The second group contains *R. turrialbae* n. sp. only. The claspers of this species are developed dorsoventrally, and the subgenital plate is very large and heavily sclerotized. The posterior margin of the eighth sternum of the female is considerably modified.



FIGS. 1–13. Meso- and metanota, dorsal (10); male genitalia, dorsal (1, 2, 3), ventral (5, 6, 7), and lateral (9, 11, 12), and aedeagus, apical half (4, 8, 13) of *Rhyacopsyche mexicana* (Flint) (1, 4, 5, 9, 10), *R. obliqua* n. sp. (2, 6, 8, 11), and *R. torulosa* n. sp. (3, 7, 12, 13).

Key to species.

1. Male with clasper produced dorsoventrally, subgenital plate large with a twisted spine from dorsal margin; female with posterior margin of eighth sternum bearing a central conical projection and lateral shelflike flaps .... *R. turrialbae*
   Male with claspers elongate, subgenital plate represented by ribbonlike straps between claspers; female with posterior margin of eighth sternum unmodified 2
2. Male with posterodorsal lobes of ninth segment obliquely truncate in both dorsal and lateral aspects; female with a pair of setate lobes from eighth tergum .... *R. obliqua*
   Male with ninth tergal lobes either rounded or with a small rounded lobe in dorsal aspect and evenly rounded in lateral aspect; female with a single setate lobe from eighth tergum 3
3. Male with ninth tergal lobes bearing a small rounded apicomesal lobe; female with ventral lobe from eighth tergum narrowed mesad and heavily sclerotized .... *R. torulosa*
   Male with ninth tergal lobes evenly rounded; female with ventral lobe tongue-shaped and more lightly sclerotized .... *R. mexicana*

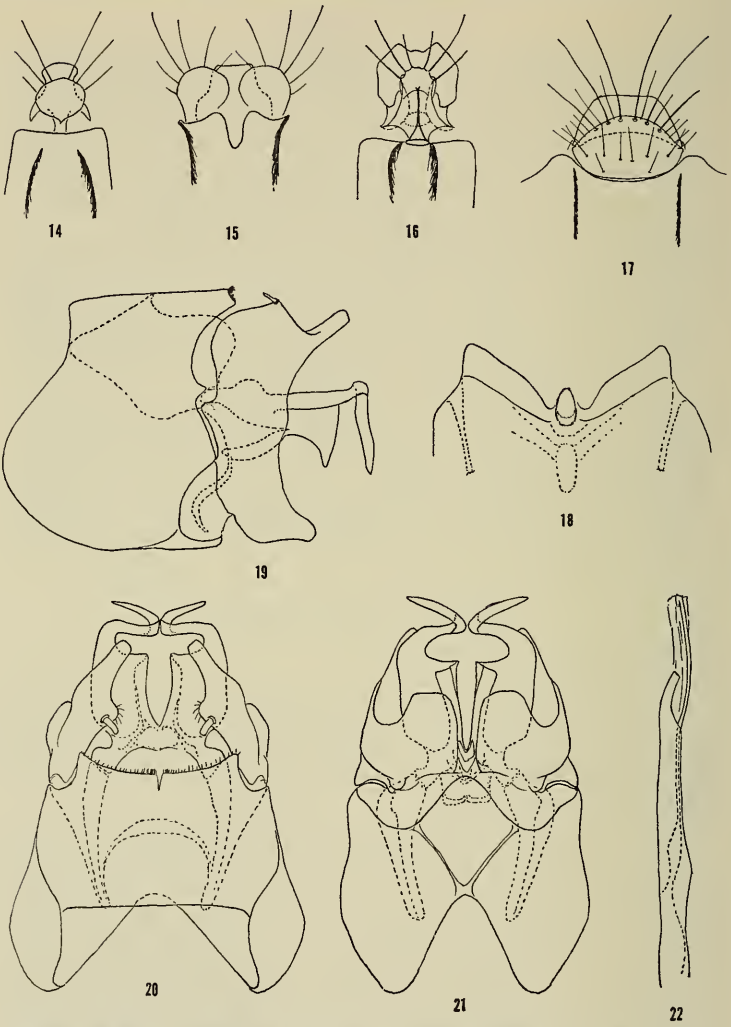
Rhyacopsyche mexicana (Flint) new combination

Figures 1, 4, 5, 9, 10, 14, 23–26.

Metrichia mexicana Flint, 1967, p. 12.

This species is very closely related to the two following species. From these it is recognized by the evenly rounded ninth tergal lobes, the rounded apicodorsal lobe of the clasper, and the crooked rodlike central tube of the aedeagus in the male, and the shape of the tergal lobes of the eighth segment in the female.

Adult: Length of forewing, 2.5 mm. Head and appendages cream-colored, tarsi annulate, forewing with large cream-colored areas mixed with fuscous spots. Abdomen without sternal processes. Male genitalia: Ninth segment produced and rounded anterolaterally; dorsolateral lobes rounded in both dorsal and lateral aspects, apicomesally with a patch of black, peglike setae. Tenth tergum with a pair of elongate, slender anterior processes; narrowly produced apicoventrally, articulating with sinuous, ribbonlike subgenital plates between claspers. Clasper elongate, parallel-sided, apicodorsal lobe produced, with rounded apex; apicoventral lobe elongate, with an enlarged apicodorsal seta. Aedeagus with basal half tubular, slightly enlarged basad; apical half with lateral filament short and tightly appressed to central tube; central tube prolonged into a slightly crooked rod, at midlength bearing a dark, appressed, basally-directed spine. Female genitalia: Eighth sternum simple. Eighth tergum with a pair of dark, slightly divergent submesal bars; from posterior margin a mesal, buttonlike dark lobe bearing 6 setae, from beneath a paler tonguelike flap.



Figs. 14–22. Female eighth tergal lobes, dorsal (14, 15, 16, 17), and eighth sternum, ventral (18): male genitalia, lateral (19), dorsal (20), ventral (21), and aedeagus, apical half (22) of *Rhyacopsyche mexicana* (Flint) (14), *R. obliqua* n. sp. (15), *R. torulosa* n. sp. (16), and *R. turrialbae* n. sp. (17–22).

Larva: Length, 3–3.5 mm. Sclerites pale yellow, sparingly marked with fuscous. Thoracic nota with anterior margins bearing a row of large, decumbent, darkened setae. Abdominal terga with 3 pairs of setae on segment 1, 2 pairs each on segments 2–8, all setae arising from a small sclerite; sterna 1–8 each with a pair of small, simple setae. Ninth tergite with a pair of large submesal setae, and 3 pairs of small lateral setae. Supporting sclerites of anal claw with 2 large conspicuous setae; claw with a single hook.

Case: Larval case, 4.5 mm. long, 1 mm wide. Silken, fusiform, outer surface completely covered with small sand grains. Pupal case, 5–6 mm. long, 1 mm. wide. Generally similar to larval case but anterior end attached by a silken stalk .5–1 mm. long, posterior end compressed and split along dorsal and ventral margins (this gapes open after emergence of pupa).

Material: MEXICO: VERACRUZ; Rio Tacolapan, route 180, km. 551, 25–26 July 1966, Flint & Ortiz, ♂ holotype, 14 ♂ 12 ♀ paratypes; Cuitlahuac, 10–12 Aug. 1964, P. J. Spangler, 1♂ paratype. GUATEMALA: SUCHITEPEQUEZ; Finca Mocá, 12 June 1966, Flint & Ortiz, 3 ♂ 1 ♀ paratypes, 2 larvae, 4 prepupae, 19 pupae, 1 ♂ 2 ♀ metamorphotypes, 20 pupal cases. ESCUINTLA; Rio Metapa, 10 km. southeast Escuintla, 275 m. elev., 5–6 Mar. 1970, E. J. Fee, 1 ♂.

Biology: The immature stages of this species have been collected only once, but in very distinctive circumstances. The Rio Bravo just above Finca Mocá is a few yards wide with an average depth of a foot or so. The bottom is mostly inorganic matter, in size from small sand grains to large boulders, and, to judge from the general rarity of caddisfly larvae, subject to rather frequent scouring floods.

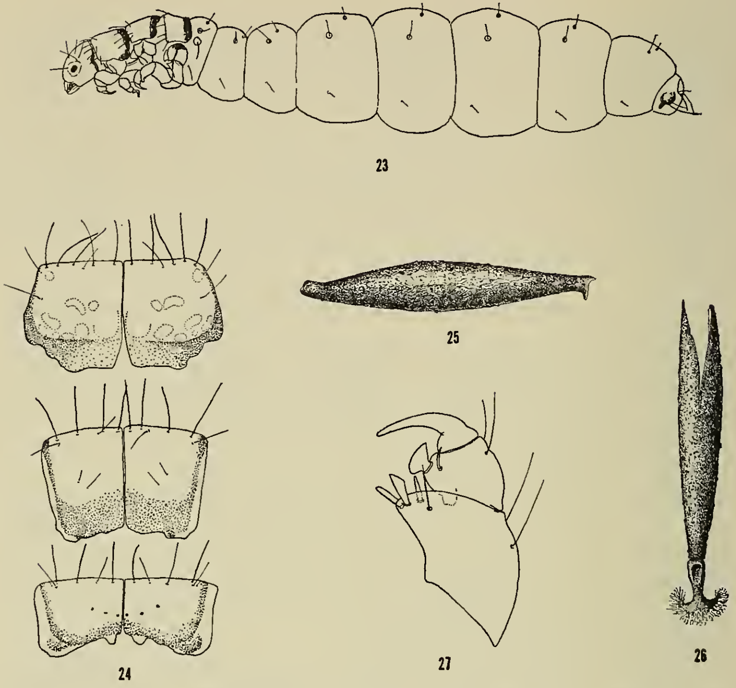
The cases were found attached to a huge boulder in a cascade that was in contact with a second boulder in such a manner that most of the water poured out between the rocks at shoulder height as from a spout. The majority of the inner and under surface of the boulders were thus out of the water, but subject to the splash and a film of water seeping down from above. The pupae were attached by their holdfasts to this inner surface in the moist, but not submerged region, and projected at right angles from the boulder.

Two larval cases were taken, but one has a slight amount of silk from its anterior end and was obviously in the process of being attached for pupation. The other has no silk whatever. Whether this is indicative that this species does not attach its larval case by a long silken thread, as does *R. hageni*, or whether it represents a specimen taken at that time after it might have cut away its larval thread and before it started its pupal attachment is not known.

Rhyacopsyche torulosa new species

Figures 3, 7, 12, 13, 16

This species is closely related to the other species of the *mexicana* group. It may be recognized in the males by the small apicomesal lobe of the ninth tergal lobes, the longer and more mesally directed apicoventral lobe of the claspers, and the truncate apex of the aedeagus. The



FIGS. 23–27. Larval habitus, lateral (23), thoracic nota of flattened prepupa, dorsal (24), apex of larval leg, lateral (27), larval case, lateral (25), and empty pupal case, anterior (26) all of *Rhyacopsyche mexicana* (Flint). Figs. 25 and 26 drawn by Mr. Andre D. Pizzini.

female eighth tergal lobes are very distinctive, especially the ventral lobe which is heavily sclerotized and shaped somewhat like a butterfly.

Adult: Length of forewing, 3 mm. Color in alcohol, dark brown. Abdomen without sternal processes. Male genitalia: Ninth segment produced and rounded anterolaterally; dorsolateral lobe rounded in lateral aspect, in dorsal aspect with a small rounded apicomesal lobe which bears ventromesally some small, black, peglike setae. Tenth tergum with long, slender anterior processes; produced ventrad apically, articulating with sinuous, ribbonlike subgenital plates between claspers. Clasper long and rather parallel-sided, apicodorsal lobe not produced; apicoventral lobe elongated mesally with a small dorsal seta. Aedeagus tubular for basal half, with base slightly enlarged; apical half bearing a filament spiraling around central tube; central tube obliquely truncate, apex bearing a dark, appressed, basally-directed spine. Female genitalia: Eighth sternum simple. Eighth tergum with submesal dark bars diverging anteriorly; from posterior margin a dark bar connecting with a heavily sclerotized mesal lobe bearing 6 setae, with a heavily sclerotized lobe subtending dorsal lobe ventrally and laterally and articulating with it basally.

Material: Holotype, male: GUATEMALA, Escuintla, Rio Metapa, 10 km. southeast Escuintla, 275 m. elev., 5–6 March 1970, E. J. Fee. USNM Type 71115. Paratypes: Same data, 16 ♂ 22 ♀.

Rhyacopsyche obliqua new species

Figures 2, 6, 8, 11, 15

This the third species of the *mexicana* group, is closely related to the others. It may be recognized in the male by the dorsolateral lobes of the ninth segment which are pointed in both dorsal and lateral aspects, the pointed apicodorsal lobe of the claspers, and the acuminate point to the central tube of the aedeagus. The female is immediately recognizable by the two, rounded, setate lobes dorsally from the apex of the eighth tergum.

Adult: Length of forewing, 2.5 mm. Color in alcohol, brown. Abdomen without sternal processes. Male genitalia: Ninth segment produced anterolaterally into a truncate lobe; dorsolateral lobe pointed in lateral aspect, in dorsal aspect obliquely truncate, apicomesal angle pointed, posteroventral surface with short, black, peglike setae. Tenth tergum with broader, shorter anterior processes; slightly produced apicoventrally and articulated with sinuous, straplike, subgenital plates between claspers. Clasper elongate, parallel-sided, with apicodorsal lobe produced into a point, apicoventral lobe shallowly bifid, dorsal part with a greatly enlarged seta. Aedeagus with basal half tubular, enlarged basad; apical half with lateral filament curving over central tube; central tube produced into a sharp point apically, subapically with a darkened, appressed, basally directed spine. Female genitalia: Eighth sternum simple. Eighth tergum with elongate, parallel, submesal, dark bars; posterior margin divided mesally, with a pair of buttonlike lobes each bearing 6 setae, ventromesially with a small tonguelike flap.

Material: Holotype, male: MEXICO, Veracruz, Fortin de las Flores, 17 May 1964, Blanton, et al. USNM Type 71116. Paratypes: Same data, 42 ♂ 22 ♀.

Rhyacopsyche turrialbae new species

Figures 17–22

This species I place in its own group due to the distinctiveness of both the male and female genitalia. In the male the vertical claspers, the greatly enlarged subgenital plate with its twisted dorsal spine, and the very different aedeagus are diagnostic. In the female the modified eighth sternum is distinctive as is the rather simple, semicircular dorsal and ventral lobes of the eighth tergum.

Adult: Length of forewing, 3–3.5 mm. Antenna cream-colored, head pale anteriorly, brown dorsally, legs mostly brown, tarsi of hind and midlegs annulate; forewing with intermingled patches of brown, cream-colored, and golden hairs. Seventh sternum with a small apicomesal point. Male genitalia: Ninth segment inflated and slightly rounded anteriorly; dorsolateral lobe slightly developed, truncate apically with posterior margin bearing short, black, peglike setae. Tenth tergum retracted within ninth tergum and with moderately long basal processes, with strong lateral supports to the subgenital plate. Subgenital plate large and strongly sclerotized, widely open dorsally, and deeply divided midventrally; dorsolateral margin partially separated and produced into a long, twisted, apical spine, apicoventral angle narrowly produced ventrad; basoventrally articulating with a lightly sclerotized, straplike sclerite lying between clasper bases. Clasper tall and narrow, developed into a small basoventral lobe and a larger dorsal lobe which bears dorsally a greatly enlarged, short seta and apically a fingerlike lobe. Aedeagus with basal half tubular and slightly inflated basad; apex basically tubular with a dark filament extending beyond central tube and ending in a lightly sclerotized sheath; central tube slightly curved and narrowed subapically and ending abruptly. Female genitalia: Eighth sternum with a small, conical, central lobe and with posterolateral margins produced into thin, shelflike flaps. Eighth tergum with parallel, submesal, dark bars; from posterior margin dorsally a heavily sclerotized, transversely oval lobe bearing numerous setae, articulating basoventrally with a large, humped, strongly sclerotized, ventral lobe.

Material: Holotype, male: COSTA RICA, CARTAGO, Chitaria, 19 June 1967, Flint & Ortiz. USNM Type 71117. Paratypes: Same data, 14 ♂ 18 ♀; 3 miles west of Turrialba, 18–21 June 1967, Flint & Ortiz, 2♂ 1♀.

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SOME POLYCHAETES OF THE SUPERFAMILY EUNICEA FROM THE NORTH PACIFIC AND NORTH ATLANTIC OCEANS[1]

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One new species of *Onuphis* is presented together with a discussion of and key to five other species of this genus and five new records of species of Lumbrineridae, Arabellidae, and Dorvilleidae. Most of the polychaetes from Washington were collected from the Strait of Juan de Fuca by the author while on *Brown Bear* cruise #365 (June 1965); from near Orcas Island by H. L. Sanders (July 1967), and obtained from the collections of K. Banse, K. D. Hobson, and F. H. Nichols from Puget Sound (February, April, and August 1963; October 1965). Some of the polychaetes from New England were collected from the slope off New England by H. L. Sanders (May 1961, August 1962); and from Cape Cod Bay by the Biotic Census of the Systematics-Ecology Program (February 1966 through October 1969). The latter are now deposited in the Gray Museum of the Marine Biological Laboratory (GM). Supplementary material was obtained from the following museums or institutions: the Allan Hancock Foundation (AHF), through O. Hartman and K. Fauchald; the British Museum of Natural History (BMNH), through J. D. George; the Bureau of Commercial Fisheries (BCF), through R. L. Wigley; the Museum of Comparative Zoology (MCZ), through H. W. Levi;

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FIG. 1. *Onuphis elegans* (collection of Banse, Hobson, and Nichols, Puget Sound): a, Anterior view of 1st parapodium; b, anterior view of 25th parapodium; c, slender pseudocompound hook from 1st parapodium; d, stout pseudocompound hook from same.

the Pacific Marine Station Museum (PMS), through J. A. Blake; and the Smithsonian Institution (USNM), through M. L. Jones. The manuscript benefitted from discussions and correspondence with K. Fauchald and K. Banse.

SUPERFAMILY EUNICEA

ONUPHIDAE

Onuphis Audouin and Milne Edwards

All species of *Onuphis* with cirriform branchiae that begin on the first setiger were reviewed in order to better characterize *O. elegans* and *O. iridescens*. In some species important specific characters, such as first occurrence of branchiae and of subacicular hooks, were found to vary with the size of the worm. Although the species discussed below are very closely related, they can be distinguished by considering this variation together with other characters.

Onuphis elegans (Johnson)

Figure 1a–d

Northria (sic) *elegans* Johnson 1901, p. 406, pl. 8, figs. 77–85.

Nothria elegans.—Hartman 1968 (in part), p. 675, figs. 1, 2, 5 only. Not Hartman 1944, p. 88, pl. 5, figs. 113–117.

Nothria sp. near *N. elegans* and *N. iridescens*.—Banse, Hobson, and Nichols 1968 (in part, Form A only), p. 534.

Onuphis elegans.—E. Berkeley 1927, p. 408.—C. Berkeley 1967, p. 1056. —Berkeley and Berkeley 1932, p. 312; 1948, p. 93, fig. 141.

Material examined: WASHINGTON, syntypes of *N. elegans* (AHF; MCZ 1895) from Puget Sound.—Collections of Banse, Hobson, and Nichols from Puget Sound (10–23 m). CALIFORNIA, Tomales Bay (PMS 180241).—*Velero* station 3048 near Los Angeles Lighthouse (19 m) and five localities in central and southern California (intertidal to 18 m) (AHF). BRITISH COLUMBIA, Long Bay, E. Berkeley, collector (intertidal) (USNM 38275).

Description: Pigmentation, when present, is usually as described by Johnson. The first 5 or 6 setigers are cylindrical, then the body becomes flattened. The inner paired antennae usually extend only to setiger 3–7 (range, 3–11).

The branchia of the first parapodium (Fig. 1a) is longer than the dorsal cirrus and becomes relatively longer farther posteriorly. The branchiae are thick (Fig. 1b) in setigers 10 through 60–80, rather than slender as in the other species treated here (c.f., Figs. 2d, 3b, 5a). Ventral cirri are usually cirriform through setiger 5, (setiger 6 in the specimens from Long Bay, B.C.).

Pseudocompound hooks occur in the first four setigers (rarely 3). The hooks are usually tridentate (Fig. 1c, d) but the third tooth may be very small (as in Fig. 2f). I have found bidentate hooks without a trace of a third tooth only in the specimens from Long Bay, B. C. and in a specimen from Tomales Bay, California. These specimens also have a few quadridentate hooks. Supraacicular narrowly limbate setae are present from the first setiger, appearing faintly hairy. Pectinate setae are present

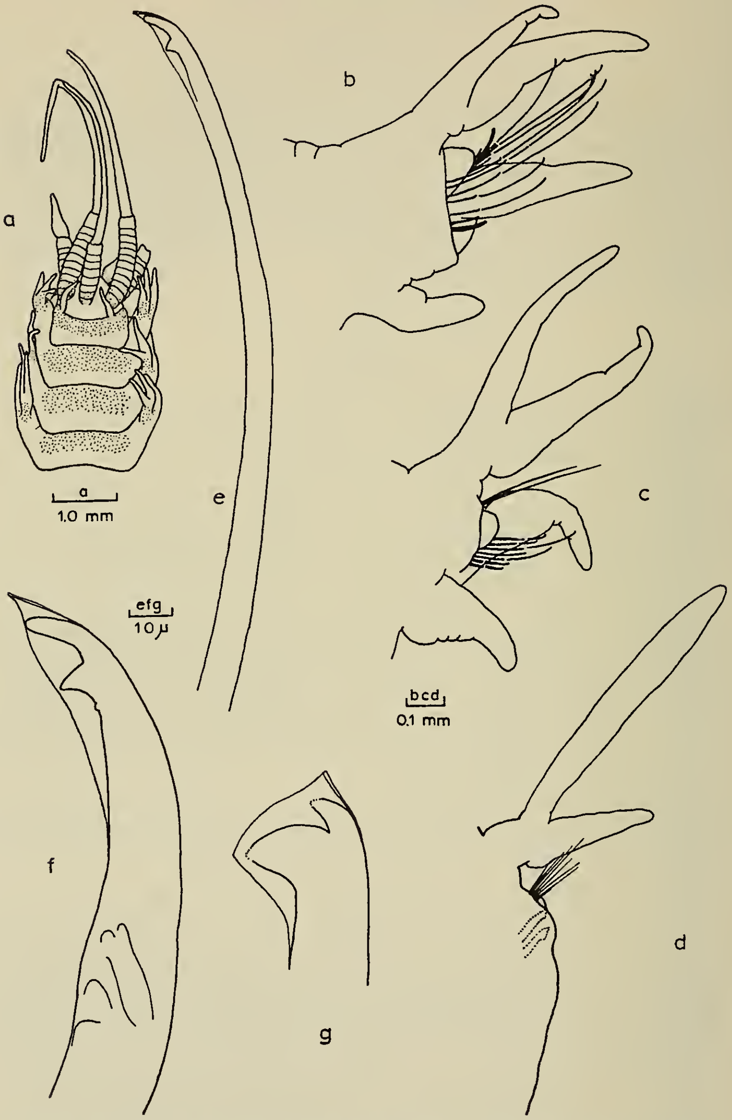

FIG. 2. *Onuphis farallonensis* new species: a, Dorsal view of anterior end of holotype (AHF), setae omitted (stippling indicates location of pigment); b, anterior view of 1st parapodium; c, anterior view of 5th parapodium; d, anterior view of 26th parapodium; e, tip of slender pseudocompound hook from 1st parapodium; f, stout pseudocompound hook

from the first setiger, are distally slightly oblique, and have about 14 teeth. There are no compound spinigers. Subacicular hooks usually begin on setiger 9 (occasionally on 10 or 11).

The tube is parchmentlike with adherent sand grains.

Remarks: There does not seem to be any variation of specific characters with size of this species. *Onuphis elegans* is characterized by its short antennae, thick branchiae, and first occurrence of subacicular hooks from setiger 9 (occasionally 10 or 11).

Distribution: British Columbia to southern California, intertidal to 23 meters.

Onuphis farallonensis new species

Figure 2a–g

Nothria elegans.—Hartman 1944, p. 88, pl. 5, figs. 113–117; 1968 (in part), p. 675, figs. 3–4 only. Not *N. elegans* Johnson, 1901.

Material examined: CALIFORNIA, *Velero* station 887, east of Middle Farallon Island (68 m), Holotype and 6 Paratypes (AHF); Paratype (USNM 42026).

Description: None of the specimens are complete. The holotype is 3.8 cm long for about 80 setigers, 1.2 mm wide at the 20th setiger. The body is subcylindrical. There are dorsal transverse reddish brown bands of pigment on the anterior margin of anterior segments (Fig. 2a) and traces of pigment on the bases of the prostomial appendages and on the dorsal surface of the parapodia. This pigmentation pattern occurs on about the first 30 setigers.

The prostomium is triangular, and the frontal antennae are elongate-oval. The ceratophores of the occipital antennae are distinctly annulated. The styli of the inner paired antenna are the longest and reach to setiger 10 to 13. The palpi are large and globular.

The presetal lobes of the first few setigers are rounded and have a transverse fold (Fig. 2b, c). Postsetal lobes are elongate through about the first 10 setigers and gradually diminish in size posteriorly. Ventral cirri are cirriform through setiger 3 to 5, depending on size of the worm, and are padlike thereafter. The branchiae begin on the first setiger, except in the smallest worm (0.6 mm wide at the first segment) where they begin on setiger 4. When fully developed the branchiae are longer than the dorsal cirri (Fig. 2c, d).

The hooded pseudocompound hooks occur in the first 4 to 6 setigers. Their distribution in a paratype is as follows: the first setiger has 11 slender hooks, most of which are bidentate (Fig. 2e), the length of the blade is about 40 to 50 times the width of the blade at midlength, there

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←

from same; g, tip of subacicular hook from 26th parapodium (teeth broken). Figures b–g from dissected paratype (AHF).

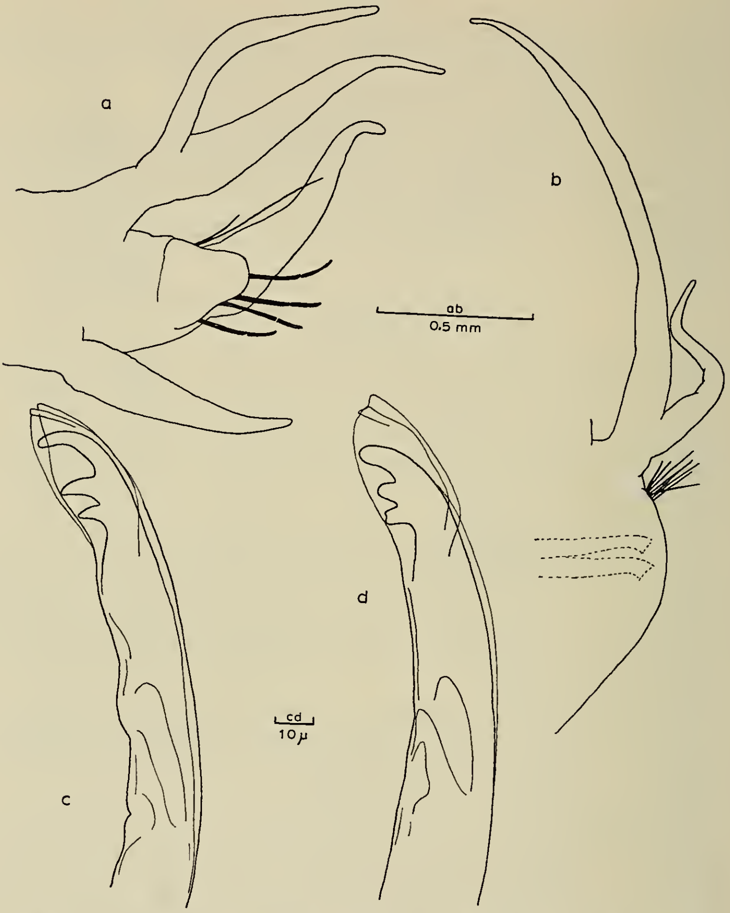

Fig. 3. *Onuphis iridescens* (F. H. Nichols' collection, Puget Sound): a, Anterior view of 1st parapodium; b, anterior view of 25th parapodium; c, pseudocompound hook from 1st parapodium; d, pseudocompound hook from 2nd parapodium of another specimen.

are 2 stout barely tridentate hooks (Fig. 2f), the second setiger has at least 8 slender hooks (7 bidentate, 1 tridentate) and 1 stout bidentate hook, the third setiger has 8 slender and 1 stout bidentate hook, the fifth setiger has 3 fairly slender and 3 stouter bidentate (or barely tridentate) hooks and 2 supraacicular limbate setae. The long slender pseudocompound hooks are most noticeable in the first 3 setigers. Hartman (1944) has given additional figures of the pseudocompound hooks.

There are no compound spinigers. Pectinate setae are distally slightly oblique, have about 11 teeth, and are first evident on the fifth setiger. Subacicular hooks (Fig. 2g) begin on the 10th setiger.

The mandibles of some specimens are calcified anteriorly. Maxilla I of a paratype is falcate. Maxilla II has 9 teeth on the left and 10 teeth on the right. Left maxilla III has 10 teeth and left maxilla IV has 6 teeth. The fused right maxilla III and IV has 11 teeth. Both maxillae V have a single tooth.

Sand grains of various sizes (0.1 to 2.0 mm diameter) adhere to the parchmentlike tube.

Diagnosis: An *Onuphis* species with reddish brown dorsal bands, cirriform branchiae from the first setiger, ventral cirri cirriform through the 5th setiger, mostly bidentate pseudocompound hooded hooks with very long slender blades, and subacicular hooks from the 10th setiger.

Remarks: This species most resembles *O. shirikishinaiensis* (Imajima) in having bidentate pseudocompound hooks with long slender blades. *Onuphis farallonensis* differs from *O. shirikishinaiensis* in having mostly bidentate hooks in the first 4 to 6 setigers, and in the first occurrence of subacicular hooks.

Distribution: Southern California, in 68 meters.

Onuphis iridescens (Johnson)

Figures 3a–d; 4a–c

Northia (sic) *iridescens* Johnson 1901, p. 408, pl. 8, figs. 86–87, pl. 9, figs. 88–92.

Nothria sp. near *N. elegans* and *N. iridescens*.—Banse, Hobson, and Nichols 1968 (in part, Form B only), p. 534.

Nothria iridescens.—Fauchald 1968, p. 24, pl. 7, fig. a.—Hartman 1944 (in part), p. 87, pl. 5, figs. 99–104; 1968, p. 681, figs. 1–3.—Moore 1911, p. 255. Not Hartman 1965, p. 104.

Onuphis iridescens.—E. Berkeley 1927, p. 408.—C. Berkeley 1967, p. 1056.—Berkeley and Berkeley 1948, p. 93, fig. 140.

Material examined: BRITISH COLUMBIA, Holotype of *N. iridescens* from Victoria (MCZ 1887).—Off Ruxton Passage, E. Berkeley, collector (USNM 38283). WASHINGTON, two specimens from Orcas Island (40 m) H. L. Sanders, collector.—Many specimens collected by the author from the Strait of Juan de Fuca (140–170 m).—Banse, Hobson, and Nichols' collections from Puget Sound (13–200 m). SOUTHERN CALIFORNIA, *Velero* stations 893, 981, 1130, 1133, 1135, 1137, 1157, 1348, 2175, 2354, 4785, 7028 (25–530 m) (AHF).

Description: The inner paired antennae of this species usually reach to setiger 13 to 20 (range, 7 to 25). The branchiae begin on the first setiger except in smaller specimens (see Fig. 4a). The first few pairs of branchiae are shorter than the dorsal cirri (as in Fig. 3a), but exceed the dorsal cirri in length thereafter. The branchiae are slender throughout

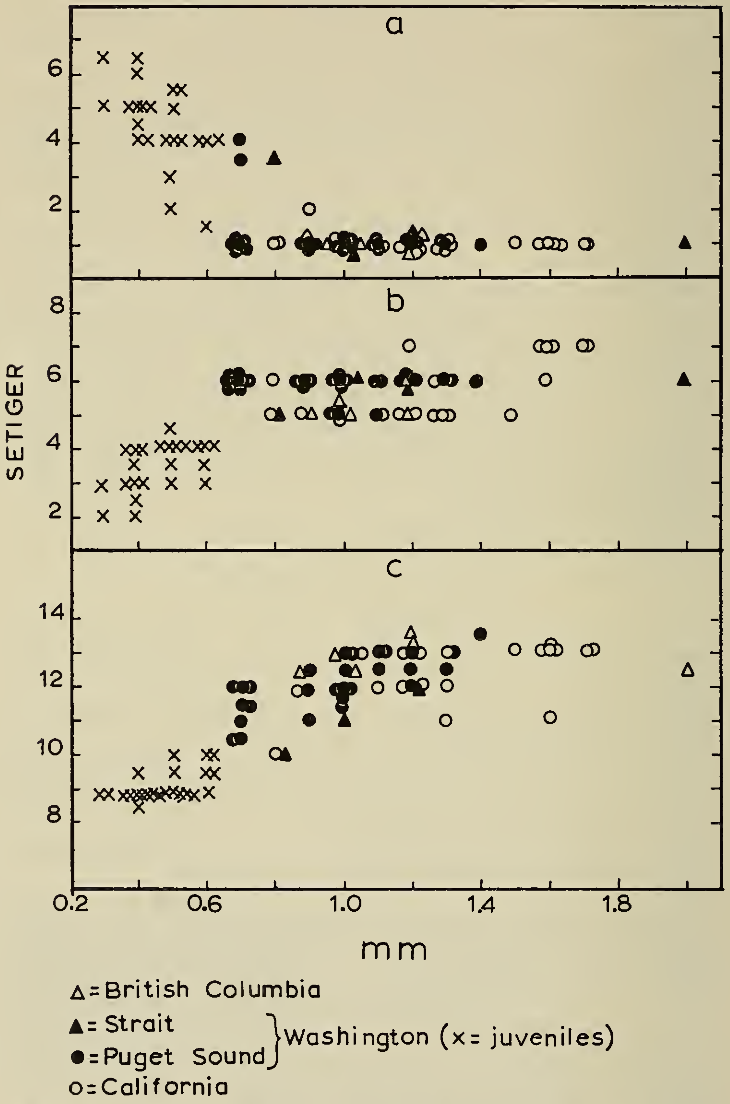

Fig. 4. Variation in specific characters of *O. iridescens* versus width of 1st segment (mm): a, First setiger with branchiae; b, last setiger with cirriform ventral cirrus; c, first setiger with subacicular hooks.

(Fig. 3b). The ventral cirri are usually cirriform through setigers 5 to 7, but through only 2 to 4 on smaller specimens (see Fig. 4b).

The first 3 to 5 setigers have tridentate pseudocompound hooks (Fig. 3c, d). The distal tooth of these setae usually extends further than in the setae of *O. elegans*; however, this character does not separate the species reliably. Narrowly limbate setae are present from the first setiger and appear faintly hairy. I have found pectinate setae no earlier than the 4th setiger. Subacicular hooks usually begin on setigers 11 to 14, but as early as 8 to 10 in smaller specimens (see Fig 4c).

The tube is parchmentlike with adherent sand grains or a thick coating of mud.

Remarks: The size of individuals of *O. iridescens* must be considered when defining this species because of the size-dependent variation of some important characters (summarized in Figure 4). The juveniles ($\leqq$ 0.6 mm width at first segment) depicted in Fig. 4a–c all have slender branchiae, and were collected from stations where the only *Onuphis* species known to occur are *O. iridescens* or *O. iridescens* and *O. elegans*. Therefore these specimens probably do represent juveniles of *O. iridescens*.

Onuphis iridescens occasionally has been regarded as being close to *O. elegans*, if not synonymous (Hartman 1944, 1961; Monro, 1930). In Washington and British Columbia the adult specimens of the two species are easily distinguished by the shape of their branchiae, the first occurrence of subacicular hooks, and the length of the inner paired antennae. In California, however, some specimens have been found that appear to be intermediate between the two species (see below).

Onuphis iridescens occurs in deeper water than does *O. elegans*. Moore (1911) reports the former species from as deep as 1460 m in Monterey Bay; Fauchald (1968) reports it from as deep as 2400 m in western Mexico; Ushakov (1950) reports it from 252–1643 m in the Sea of Okhotsk; and Monro (1930) reports it from 650 m near the southern tip of South America. I have not verified the records from the western Pacific or southern Atlantic by examination of material.

Distribution: British Columbia to western Mexico, possibly also in the Sea of Okhotsk and the South Atlantic Ocean. In 13 to 2400 meters.

Onuphis sp. "intermediates"

Onuphis iridescens.—Hartman 1944 (in part), p. 87.

Material examined: CALIFORNIA, Tomales Bay (PMS 180240, 180242).—Southern California, *Velero* stations 887, 893, 1126, 2114, 2314, 3048, and 4842 (8–143 m) (AHF).

Description: These specimens range from 0.6 to 1.4 mm in width at the first segment. They may have either no pigmentation pattern or dorsal transverse reddish brown bands of pigment on the posterior part of each segment or in the intersegmental grooves. The inner paired antennae reach to setigers 7 to 17; the branchiae are slender throughout; ventral cirri are

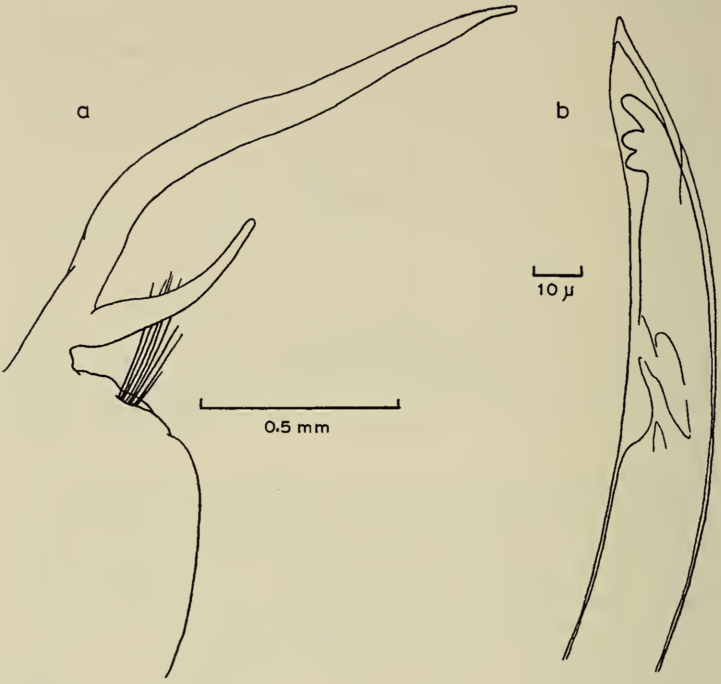

FIG. 5. *Onuphis opalina* (BCF): a, Anterior view of 24th parapodium; b, pseudocompound hook from 1st parapodium.

cirriform through setigers 5 or 6; hooded pseudocompound hooks are tridentate and occasionally have long slender blades; pectinate setae occur from the 5th setiger; and subacicular hooks begin on the 9th setiger.

Remarks: The "intermediates" resemble *O. iridescens* (see above) in the shape of the branchiae and *O. elegans* (see above) in the first occurrence of subacicular hooks. These specimens have been found in samples with *O. iridescens*, *O. elegans*, or *O. farallonensis*. However, I have found no samples from California in which one of these three species co-occurs with another. "Intermediates" are not known for Washington and British Columbia. In Puget Sound, *O. iridescens* and *O. elegans* do co-occur in the same grab sample. The "intermediates" may result from interbreeding between *O. elegans* and *O. iridescens* (and perhaps also *O. farallonensis*); they may represent a new species; or they may belong to a highly variable *O. iridescens*. Only through a laboratory

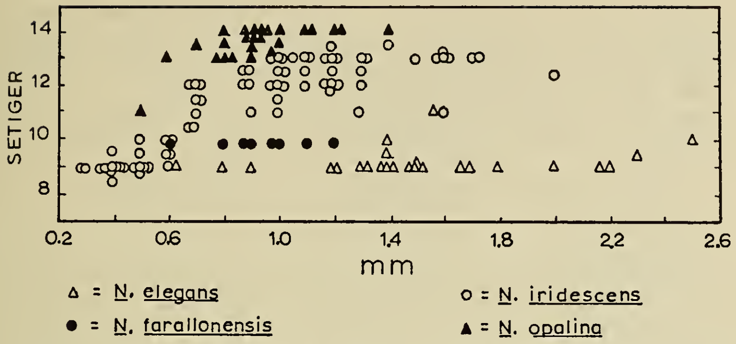

FIG. 6. First setiger with subacicular hooks versus width of first segment (mm) for four species of *Onuphis*. Values of, say, 13.5 are obtained from an individual whose subacicular hooks begin on setiger 13 on one side and 14 on the other side.

study involving interbreeding of the species in question can this problem be resolved.

Distribution: Southern and central California, in 8 to 143 meters.

Onuphis opalina (Verrill)
Figure 5a–b

Nothria opalina Verrill 1873, p. 102.
Onuphis (*Nothria*) *opalina*.—Pettibone 1963, p. 245, fig. 64.
Nothria iridescens.—Hartman 1965, p. 104. Not *N. iridescens* Johnson, 1901.

Material examined: NEW ENGLAND, numerous specimens from the shelf (26–229 m) (USNM 6110, 6114, 6137, 6144, 6764, 16038; BCF).—Four specimens from the slope, H. L. Sanders collector (station Slope 3, 300 m, 39°58′24″N, 70°40′18″W [AHF]; station F1, 1500 m, 39°47′N, 70°45′W).

Description: There is no noticeable pigment pattern. The inner paired antennae reach setigers 10 to 19. Anterior presetal lobes have a transverse fold. Branchiae are slender throughout (Fig. 5a). They begin on the first setiger in all specimens examined, except in the two specimens from 1500 meters, which have branchiae from the second setiger. Ventral cirri are cirriform through setigers 5 to 7, depending on the size of the worm. Pseudocompound hooks have 3 stout teeth (Fig. 5b) and occur on the first 4 to 5 setigers. Subacicular hooks begin on setigers 13 to 14, but on 11 in a smaller worm.

Remarks: *Onuphis opalina* is very closely related to *O. iridescens*, and its distribution in the northwest Atlantic parallels that of *O. iridescens* in the northeast Pacific. It differs from the latter species in having pseudocompound hooks with stouter teeth and a more pointed hood.

Also, for a worm of a given size, the subacicular hooks begin further posteriorly in *O. opalina* than in *O. iridescens* (see Fig. 6). Augener (1906) reports *O. opalina* from the West Indies, but his specimens cannot be found at the MCZ, so this record cannot be verified.

Distribution: From the Gulf of St. Lawrence to off Chesapeake Bay, possibly also the West Indies. In 26 to 2300 meters.

Key to Species of *Onuphis* with Cirriform Branchiae from Setiger One

This key should be used only for specimens wider than 0.6 mm at the first segment, because of the size dependency of some of the characters in *O. iridescens*, *O. opalina*, and possibly *O. farallonensis*. Because I have seen no specimens of the two Japanese species, *O. shirikishinaiensis* (Imajima) 1960, and *O. holobranchiata* Marenzeller (1879), original descriptions were studied for their inclusion in the key. Types of the latter species cannot be found in Japan, and the species has not been collected again from the type locality (M. Imajima, personal communication). The four species studied also are distinguished by the first occurrence of subacicular hooks with respect to size (see Fig. 6).

1. Pseudocompound hooded hooks occur in setigers 1 through 4 to 6 and are mostly bidentate (Fig. 2e) with a few barely tridentate (Fig. 2f) .... *O. farallonensis*
– Pseudocompound hooded hooks tridentate in first 2 setigers and mostly bidentate in setigers 3 to 7 .... *O. shirikishinaiensis*
– Pseudocompound hooded hooks mostly tridentate (Figs. 1d; 3c, d) and rarely a few bidentate or quadridentate 2
2. Branchiae of setigers 10 through 60 to 80 are thick (Fig. 1b) .... *O. elegans*
– All branchiae are slender (Figs. 3b; 5a) 3
3. Presetal lobes on first 4 parapodia digitate. Subacicular hooks begin on setiger 18 .... *O. holobranchiata*
– Presetal lobes on anterior parapodia rounded (Fig. 3a). Subacicular hooks begin before setiger 15 4
4. Pseudocompound hooded hooks with short stout teeth and pointed hood (Fig. 5b). Subacicular hooks begin on setiger 13 to 14 (Fig. 6) .... *O. opalina*
– Pseudocompound hooded hooks with more slender teeth and less pointed hood (Figs. 3c, d) 5
5. Subacicular hooks begin on setiger 9 .... *Onuphis* sp. "intermediates"
– Subacicular hooks begin on setigers 11 to 14 (Fig. 6) .... *O. iridescens*

LUMBRINERIDAE

Lumbrineris Blainville

Lumbrineris pallida Hartman

Figure 7a–e

Lumbrineris pallida Hartman 1944, p. 166, pl. 12, figs. 270–274, pl. 13, figs. 275–277; 1968, p. 773, figs. 1–6.

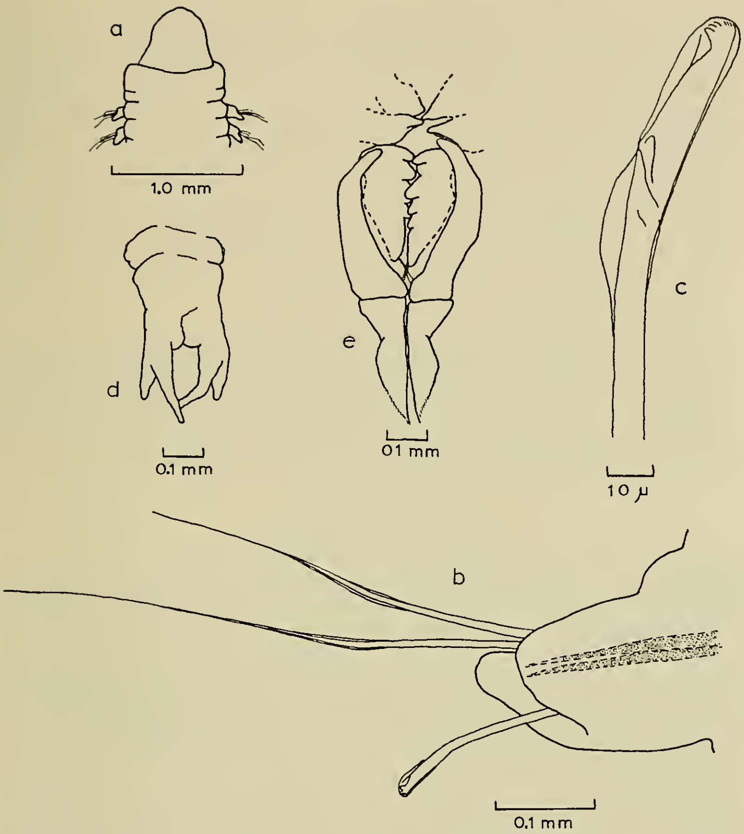

FIG. 7. *Lumbrineris pallida* (USNM 42661): a, Dorsal view of anterior end; b, anterior view of 20th parapodium (some setae missing); c, compound hook from 7th parapodium; d, dorsal view of pygidium slightly from left side; e, dorsal view of maxillae.

Material examined: CALIFORNIA, Hartman's type specimens from *Velero* station 1205 (AHF), and specimens from *Velero* stations 1388 and 4802 (AHF). WASHINGTON, two specimens collected by the author from 140 m depth in gravelly mud in the Strait of Juan de Fuca (48°22.4′ N, 124°26.3′W) (USNM 42661; AHF).

Description (specimens from Washington): A complete specimen has about 105 setigers and is about 0.8 mm wide without parapodia. The prostomium (Fig 7a) is bluntly conical.

The postsetal lobes of the parapodia (Fig. 7b) are longer than the presetal lobes. In posterior segments, the postsetal lobes are only slightly longer than in anterior segments. In the California material the postsetal lobes are distally broader than in the Washington specimens. The compound hooded hooks (Fig. 7c) occur from the first setiger through the 14th and 18th setigers. Capillary setae begin on the first setiger, gradually increase in length posteriorly and disappear at the 37th setiger. They appear to be longest at about the 20th setiger. In this region, a typical parapodium has four long limbate setae (the lower two being the longer ones) dorsal to and three simple hooded hooks ventral to the aciculae. The aciculae are black throughout the body.

The pygidium (Fig. 7d) terminates in four cirri, of which the dorsal pair is the longer one.

Maxilla I is falcate; II has 4 teeth on each side, or there may be a small fifth tooth on the right side; III and IV appear unidentate (Fig. 7e). Maxilla IV lacks the broad base depicted by Hartman (1944).

Distribution: Washington, in 140 meters (new record); southern California and Todos Santos Is., Mexico in 44 to 104 meters.

ARABELLIDAE

Drilonereis Claparède

Drilonereis longa Webster

Drilonereis longa Webster 1879, p. 240, pl. 7, figs. 84–88.—Hartman 1968, p. 801, fig. 1.—Pettibone 1963, p. 272, fig. 72.

Material examined: WASHINGTON, one specimen (USNM 42662) collected by the author from 140 m depth in gravelly mud in the Strait of Juan de Fuca (48°22.4′N, 124°26.3′W). MASSACHUSETTS, specimens from numerous stations in Cape Cod Bay (now deposited in Gray Museum).

Description: The specimen from Washington is 0.8 mm wide without parapodia and in several pieces. There appear to be 5 and 6 teeth on maxillae I and II, respectively. Maxillae III and IV are unidentate. The mandibles are missing, a condition which Webster noted in some of his specimens. The anterior parapodia are inconspicuous, and the far posterior parapodia are noticeably bilabiate.

Distribution: Washington (new record), southern California, and Massachusetts to Georgia. Intertidal to 2452 meters.

DORVILLEIDAE

Dorvillea Parfitt

Dorvillea caeca (Webster and Benedict)

Staurocephalus caecus Webster and Benedict 1884, p. 721, pl. 4, figs. 44–48.—Ushakov 1955, p. 246, fig. 83.

Stauronereis caecus.—Pettibone 1963, p. 233, fig. 61;—1961, p. 181.

Material examined: WASHINGTON, near Orcas Island, 76 specimens collected by H. L. Sanders from muddy sediment in Massacre Bay (15 m), Harney Pass (27 m), and West Sound (40 m) (14 specimens, USNM 42663; 62 specimens, in reference collection of Friday Harbor Laboratories). MASSACHUSETTS, numerous stations in Cape Cod Bay (4–58 m) (GM).

Description: The specimens from Washington have the furcate setae characteristic of this species, and seem to be identical to the Cape Cod Bay specimens.

Distribution: Washington (new record), Sea of Okhotsk, Bering Sea, Gulf of St. Lawrence to Massachusetts. Low water to 155 meters.

Protodorvillea Pettibone

Protodorvillea gracilis (Hartman)

Stauronereis gracilis Hartman 1938, p. 100, figs. 36–38.
Protodorvillea recuperata Banse and Nichols 1968, p. 225, fig. 1.
Dorvillea gracilis.—Hartman and Reish 1950, p. 25.
Dorvillea kefersteini.—Berkeley and Berkeley 1960, p. 791.—C. Berkeley 1967, p. 1056. Not *Staurocephalus kefersteini* McIntosh 1869.
Protodorvillea gracilis.—Pettibone 1961, p. 180.—Hartman 1968, p. 825, figs. 1–3.

Material examined: WASHINGTON, Puget Sound, Holotype of *P. recuperata* (USNM 36282). CALIFORNIA, Holotype of *S. gracilis* (USNM 20364; Paratype, AHF).—*Velero* stations 905, 1451, and 2788 (AHF). WESTERN CANADA, E. and C. Berkeleys' specimen from plankton (50–0 m) (USNM 39304).

Description: The structure of the parapodial lobe of *P. gracilis* and the emergence of the setae are as described below for *P. kefersteini*. The lobe from which the compound setae emerge may be withdrawn and appear as in Fig. 37 of Hartman (1938) or it may be extended as in Fig. 8b.

The Berkeleys' specimen, taken from a plankton sample, has very long capillary setae in its median parapodia.

Remarks: Banse and Nichols (1968) also noted that some parapodial lobes of a specimen may be withdrawn. The only difference that I have observed between the specimens of *P. gracilis* from Washington and specimens of *P. kefersteini* from Massachusetts and Ireland is the prominence of the subterminal spines on the compound setae of the former (see Banse and Nichols, 1968, Fig. 1h, i); I could discern subterminal spines only on the superiormost compound setae of the latter, where they are fairly indistinct.

Although the minor difference between *P. kefersteini* and *P. gracilis* probably is not of specific importance, it seems best at present to retain the latter name for the populations of the northeastern Pacific.

Distribution: British Columbia (new record, by Berkeleys 1960, as *D. kefersteini*), Washington (new record, by Banse and Nichols 1968, as *P. recuperata*), Oregon and California. Intertidal zone and shelf depths.

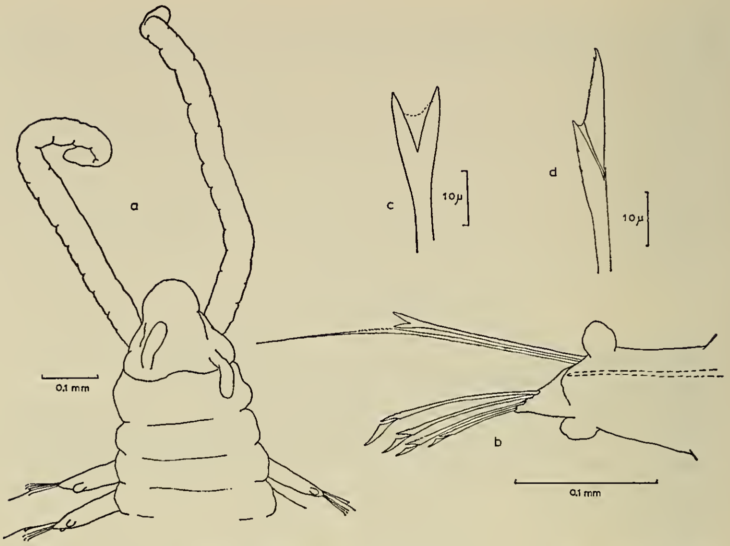

FIG. 8. *Protodorvillea kefersteini* (GM 1412): a, Dorsal view of anterior end; b, posterior view of 10th parapodium; c, furcate seta; d, compound seta (next to uppermost).

Protodorvillea kefersteini (McIntosh)

Figure 8a–d

Staurocephalus kefersteini McIntosh 1869, p. 417, pl. 16, fig. 11.—Southern 1914, p. 84. Not *Dorvillea kefersteini* Berkeley and Berkeley 1960.
Protodorvillea kefersteini.—Pettibone 1961, p. 180.

Material examined: SCOTLAND, Lochmaddy, a type specimen of *S. kefersteini* (BMNH). IRELAND, Blacksod Bay, R. Southern collector (BMNH). MASSACHUSETTS, Cape Cod Bay in gravelly sand (St. 1412, 15 m, 41°54.5′N, 70°8.0′W and St. 1514, 18 m, 41°53.5′N, 70°10.7′W) (200+ specimens, GM; 8 specimens, USNM 42027).

Description: The complete specimens are about 5 mm long for 50 to 60 setigers. They differ from the specimens of McIntosh and Southern in lacking eyes. The antennae are clavate and very indistinctly articulated (Fig. 8a). In many specimens, there is no noticeable articulation. The parapodial lobes are usually prolonged (Fig. 8b), but may be so withdrawn that they do not extend much beyond the acicula. The dorsal cirri are variable in form and may be more prolonged than is shown in Fig. 8b. The furcate setae have two nearly equal branches (Fig. 8c). The compound setae (Fig 8d) emerge from the tip of the parapodium; thus there are neither presetal nor postsetal lobes.

The antennae of McIntosh's and Southern's specimens are clavate and as indistinctly articulated as in Fig. 8a. The structure of the parapodium and the emergence of the setae are as described for the Cape Cod Bay specimens, although the parapodial lobes are not quite as prolonged as in the latter.

Distribution: Massachusetts (new record) and Europe. Intertidal to 44 meters.

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PROCEEDINGS
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WESTERN ATLANTIC *DONAX*

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Continuing misconceptions of speciation of *Donax* and misidentifications of species living on the coasts of Virginia and the Carolinas prompted this review of all Western Atlantic *Donax* species. Critical microscopic study of the collections of *Donax* in the Smithsonian Institution and of those in the Academy of Natural Sciences of Philadelphia (more than 500 samples and more than 45,000 specimens) and of the literature, has produced clear and specific answers. There are eleven forms of *Donax* living along Western Atlantic shores. Each of the ten distinct species and one subspecies has a distinct geographic range. The geographic ranges of certain species overlap. In a number of cases two (sometimes three) species may be living on the same shores. In three cases there is a definite ecological zonation indicated for such dual occupation of the sandy beach habitats. Because they are not completely separated throughout the year, more than one species of *Donax* of the Western Atlantic has often been collected in, and left mixed in museums, in the same sample.

These studies indicate that a two year life-span is normal for all six *Donax* that are recorded from the Atlantic shores of the United States and Mexico, just as reported for the Californian species *Donax gouldi* by Coe 1955, and for the Indian *Donax* (*Latona*) *cuneata* by Nayar 1955.

All reports of United States *Donax* being "annual" species are based on mixtures of species incompletely collected and/or analyzed.

In this monograph the species are arranged in a geographic and group series. All species known to be living on Western

Atlantic shores are figured here together; three for the first time. Pertinent references are listed chronologically under each species heading.

Donax fossor Say 1822

Pl. 1, Fig. F; and Pl. 2, Fig. F

1822. *Donax fossor* Say, Journ. ANSP., 2: 306.
1834. *Donax fossor* Say, Amer. Conch., plate 61, fig. 2.
1843. *Donax fossor* DeKay, Nat. Hist. N. Y., p. 211, pl. 23, fig. 255.
1843. *Donax fossor* Hanley, Bivalve Shells, p. 85.
1844. *Donax fossor* Hanley, Bivalve Shells, p. 349, pl. 9, fig. 36.
1857. *Donax variabilis* Tuomey & Holmes (not of Say), Pl. Fossils S. Car., p. 95, pl. 23, fig. 6.
1858. *Donax fossor* Say, Binney's Edn. Amer. Conch., plate 61, fig. 2.
1869. *Donax fossor* Tryon, Am. Journ. Conch., 4 (5): append., p. 112.
1869. *Donax* (*Serrula*) *fossor* Romer, Conch. Cab., 10 (3): p. 52, pl. 9, figs. 11–14.
1881. *Donax fossor* Bertin, Nouv. Archiv. Mus. (ser. 2), 4: 93.
1889. *Donax fossor* Dall, Bull. 37 USNM, p. 58.
1890. *Donax fossor* Dall (in part), Tert. Fauna Fla., 3 (5): 967.
1892. *Donax fossor* Dall, Nautilus, 5 (11): 126.
1903. *Donax fossor* Dall, Bull. 37 USNM, Reprint, p. 58.
1920. *Donax fossor* Maury, Bull. Amer. Paleont., 8: 128.
1922. *Donax fossor* Jacot, Nautilus, 36 (2): 60.
1922. *Donax variabilis* Jacot (in part), Nautilus, 36 (2): 60.
1927. *Donax variabilis* Wood & Wood (not Say), Nautilus, 41: 10.
1927. *Donax fossor* Johnson, Nautilus, 41: 140.
1929. *Donax variabilis* Jacot (in part), Nautilus, 42 (4): 142–143.
1929. *Donax fossor* Johnson, Nautilus, 43 (1): 28–30.
1934. *Donax fossor* Johnson, Proc. Boston Soc. Nat. Hist., 40 (1): 53.
1937. *Donax fossor* M. Smith, East Coast Marine Shells, p. 62, pl. 10, fig. 12.
1940. *Donax fossor* Alexander, Nautilus, 54: 127.
1951. *Donax fossor* Morris, Field Guide Shells, 2nd Edn., p. 82.
1954. *Donax fossor* Abbott, American Sea Shells, p. 437.
1955. *Donax fossor* Jacobson, Nautilus, 68 (3): 73–77.
1961. *Donax fossor* Jacobson & Emerson, Shells, N. Y. City, p. 93, fig'd.
1967. *Donax fossor* Jacobson, N. Y. Shell Club Notes, No. 134: 2.
1968. *Donax fossor* Abbott, Sea Shells N. America, p. 248, fig'd.
1969. *Donax variabilis* Chanley (not Say), Bull. Marine Sci., 19 (1): 214–224.
1969. *Donax fossor* Chanley (in part), Nautilus, 83 (1): 1–14.

Type locality: *fossor* Coasts of New Jersey and Maryland (Say, 1822).

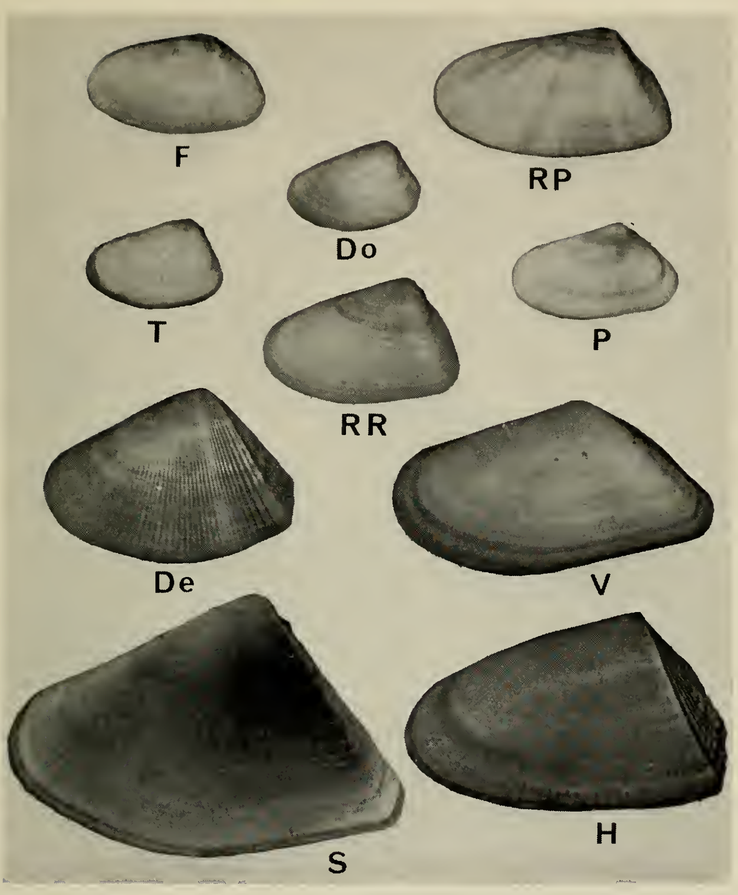

Plate 1

F = *fossor* Say. USNM no. 679770, Ocean City, Maryland. RP = *roemeri protracta* Conrad. USNM no. 679771, 77° West Longitude, North Carolina. P = *parvula* Philippi. USNM no. 679772, Windy Hill Beach, South Carolina. Do = *dorotheae*, New Species, Holotype USNM no. 679773, Alligator Point, Franklin Co., Florida, 14.0 mm. T = *texasiana* Philippi. USNM no. 679127, Galveston, Texas. RR = *roemeri roemeri* Philippi, USNM no. 598104. Port Aransas, Texas. De = *denticulata* Linnaeus, USNM no. 660273, Mayaguez, Puerto Rico. S = *striata* Linnaeus, USNM no. 253131, Wounta Haulover, Nicaragua. V = *vellicata* Reeve, USNM no. 518549, Chaguaramas Bay, Trinidad. H = *hilairea* Guerin, USNM no. 341711, La Paloma, Uruguay. (All figures approximately 1¼×.)

D. fossor lives on the coasts from Nag's Head, North Carolina to New Jersey. Intermittently, populations of this species are established on the south shore of Long Island, New York. It is distinct and overlaps part of the range of *Donax roemeri protracta* without any hybridization or intergradation. No living *Donax fossor* have been seen south of Cape Hatteras, North Carolina.

Shell distinctions between the species *fossor* and *roemeria protracta,* with which it may be living in the sand beaches between the mouth of Chesapeake Bay and Cape Hatteras, are positive even if not immediately evident. The shell of *Donax fossor* is more evenly radially sculptured throughout its length. *D. roemeri protracta* is much more distinctly and strongly radially ridged on the posterior slope. Particularly in the juveniles of about 5 mm length, the escutcheon area of *Donax roemeri protracta* is more rounded toward the vertical, not regularly sloping parallel to the rounded posterior ridge as in *fossor.* With the thickened lips apparent on the anterior curve of the shell in *roemeri protracta,* that same anterior end of the shell is proportionately vertically narrower in *roemeri protracta* than it is in *fossor* shells of the same size. Note that the thickened anterior lips of *roemeri protracta* were figured by Say in 1834, in distinguishing *fossor* from his second species (*variabilis*).

In 1969, a marked difference in ecology and life history between *D. fossor* and *D. roemeri protracta* was discovered. When *D. fossor* disappears from the beaches at the end of the season, it moves outside the intertidal zone, to spend the rest of the winter and spring in surf and subtidal waters. Chanley's theory regarding *fossor* as a "summer range extension of *variabilis*" (Nautilus 83:1–14:1969) was proven incorrect by the collection of specimens of the species *fossor* by me in May 1969 and in February and April 1970. All the *Donax* from the Wachapreague region of Virginia studied by Chanley, belong to the species *fossor* Say. He experimentally raised young from *fossor* parents, that "set" as *fossor.* They cannot be identified as any other species.

One hundred and one living juveniles of *fossor* were dredged in 2 and 3 feet of water 10 to 30 feet offshore, off the north end of Parramore Island, Accomack Co., Virginia on 23 Feb. 1970, with the help of Michael Castagna of the Virginia Institute of Marine Science at Wachapreague. These specimens of *fossor* (USNM No. 701590 and No. 701601) were between 2.1 and 7.6 mm long, with an average length of 3.94 mm.

On 19 April 1970, a population of *Donax fossor* previously sampled at Sand Bridge Beach, Princess Anne Co., Virginia on 30 September 1969, was relocated and, under storm conditions, four living juveniles of *Donax fossor* were dredged from the shoreward fringe of the population, in 3 feet of water at or near low tide. These four specimens (USNM No. 701583) measured from 3.2 to 5.2 mm in length, with an average length of 4.3 mm. The previous season, living juveniles were dredged in 4 and 6 feet of water off Cedar and Parramore Islands, Accomack Co., Virginia, 17 May 1969, also with the help of Castagna and his staff. These

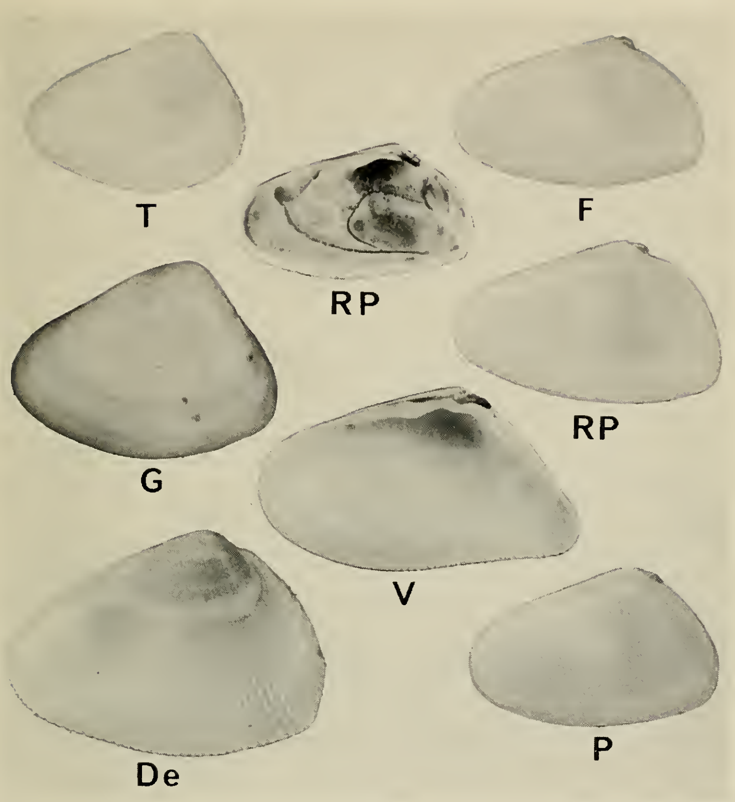

Plate 2

T = *texasiana* Philippi, Juvenile, USNM no. 33721, Corpus Christi, Texas. F = *fossor* Say, Juvenile, USNM no. 680622, Ocean City, Maryland. RP = *roemeri protracta* Conrad, Right valve interior showing pallial sinus, USNM no. 680624, 77° West Longitude, North Carolina. RP = *roemeri protracta* Conrad, Juvenile, USNM no. 680623, 77° West Longitude, North Carolina. G = *gemmula*, New Species, Holotype (enlarged), ANSP No. 244125, Rio Grande do Sul, Brazil, 6.5 mm. V = *vellicata* Reeve, Right valve interior showing pallial sinus. USNM no. 518549, Chaguaramas Bay, Trinidad. De = *denticulata* Linnaeus, Juvenile, USNM no. 534936, Greytown, Nicaragua. P = *parvula* Philippi, Juvenile, USNM no. 680625, Windy Hill Beach, South Carolina. (Figures of juveniles approximately 3⅛×. Pallial sinus figures approximately 1¼×.)

juveniles of 17 May 1969 (USNM numbers 701638, 701639 and 701641) ranged between 3.0 and 7.2 mm long with an average length of 4.26 mm.

Unlike the 4 to 5 mm long juveniles of the intertidal beach sand collected by me at Ocean City, Md., Sept. 1963, which were uniformly smooth, these Feb. 23rd and April 19th and May 17th juveniles had overwintered. They show a marked winter ring on every shell. Measurement of ten population samples (more than 6000 specimens) has conclusively shown that a two year life span is normal for this most northern Western Atlantic species, *Donax fossor* Say. A few of the largest specimens seen may have survived into their third season, as did the Weingartner Collection of May 30 from Beach Haven Inlet, New Jersey reported by Chanley (1969, p. 7).

Donax roemeri protracta Conrad 1849

Pl. 1, fig. RP; and Pl. 2, figs. RP

1822. *Donax variabilis* Say, Journ. ANSP, 2: 305. (not: (*Donax*) *Latona variabilis* Schumacher 1817).
1834. *Donax variabilis* Say, Amer. Conch., plate 61, fig. 1.
1843. *Donax variabilis* Hanley, Bivalve Shells, p. 85.
1844. *Donax variabilis* Hanley, Bivalve Shells, p. 349, pl. 14, fig. 3.
1849. *Donax protracta* Conrad, Journ. ANSP (2nd ser.), 1: 208, 280, pl. 39, fig. 8.
1854. *Donax variabilis* Reeve, Conch. Icon., 8 (*Donax*) plate 7, sp. 47.
1858. *Donax variabilis* Say, Binney's Edn. Amer. Conch., plate 61, fig. 1.
1860. *Donax variabilis* Stimpson, Am. Journ. Sci., May 1860, p. 443.
1866. *Donax variabilis* Sowerby, Thesaurus, 3: 309, sp. 27, figs. 37–39.
1866. *Donax angustatus* Sowerby, Thesaurus, 3: 309, sp. 29, fig. 44.
1869. *Donax angustatus* Tryon, Am. J. Conch., 4 (5): append., p. 112.
1869. *Donax protractus* Tryon, Am. J. Conch., 4 (5): append., p. 113.
1869. *Donax variabilis* Tryon, Am. J. Conch., 4 (5): append., p. 114.
1869. *Donax variabilis* Romer, Conch. Cab., 10 (3): p. 45, pl. 8, figs. 9–14.
1871. *Donax variabilis* Coues, Proc. ANSP, p. 137.
1878. *Donax variabilis* Calkins, Proc. Davenport Acad. Sci., p. 248.
1878. *Donax protractus* Calkins, Proc. Davenport Acad. Sci., p. 248.
1881. *Donax variabilis* Bertin, Nouv. Arch. Mus. (ser. 2), 4: 91.
1881. *Donax angustatus* Bertin, Nouv. Arch. Mus. (ser. 2), 4: 98.
1881. *Donax protractus* Bertin, Nouv. Arch. Mus. (ser. 2), 4: 104.
1889. *Donax variabilis* Dall, Bull. 37 USNM, p. 58.
1889. *Donax variabilis* Simpson, Proc. Davenport Acad. Sci., 5: 63.
1890. *Donax variabilis* Johnson, Nautilus, 4 (1): 5
1892. *Donax variabilis* Dall, Nautilus, 5 (11): 125.
1900. *Donax variabilis* Dall, Tert. Fauna Fla., 3 (5): 969.
1903. *Donax variabilis* Dall, Bull. 37 USNM, reprint p. 58.
1903. *Donax variabilis* Vanatta, Proc. ANSP, 55: 757.

1913. *Donax variabilis* Mazyck, Contrib. Charleston Mus. II, Cat. Moll. S. Carolina, p. 30.
1919. *Donax variabilis* Johnson, Nautilus, 33 (1): 4.
1920. *Donax fossor* Maury (in part), Bull. Amer. Paleont., 8: 128.
1920. *Donax variabilis* Maury, Bull. Amer. Paleont., 8: 129.
1922. *Donax variabilis* Jacot (in part), Nautilus, 36 (2): 60.
1927. *Donax variabilis* Johnson, Nautilus, 41 (1): 140.
1929. *Donax variabilis* Jacot (in part), Nautilus, 42 (4): 142–143.
1929. *Donax variabilis* Johnson, Nautilus, 43 (1): 29.
1934. *Donax fossor protractus* Johnson, Proc. Boston Soc. Nat. Hist., 40 (1): 53.
1934. *Donax variabilis* Johnson, Proc. Boston Soc. Nat. Hist., 40 (1): 54.
1936. *Donax variabilis* Pearse, Journ. Elisha Mitchell Sci. Soc., 52 (2): 189.
1937. *Donax variabilis* M. Smith, E. Coast Marine Shells, p. 62, pl. 25, fig. 10.
1940. *Donax variabilis* Haas, Amer. Midland Nat., 24 (2): 370–371.
1942. *Donax variabilis* Pearse, et al. (in part), Ecol. Mon., 12: 135–190.
1945. *Donax variabilis* Vilas & Vilas, Florida Marine Shells, p. 45, pl. 5, figs. 4 a–d.
1947. *Donax variabilis* Morris, Field Guide Shells, p. 57, pl. 14, fig. 1.
1951. *Donax variabilis* Morris, Field Guide Shells, Edn. 2, p. 81, pl. 12, fig. 1.
1954. *Donax variabilis* Abbott, Amer. Sea Shells, p. 437, pl. 30r.
1955. *Donax variabilis* Perry & Schwengel, Marine Shells, S. W. Fla., Edn. 2, p. 86, pl. 17, fig. 109.
1957. *Donax variabilis* Turner & Belding (in part), Limn. Oceanogr., 11 (2): 120–124.
1957. *Donax variabilis* Siekman, Handbook of Fla. Shells, Great Outdoors Assn., St. Pete., Fla., p. 40.
1959. *Donax variabilis* Aldrich, Atlantic Naturalist, Jan.–Mar., pp. 41–43.
1959. *Donax variabilis* Edgren, Ecology, 40 (3): 498–502.
1961. *Donax variabilis* Moore, Gulf Research Reports, 1 (1): 46.
1968. *Donax variabilis* Abbott, Sea Shells N. America, p. 248, fig'd.
1969. *Donax variabilis* Chanley (in part), Nautilus, 83 (1): 1–14.

Type localities: *variabilis* Coasts of Georgia and E. Fla. (Say, 1822): *protracta* Coast of Florida, near St. Joseph's Bay, (Conrad 1849): *angustatus* United States (Sowerby 1866).

The familiar name *variabilis* Say 1822 is preoccupied by *Latona variabilis* Schumacher 1817, proposed as a new name for *Donax cuneatus* Linnaeus when it was transferred to the new genus *Latona*. Note that this specific renaming was a requirement in the time of Schumacher and Lamarck, upon transfer to another genus. As long as *Latona* and other groups are considered subgenera, but still in *Donax*, the name *Donax variabilis* Say 1822 cannot be used. In its place we are using the next available name, *Donax roemeri protracta* Conrad 1849. Conrad's name for the eastern subspecies was published about five months after *Donax roemeri* Philippi appeared in March 1849.

This eastern subspecies of *roemeri* is recorded from Virginia Beach, Virginia southward and westward to Alabama and Mississippi. It is present in all years from Cape Hatteras, North Carolina southward, but only intermittently does it overlap, and live in the same sands with, *Donax fossor* north of Cape Hatteras.

In contrast to the shells of *fossor* living to the north; of *parvula* living alongside it from Ocracoke, North Carolina to St. Lucie Co. Park, Florida; and of *dorotheae* living alongside it on the northern shores of the Gulf of Mexico, the shells of *roemeri protracta* are strongly radially striate on the posterior slope. The posterior ridge of *protracta* is much more abrupt than that of the smaller species that may be living with it.

As far as known, *Donax roemeri protracta* lives in the intertidal beach sands throughout the entire year. In fact, this species may have part or all of the population inactive or "stranded" in the mid-tidal sand whenever the tide is low. In South Carolina, *protracta* was found completely "stranded" in December 1959, partially "stranded" in June 1960, and probably 98 percent "stranded" in a 10 ft. wide band of pock-marked sand in the upper intertidal zone near the high tide line on 14 July 1969.

The lumping of almost all *Donax* from the Carolina region under the name *variabilis* in previous studies, has confused more than the species picture. In scores of samples studied in the Smithsonian Institution and the Academy of Natural Sciences of Philadelphia collections, the "young" included the following species (*D. parvula* Philippi). Because of their collection, study, and deposit in collections as mixtures, these samples indicate the need to repeat all research on the ecology, spawning, growth, and life spans of *Donax* species on the Carolina coasts, before the results of such researches can be accepted at full value.

When *protracta* has been correctly identified, and the admixed *parvula* has been separated, the two year life-span of both species can be readily seen. Collections made near Beaufort, North Carolina in April 1912, and in June 1960, both show a normal two year life-span, with a three year span for some individuals of *D. roemeri protracta.* In both of these cases, *D. parvula* living in the same sand of the same beaches confused the growth picture until the two species had been separated. The statements of Pearse (1942, p. 156) that *protracta* is an "annual", and of Chanley (1969, p. 3) that the average size of *Donax* does not increase during the season in North Carolina, are understandable mistakes based on mixed samples of *protracta* and *parvula.*

Donax parvula Philippi 1849

Pl. 1, fig. P; and Pl. 2, fig. P

1849. *Donax parvula* Philippi, Zeits. f. Malakoz., 5 (10): 146.
1869. *Donax parvulus* Tryon, Am. J. Conch., 4 (5): append., p. 113.
1881. *Donax parvulus* Bertin, Nouv. Arch. Mus. (ser. 2), 4: 103.

1889. *Donax obesa* Dall (in part), Bull. 37 USNM, p. 58 (St. Augustine).
1889. *Donax fossor* Simpson, Proc. Davenport Acad. Sci., 5: 63 (Mayport, Fla., Upson).
1890. *Donax obesa* Johnson (not Orbigny 1846), Nautilus, 4 (1): 5.
1892. *Donax tumida* Dall (in part), Nautilus 5 (11): 126.
1892. *Donax parvula* Dall, Nautilus, 5 (11): 126.
1900. *Donax fossor* Dall (in part), Tert. Fauna Fla., 3 (5): 967.
1903. *Donax obesa* Dall (in part), Bull. 37 USNM Reprint, p. 58 (St. Augustine).
1913. *Donax fossor* Mazyck, Contrib. Charleston Mus. II., Cat. Moll. S. Carolina, p. 30.
1919. *Donax obesa* Johnson (not Orbigny 1846), Nautilus, 33 (1): 4.
1920. *Donax fossor* Maury (in part), Bull. Amer. Paleont., 8: 128.
1920. *Donax tumida* Maury (in part), Bull. Amer. Paleont., 8: 128.
1929. *Donax tumida* Johnson (in part), Nautilus, 43 (1): 30.
1934. *Donax tumidus* Johnson (in part), Proc. Boston Soc. Nat. Hist., 40 (1): 54.
1936. *Donax fossor fossor* Pearse, Journ. Elisha Mitchell Sci. Soc., 52 (2): 189.
1937. *Donax tumida* M. Smith (in part), East Coast Marine Shells, p. 62, pl. 10, fig. 9.
1942. *Donax variabilis* Pearse, et al. (in part), Ecol. Mon., 12: 156.
1957. *Donax variabilis* Turner & Belding (in part), Limn. Oceanogr., 11 (2): 120–124.
1969. *Donax variabilis* Dexter, Chesapeake Sci., 10 (2): 93–98.
1969. *Donax variabilis* Chanley (in part), Nautilus, 83 (1): 1–14.

Type locality: Florida? (Philippi 1849); here confirmed, and restricted to Jacksonville Beach, Florida.

Donax parvula Philippi 1849 has been incorrectly listed as *obesa* and as *tumida* from East Florida; and as *fossor* from south of Cape Hatteras, North Carolina. Never previously figured, it does not attain the maximum size of *roemeri protracta* with which it has usually been collected. It may be easily distinguished from *protracta* by the lack of distinct radial sculpture over most of the shell. Over the subangulate posterior ridge, and on the posterior slope of *protracta,* the radial ribs are most prominent, and more or less sharply incised. In contrast, *D. parvula* has a smaller, thicker shell, more glossy in appearance, with a rounded posterior ridge ending in an evenly rounded postbasal curve. The posterior slope of *parvula* is glossy, and is not externally radially ribbed. It is presently known to be living from Ocracoke, North Carolina southward to St. Lucie Co. Park, Florida. The most recently published ecological study on *Donax* in the Beaufort area probably concerns only *D. parvula,* living inside the mouth of the Beaufort estuary system. (Dexter 1969).

The St. Augustine, Florida record (1890 & 1919) of C. W. Johnson of "*obesa*" stated that it was common at the mouth of the lagoon. Nearly all other samples of *parvula* in the Smithsonian Institution and the Philadelphia Academy collections were collected with, and were left mixed with, lots of *protracta* (both active and inactive) from the mid-tidal sands of narrow beaches. On the extremely wide beach at Ocean Drive Beach, South Carolina, on 14 July 1969, *Donax parvula* was found living alone in a zone near the low tide line (in three feet of water at time of mid-tide), about 30 yards seaward of the high tide line zone of the "stranded" *Donax roemeri protracta* population. At this time and place there was no overlap of the two *Donax* populations, although many empty, paired shells of both species were evident in the drift at the high tide line. If it proves constant, this low to sub-tidal zonation of *parvula* appears to parallel that reported for *texasiana* by Loesch in 1957, and now known for the previously unnamed *dorotheae* from the northern shores of the Gulf of Mexico.

The present studies indicate that *Donax parvula* normally shows a two year life-span. Two age groups of *parvula* mixed with two age groups of *protracta* have completely blanketed growth studies on *Donax* in the Carolina region, and produced some false results in some previously published reports. Another reason for confusion of previous growth studies is some evidence at hand that *parvula* may spawn and set its young later in the season than does *protracta*. In November 1958, two sizes were evident in the *parvula* population sampled at Windy Hill Beach, South Carolina. One group was adult, ranging from 10 to 15 mm in length. The younger group (probably spawned in 1958) were minute, ranging from 3 to 5 mm in length.

Donax dorotheae new species

Pl. 1, fig. Do

1889. *Donax obesa* Dall (in part), Bull. 37 USNM, p. 58 (not *obesa* Orbigny 1846).
1903. *Donax obesa* Dall (in part), Bull. 37 USNM. Reprint, p. 58.
1904. *Donax obesa* Vanatta, Proc. ANSP, 55: 757.
1920. *Donax tumida* Maury (in part), Bull. Amer. Paleont., 8: 128, (not *tumida* Phil. 1849).
1920. *Donax obesa* Maury, Bull. Amer. Paleont., 8: 129.
1929. *Donax tumida* Johnson (in part), Nautilus, 43 (1): 30.
1929. *Donax tumida* Clench, Nautilus, 43 (1): 35.
1934. *Donax tumidus* Johnson, Proc. Boston Soc. Nat. Hist., 40 (1): 54.
1942. *Donax variabilis* Harry, Occ. Papers, Marine Lab., L.S.U., No. 1. (Not *variabilis* Say 1822).
1952. *Donax tumida* Pulley (in part), Texas Journ. Sci., 1952 (2): 183.
1956. *Donax tumida* Parker, Bull. Am. Assn. Petroleum Geol., 40 (2): 295–376 Plate 6, figs. 6a, 6b.
1957. *Donax tumida* Loesch (in part), Publ., Inst. Marine Sci., Univ. Texas, 4 (2): 213–214.
1961. *Donax tumida* Moore, Gulf Research Reports, 1 (1): 46.

Type locality: Alligator Point, Franklin Co., Florida.

Shell small to medium, oval, posteriorly ventricose, surface almost evenly smooth from anterior to posterior margins. Posterior slope roundly biangulate, with the posterior point at almost mid height. The left valve is higher, distinctly overlapping the right valve ventrally behind the middle. The ventral margin is regularly rounded, almost continuous with the upswept basal curve. Pallial sinus relatively large, more than half the height of the general mantle chamber, and more than half the length between the adductor muscle scars. The ventral internal margins of the valves are regularly denticulate, as in all other Western Atlantic species of the genus *Donax.*

The holotype, U.S.N.M. No. 679773, was collected at Alligator Point, Franklin Co., Florida, February 1968 by William J. Tiffany III in the course of his research on *Donax.* It measures 14.0 mm × 8.5 mm × 6.9 mm. Paratypes, U.S.N.M. No. 680614, from the same original lot, measure: 16.0 mm × 9.4 mm × 7.6 mm, 15.5 mm × 9.4 mm × 7.2 mm, 14.9 mm × 9.1 mm × 7.4 mm, 14.0 mm × 8.6 mm × 6.6 mm, 13.0 mm × 7.8 mm × 6.3 mm, 10.6 mm × 6.7 mm × 5.5 mm and 10.0 mm × 6.4 mm × 5.0 mm.

Additional paratypes from the same original lot, ANSP No. 316126; from Indian Pass, Apalachicola Bay, Fla., ANSP No. 83833; Crooked Island, off St. Andrews Sound, Fla., ANSP No. 83832; St. Joseph Bay, Fla., ANSP No. 83831; Pensacola, Fla., USNM Nos. 103200, 706469, and 706471; Horn Island, Miss., ANSP No. 81066; near Ships Island, Miss., Gulf Coast Res. Lab. Colln.; Grand Isle, La., USNM Nos. 680746, 680750, 706475, and 706477; Grande Terre, La., USNM No. 680615; Isles Derniere, La., (90°45′ W. Long.), USNM No. 680616, and the Houston Mus. Nat. Sci. Colln.; Cameron Parish, La., USNM Nos. 467020, 681612, 681615, 681617, 706472, and 706473; and Jefferson County, Texas, USNM Nos. 681619 and 681623, have been studied to date.

Commonly reported previously as *tumidus*, *dorotheae* also shows the ventral overlap of the left valve below the right, as in *texasiana.* In contrast to the beaded or crenulate posterior dorsal slope of *texasiana*, *dorotheae* is smooth, barely radially striate there.

This species parallels, in its subtidal or extremely low tidal zonation, the Atlantic coastal *Donax parvula*, and the even more closely related *D. texasiana* Philippi, as reported by Loesch 1957. Harry (1942) recorded it as living in 1 to 6 ft. of water in front of the beach at Grande Isle, Louisiana. It has also been dredged in 4 ft. of water off Dog Keys, off the eastern end of Ships Island, and in 13 feet of water in Mississippi Sound, halfway out to Ships Island, Mississippi.

On 3 January 1970, a population concentration of more than 10,000 immature individuals per linear foot of beach was found near the low tide line on Grand Isle, Louisiana. Living in the same sand with them was an extremely sparse population of approximately two individuals of *Donax roemeri protracta* per linear foot of beach.

This species is named in appreciation of (Mrs.) Dorothy Morrison, who has been forbearingly tolerant of time-consuming malacological research for four decades.

Donax texasiana Philippi 1847

Pl. 1, fig. T; and Pl. 2, fig. T

1847. *Donax texasiana* Philippi, Zeits. f. Malakoz., 4: 77.
1849. *Donax tumida* Philippi, Zeits. f. Malakoz., 5: 147.
1849. *Donax texasiana* Philippi, Roemer's Texas, p. 452.
1849. *Donax tumida* Philippi, Roemer's Texas, p. 453.
1869. *Donax texasianus* Tryon, Am. J. Conch., 4 (5): append., p. 114.
1869. *Donax tumidus* Tryon, Am. J. Conch., 4 (5): append., p. 114.
1869. *Donax* (*Serrula*) *texasiana* Romer, Conch. Cab., 10 (3): 40: pl. 8: figs. 1–4.
1881. *Donax texasianus* Bertin, Nouv. Archiv. Mus. (ser. 2), 4: 105.
1881. *Donax tumidus* Bertin, Nouv. Archiv. Mus. (ser. 2), 4: 106.
1889. *Donax obesa* Dall (in part), Bull. 37 USNM, p. 58.
1891. *Donax fossor* Baker, Proc. ANSP., p. 48 (Veracruz).
1892. *Donax texasiana* Dall, Nautilus, 5 (11): 126.
1892. *Donax tumida* Dall (in part), Nautilus, 5 (11): 126.
1893. *Donax tumida* Singley, 4th Ann. Rept. Geol. Survey Texas, p. 328.
1895. *Donax tumida* Harris, Bull. Amer. Paleont., 1: 92.
1903. *Donax obesa* Dall (in part), Bull. 37 USNM. Reprint, p. 58.
1920. *Donax texasiana* Maury, Bull. Amer. Paleont., 8: 128.
1920. *Donax tumida* Maury (in part), Bull. Amer. Paleont., 8: 128.
1929. *Donax tumida* Johnson (in part), Nautilus, 43 (1): 30.
1934. *Donax texasiana* Johnson, Proc. Boston Soc. Nat. Hist., 40 (1): 54.
1934. *Donax tumidus* Johnson (in part), Proc. Boston Soc. Nat. Hist., 40 (1): 54.
1937. *Donax tumida* M. Smith (in part), E. Coast Marine Shells, p. 62: pl. 10: fig. 9.
1952. *Donax tumida* Pulley (in part), Texas Journ. Sci., 1952 (2): 183.
1957. *Donax tumida* Loesch (in part), Publ. Inst. Marine Sci., Univ. Texas, 4 (2): 205.
1968. *Donax tumidus* Abbott, Sea Shells N. America, p. 248, fig'd.

Type localities: *texsiana* Galveston, Texas (Philippi 1847); *tumida* Galveston, Texas (Philippi 1849).

Actually *texasiana* was the name given two year old specimens 12 mm long, while two years later *tumida* was based on (one year old?) shells 9 mm long. This smaller species is much more rotund, more rounded posteriorly, without the prominent posterior ridge of *roemeri* shells which may be found on the same beaches between the Mississippi delta and Vera Cruz, Mexico. *D. texasiana* is minutely beaded or crenulate on the posterior slope; *roemeri* is radiately striate only, but distinctly so, on this part of the shell; *dorotheae* living east of the range of *texasiana* is smooth on the rounded posterior slope.

This species is now recorded from Cameron Parish, Louisiana, and Galveston, Texas (the type locality) southward to Vera Cruz, Mexico. It has not been critically searched for south of the City of Vera Cruz, so its range along the southern Gulf of Mexico shores is unknown.

In 1957 Loesch pointed out the ventral overlap of the left valve, which will differentiate *texasiana* from *roemeri*, with which it may be living on occasion. Loesch also reported that this species lives part of the year below the low tide line. His explanations and collections are not complete, however; "After a storm" numerous 6 mm long individuals of *texasiana* showed up as 30 percent or more of the samples, in contrast to a previous 100 percent of *roemeri*. This can only be explained as a storm shift of the immature *texasiana* into the intertidal surf zone, from the subtidal waters. Certainly no species of *Donax* "sets" out of the larval stage at a length of 6 mm. Loesch also said that *texasiana* and *roemeri* lived together in the spring months in the surf, but had no records or proof of observations to support this statement. In all of Loesch's published report, there is no record of collections or of observations of any species of *Donax* whatsoever either on the Texas or Louisiana coasts, in the "spring months" between December and May! On the other hand, the subtidal habitat of *texasiana* was at least partially conformed by the fact that none were present in the intertidal sands of Mustang Island when *roemeri* was there in July 1968.

Donax roemeri roemeri Philippi 1849

Pl. 1, fig. RR

1849. *Donax roemeri* Philippi, Zeits. f. Malakoz., 5: 147.
1849. *Donax roemeri* Philippi, Roemer's Texas, p. 452.
1869. *Donax roemeri* Tryon, Am. J. Conch., 4 (5): append., p. 113.
1881. *Donax roemeri* Bertin, Nouv. Arch. Mus. (ser. 2), 4: 104.
1881. *Donax variabilis* Bertin (in part), Nouv. Arch. Mus. (ser. 2), 4: 91.
1891. *Donax variabilis* Baker, Proc. ANSP., P. 48.
1892. *Donax roemeri* Dall, Nautilus, 5 (11): 125.
1893. *Donax roemeri* Singley, 4th Ann. Rept. Geol. Survey Texas, p. 328.
1920. *Donax roemeri* Maury, Bull. Amer. Paleont., 8: 129.
1926. *Donax variabilis* Weisbord (not of Say), Nautilus, 39: 84.
1934. *Donax roemeri* Johnson, Proc. Boston Soc. Nat. Hist., 40 (1): 54.
1942. *Donax denticulata* Harry (not of Linn.), Occ. Papers Marine Lab., L.S.U. No. 1.
1949. *Donax variabilis* Pulley, Texas Journ. Sci., 1 (3): 66.
1952. *Donax texasiana* Pulley (not *texasiana* Phil. 1847), Texas Journ. Sci., 1952 (2): 183: pl. 12: figs. 10–11.
1952. *Donax roemeri* Pulley, Texas Journ. Sci., 1952 (2): 183.

1952. *Donax variabilis* Pulley, Texas Journ. Sci., 1952 (2): 183.
1957. *Donax variabilis texasiana* Loesch (not *texasiana* Phil.), Publ. Inst. Marine Sci., Univ. of Texas, 4 (2): 201–227.
1968. *Donax variabilis roemeri* Abbott, Sea Shells N. America, p. 248.

Type locality: Galveston, Texas (Philippi 1849).

The typical form of *D. roemeri roemeri* from Galveston is almost as variable as, and overlaps forms of what is considered *protracta* from the Atlantic coast beaches of the United States. It is recorded from Louisiana, west of the Mississippi delta, south along the Texas and the Mexican beaches, and eastward along the Gulf of Mexico shores at least as far as Chenkan, Campeche. Beyond the shores of the Yucatan peninsula it seems to be replaced by two other species.

All the specimens seen to date indicate that *Donax roemeri roemeri* has a normal life span of two years, just the same as in the case of the eastern subspecies *Donax roemeri protracta.* As far as known to date, *Donax roemeri* lives only intertidally (all year round). Because they are in the intertidal sands whenever they are present on any particular stretch of beach, they are the most obvious, and the most often collected *Donax* of their region.

Donax denticulata Linnaeus 1758

Pl. 1, fig. De; and Pl. 2, fig. De

1685. ———— Lister, 2: 8: 1: 376: 218, (Nevis).
1757. Le Nusar ———— Adanson, Senegal, p. 238, pl. 18, fig. 3.
1758. *Donax denticulata* Linnaeus, Syst. Nat., 10th Edn., p. 683.
1770. *Donax denticulata* Linnaeus, Syst. Nat., 12th Edn., p. 1127.
1770. *Donax denticulata* Linnaeus, Syst. Nat., 12th Edn., p. 1127.
1770. ———— Lister (Huddesford Edn.), 376: 218.
1777. *Chion denticulatus* Scopoli, Introd. Hist. Nat., p. 398.
1778. *Cuneus truncatus* DaCosta, Brit. Conch., p. 205, sp. 40.
1782. ———— Chemnitz, Conch. Cab., 6: 262: pl. 26: figs. 256–7.
1791. *Donax denticulata* Gmelin, Syst. Nat., 13th Edn., p. 3263 ("Medit. Atlantic American").
1797. ———— Bruguiere, Encyclop. Method., Pl. 262, fig. 7.
1800. *Donax crenulata* Donovan, British Shells, vol. 1, pl. 24.
1817. *Donax denticulata* Dillwyn, Descr. Cat. 1: 151.
1818. *Donax caianensis* Lamarck, Anim. Sans Vert., 5: 550, No. 18.
1818. *Donax denticulata* Lamarck, Anim. Sans Vert., 5: 550, No. 20.
1825. *Donax denticulata* Wood, Index. Test., p. 32, pl. 6, fig. 8.
1828. *Donax sexradiata* Gray, Wood Index. Test., suppl., 5: pl. 2, fig. 5.
1841. *Donax caianensis* Delessert, Coq. de Lam., Pl. 6, fig. 13.
1843. *Donax cayennensis* Hanley, Bivalve Shells, p. 82.
1843. *Donax denticulata* Hanley, Bivalve Shells, p. 82.
1844. *Donax cayennensis* Hanley, Bivalve Shells, p. 349, pl. 13, fig. 8.
1846. *Donax cayanensis* Orbigny, Voyage Amer. Merid., p. 540, No. 544.
1846. *Donax cayanensis* Orbigny, Sagra's Cuba (Sp. Edn.), p. 308.

1847. *Donax cayanensis* Orbigny, Sagra's Cuba (Fr. Edn.), 2: 260.
1854. *Donax denticulata* Reeve, Conch. Icon., 8 *Donax*, pl. 7, sp. 48.
1855. *Donax denticulata* Hanley, Linnaean Shells, p. 61.
1858. *Donax denticulata* Beau, Cat. Coquilles Guadeloupe, etc., p. 25.
1864. *Donax cayennensis* Krebs, W. Indian Marine Shells, p. 99.
1864. *Donax denticulatus* Krebs, W. Indian Marine Shells, p. 99.
1866. *Donax denticulata* Sowerby, Thesaurus, 3: 308: sp. 24: figs. 33–36.
1869. *Donax cayenensis* Tryon, Am. J. Conch., 4 (5): append., p. 107.
1869. *Donax denticulatus* Tryon, Am. J. Conch., 4 (5): append., p. 108.
1869. *Donax (Chion) denticulatus* Romer, Conch. Cab., 10 (3): 21: pl. 2, figs. 4–5, and pl. 5, figs. 1–7.
1870. *Donax denticulatus* Humbert (French Edn.), Woodward's Conchyl., p. 499, pl. 21, fig. 19.
1871. *Donax denticulatus* Tate, Woodward's Manual (Edn. 2), p. 540: pl. 21, fig. 19.
1877. *Donax denticulatus* Guppy, Proc. Sci. Assn. Trinidad, 2 (2): 148.
1878. *Donax cayenensis* Arango, Contr. Fauna Mal. Cubana, p. 247.
1878. *Donax denticulatus* Arango, Contr. Fauna Mal. Cubana, p. 247.
1881. *Donax (Chion) denticulatus* Bertin, Nouv. Arch. Mus. N. H. (2), 4: 81.
1884. *Donax denticulatus* Tryon, Struct. & Syst. Conch., 3: 172: pl. 112: figs. 80–81.
1886. *Donax denticulatus* Fischer, Manuel de Conch., p. 1102, pl. 21, fig. 19.
1887. *Donax denticulatus* Schepman, Samml. Geol. Reichs Museums Leiden, Ser. 2, bd. 1, p. 158.
1889. *Donax denticulatus* Dall, Bull. 37, USNM, p. 58.
1889. *Donax denticulatus* Simpson, Proc. Davenport Acad. Sci., 5: 63.
1891. *Donax denticulatus* Baker, Proc. ANSP, 43: 48.
1892. *Donax denticulata* Dall, Nautilus, 5 (11): 125.
1894. *Donax denticulatus* Guppy, Proc. Victoria Inst. of Trinidad, part 2, p. 141.
1900. *Donax denticulata* Dall, Tert, Fauna Fla., 3 (5): 963, 965.
1901. *Donax denticulata* Dall & Simpson, Bull. U.S.F.C., 20 (1) 1900: 476.
1903. *Donax denticulata* Dall, Bull. 37, USNM. Reprint, p. 58.
1914. *Donax denticulata* Lamy, Bull. Mus. Nat. Hist., Paris 20 (6): 340.
1920. *Donax denticulata* Maury, Bull. Amer. Paleont., 8: 128.
1934. *Donax denticulata* Johnson, Proc. Boston Soc. Nat. Hist., 40 (1): 54.
1936. *Donax denticulata* McLean, Mem. Soc. Cubana. H. N. "Poey", 10 (1): 42.
1937. *Donax denticulatus* M. Smith, East Coast Marine Shells, p. 62: pl. 25: fig. 3.

1940. *Donax denticulatus* M. Smith, World Wide Sea Shells, p. 113, fig. 1481.
1940. *Donax denticulata* Richards, Soc. Venez. Cienc. Nat., Bol. 6 (46): 306.
1943. *Donax denticulata* Richards, Journ. Paleont., 17 (1): 121.
1945. *Donax denticulatus* Jutting, Geol. Mijnbowk, Gen. Ned. en Kolonien, Geol. Ser., Vol. 14, p. 78.
1947. *Donax denticulatus* Morris, Field Guide Shells, p. 58, 98: pl. 21: fig. 8.
1948. *Donax cayennensis*, Clench, Aguayo & Turner (Republication of Krebs 1864), Rev. de la So. Malac. "Carlos de la Torre," p. 17.
1949. *Donax denticulatus* Morretes, Arq. Mus. Paranense, 7 (1): 41.
1951. *Donax denticulatus* Morris, Field Guide Shells, 2nd Edn., p. 82, p. 108: pl. 21: fig. 8.
1951. *Donax denticulata* McLean, N. Y. Acad. Sci., Sci. Survey P. Rico & the Virgin Ids., 17 (1): 105: pl. 21: fig. 7.
1952. *Donax denticulatus* Dodge, Bull. Am. Mus. N. H., 100 (1): 83.
1954. *Donax denticulata* Abbott, American Sea Shells, p. 438, pl. 30p.
1958. *Donax denticulata* Olsson & McGinty, Bull. Amer. Paleont., 39 (177): 22.
1959. *Donax denticulata* Usticke, Checklist Marine Shells St. Croix, p. 19.
1961. *Donax denticulatus* Warmke & Abbott, Caribbean Sea Shells, p. 201, pl. 41: 42d.
1964. *Donax denticulatus* Weisbord, Bull. Amer. Paleont., 45 (204): p. 361: pl. 52: figs. 3–8.
1965. *Donax denticulata* Wade, Proc. Gulf & Carib. Fish. Inst., 17th Ann. Sess., (1964), pp. 36–42.
1967. *Donax denticulatus* MacSotay, Geominas, Bol. 5, p. 43.
1967. *Donax denticulatus* Wade, Bull. Marine Sci., 17 (1): 149–174.
1968. *Donax denticulatus* Wade, Bull. Marine Sci., 18 (4): 876–901.
1968. *Donax denticulatus* Altena, Fauna Suriname, etc., Vol. 10, no. 42, p. 177.
1969. *Donax denticulatus* Altena, Marine Moll. Suriname, pp. 18, 19.

Type localities: *denticulata* Mediterranean (Linn. 1758 in error): *truncatus* Shores of England, Wales, Scotland and Ireland (Dacosta 1778 in error): *crenulata* Western Coasts of England, Ireland and Scotland (Donovan 1800 in error): *caianensis* Ocean of Guyana (Lamarck 1818): *sexradiata* no locality (Gray 1828): *cayanensis* Bahia, Brasil & Sta Lucia (Orbigny 1846). In the absence of any previous declaration except that this species is West Indian, the type locality of *Donax denticulatus* is here restricted to the original locality published by Lister, namely: Nevis Island, B.W.I.

This could be called the typical West Indian species of *Donax*. It is reported from Nassau in the Bahamas, and known to be living on the sandy shores of all the Greater Antilles, and the Lesser Antilles, all the way southward to the Islands of Tobago and Trinidad. On the Central

American beaches, it is living from the north coast of Honduras (Puerto Cortez) all the way south to Aspinwall (Colon) Panama, and eastward to Cartagena, Colombia; Puerto Cabello, Venezuela; to Curacao, to Suriname. It has been reported from northern Brazil at Salinopolis, Para: Fortaleza, Ceara; and Jaragua, Paripuera, Alagoas.

Donax denticulatus reached England early enough from the West Indies to have been figured in Dr. Lister's Picture Book of Shells (1685). It has received a few other names in addition to that given by Linnaeus in 1758, but it remains as the most beautifully sculptured of all the Western Atlantic species of *Donax.* The general surface of this shell, forward of the escutcheon, is radially sculptured with wide flat ribs, separated by puncticulate grooves. These continue over the posterior ridge, but are replaced by wavy transverse sculpture on the central escutcheon area in striking contrast to the puncticulate radial sculpture over the rest of the shell.

Barry Wade has recorded the ecology of this species on Jamaican shores. It apparently stays in the intertidal sands more continuously than do other species of the same region. Without a reduction in rate of growth in the winter season on these subtropical beaches, there is less of a distinct separation of year-classes in these *Donax* populations. On the other hand, Wade very plainly showed that any age group or "set" of young has an 18 month growth and life-span, to parallel the two growth seasons of our more northern (temperate and sub-temperate) species that are interrupted by a winter season of very slow growth. The details of seasonal occurrence and actual sizes on any of the tropical West Indian beaches may be variable, but I believe will agree with Wade's Jamaican studies on the life history and life-span of *Donax denticulatus.*

Donax striata Linnaeus 1767

Pl. 1, fig. S

1685. ———— Lister, 2: 8: 1: 376: 219 (Jamaica).
1767. *Donax striata* Linnaeus, Syst. Nat., 12th Edn., p. 1127.
1770. ———— Knorr, Deliciae, 6: 7: 7.
1770. ———— Lister, Huddesford Edn., 376: 219.
1791. *Donax striata* Gmelin, Syst. Nat. 13th Edn., p. 3263.
1797. ———— Bruguiere, Encycloped. Method., pl. 262, fig. 5.
1817. *Donax striata* Dillwyn Descr. Cat., 1: 151.
1825. *Donax striata* Wood, Index test., p. 31, pl. 6, fig. 7.
1843. *Donax striata* Hanley, Bivalve Shells, p. 82.
1844. *Donax striatus* Hanley, Bivalve Shells, p. 349, pl. 14, fig. 32.
1846. *Donax rugosa* Orbigny, Sagra's Cuba, p. 309 (Sp. Edn.) (Not: *D. rugosa* Linn. 1758).
1847. *Donax rugosa* Orbigny, Sagra's Cuba, 2: 260 (Fr. Edn.).
1853. *Donax flexuosa* Gould, Boston Journ. Nat. Hist., 6: 394: pl. 15: fig. 8. (Not of Cooper, 1888; from wrong locality).
1854. *Donax lamarckii* Reeve, Conch. Icon., 8 *Donax*, pl. 5, sp. 27.

1855. *Donax striata* Hanley, Linnaean Shells, p. 61.
1855. *Donax striata* Hanley, Index. Test., Hanley's Edn., p. 82, pl. 14, fig. 32.
1864. *Donax rugosa* Krebs, W. Indian Marine Shells, p. 99 (Not of Linn.).
1864. *Donax striata* Guppy, Trans. Sci. Assoc. Trinidad, pp. 164, 167.
1866. *Donax striata* Sowerby, Thesaurus, 3: 309: sp. 25: fig. 52.
1867. *Donax striata* Tryon, Amer. J. Conch., 4 (5): append., No. 15, p. 113.
1869. *Donax striatus* Romer, Conch. Cab., 10 (3): 12: pl. 5: figs. 8–10.
1869. *Donax* (*Serrula*) *flexuosus* Romer, Conch. Cab., 10 (3): 61: pl. 11: figs. 1–4.
1877. *Donax striatus* Guppy, Proc. Sci. Assn. Trinidad, 2 (2): 148.
1878. *Donax rugosa* Arango, Contr. Fauna Mal. Cubana, p. 247.
1881. *Donax striatus* Bertin, Nouv. Arch. Mus. (ser. 2), 4: 94.
1881. *Donax flexuosus* Bertin, Nouv. Arch. Mus. (ser. 2), 4: 102.
1887. *Donax striatus* Schepman, Samml. Reichs Museums Leiden, Ser. 2, bd. 1, p. 158.
1892. *Donax striata* Dall, Nautilus, 5 (11): 125.
1894. *Donax striatus* Guppy, Proc. Victoria Instit. Trinidad, Part 2, p. 141.
1900. *Donax striata* Dall, Tert. Fauna Fla., 3 (5): 968.
1911. *Donax denticulata* Da Rocha (not *denticulatus* L.), Bol. do Mus. Rocha, 1 (2): 31.
1914. *Donax striata* Lamy, Bull. Mus. H. N. Paris, 20 (6): 338.
1915. *Donax cacuminatus* Sowerby, Ann. Mag. Nat. Hist. (ser. 8), vol. 16 (no. 93): p. 170: pl. 10: fig. 13.
1920. *Donax mediamericana* Pilsbry, Proc. ANSP, 1919: 222: pl. 11: fig. 10.
1920. *Donax mediamericana* Pilsbry, Proc. ANSP, 1920: 195.
1924. *Donax striata* Strong, Nautilus, 37 (3): 83.
1925. *Donax striata* Maury, Bull. Amer. Paleont., 10 (42): 268.
1934. *Donax striata* Maury, Bull. Am. Mus. Nat. Hist., 67 (4): 165–6: pl. 19: fig. 5.
1945. *Donax striatus* Jutting, Geol. Mijnbowk, Gen. Ned. en Kolon., Geol. Ser., vol. 1, p. 78.
1948. *Donax rugosa* Clench, Aguayo & Turner, (Republication of Krebs 1864) Rev. de la Soc. Malac. "Carlos de la Torre," p. 17.
1951. *Donax fossor* Morris (in part), Field Guide Shells, 2nd Edn., pl. 43, fig. 10.
1952. *Donax striatus* Dodge, Bull. Am. Mus. Nat. Hist., 100 (1): 81–82.
1954. *Donax striata* Abbott, American Seashells, p. 438.
1958. *Donax striatus* Olsson & McGinty, Bull. Amer. Paleont., 39 (177): 22.
1961. *Donax striatus* Warmke & Abbott, Caribbean Seashells, p. 202, pl. 42h.

1961. *Donax striatus* Olsson, Panamic-Pacifica Pelecypods, pp. 340, 343.
1964. *Donax striatus* Weisbord, Bull. Amer. Paleont., 45 (204): p. 363: pl. 52: figs. 9–17.
1967. *Donax striatus* MacSotay, Geominas, Vol. 5, p. 43.
1967. *Donax striatus* Wade, Bull. Marine Sci., 17 (1): 162 and 168.
1968. *Donax striatus* Altena Fauna Suriname, etc., Vol. 10, No. 42, p. 177.
1969. *Donax striatus* Altena, Marine Moll. Suriname, pp. 18, 19.

Type localities: *striatus* (Ocean of Southern Europe, in error (Linn. 1767)). *flexuosa* Gould, Santa Barbara, Calif. (Gould 1853 in error). *lamarckii* (of no locality) Reeve 1854. *cacuminatus* New Caledonia (Sowerby 1915 in error). *mediamericana* Livingston, Guatemala (Pilsbry 1920). The type locality of *Donax striata* is here restricted to shores of Jamaica, the first locality recorded by Lister 1685.

This largest Atlantic species of Central America is higher, more strongly triangular, with a much sharper posterior ridge than either *denticulata* or *vellicata* with which it may be living. The sculpture of *striata* on the posterior slope consists only of regular radial ridges. It has none of the puncticulate incised lines of *denticulata*.

Donax striata is recorded only from Jamaica, Hispaniola and Puerto Rico, of the Greater Antilles. On continental shores, it is living from 17° 14′ North latitude near Belize, British Honduras, south to Colon, Panama, and eastward on Colombian and Venezuelan beaches to Trinidad and Suriname, and also northern Brazil. In Brazil it has been collected on the shores of Maranhao, Piaui, Ceara and Rio Grande do Norte.

The geographic ranges of *Donax striata* and *D. denticulata* overlap to a great extent. Wade (in 1967) has shown that though they may be living together in the same sand beach, their tidal reactions and migrations may be different. In one set of studies on Jamaican shores, Wade found that both species were together in the wash or intertidal surf zone when the tide was high. When the tide receded *denticulata* moved downward with the tidal level, while *striata* remained in the higher intertidal sands. In other words, *Donax striata* lives in the sand at a certain level or zone of the intertidal slope. If it lives there at all times, whether the water is high or low, it as a species parallels the habit of *Donax roemeri* on the shores of the southern United States of (North) America.

Donax vellicata Reeve 1855

Pl. 1, Fig. V; and Pl. 2, Fig. V

1855. *Donax vellicata* Reeve, Conch. Icon., 8 *Donax*, pl. 9, sp. 66.
1864. *Donax* ———— Krebs, W. Indian Marine Shells, p. 99 (Cumana, Chagres & St. Juan del Norte).
1866. *Donax vellicatus* Sowerby, Thesaurus, 3: 313: sp. 53, figs. 61–63.
1869. *Donax* (*Serrula*) *vellicatus* Tryon, Am. Journ. Conch., 4 (5): append. p. 114.

1869. *Donax* (*Serrula*) *vellicatus* Romer, Conch. Cab., 10 (3): 37: pl. 7: figs. 10–13.
1877. *Donax pulchellus* Guppy, Proc. Sci. Assn. Trinidad, 2 (2): 148. (Not *D. pulchellus* Hanley 1843).
1881. *Donax vellicatus* Bertin, Nouv. Arch. Mus. (ser. 2), 4: 106.
1894. *Donax pulchellus* Guppy, Proc. Victoria Inst. Trinidad, p. 141 (Not *D. pulchellus* Hanley 1843).
1948. *Donax* ———— Clench, Aguayo, & Turner (Republication of Krebs 1864), Rev. de la Soc. Malac. "Carlos de la Torre," p. 17. (Cumana, Chagres & St. Juan del Norte).
1964. *Donax higuerotensis* Weisbord, Bull. Amer. Paleont., 45 (204): p. 366: pl. 53: figs. 1–9.
1967. *Donax higuerotensis* MacSotay, Geominas, Bol. 5, p. 43.
1969. *Donax striata* var. *intermedius* Usticke, Suppl. List St. Croix Shells, p. 7, pl. 1. (Trinidad).

Type localities: *vellicata* (locality unknown) (Reeve, 1855). *higuerotensis* beach at Higuerote, Venezuela (Weisbord, 1964). *Intermedius* Trinidad (Usticke, 1969).

Photographs of the holotype of *vellicata* Reeve, kindly furnished by Dr. John F. Peake of the British Museum (Natural History), correspond in characters with the specimens here figured. The holotype of *vellicata* may have been collected on some northern Brazilian shore. Because it has almost the exact appearance of some now catalogued as A.N.S.P. no. 300325 (from that locality), the type locality of *Donax vellicata* Reeve is here restricted to the Praia Upanema, Ariea Branca, Rio Grande do Norte, Brazil.

Donax vellicata is known to be living on Western Atlantic shores between Belize, Panama, Trinidad, and northern Brazil. Apparently it has been less often seen and collected than either *denticulata* or *striata*, either or both of which may be living in the same sandy beach. Krebs, in 1864, reported this species as the third species he had seen from Central American shores, but did not put a name on it. Guppy recorded it from Trinidad in 1877 (as *pulchellus*). Recently it has been noticed (and named) by Weisbord 1964; MacSotay, 1967; and Usticke, 1969 (as *higuerotensis*, and *intermedius*). It has been identified as *Donax variabilis* by some authors because of its similarity of shape, but internally the shells are different. *D. vellicata* has a much smaller pallial sinus than other American species of comparable size. In *vellicata*, the pallial sinus is markedly less than half the length of the span between the anterior and posterior adductor muscle scars.

In the case of *vellicata*, the denticulations on the edge of the shell are more nearly equal in number and width immediately in front of and behind the posterior ridge. In *striata*, the denticulations immediately in front of the more sharply angled posterior ridge appear to be twice as wide (half as numerous) as along the posterior edge of the shell. This change in size of denticulations is very abrupt in most *striata* shells seen.

MacSotay 1967, in studying the zonation of species in the biotop of *Donax* on Venezuelan shores, indicated that *vellicata* might be more abundant in the immediate subtidal zone. The type locality sample from the Praia Upanema, Ariea Branca, Rio Grande do Norte (ANSP no. 300325) consisted of hundreds of this species, and only scores of *D. striata*, apparently living together. Young specimens, probably of *vellicata*, have been seen from Ponta Verde, Maceio, Alagoas, Brasil (ANSP no. 244133).

Donax gemmula new species
Pl. 2, fig. G

1897. *Donax obesa* Ihering, Revista do Museu Paulista, 2: 168. (not *D. obesa* Orbigny 1846).

1949. *Donax tumida* Morretes, Arquiv. do Museu Paranense, 7 (1): 42, (not *D. tumida* Philippi 1849).

Type locality: Praia do Cassino, Rio Grande, Rio Grande do Sul, Brazil.

Shell minute (for the genus), subglobose, triangular ovate in lateral outline, whitish, glossy, with pale triradial zones of purplish color, most evident on the interior of the shells. Umbones prominent, moderately rounded; anterior and posterior slopes nearly rectilinear; umbonal angle about 90°. The lateral shell surface is marked by spaced radial incised lines. The anterior margin is narrowly rounded, the ventral margin evenly full. The posterior slope is almost as glassy smooth as the rest of the shell. The posterior ridge is abruptly but evenly rounded, ending on a narrow-evenly rounded post-basal curve. Hinge plate narrow, with anterior and posterior laterals close to the umbones. The denticulations of the shell margins, subequal along the entire ventral margin, are somewhat finer along the post-basal curve. Pallial sinus proportionately large, more than half the height of the shell chamber, and more than half the length of the span between the adductor muscle scars.

The holotype, ANSP no. 244125, was collected from the Praia do Cassino, Rio Grande, Rio Grande do Sul, Brazil, by E. C. Rios, 17 January 1960. It measures 6.5 × 4.8 × 3.5 mm. Additional specimens, paratypes, from the same lot, are catalogued as ANSP no. 319027. Beach worn shells of this species were collected by Von Ihering from Sao Sebastiao, Sao Paulo (USNM no. 150783) a number of years ago. The Sao Sebastiao paratypes are part of those recorded as *obesa* by Ihering in 1897 and as *tumida* by Morretes in 1949.

This extremely small, glossy shell has been collected only a few times. It undoubtedly has been thought to be the youngest size of *Donax hilairea*, if it has been seen in the same places. It is more than interesting to speculate upon the reason why this smallest Western Atlantic *Donax* species from Sao Paulo and Rio Grande do Sul beaches is living in the same region as the largest *Donax* of the Western Atlantic, namely *Donax hilairea* Guerin. *Donax gemmula* is proven to be specifically distinct by the complete lack of a sharp posterior ridge, such as the smallest shells of *D. hilairea* exhibit. It will be interesting to determine if *D. gemmula* might live in a different zone of the intertidal (or subtidal) habitats than does the much more obvious *Donax hilairea.*

Donax hilairea Guerin 1832

Pl. 1, fig. H

1832. *Donax hilairea* Guerin, Icon. du Regne Anim., pl. 30, fig. 4.
1843. *Donax rugosa* Hanley (in part), Bivalve Shells, p. 82, (not *D. rugosa* Linnaeus).
1843. *Donax elongata* Hanley (in part), Bivalve Shells, p. 82, (not *D. elongatus* Lamarck 1819).
1844. *Donax elongata* Hanley, Bivalve Shells, p. 349, pl. 13, fig. 47.
1844. *Donax denticulata* Guerin, Icon. du Regne Anim., Expl. text, p. 47. (not *D. denticulata* Linn. 1758).
1847. *Donax hanleyana* Philippi, Zeits. f. Malakoz., 4: 84.
1854. *Donax hanleyana* Reeve, Conch. Icon., 8 *Donax* pl. 2, sp. 6.
1866. *Donax elongatus* Sowerby, Thesaurus 3: 208, sp. 22, fig. 12 (not *D. elongatus* Lamarck 1819).
1868. *Donax elongata* Guerin (not of Lamarck), Icon. du Regne Anim., reprint, plate 29, fig. 4.
1869. *Donax elongatus* Tryon (in part), Am. J. Conch., 4 (5): append., p. 108.
1869. *Donax rugosus* Tryon (not of L.), Am. J. Conch., 4 (5): append., p. 109.
1869. *Donax* (*Chion*) *hanleyanus* Romer, Conch. Cab., 10 (3): 18: pl. 4: figs. 5–8.
1881. *Donax hanleyanus* Bertin, Nouv. Arch. du Mus., (ser. 2), 4. 84.
1892. *Donax rugosa* Dall (in part), Nautilus, 5 (11): 125.
1897. *Donax rugosa* Ihering, Revista do Museu Paulista, 2: 161.
1949. *Donax hanleyana* Morretes, Arquiv. Mus. Paranense, 7 (1): 41.
1950. *Donax hanleyana* Gofferje, Arquiv. Mus. Paranense, 8: 272.
1950. *Donax hanleyana* Oliviera, Mem. do Institut. Oswaldo Cruz, 48: 373.
1964. *Donax hanleyana* Magnanina & Filo, "Animas da Praia," Dept. Rec. Nat., Secr. de Econ., Est. de Guanabara, R 10., p. 16 (figured also in color on covers).

Type locality: both *hilairea* Guerin 1832, and *hanleyana* Philippi 1847, were published without a known locality. We are accepting the first locality published by Reeve (1854) as a designation and/or restriction of the type locality to Rio de Janeiro, Brazil.

The large *Donax hilairea* Guerin is apparently the most common, and certainly the most obvious *Donax* on southern Brazilian shores. It was recorded as one of the edible species by Von Ihering at Sao Sebastiao in

1897, under the name of "Beguaba." The common name of "Sernambi" is reported by Magnanina & Filo (1964, p. 16).

Specimens of *Donax hilairea* have been seen from Vitoria, Espiritu Santo, Brazil, as far south as the Isla de Lobos, off Punta del Este, Uruguay. It seems probable that the lack of records of *hilairea* from beaches north of Vitoria is due to lack of scientific collections from those Brazilian shores.

The strong radial ribs of the outer portion of the posterior slope are replaced on the distinct escutcheon by finer ribs and a tendency to transverse beaded sculpture, reminescent of the closely related but distinct West African species, *Donax rugosa* Linnaeus. Even the youngest shells of *hilairea* seen have a very distinct ridge setting off the striated posterior slope, in contrast to the rounded posterior edge of *gemmula* shells.

DOUBTFUL SPECIES RECORDS

It is doubtful that *Donax incerata* Reeve, 1855, is from the West Indies. Only two odd valves are known. It has not been rediscovered in more than a century.

Donax pulchella Hanley, 1843, supposedly from the West Indies, is as recorded by Nickles, 1950 a West African species.

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PROCEEDINGS
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BIOLOGICAL SOCIETY OF WASHINGTON

HENICOXIPHIUM REDACTUM, A NEW CYCLOPOID COPEPOD ASSOCIATED WITH AN ASCIDIAN IN FLORIDA AND NORTH CAROLINA

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The new copepod described below lives in the pharynx of a simple ascidian. The specimens studied comprise several collections made chiefly by H. J. Humm in Florida and one collection made by W. H. Sutcliffe, Jr., in North Carolina. These collections were originally deposited in the Smithsonian Institution.

The study of the material has been aided by grants to the authors from the National Science Foundation (GB-6474X; GB-8381X).

All figures have been drawn with the aid of a camera lucida. The letter after the explanation of each figure refers to the scale at which it was drawn. The abbreviations used are: A_1 = first antenna, A_2 = second antenna, L = labrum, MD = mandible, MX_1 = first maxilla, MX_2 = second maxilla, MXPD = maxilliped, and P_1 = leg 1.

Lichomolgidae Kossmann, 1877

Henicoxiphium new genus

Body elongated cyclopiform. First antenna 7-segmented, formula in female: 4, 13, 6, 3, 4 + 1 aesthete, 2 + 1 aesthete, and 7 + 1 aesthete (in male with one aesthete added on second segment and one on fourth segment). Second antenna 3-segmented, terminally with one claw and a clawlike element. Mandible slender, without indentation; lash with a row of spinules on concave side and numerous spinules on convex side.

First maxilla with three elements. Second maxilla 2-segmented. Maxilliped in female 3-segmented; in male 4-segmented, if proximal part of claw is regarded as a fourth segment.

Legs 1–4 with 3-segmented rami. Last segment of exopod of leg 4 with II,I,5. Endopod of leg 4 with 0-1; 0-1; I. Leg 5 with a free segment bearing two unequal setae.

Other features as in the species described below.

Associated with ascidians.

Type species: *Henicoxiphium redactum* new species.

Gender neuter.

Etymology: The generic name is a combination of ἑνικός = single and ξίφιον (a diminutive of ξίφος) = a small straight sword, in allusion to the single swordlike spine on the third segment of the endopod of leg 4.

Henicoxiphium redactum new genus, new species

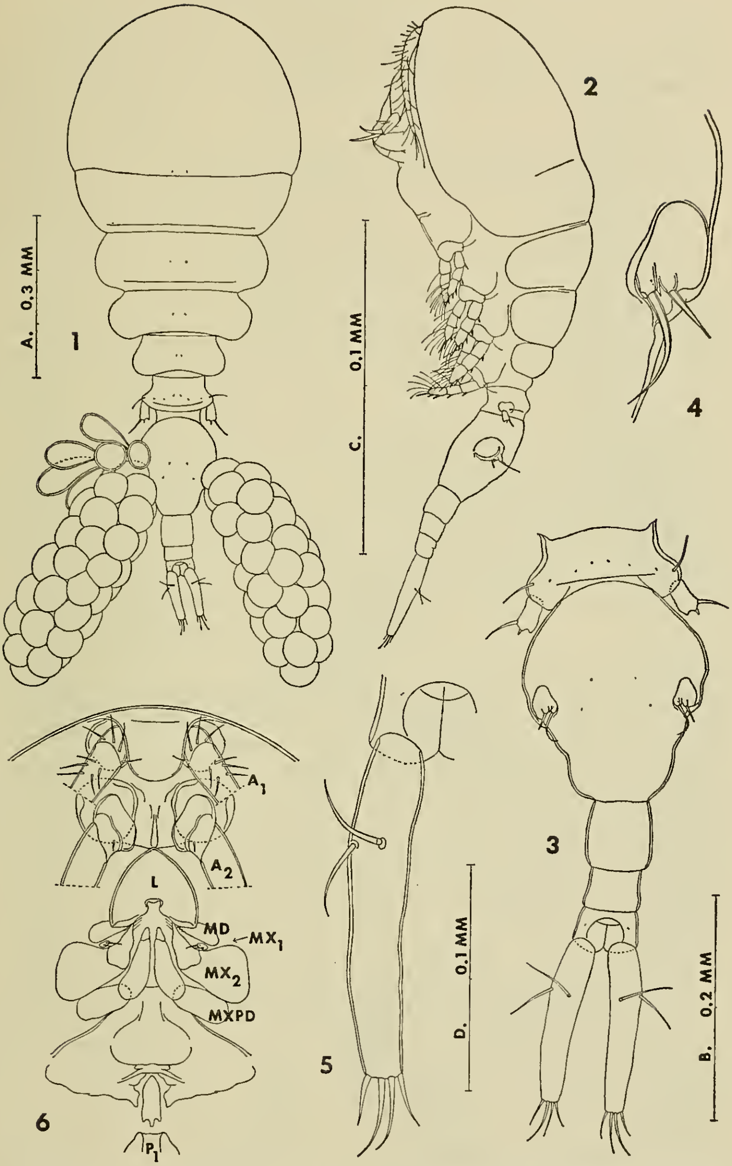
Figures 1–26

Type material: 191 ♀♀, 152 ♂♂, and 77 copepodids from the pharynx of approximately 75 ascidians, *Styela plicata* (Lesueur), Lemon Bay (near inlet), Englewood, Florida, 13 May 1950, collected by H. J. Humm (USNM Acc. No. 186261). Holotype ♀, allotype, and 275 paratypes (157 ♀♀, 118 ♂♂) deposited in the Smithsonian Institution, Washington; 20 paratypes (10 ♀♀, 10 ♂♂) in the Zoölogisch Museum, Amsterdam; and the remaining paratypes in the collections of the authors.

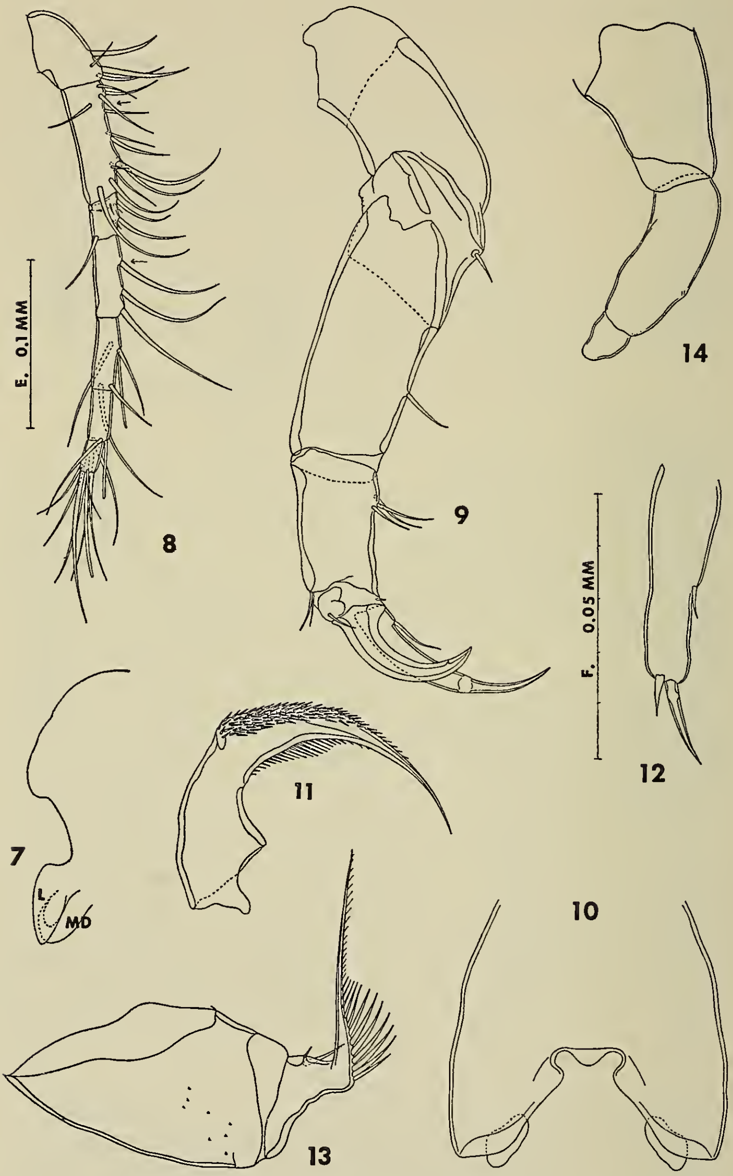
Other specimens (all from *Styela plicata*): 2 ♀♀ (USNM Acc. No. 186261), Alligator Harbor, Florida, 10 April 1950, collected by H. J. Humm; 1 ♀, 4 ♂♂, and 1 copepodid (USNM Acc. No. 187438), Alligator Harbor, Florida, 16 December 1950, collected by H. J. Humm; 2 ♀♀, 1 ♂ (USNM Acc. No. 189912), Institute of Fisheries Pier, Bogue Sound, Morehead City, North Carolina, 14 February 1951, collected by W. H. Sutcliffe, Jr.; and 2 ♀♀, 1 ♂, Florida, purchased from the Marine Biological Laboratory, Woods Hole, 4 April 1954.

Female: Body (Figs. 1, 2) moderately elongated and thinly sclerotized, with prosome not unusually thickened. Length (excluding setae on caudal rami) 1.14 mm (1.05–1.29 mm) and the greatest width 0.42 mm (0.41–0.46 mm), based on ten specimens in lactic acid. Segment of leg 1 separated from cephalosome by a dorsal transverse furrow. Epimeral areas of segment of legs 2–4 rounded. Ratio of length to width of prosome 1.56 : 1. Ratio of length of prosome to that of urosome 1.49 : 1.

Segment of leg 5 (Fig. 3) 52 × 130 μ. Between this segment and genital segment no ventral intersegmental sclerite. Genital segment somewhat pyriform in dorsal view, 169 × 156 μ. Areas of attachment of egg sacs located dorsolaterally near middle of segment. Each area (Fig. 4) bearing two setae 30 μ and 18 μ, with a minute spiniform process between them. Three postgenital segments 55 × 57 μ, 39 × 47 μ, and 36 × 53 μ from anterior to posterior. Posteroventral border of anal segment smooth.



FIGS. 1–6. *Henicoxiphium redactum* new genus, new species. Female: 1, Dorsal, with egg sacs and six spermatophores attached (A). 2, Lateral (A). 3, Urosome, dorsal (B). 4, Area of attachment of egg sac, dorsal (C). 5, Caudal ramus, dorsal (D). 6, Median area of cephalosome, ventral (B).



FIGS. 7–14. *Henicoxiphium redactum* new genus, new species. Female: 7, Outline of rostrum and labrum, lateral (B). 8, First antenna, dorsal (E). 9, Second antenna, anterior (C). 10, Labrum and parag-

Caudal ramus (Fig. 5) elongated, 143 × 27 μ in greatest dimensions, or 5.3 times longer than wide. All six setae relatively short and naked. Outer lateral seta and dorsal seta placed proximally at about one-third length of ramus.

Body surface bearing a few hairs (sensilla) as indicated in the figures.

Egg sac (Fig. 1) elongated, 440 × 165 μ, reaching well beyond caudal rami, and containing numerous eggs about 56 μ in diameter (though often of irregular form).

Rostrum (Fig. 6) seen in ventral view as a linguiform lobe, but in lateral view (Fig. 7) as a ventrally protruding area.

First antenna (Fig. 8) 7-segmented and 259 μ long. Lengths of segments (measured along their posterior non-setiferous margins): 14 (44 μ along anterior margin), 66, 20, 44, 39, 28, and 18 μ respectively. Formula for armature: 4, 13, 6, 3, 4 + 1 aesthete, 2 + 1 aesthete, and 7 + 1 aesthete. All setae naked.

Second antenna (Fig. 9) 3-segmented. First and second segments bearing a small naked inner seta. Third segment (probably result of fusion of two original segments) bearing a proximal inner group of three naked setae; distally carrying a recurved claw 42 μ along its axis, a claw-like element 61 μ long which has an accessory seta, and four small setae.

Labrum (Figs. 6, 10) almost cordiform in ventral view, and in lateral view (Fig. 7) abruptly set off anteriorly from postrostral region. Its two posteroventral lobes widely divergent.

Mandible (Fig. 11) having a slender blade without an indentation. Lash bearing a row of slender spinules along its concave margin and its convex surface carrying numerous shorter spinules. Paragnath (Fig. 10) a weakly sclerotized lobe without hairs. First maxilla (Fig. 12) a slender elongated segment with three elements. Second maxilla (Fig. 13) 2-segmented. Large first segment bearing a few minute outer surficial spines. Second segment, with concave ventral edge, having two small naked dorsal elements and its long lash, spinulose along one edge, placed at about a 90° angle to segment. Maxilliped (Fig. 14) 3-segmented and devoid of armature except for two extremely small (2 μ) vestigial setae on second segment.

Ventral area between maxillipeds and first pair of legs (Fig. 6) somewhat protuberant (Fig. 2). A line connecting bases of maxillipeds.

Legs 1–4 (Figs. 15–18) with 3-segmented rami. Spine and setal formula as follows:

P_1	coxa	0–1	basis	1–0	exp	I–0;	I–1;	III,I,4
					enp	0–1;	0–1;	I,5

←

naths, ventral (C). 11, Mandible, anterior (C). 12, First maxilla, posterior (F). 13, Second maxilla, outer (C). 14, Maxilliped, antero-inner (C).

P_2	coxa	0–1	basis	1–0	exp	I–0;	I–1;	III,I,5
					enp	0–1;	0–2;	I,II,3
P_3	coxa	0–1	basis	1–0	exp	I–0;	I–1;	III,I,5
					enp	0–1;	0–2;	I,II,2
P_4	coxa	0–1	basis	1–0	exp	I–0;	I–1;	II,I,5
					enp	0–1;	0–1;	I

Inner coxal seta of legs 1–3 long and plumose, but in leg 4 shorter (17 μ) and naked. Inner margin of basis of leg 1 bearing a row of several minute spines, but in legs 2–4 with a row of hairs. Spines on rami with smooth lamellae, except for outer spine on last segment of endopod of legs 1–3 which is naked. Exopod of leg 4 128 μ long. Endopod of this leg 74 μ, ith its third segment 24 × 13 μ (in one endopod of a single female 19 × 13 μ), and its terminal spine 44 μ. A certain amount of variability in the armature observed in leg 1 (where the right exopod in one female was I–0: I–1; II,I,4) and in leg 2 (where the left endopod in one female was 0–1; 0–1; I,II,3 and in another female 0–1; 0–3; I,II,3).

Leg 5 (Fig. 19) with free segment 34 × 16 μ in greatest dimensions, having a smaller inner terminal lobe but without fine ornamentation. Two terminal setae very unequal, the longer 28 μ, the shorter 5 μ and without a distinct articulation. All setae naked.

Leg 6 represented by the two setae near attachment of each egg sac (Fig. 4).

Color in life unknown.

Male: Body form (Fig. 20) resembling that of female. Length (without ramal setae) 0.90 mm (0.85–0.99 mm) and greatest width 0.27 mm (0.26–0.30 mm), based on ten specimens in lactic acid. Ratio of length to width of prosome 1.74 : 1. Ratio of length of prosome to that of urosome 1.17 : 1.

Segment of leg 5 (Fig. 21) 34 × 92 μ. No ventral intersegmental sclerite. Genital segment 135 × 130 μ. Four postgenital segments 41 × 55 μ, 41 × 44 μ, 27 × 39 μ, and 27 × 42 μ from anterior to posterior.

Caudal ramus resembling that of female, but smaller, 126 × 21 μ, or six times longer than wide.

Body surface with a few hairs as in female.

Rostrum like that of female.

First antenna similar to that of female, but two aesthetes added (at locations indicated by arrows in Fig. 8), so that formula is: 4, 13 + 1 aesthete, 6, 3 + 1 aesthete, 4 + 1 aesthete, 2 + 1 aesthete, and 7 + 1 aesthete. Second antenna also resembling that of female, but with a few short spinules along outer margin of second segment.

Labrum, mandible, paragnath, first maxilla, and second maxilla like those of female. Maxilliped (Fig. 22) 4-segmented (assuming that proximal part of claw represents a fourth segment). First and third segments unarmed. Second segment bearing only a single naked seta (instead of two elements as in most related genera). Slender claw 97 μ along its axis, lacking a terminal lamella, with a weak division about midway

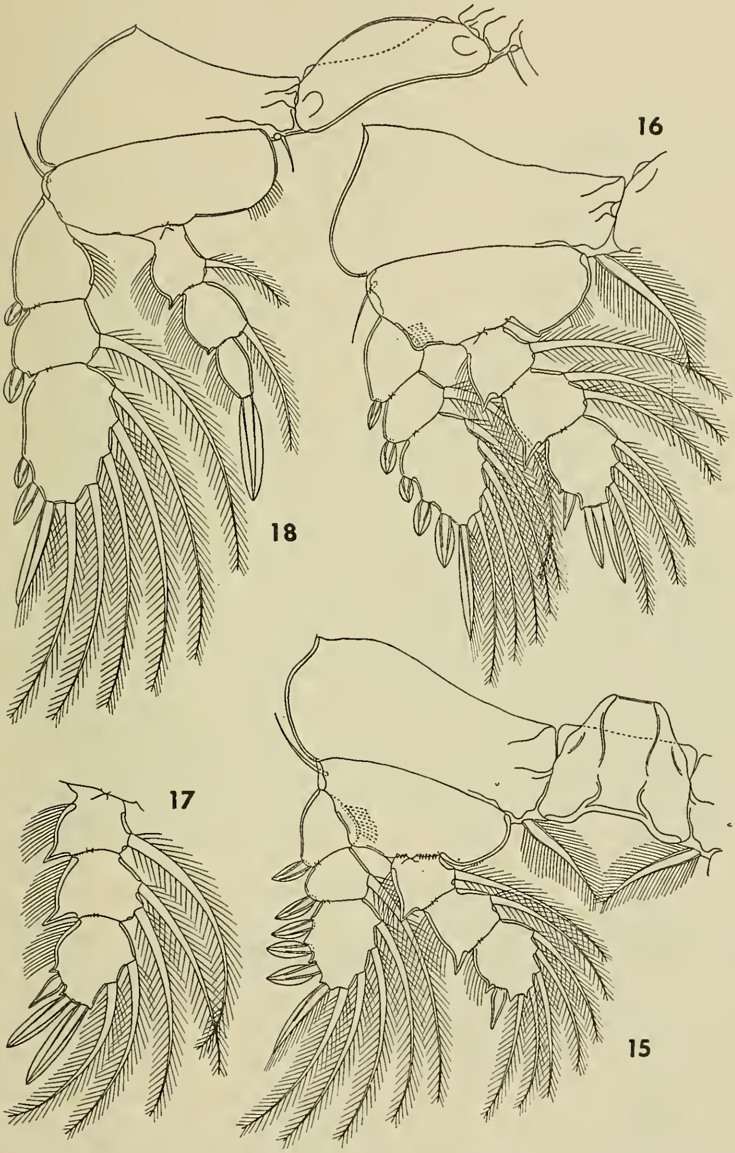
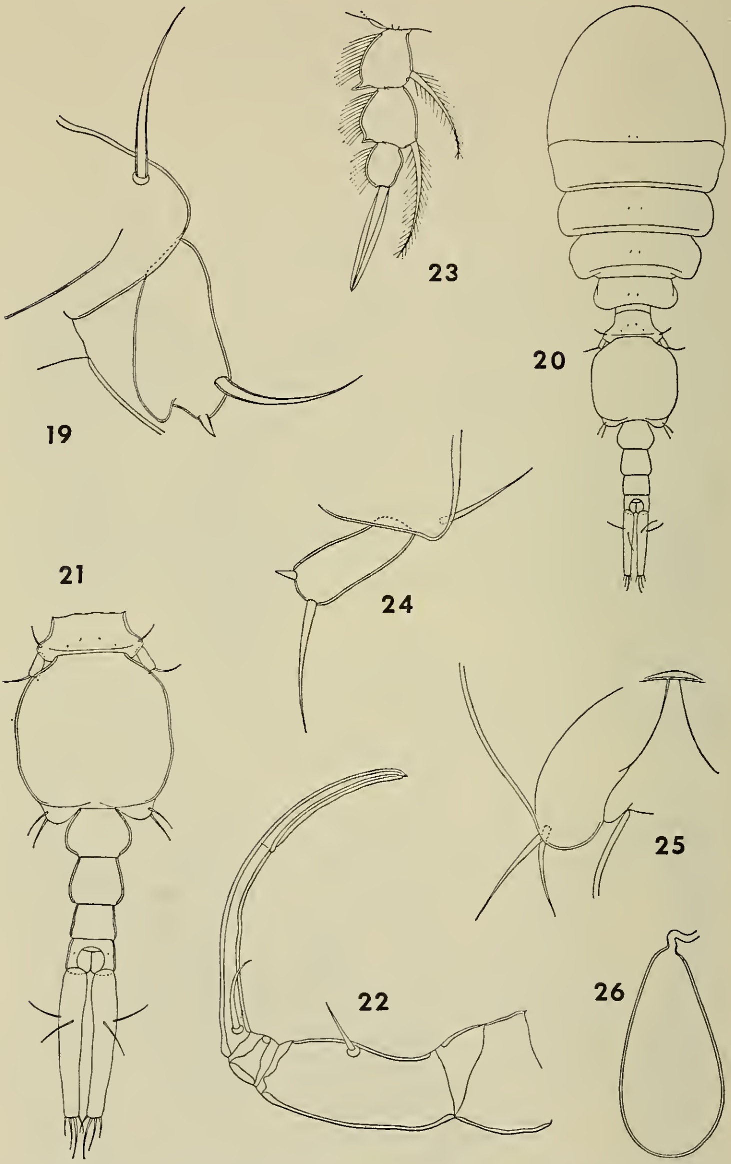


FIG. 15–18. *Henicoxiphium redactum* new genus, new species. Female: 15, Leg 1 and intercoxal plate, anterior (D). 16, Leg 2, anterior (D). 17, Endopod of leg 3, anterior (D). 18, Leg 4 and intercoxal plate, anterior (D).



Figs 19–26. *Henicoxiphium redactum* new genus, new species. Female: 19, Leg 5, dorsal (F). Male: 20, Dorsal (A). 21, Urosome, dorsal (B). 22, Maxilliped, postero-inner (C). 23, Endopod of leg 4, anterior (C). 24, Leg 5, ventral (F). 25, Leg 6, ventral (C). 26, Spermatophore, attached to female, dorsal (B).

beyond which there is an inner fringelike lamella, and bearing two very unequal proximal naked setae.

Ventral area between maxillipeds and first pair of legs like that in female.

Legs 1–4 segmented and armed as in female. Third segment of endopod of leg 4 (Fig. 23) 13 × 10 μ, shorter than in female, with its spine 34 μ.

Leg 5 (Fig. 24) with free segment 23 × 9 μ, without the inner terminal lobe seen in female, but with the two setae very unequal as in that sex.

Leg 6 (Fig. 25) a posteroventral flap on genital segment bearing two naked setae, both about 28 μ.

Spermatophore (Figs. 1, 26) elongated and shaped like a teardrop, 92 × 44 μ, not including the neck.

Color in life unknown.

Etymology: The specific name *redactum*, Latin = reduced, refers to the reduction of the armature on the maxillipeds of both sexes, to the very short terminal seta on leg 5, and to the relatively short setae on the caudal ramus.

Remarks: *Henicoxiphium* appears to be related to *Paranthessius* Claus, 1889 (taken in the broad sense, as in the work of Illg, 1949) and to *Modiolicola* Aurivillius, 1882. There are important differences, however, between *Henicoxiphium* and these two genera. In *Paranthessius* the second antenna is 4-segmented with one terminal claw, there is a single row of spinules on the convex side of the mandible, and the endopod of leg 4 has the formula 0–1; 0–1; II (in *P. anemoniae* Claus, 1889, and *P. panopeae* Illg, 1949, the formula is 0–1; 0–1; II,I). In *Modiolicola* the second antenna is 4-segmented and bears three terminal claws, the mandible has a single row of spinules on the convex side, the last segment of the endopod of leg 3 has the formula II,II,2 or I,III,2, and the armature of the endopod of leg 4 is 0–1; 0–1; II.

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PROCEEDINGS
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A NEW OSTRACOD (ENTOCYTHERIDAE, NOTOCYTHERINAE) COMMENSAL ON NEW ZEALAND CRAYFISH[1]

By C. W. Hart, Jr. and Dabney G. Hart
Academy of Natural Sciences of Philadelphia

Examination of a crayfish collection from New Zealand in the U.S. National Museum (*Paranephrops planifrons* White collected by Charles Chilton from Pelorus Valley, South Island, USNM 18173) yielded 12 specimens of a new entocytherid ostracod.

Subsequently, in 1967, examination of crayfishes that we collected on North and South Islands of New Zealand failed to yield commensal ostracods. Instead, virtually every crayfish examined appeared to be so heavily infested with temnocephalid worms that we surmised the absence of ostracods to be correlated with competition between the two organisms. We did not, however, collect crayfishes from Pelorus Valley.

Laccocythere new genus

Diagnosis: A genus of the entocytherid subfamily Notocytherinae. Antennule with six podomeres. Dorsal antennal claw truncate and devoid of setae. Mandibular protopodite with distal row of five teeth. Peniferum terminating bluntly with two possibly opposable processes. Penis short, ventrally directed, and situated entirely above mid-length of peniferum. Commensal on freshwater crayfishes in New Zealand.

Type-species: *Laccocythere aotearoa* new species.

Etymology: From the Greek *lakkos* = pond + *cythere*.

Laccocythere aotearoa new species

Male: Shell (Fig. 1) subelliptical in outline with eyespot situated approximately ⅕ shell length from anterior end. Measurements of 7 specimens are given below in Table 1.

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[1] This work was supported by National Science Foundation Grant No. GB-6943 to the authors.

Table 1. Length and height ranges and averages for specimens of *Laccocythere aotearoa*

	Immature females (six legs-biunguis)	Adult females (triunguis)	Adult males
No. of specimens	4	1	7
Length (ranges)	240μ-300μ	320μ	280μ–310μ
averages	272μ	320μ	298μ
Height (ranges)	150μ–160μ	180μ	160μ–190μ
averages	157μ	180μ	170μ

Antennule (Fig. 3) composed of six podomeres. Second podomere from proximal end bearing single terminal seta extending to distal portion of antipenultimate podomere. Third podomere from proximal end bearing two terminal setae extending to mid-length of penultimate podomere. Antipenultimate podomere bearing five terminal setae extending approximately to level of distal end of ultimate podomere. Penultimate podomere devoid of setae. Ultimate podomere bearing five terminal setae subequal in length to combined penultimate and ultimate podomeres.

Antenna (Fig. 4) consisting of four podomeres.[2] Basal podomere devoid of setae, with tapering exopodite, or "flagellum," extending from its distal extensor margin for distance equal to that of remainder of antenna. Second, or antipenultimate podomere bearing two setae on distal flexor margin, one approximately ½ the length of other; longest seta extending past distal margin of third podomere. Third, or penultimate podomere bearing two setae on distal flexor margin, subequal in length and extending approximately to midlength of ultimate podomere. Fourth, or ultimate podomere, bearing single seta on flexor margin at approximately midlength of podomere. Distal portion of ultimate podomere bearing three claws. Dorsal claw truncate, curved 90° in distal half, and devoid of setae; mesial claw shorter, slightly curved distally, and bearing row of setae; ventral claw extending beyond dorsal and mesial claws, curved slightly and bearing row of setae along distal half, diminishing in size proximally.

Mandibular protopodite (Fig. 5) with distal row of five teeth. Proximal tooth with two cusps; second, third and fourth teeth with three cusps each, and large distal tooth with five cusps. Podomeres of mandibular palp not clearly defined. Single seta present adjacent to base of spatulate terminal spine of palp.

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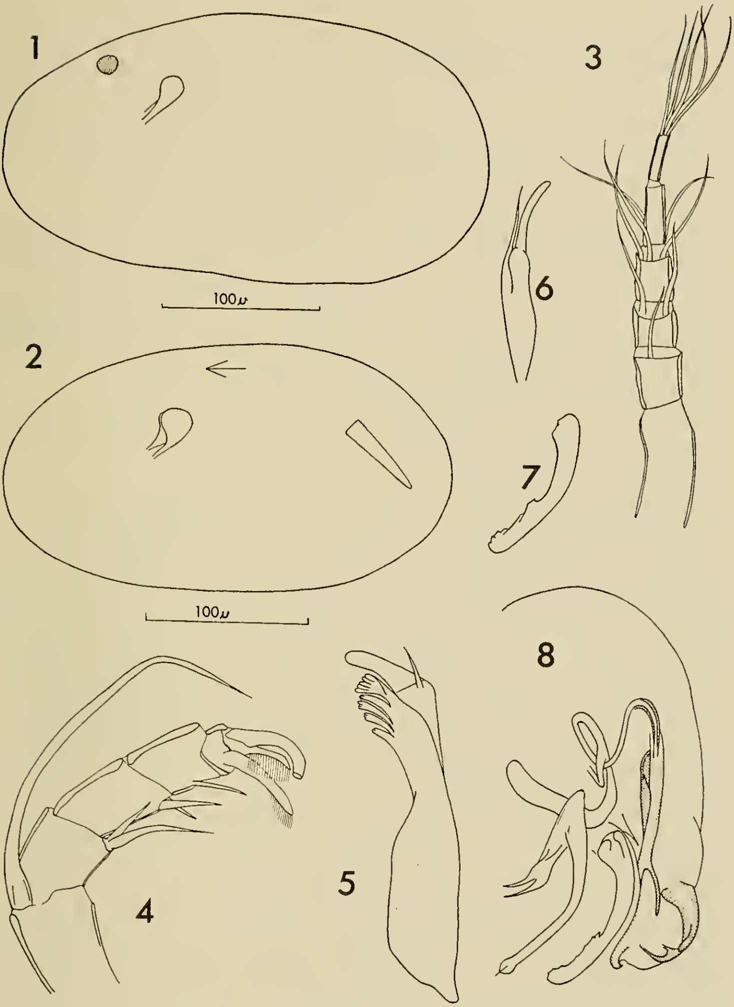
[2] As pointed out by Hart, Nair, and Hart (1967), it has been usually considered that entocytherid antennae consist of five podomeres—the ultimate one being reduced in size and situated distal to what we have considered to be the penultimate podomere. It seems likely to us that this "fifth podomere" is actually only a complex area in the distal portion of the fourth podomere where the terminal claws have their origins, and it is so considered in this description.



Figs. 1–8. Outline of shell of adult male in lateral aspect, showing antennal glands and eyespot; 2, Outline of shell of adult female, showing female genital apparatus and antennal glands. Arrow indicates anterior end; 3, Antennule; 4, Antenna; 5, Mandible; 6, Maxilla; 7, Clasping apparatus of paratype; 8, Copulatory apparatus.

Copulatory complex (Fig. 8) with ventral portion of peniferum blunt and terminating in two sclerotized tapering processes, which may or may not be apposable. Penis short, curved, ventrally directed, and situated above midlength of peniferum. Penis apparently introduced into well-defined duct leading antero-ventrally to anterior face of peniferum. Clasping apparatus (Fig. 8) falcate, bearing no teeth on external surface, four terminal denticles, and four irregular teeth on internal surface.

Variations: On some specimens terminal denticles may be more or less indistinguishable from teeth on the internal margin. The paratypic specimen shown in Figure 7 has four teeth that might be considered terminal denticles and two or possibly three that might be considered teeth on the internal margin. The most proximal of these teeth might be described as a large truncated tooth or as two distinct teeth—depending upon the whim or point of view of the describer.

Type-locality, distribution, and host: New Zealand—South Island—Pelorus Valley. Host, *Paranephrops planifrons* White. This ostracod is known only from the type-locality.

Disposition of types: Male holotype, female allotype, and a paratypic series are deposited in the Smithsonian Institution. Paratypes are deposited in the Academy of Natural Sciences of Philadelphia.

Female: Shell of triunguis female similar to that of adult male in shape, but averaging 22μ more in length. Conspicuous slender conical apparatus described in females of a new species from New Guinea (Hart and Hart, 1970). This apparatus is probably homologous with the *amiculum* of the genus *Dactylocythere* in North America (Hart, 1962).

The difference between average instar lengths of six-legged immature (biunguis) females and an adult (triunguis) female of 48μ (Table 1) appears similar to the difference of 44μ noted by Hart, Nair and Hart (1967) for *Microsyssitria indica*.

Relationships: This ostracod appears to have close affinities with the entocytherid subfamily Notocytherinae of Australia and New Guinea (Hart and Hart, 1967; Hart and Hart, 1970) as well as with the Indian subfamily Microsyssitrinae (Hart, Nair, and Hart, 1967). It is similar to the Australian and New Guinea species in having six antennular podomeres (as opposed to five in the Indian), but similar also to the Indian and New Guinea forms in having five mandibular palp teeth (as opposed to six in the Australian). We feel, however, that it should be placed in the subfamily Notocytherinae.

Although the distal portion of the peniferum is apparently bifid, we doubt that the two projections are apposable as they are in *Microsyssitria indica* and as they may be in *Chelocythere kalganensis* (Hart and Hart, 1967).

Etymology: From the Maori *aotearoa*, "the long white cloud." With reference to the descriptive Maori name for the South Island of New Zealand.

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PROCEEDINGS
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A MOLLUSCAN FAUNULE FROM 200 METERS OFF VALPARAISO, CHILE, WITH DESCRIPTIONS OF FOUR NEW SPECIES

By Harald A. Rehder
Smithsonian Institution, Washington, D.C.

During a cruise on the R/V *Anton Bruun* in early 1966, Roger F. Cressey, Jr. and Robert H. Gibbs, Jr. of the Smithsonian Institution, and Bruce B. Collette of the Bureau of Commercial Fisheries, Department of the Interior, spent some days between trips in Valparaiso, Chile. On 12 February they were given the opportunity of going out in a private fishing boat, the M/V *Ruiz*, and doing some trawling off the coast. Two hauls were made, and on one of them, made with a shrimp trawl in 200 meters depth, 17–18 kilometers NW of Valparaiso, six species of mollusks were found in the haul. Because of the interesting nature of this small collection, which included four new species, I have thought it worthwhile to publish this paper. My thanks are due to my three colleagues for taking the trouble to save and preserve the mollusks they found in this haul, and to Walter O. Cernohorsky, now of the Auckland Institute and Museum, Auckland, New Zealand, for preparing the radula slide of the new species of *Aeneator* described below and making the drawings I have used. To Dr. Harold E. Vokes of the Department of Geology, Tulane University, New Orleans, Louisiana and to Mrs. Thomas H. Marshall of Seattle, Washington, I am grateful for allowing me to examine additional lots of *Bathybembix chilensis* n. sp.

LIMOPSIDAE

Limopsis Sassi, 1827

Subgenus *Felicia* Mabille and Rochebrune, 1899

Limopsis (Felicia) ruizana new species

Fig. 1

Description: Shell rather large for genus, obliquely and broadly oval, valves rather thick, exterior sculptured with low concentric ridges along the growth lines, covered with a thin brown periostracum from which periostracal bristles originate in radially oriented rows; periostracal bristles rather stiff, not appressed, very dense at margin of shell and projecting somewhat beyond edge. Beaks centrally located, worn, hinge line, measured as the base line of the cardinal area, relatively long, about half the maximum length of the shell, ligament relatively large, in a triangular pit whose base line measures 55 percent of the hinge line. Taxodont hinge teeth rather heavy, numbering 9 posterior to beak and 11 anterior to beak, the third and fourth teeth from anterior end of tooth-row angulate; the third and fourth teeth in from both ends rather large. Interior white, ventral edge thickened, smooth, with the fringed, somewhat matted periostracum extending beyond it. Anterior adductor muscle scar small, close to anterior end of hinge-teeth, with rather strong ridge running from its ventral edge to below hinge plate just below anterior end of posterior row of teeth. An anterior protractor muscle scar is not apparent, but a scar for the posterior protractor muscle seems to be present. In addition there seems to be a small muscle scar on each valve under the beak that may be the place of insertion of elevator muscles (dried muscle fibers are present in these small scars in our specimen).

Holotype: USNM 701671; 17–18 km NW of Valparaiso, Chile, in 200 meters.

Measurements: length 33.18 mm. height 27.2 mm; width (complete shell) 13.57 mm.

Remarks: This species is closest to *Limopsis* (*Felicia*) *compressa* Dall, 1896 from the Gulf of Panama, and *L.* (*F.*) *marionensis* Smith, 1885 (see Nicol, 1966, pp. 22–25) from the Antarctic and Subantarctic. From the former it differs in the shell being more inflated, heavier, not as elongate, and with coarser, denser and darker periostracal hairs; the hinge line is proportionately longer, and the teeth are more numerous and considerably larger. From *marionensis* Smith it differs in possessing a heavier shell with a proportionately longer hinge line, with the posterior hinge teeth larger, not gradually becoming smaller posteriorly. The periostracal hairs are coarser, denser, and somewhat shorter at the edge of the shell, and not appressed.

The trivial name is based on the name of the private fishing vessel from which the specimens here described were collected.

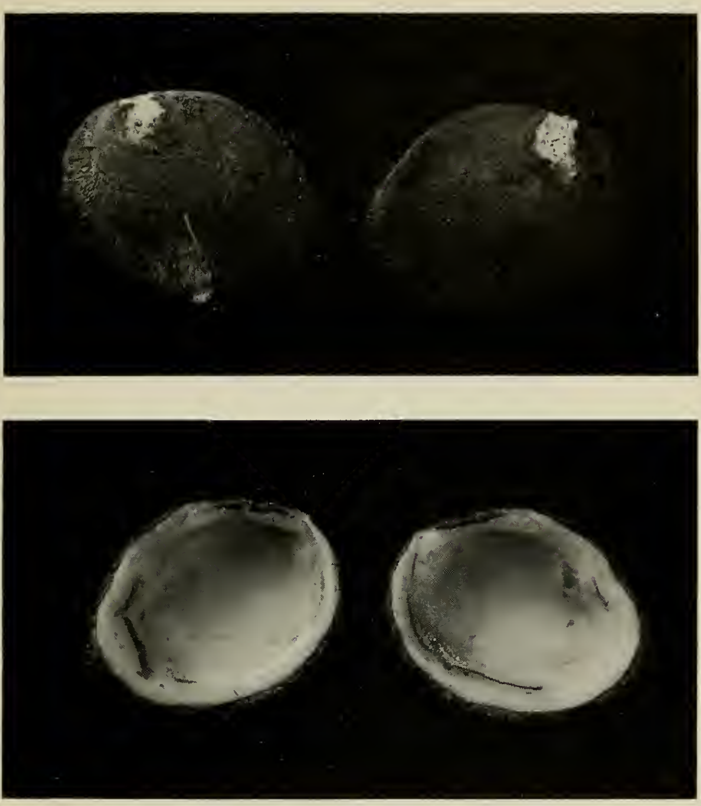

Fig. 1. *Limopsis* (*Felicia*) *ruizana*, new species, holotype, ×1.

TROCHIDAE

Bathybembix Crosse, 1893

Bathybembix humboldti new species

Fig. 4

Description: Shell large, thin, trochoid, imperforate, covered with a thin periostracum, that on the body whorl varies from moderate yellowish brown* through moderate to dark olive brown to dark grayish brown, in color, sometimes somewhat darker just below the periphery and lighter towards the base; the penultimate and antepenultimate whorls maybe somewhat lighter.

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* Color names here and subsequently from ISCC-NBS Color Names, Kelly and Judd, 1965.

Nuclear whorls missing, as is the case in all observed specimens of this genus, even in juvenile specimens. Postnuclear whorls almost six, the surface of the first 2½ rather eroded, last 3½ whorls covered with a thin periostracum; the early moderately convex whorls show axial ribs which are more prominent below the suture and at the periphery, whorls just below the suture flattened and tabulate and slightly concave between the upper series of axial nodes and those at the periphery; the ribs in this latter area subobsolete, especially in the earliest whorls; at the periphery the ribs are biangulate and vertical so that suture is markedly indented; the last 1¼ whorl becomes more concave on the upper part of the whorl, the axial ribs more pronounced, and less angulate at the periphery. The body whorl is strongly convex, with several spiral, finely subnodulose ridges on the lower part of the base. Aperture nearly circular, outer lip thin, simple, expanding in the basal columellar area, interior nacreous, with the axial sculpture showing through. Operculum circular, thin, chitinous, light horn in color, slightly concave, with about six whorls around a central nucleus.

Range: From off northern Peru (95 km S of Islas Lobos de Afuera) south to central Chile (17 km. NW of Valparaiso), in 200 to 735 meters.

Specimens examined: Holotype: USNM 701665, Paratype, USNM 701666, both from 17–18 km NW of Valparaiso, Chile, in 200 meters; four paratypes (USNM 701664) from 28 km SW of Coquimbo, Chile; four paratypes (USNM 701663) and two other paratypes (Colln. Dept. Geology, Tulane Univ.), all from 95 km S (07°49′S; 80°38′W) of Islas Lobos de Afuera, northern Peru (*Anton Bruun* Cruise 18B, sta. 754, 5 Sept. 1966).

Measurements (in mm):

		Height	Width	
Holotype	USNM 701665	53.1	44.3	—off Valparaiso, Chile
Paratype*	USNM 701666	55.4	48.1	—off Valparaiso, Chile
Paratype*	USNM 701664	54.1	46.9	—off Coquimbo, Chile

* apical whorls missing

Remarks: *Bathybembix humboldti* is the third species of the genus to be described from the eastern Pacific, and is clearly different from the other two. From *B. bairdii* Dall, 1889, which occurs in 263–685 fms from off the Columbia River to off San Diego, California, (with one lot

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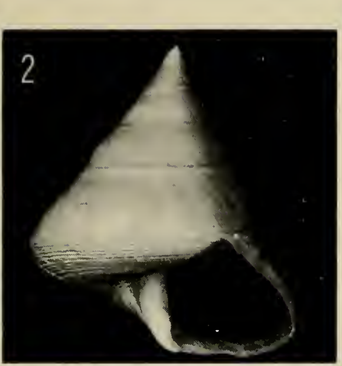
FIGS. 2–6. 2, *Calliostoma chilena* new species, holotype, ×1; 3, *Calliostoma platinum* Dall, ×1; 4, *Bathybembix humboldti* new species, holotype, ×1; 5, *Calliostoma chilena*, holotype, early whorls, ×5; 6, *Calliostoma platinum* Dall, early whorls, ×5.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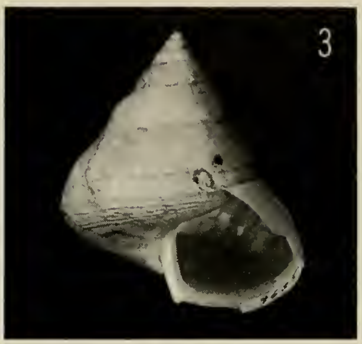
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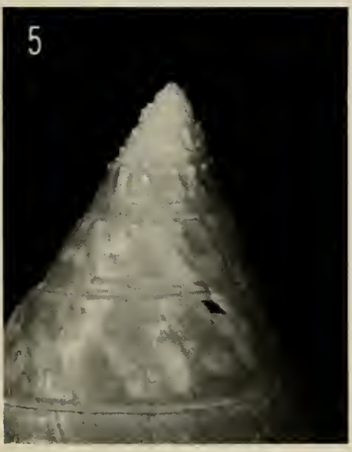
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from the Bering Sea northwest of Unimak Island, Alaska in 27 fathoms), it differs in having the whorls not as roundly convex, the periostracum darker and in having the axial sculpture more prominent, the spirally oriented sculpture much reduced, especially on the base. *Bathybembix macdonaldi* Dall, 1908, from the Gulf of Panama (546 fms.) and off Manta Ecuador (401 fms.), differs from *humboldti* in being larger and in possessing a single strong nodulose keel at the periphery, giving the whorls a distinctly angulate appearance, and in having the base sculptured with numerous low spiral ridges.

The three populations examined by me are fairly consistent in general shape, size and sculpture.

A statistical table of measurements and mean values was found impractical because of the considerable erosion of the early whorls in most of the specimens, particularly those from south of the Islas Lobos de Afuera. In color, however, these populations differ rather markedly, those from south of Islas Lobos de Afuera being darker with a more greenish cast (moderate to dark olive brown, nos. 95–96 in Kelly and Judd, 1965) than those from off Valparaiso, while the specimens from off Coquimbo are still darker but without a greenish cast (dark grayish brown, no. 62, Kelly and Judd, 1965).

Named for the famous geographer, Alexander von Humboldt, and for the ocean current in whose waters the present collection was made.

Calliostoma Swainson, 1840

Calliostoma chilena new species

Figs. 2, 5

Description: Shell about 36 mm. (1⅜ inches) in height, thin, trochoid, imperforate, close to yellowish gray in color.

Nuclear whorls 1¼, smooth, convex; postnuclear whorls 8¾, first two convex, later ones straight-sided to very slightly convex, the suture almost flush; first postnuclear whorl with three spiral cords, the lowest one the strongest, and the uppermost one, which is situated immediately below the suture, weakest; after the first ¼ whorl obscure, axial, prosocline ribs become apparent; these sculptural elements become increasingly stronger in the subsequent whorls with the ribs forming nodes at the intersections with the spiral cords; in the second postnuclear whorl these nodes are largest on the central cord, with the rib elements between the cords becoming gradually weaker, and the part of the whorl between the lowest cord and the suture more strongly concave; in the third postnuclear whorl the nodes on the central and lowermost cord diminish in strength and finally disappear; at the end of the fourth postnuclear whorl the central cord has disappeared, the lowermost cord is a slender ridge, and the uppermost cord has become obscure, connecting a series of low, somewhat elongated subsutural nodes; at the end of the fifth postnuclear whorl all spiral cords and nodes have disappeared; last postnuclear whorls gently concave at top and bottom, and slightly convex in the middle, and marked with very fine, obscure, irregular spiral striae, particularly on the lower half. Last whorl with a sharp peripheral carina, and with the base strongly sculptured with fine crowded ridges, those near the columellar area broader and flattened.

Aperture subquadrate, columella thickened, slanted 5° from the axis, outer lip rather thin. Operculum, typical, circular, corneous, thin, multispiral.

Range: Central Chile, about 17 km. NW of Valparaiso, in 200 meters.

Measurements (in mm):

		Height	Width
Holotype:	USNM 701669	36.1	31.9

Remarks: This species was at first glance identified as *Calliostoma platinum* Dall, 1889 (Figs. 3, 6), found most abundantly off Southern California but occurring as far north as the Farallon Islands, and the presence of this species in a locality 3900 miles to the south was considered most unusual. This led to a more critical examination of the shells, and differences in the sculpture of the early postnuclear whorls and in other minor characters were revealed.

The spire in *C. chilena* (Fig. 5) appears to be more slender (spire angle 65° as opposed to 70° in *platinum*), the whorls less convex, and the sculpture of the early postnuclear whorls stronger. In *C. platinum* (Fig. 6) the axial sculpture is reduced and all sculpture disappears one whorl earlier. The sculpture of the base is not as pronounced, with much of the sculpture consisting of incised lines rather than raised striae or cords.

The allocation of this species to one of the subgenera of *Calliostoma* must await an examination of the radula.

CYMATIIDAE

Fusitrition Cossmann, 1903

Fusitriton cancellatum Lamarck, 1816

Two specimens, 70.9 mm and 69.4 mm in height, (USNM 701670) were dredged at this locality, which is near the northern limit of this species. The northernmost locality known for this basically Magellanic species is recorded by J. T. Smith (1970, pp. 478–479) who cites a large number of specimens, taken by the *Anton Bruun* on Cruise 18A in 580 meters off Punta Pichicui, Chile (sta. 702: 32° 17′S, 71° 40′W); this locality is about 83 km. north of Valparaiso. The Valparaiso specimens resemble these specimens from Tictoc Bay in that they are relatively smaller than those found farther south.

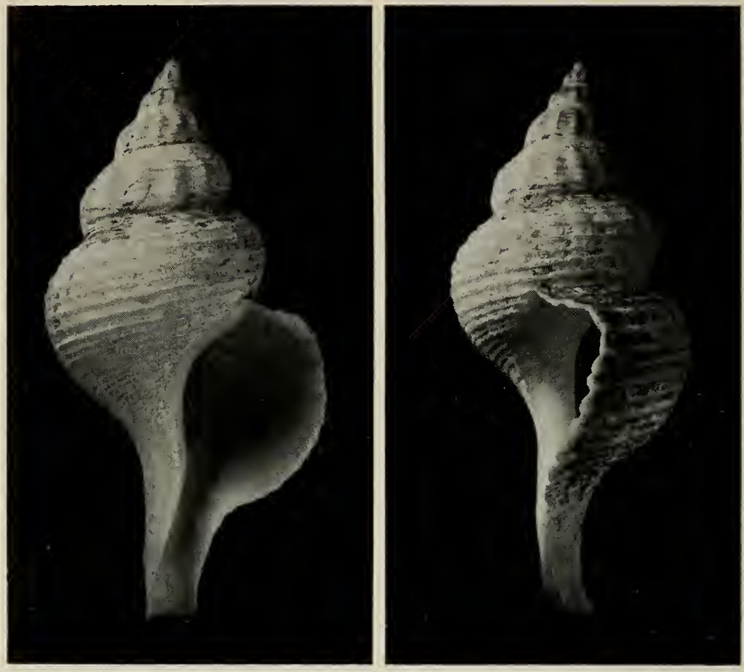

FIG. 7. *Aeneator* (*Ellicea*) *loisae*, new species, holotype, ×1.

BUCCINULIDAE

Aeneator Finlay, 1927

Subgenus *Ellicea* Finlay, 1928

The relationship of *Ellicea* to *Aeneator* has been discussed by Powell (1929: 91) and Dell (1956: 97–98, and 1963: 210). The presence of a member of this hitherto strictly Neozelanic group in Chilean waters is of great interest, and is further evidence of the close connection of the southernmost American faunas (Magellanic, Peruvian, and Argentinian) with those of the Neozelanic provinces.

Powell (l. c.) has stressed the closer resemblance of the radula of *Aeneator* to that of the *Buccinulum* than to the radula of *Penion* (as *Austrosipho*) but the figures that Dell gives for the radulae of species of *Aeneator* and *Aeneator* (*Ellicea*) (Dell, 1956: pl. B, figs. 8–10) show a quadrangular base to the rachidian, resembling more that of *Penion*. The radula of the new Chilean species (Fig. 8A) is close in appearance to that of *Penion dilatata* (Q. & G.) (Powell, l. c., Fig. 122) as well as to that of *Aeneator* (*Ellicea*) *recens* Dell (Dell l. c., pl. B, fig. 9).

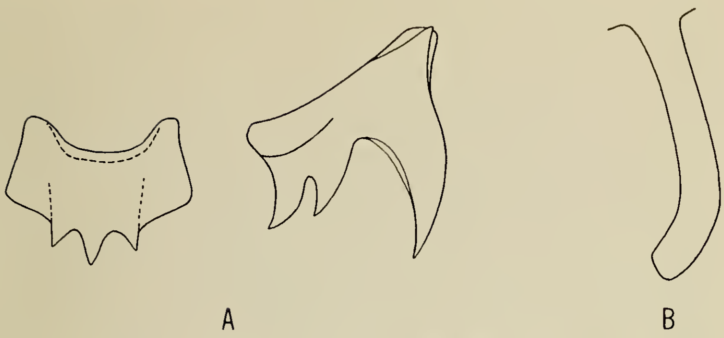

FIG. 8. *Aeneator (Ellicea) loisae* new species: A. Radula: rhachidian and lateral; B. Penis.

Aeneator (Ellicea) loisae new species

Figs. 7,8

Description: Shell moderately large for genus, somewhat elongate-fusiform, chalky yellowish white in color, covered with a thin light straw-colored periostracum. Nuclear whorls missing; remaining whorls number about six. Early whorls moderately convex, obscurely angulate at periphery (a character that disappears in the later whorls), marked by strong axial, rather distant, retractively curved ribs which are crossed by fine equidistant spiral cords; these ribs, which number 14 on the antepenultimate whorl, gradually diminish in strength until they disappear completely on the last ⅛ of the penultimate whorl; penultimate whorl rather convex, with eleven spiral cords, the first three, below the suture, finer and crowded, the others equidistant. Last whorl convex, the spiral cords below the first three finer subsutural cords may have one or two finer threads in the interspaces; below the periphery the spiral cords become somewhat more crowded. Anterior canal rather long, somewhat bent, open, parietal and columellar area with a sharply delimited, thin, shiny glaze. Aperture elongate ovate, outer lip reflexed, somewhat thickened, scalloped, with a broad sinus above the periphery, the upper edge strongly retracted, the lower and longer edge curving forward at a right angle into the broadly arcuate portion of the lower part of the outer lip.

The radula ribbon, is about 9 mm long and 0.5 mm wide, with 97 rows of mature teeth and 7 rows of immature teeth. Most of the ribbon is white with rows 73–97 brownish.

The penis in the preserved state is creamy white and about 30 mm long.

Measurements: Holotype: USNM 701667; height: 74.7 mm; width 37.3 mm, length of spire 34.4 mm.

Remarks: Because of the similarity of the radula of this species (fig. 8A) to those of *Aeneator*, *Aeneator* (*Ellicea*), and the related genus

Penion, and the close resemblance of the shell of our new Chilean species to that of *A.* (*Ellicea*) *benthicolus* Dell (1963, p. 210, pl. 1, figs. 5–6), found in 200–340 fathoms off the northeastern coast of North Island, New Zealand, I am considering this species to belong to the New Zealand group *Aeneator* (*Ellicea*). The occurrence of this genus on the other side of the South Pacific Ocean from New Zealand, an extension of range amounting to about 5,000 miles, is of great interest not because it is wholly unexpected or novel but because it adds another group to those genera and groups of species of mollusks that show similar patterns of distribution. An example of this pattern is *Argobuccinum ranelliforme* (King, 1832) from southern Chile, and *A. tumidum* (Dunker, 1862) from New Zealand.

Our species differs from its closest relative *A.* (*E.*) *benthicolus* Dell in being larger, with a relatively wider and more inflated body whorl, with more prominent axial ribs on the spire, and a slightly deeper sinus on the outer lip. From the other living species, *A.* (*E.*) *recens* Dell, 1951 (Dell, 1956, p. 101, fig. 142), it differs in possessing weaker, less angulate, axial ribs on the spire and body whorl. The earliest whorls of the specimen of *A.* (*E.*) *loisae* are missing but from the nature of the remaining early whorls the protoconch appears to have been paucispiral and somewhat elevated, differing in this respect from the protoconch of specimens of *A.* (*E.*) *benthicolus* which is low, broad, and which numbers 2½ whorls. More perfect material of the new species is needed before the possible importance of this character can be assessed.

This species is named for my wife.

VOLUTIDAE

Miomelon Dall, 1907

Miomelon philippiana (Dall, 1890)

A specimen of this relatively rare species, measuring 50.1 mm in length (USNM 701668) was found at this locality, which is almost midway between the type locality—north of Isla Mocha, Arauco Province, Chile—and the only other previously recorded locality for this species—off Coquimbo, Chile (Weaver, 1964, p. 8).

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